Investment Justification of Information Systems: A Focus on the Evaluation of MRPII

A thesis submitted for the degree of Doctor of Philosophy

by

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Abstract

A review of the normative literature, in the field of Information Technology (IT)/ Information System (IS) justification, examines how organisations evaluate their investments in Manufacturing Resource Planning (MRPII). This is achieved through investigating the issues surrounding capital budgeting, with a particular focus on investment appraisal. In doing so, a novel taxonomy of generic appraisal techniques is proposed. This taxonomy identifies a number of methods for appraising MRPII investments, and through describing these techniques, a classification is offered that identifies their respective characteristics and limitations. In doing so, it becomes clear that although many of the benefits and savings resulting from MRPII are suitable for inclusion within traditional accountancy frameworks, it is their intangible and non-financial nature, together with a range of indirect project costs that confuse the justification process. These factors, together with a range of human and organisational implications, that further complicate the decision making process are also identified. Hence, it appears through a critical review of the literature that many companies are unable to assess the implications of their MRPII investments, thus amounting to a myopic appraisal process that focuses on the analysis of those benefits and costs that are financially quantifiable.

In acknowledging the limitations of traditional appraisal techniques, a conceptual model for IT/IS investment evaluation is proposed, which is underpinned by research hypotheses. To test the validity of the proposed hypotheses, a robust novel research methodology is then developed. In doing so, an interpretivist stance is adopted, which favours the use of qualitative research methods during a multiple case enquiry. Whilst conducting the empirical research, it soon emerged that the hypotheses represented significant factors for consideration within the presented model. As a result, such constructs now establish themselves as integral parts within a structured evaluation process. However, during the empirical research, complementary evaluation criteria also emerged, which resulted in modifications being made to the previously presented conceptual model. In doing so, culminating in the development of descriptive MRPII evaluation criteria and a model, which provides investment decision makers with novel frames of reference during the evaluation of MRPII investment proposals.

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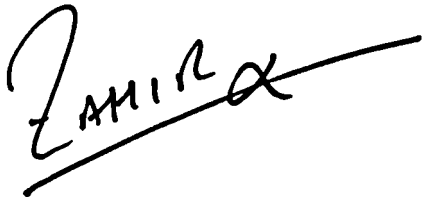
Declarations

I declare that, to the best of my knowledge, no portion of the work referred to in the thesis has been submitted in support of an application for another degree, or qualification to any other university, or institute of learning.

The thesis conforms to British Standard BS 4821: 1990, the 'British Standard Recommendations for the Presentation of Thesis and Dissertations', and follows the Harvard referencing system.



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Chapter 1

Introduction

This chapter distinguishes between Information Technology (IT) and Information Systems (IS), and describes how IT forms an integral part of a computerised IS. In differentiating the two terms, it is suggested that the broader concept of IS requires amongst others, the consideration of human and organisational factors during it's adoption. However, the consequence of this would appear to complicate the decision of whether to adopt IT/IS, with such issues appearing pertinent, as more and more organisations identify the need to embrace technological change. Clearly, the need to investigate this concern is in part reflected by the high levels of revenue being generated by the IT industry.

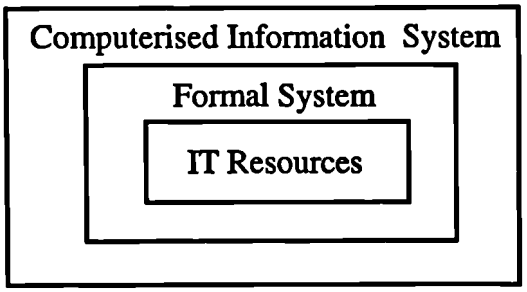
However, in justifying IT/IS expenditure, organisational approaches to investment decision making vary significantly, with each company often having their own idiosyncrasy. The reason for this is that there appears to be no 'agreed' generic framework for evaluating 'all' IT/IS projects, with no single technique accessible, or acceptable in accounting for the wide range of implications associated with deploying IT. This appears further complicated by the changing role of IT/IS, with many organisations having to re-align their IT/IS investment applications from traditional business support deployments, to ones that now take a long-term strategic view of the organisation. In addressing this, the research proposed will extend traditional views of project justification beyond their myopic short-term financial analysis, and align it more toward one that acknowledges strategic implications. In doing so, offering investment decision makers a clear insight into the varied implications of evaluating IT/IS in manufacturing. Such an enquiry needs to also investigate the impact of developing an IS infrastructure, in terms of human and organisational consequences, thus establishing their significance and consideration for integration within a robust frame of reference, for MRPII investment evaluation.

1.1 Information Technology and Information Systems

The adoption of IT is one of the most important issues facing manufacturing and service industries. Although several definitions have been offered to describe such technology, a useful definition of IT is:

> *"A generic term that describes the convergence of computers, telecommunications, electronics and resulting technologies."*
>
> Willcocks (1994 p.1)

Therefore, from this definition, it would appear that IT can be regarded as technology based resources, which include hardware, software, peripheral and communication systems. However, although the terms IT and IS are generally used interchangeably, the concept of IS is broader than that of IT. Information systems encompass a whole range of business processes that involve human interaction. Such systems refer to how information flows meet the requirements of an organisation. This flow of information may involve formal, or informal procedures, and be processed using computerised, or non-computerised systems. As a result, the concept of a computerised IS is one that has a degree of formality, and is always based around IT resources. Hence, in the context of the dissertation, IS are considered in their computerised form, and taken as a set of hardware, software, people and information exchange procedures, which are required to process data that then produces information. The conceptual form of a computerised IS is presented diagramatically in figure 1.1.



Source: Modified from Liebenau and Blackhouse (1990)

Figure 1.1: Where IT and IS Integrate Together

The implementation of a computerised IS provides a framework where employee performance can be improved, through interacting with IT. However, Liebenau and Blackhouse (1990) point out that, improving the IS does not necessarily mean improving the IT. Conversely, an improvement in IT does not always mean an improvement in the IS. However, substantial amounts of monies continue to be spent on the purchase of IT, in the anticipation that in some way the deployment of new technology will offer itself as a panacea, and help companies improve their business performance. Clearly, the development of a IS goes beyond the adoption of IT, and requires an account of those factors that complement IT, during the development of an IS infrastructure. As a result, the dissertation proposes to discuss the human and organisational factors that support the development of a IS infrastructure. In doing so, offering decision makers a frame of reference when evaluating IT/IS, thus ensuring the necessary constructs for success are in place before implementation. Therefore, offering itself as a descriptive set of criteria that provide an account of human and organisational issues that need considering, to ensure the IS achieves it's 'full' potential.

1.2 World-wide IT/IS Expenditure

The recession of the late 1980's and early 1990's forced many organisations to re-formulate their IT/IS budgets. This resulted in significant reductions in technology related expenditure. However, as investment confidence appears to be returning, large sums of money are again being spent on new and innovative technology. As a result, the competitive performance of many companies is changing. In response, others find that they too must install more computers, implement new technology, to gain, or even maintaining a competitive advantage. Surveys such as those reported by Cane (1992) demonstrate the steady growth of the IT industry, which was estimated to have had a world-wide revenue worth $840 billion in 1985 and $1,490 billion in 1990. Similarly, Computer Economics (1993[a]) reported the results of a IS expenditure survey, which states that IT/IS budgets from a cross-section of Fortune 500 companies has continued to rise, with participating companies predicting the slight but steady growth of their future IT expenditure. This would appear to have been the case, with Willcocks (1994) reporting the IT industry having generated $2,100 billion in 1995, which represents a growth of 40%, over the 1990 figure reported by Cane (1992).

Views of further optimism are shared by Heath and Swinden (1992), who predict that the whole IT industry will account for ten per cent of world economic activity by the millennium. Similarly, Price Waterhouse (1996) forecast corporates continued substantial expenditure on new technology in the UK. Manufacturing Computer Solutions (1998) reported that the UK had the second fastest IT growth rate in western Europe during 1997, at which time Spain grew by ten per cent and the UK at 9.4 per cent. To put this growth in perspective, Benchmark Research (1997) estimated the total UK IT market to be worth £10 billion. Therefore, with such expenditure predicted to grow, the IT industry is increasingly encouraging their corporate customers to regard their IT/IS investment outlay as an emerging business opportunity. In doing so, suggesting that decision makers view IT/IS less a cost, and more as a strategic investment.

Peters (1994) reports that corporate IT investment levels appear to be rising in proportion with turnover. However, according to a survey reported by the National Computing Centre (1987), IT expenditure levels vary from industry to industry. This variable expenditure is considered by McFarlan (1984) to be due to the complexity of information content in the supply chain, and because of the different strategic positioning of the various industry's. In particular, Peters (1989) reports retail expenditure on IT/IS to be as low as one per cent of turnover, whilst the same study also reports that expenditure figures in banks and other financial institutions can be as high as three per cent. Regardless of such variation, Willcocks and Lester (1994) report the average UK expenditure on IT, to be 1.5 per cent of annual turnover, although Strassmann (1990) reports increased levels. However, corporate IT expenditure levels do not reflect the 'true cost' of developing a IS, as there are significant 'indirect' human and organisational factors related to developing an IS infrastructure. As a result, organisations may be spending more money developing IS than they realise, with additional costs not necessarily generating revenue for the IT industry. In considering this, caution should be exercised when interpreted from the figures quoting revenue generated by the IT industry, or proportion of turnover allocated to an IT budget. Hence, to develop a broader understanding of these issues, the thesis proposes to identify those human and organisational factors associated with deploying IT. In doing so, providing decision makers with a more realistic 'picture' of the issues and cost surrounding IT/IS.

1.3 Manufacturing Investments in IT/IS: A Focus on MRPII

Applications of IT/IS in manufacturing are often given generic names such as: Computer Aided Design (CAD), Computer Integrated Manufacturing (CIM), Computer Aided Manufacturing (CAM), and Manufacturing Resource Planning (MRPII) etc. However, non-technical managers and much literature refers to these systems as IT/IS.

As discussed in section 1.2 the revenue generated by the IT industry is significant, with large amounts of monies being spent by UK companies on the adopting of IT/IS in manufacturing. Benchmark Research (1997) reported that UK related manufacturing expenditure rose above £3 billion in 1997, which represents a 4.6 per cent rise over the previous year's spending. Furthermore, Bowman (1997[a]) predicts that this trend in manufacturing growth is set to continue into 1998, with such manufacturing expenditure appearing firmly 'rooted' in managing the production process. Bowman (1997[b]) explains that typically around 40 per cent of manufacturing IT/IS budgets are spent on manufacturing management systems; such as MRPII, 17 per cent on CAD, seven per cent on sales, and five per cent on distribution. Manufacturing Computer Solutions (1998) explains that UK manufacturers have invested heavily in MRPII, and reports that 75 per cent of large companies have implemented MRPII. The reason for this is that such software integrates manufacturing management processes, with these systems helping businesses meet their internal and external customer requirements. Randhawa and West (1992) suggest that the momentum behind such investments is increasingly strategic, with typical benefits including, shorter time to market, flexibility to react to market changes, improved product and service quality, and the ability to exploit global trading. Regardless of such strategic significance, operational benefits such as reduced inventory holding, controlled levels of work in progress, improved stock-turns, personnel reductions, etc, still feature strongly in the justification to adopt such systems. However, the motivation 'driving' such investments may not necessarily be to increase efficiency alone but to increase efficiency and effectiveness within the supply chain. As a result, MRPII (Wight, 1984; Wight, 1993), or Enterprise Resource Planning (ERP) (Appleton, 1997) remains the natural choice. However, the magnitude of aggressively marketed manufacturing management systems presents a somewhat misleading 'picture' in the distribution of MRPII investments.

Manufacturing resource planning software has been available for over three decades. In the past, the best established platforms have been mainframe-based MRPII system. Computer Economics (1993[b]) reported that in 1988, mainframe-based MRPII software accounted for 57.2 per cent of sales, with Goddard (1985) estimating an average MRPII deployment cost of around $907,000. However, more powerful and relatively inexpensive file servers have become the platform of choice for many MRPII users. This in turn, has increased the accessibility of MRPII to many Small and Medium Enterprises[1] (SMEs). As a result, there is bewildering choice of MRPII software that can be used with relatively low specification hardware, with all systems appearing to guarantee increases in profitability, through higher productivity, reduced production costs and optimised levels of inventory. Such potential business savings and benefits have prompted many SMEs to capitalise on the substantial gains that can be achieved through adopting MRPII. Consequently, Computer Economics (1993[b]) reported substantial growth in MRPII sales, with the United States accounted for 63.5 per cent of world wide sales. Similarly, the same study estimated revenue shares for Europe and Japan/Rest-Of-World to be 31 per cent and 5.5 per cent respectively. Despite such investment in MRPII, there are few signs of market fatigue. Over the last five years, Bowman (1996[a]) reported the number of large UK process companies using some variation of manufacturing management software to have grown from 64 per cent to 73 per cent. This rise in sales represents an increase of around 1,000 large new customers, over a five year period.

Murdoch (1998) reports that UK based SME investments in IT are gaining pace, with 70 per cent of companies surveyed, saying that their total IT spend will increase in the next three years; two in five companies claim their spending will increase by 20 per cent. Furthermore, the survey suggests that SMEs perceive IT spend levels to be closely aligned to organisational success, with Bowman (1996[a]) reporting much scope for SMEs to investment in MRPII. Such investments appear partly motivated by their increased accessibility, through reduced direct costs; hardware and software, together with the portfolio of savings and benefits. However, the author suggests that further motivation encouraging SMEs to adopt MRPII could be attributable to:

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[1] Small and Medium Enterprises (SMEs) employ less than 500 employees (Storey, 1994).

- The ability of MRPII to expand the functionality of existing systems;
- The upgrade of existing systems to exploit functionality;
- The increasing need for an integrated software solution, to efficiently and effectively control manufacturing related processes (operational benefits);
- The needs to 'bridge' the misalignment between the changing 'business needs' and current systems in operation (strategic benefits); and,
- The need to achieve a competitive advantage through the implementation of innovative software systems.

As a result of such motivation to adopt MRPII, many companies are being asked to justify their capital expenditure, to ensure the appropriate allocation of competitively sought financial resources. Yet, Wirszycz (1998) reports this attitude is somewhat tempered, with a recent survey reporting that 77 per cent of SMEs are unable to measure the returns that they get from their IT investments. Clearly, the adoption of systems such as MRPII, presents many SMEs with a number of investment evaluation concerns, as this sector is traditionally under resourced, and known to lack the necessary skills to identify and analyse the implications associated with IT/IS such as MRPII. This is further complicated by their inability to identify and financially quantify the multitude of benefits and investment related costs associated with MRPII. Clearly, such factors act as investment barriers, and present decision makers within SMEs with much concern. As a result, there would appear to be a need for a simple descriptive investment decision making model, which organisation such as SMEs, who have limited resources can use as a frame of reference. Therefore, offering themselves an insight into the wider implications of MRPII; human and organisational factors, when evaluating their IT/IS deployment. Such issues appear increasingly pertinent, as the frequency of technological change and motivation to adopt MRPII increases. As a result, suitable decision making criteria would appear necessary in guiding the justification process.

Although MRPII investment trends displayed by SMEs are encouraging; Bowman (1996[a]) reports that three quarters of SMEs have implemented MRPII, with Bowman (1996[b]) also reporting that only 25% of small companies (those employing less than 200 people) have adopted MRPII. The author suggests that possible reasons for this slow adoption by small manufacturing companies may be attributed to:

- Limited managerial and technological knowledge;
- A lack of long-term strategic vision;
- Limited company resources and resistance to technology related change;
- Limited financial resources and the need to show quick financial returns;
- The multiplicity of justification and implementation paths;
- An insufficient level of support infrastructure; or,
- The inability to account for the 'full' business benefits [tangible: financial, non-financial; and/or, intangible], and costs [direct and indirect].

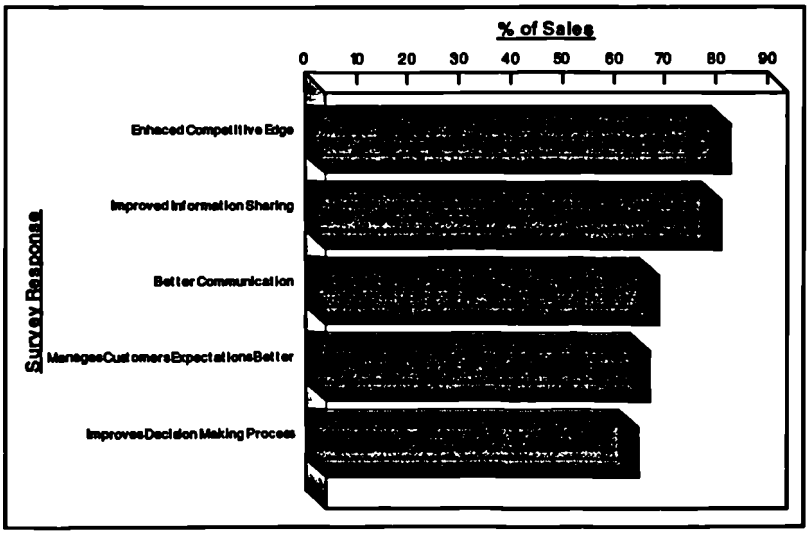
Yet, many vendors see those manufacturing companies that employ less than 200 people, as burgeoning opportunities, and forecast that their investments in IT/IS will grow faster than any other sector. Manufacturing Computer Solutions (1997) suggests the reason for this is that such companies are finding themselves unable to compete without a flexible IT/IS infrastructure. The consequences of this are reported by Lefley and Sarkis (1997), who suggest that a lack of IT/IS infrastructure can make firms vulnerable to competitive market forces. As a result, such consequences may be seen as a 'driving force' in the future adoption of MRPII, by small companies. Clearly, establishing the 'need' for an IT/IS evaluation model that can be used as a frame of reference, for the evaluation of MRPII.

1.4 Manufacturing Industry's Expectations of IT/IS

The 'Manufacturing Attitude' survey carried out by Benchmark Research (1996), revealed that UK manufacturers view IT/IS as crucial, in enabling the manufacture of competitively priced goods. The survey showed that manufacturers want their IT/IS systems to go beyond their traditional shop-floor confines, by taking a long-term strategic view of the organisation. There appears to be a desire expressed for an enterprise-wide system that brings together product development, manufacturing, supply chain management and the ability to manage a products' life-cycle. Manufacturers are reported as acknowledging the advantages of IT/IS at an operational levels, and now want IT/IS to deliver strategic changes. This is perhaps not surprising, as the survey also suggests that respondents view IT/IS as a competitive weapon, in their bid to shorten the gap between their industry leaders.

However, the changing focus of IT/IS investments has serious implications for decision makers. The reason for this is that traditional[2] appraisal techniques are unable to account for the long-term strategic benefits often delivered by IT/IS (Irani *et al.*, 1999[a]). In establishing the limitations of traditional appraisal processes, there is a need for a new approach to investment decision making. It appears that many of the benefits sought through developing an IS infrastructure are qualitative, and as a result, require context to the organisations' strategy. Therefore, this would suggest that it is necessary to align IT/IS investment decisions to a corporate strategy. In doing so, those considerations associated with strategic IT/IS investments must be integrated into the investment decision making process. Regardless of the benefit portfolio achievable through IT/IS, Farbey *et al.*, (1993) discuss that such investment decisions are often complex, and should not be simply seen as a capital budgeting formality.

The manufacturing attitudes survey also reports industry's perception of IT/IS as a key 'driver' in reducing the so-called 'death of geography'. This is the ability of IT/IS to allows Original Equipment Manufacturers (OEMs) to extend their design and manufacturing functions out to their suppliers. In doing so, allowing a supplier and assembler at different global locations, to work on the same project, at the same time. A significant advantage being the sharing of information across sites. Further survey conclusions are in figure 1.2.



Source: Benchmark Research (1996)

Figure 1.2: The Impact of IT/IS on British Manufacturing

[2] Traditional financial appraisal techniques include frameworks such as: Payback; Return on Capital Employed (ROCE) and it's variations; Net Present Value (NPV); and, Internal Rate of Return (IRR).

Respondents to the survey also recognised the value of the emerging enterprise model, as the future of manufacturing; a future in which companies develop strategic partnerships, and pool information, skills and resources, towards the achievement of a common goal. However, many of the respondent companies to the survey were reported as being unable to take advantage of this possibility, with the survey identifying 70% of companies still using non-computerised IS to disseminate information. Although, Gunasekaran and Nath (1997) report this lack of computerisation as a business improvement opportunity that is set to change.

As more manufacturing companies implement IT/IS, many are increasingly expressing their difficulty, and identifying the complexity associated with it's justification. For example, investments in MRPII offer the opportunity to reap a wide variety of benefits and savings, with the nature and size of such benefits causing much controversy. Yet, the evaluation of IT/IS is an integral part of an IT/IS life-cycle (Kumar, 1990) but remains subjective in approach. Although many of the benefits offered by IT/IS are suitable for inclusion within traditional accountancy frameworks, it is the intangible and non-financial benefits, together with the indirect project costs, which are considered to complicate the justification process. As a result, many companies are finding themselves unable to assess the 'full' portfolio of investment related benefits and costs, which are associated with developing an IS infrastructure.

Small and Chen (1995) explain that as a result of the limitations inherent in traditional investment appraisal techniques, many companies are often forced into an ad-hoc approach to the justification process. The restrictive use of traditional appraisal techniques favour the analysis of financially quantifiable benefits and costs, and ignores the wider intangible and non-financial implications of IT/IS. Also, there are implications regarding the inability of such techniques to account for the 'full' dimension of costs associated with IT/IS, together with associated human and organisational implications (Irani *et al.*, 1997[a], 1998). Therefore, questions are not only being raised regarding the 'value' of many appraisal techniques but, also there are implications associated with their limitations. Thus, potentially compromising the UK's competitive performance, as the use of these techniques may actually be seen as a barrier in the adoption of IT/IS.

1.5 Research Aim and Objectives

Farbey *et al.*, (1993) claims that there can *"never be a suitable generic framework for the evaluation of 'all' IT/IS projects because the range of circumstances where a 'single' technique would be applied, is so wide and varied, that no one method can cope"*. As a result, organisational approaches to investment justification are often unique, based on their idiosyncratic decision making processes. These may range from using structured prescriptive appraisal techniques, to the use of ad-hoc approaches that are based on 'acts of faith'. However, much of the problem lies in the very nature of deploying IT, as the use of prescriptive appraisal guidelines ignore the wider human and organisational implications of developing an IS infrastructure. However, although such factors are unique to companies, with an appropriate investigative methodology, much can be researched and extrapolated from organisational idiosyncratic decision making processes. In doing so, contributing towards identifying investment decision making criteria that can translate into a model, which others can use as a frame of reference.

As section 1.3 has already discussed, SMEs continue to spend significant amounts of monies on the adoption of MRPII, hence, the thesis proposes to identify and integrate key facets associated with SME decision making into a MRPII evaluation model. As a result, offering a wider perspective of those implications associated with evaluating the adoption of MRPII. Hence, resulting in a model that can be used by SMEs, to identify and analyse the wider implications of developing a MRPII infrastructure. Therefore, the aim of this research is to:

> *Identify the idiosyncrasies of SMEs when justifying their investments in Manufacturing Resource Planning (MRPII). In doing so, resulting in the development of a descriptive MRPII application specific frame of reference for managers, which translates into a model.*

As a result, the main objectives of this research are to:

(i) Critically review the published literature on capital budgeting, with a particular focus on investment appraisal. Then describe the characteristics and limitations of such techniques from a MRPII perspective, thus establishing the basis for the research.

(ii) Translate the research need into a conceptual model and hypotheses.

(iii) Identify human and organisational issues associated with MRPII decision making.

(iv) Generalise (within the confines of the study) the empirical results to the hypotheses. Then, extrapolate data that translates into a revised MRPII evaluation model.

(v) Offer conclusions and recommend further work.

1.6 Structure of the Dissertation

The structure of the dissertation is based on the methodology described by Phillips and Pugh (1994), and consists of the *generic* form that a doctoral dissertation should take. This structure proposes that the dissertation should consist of four elements, namely: (i) background theory; (ii) focal theory; (iii) data theory; and; (iv) novel contribution. Hence, the following sub-sections offer a summary to the structure of the dissertation, and direct the reader to the relevant chapters.

1.6.1 Background Theory

Establishing a comprehensive background theory involves assessing the field of research, and identifying the problem domain. Essentially, awareness of those factors affecting the phenomenon being researched needs to be demonstrated. Issues such as developments, limitations, controversies and breakthroughs all have to be addressed and included within the background theory. The standard that needs to be demonstrated is a clear and concise 'grasp' of the area under investigation. Therefore, suggesting a literature review of the research domain, which is presented in Chapter 2. Hence, the background theory presented in the dissertation is described as a literature review on capital budgeting, with a particular focus on investment appraisal. As part of this process, the criteria and characteristics that form strategic applications of IT/IS will be identified, This is followed by a discussion of those barriers restricting the adoption of strategic IT/IS. Then, an overview on capital budgeting is given, where a novel taxonomy of investment appraisal techniques is presented. This is followed by a discussion of the conflicting perspectives revolving around the evaluation of IT/IS. Finally, management issues and concerns associated with IT/IS evaluation are presented.

1.6.2 Focal Theory

The second element in the form of a doctoral dissertation is the focal theory. It is here that the area of research is identified and the nature of the issues under investigation described, and a process of their analysis begins. The generation of conceptual models and hypotheses, to push forward the academic discussion, are key tasks during this phase. A narrow sense of research is described, which gives a clear 'story line' to the thesis, and identifies the need to support any theoretical conjectures with data. Hence, the focal theory of the research is described as a conceptual model and research hypotheses, which are presented in Chapter 3. It is here that the need for a rigorous MRPII evaluation process is emphasised, and in particular, a discussion is presented on *how* IT/IS failure might be avoided, through rigorous evaluation. Then, a perspective on the different types of justification processes is described. This is followed by a presentation of IT/IS cost portfolios, and differing IT/IS planning and benefit levels.

1.6.3 Data Theory

The third element of a doctoral dissertation is the data theory, which essentially justifies the relevance and validity of the material that supports the thesis. The content of the data theory needs to address issues such as: (i) the conditions affecting the choice of research strategy; (ii) the most appropriate epistemological stance to adopt; and, (iii) the development of suitable research method(s). As a result, appropriate and reliable lines of enquiry are established, and data gathering research methods developed. Hence, the data theory in the dissertation is described as the research methodology, which is presented in Chapter 4. The empirical data analysis and hypotheses testing is then presented in Chapter 5. During the development of the data theory, decisions justifying the use of a multiple case study strategy are made, together with the development of qualitative research methods that favour interpretivism. Such constructs then form part of the empirical research methodology that is used to guide the research process. The constructs of the data theory essentially consists of: (i) a research design; (ii) case study data collection methods; and, (iii) a case study data analysis process. The data theory is then operationalised into a research protocol that serves as an 'action plan' for the investigator.

1.6.4 Novel Contribution

The final element of the doctoral dissertation is concerned with aligning the importance of the thesis, to the development of the discipline being researched. It is here that the contribution that the thesis makes is discussed, limitations of the research identified, and any suggestions raised for further work. Essentially, this section of the dissertation discusses why, and in what way, the background theory and the focal theory are now different, as a result of the research. Hence, the contribution that the thesis makes to the background theory is presented in Chapter 6. Chapter 7 then summarises the research findings, evaluates the data theory and presents the aspects of novelty claimed in the dissertation, before discussing proposals for further work. In Chapter 7, emphasis is placed on the way that the boundaries of investment decision making have been extended, through researching the evaluation of MRPII.

1.7 Conclusions

This chapter has described business competition as being global, intense and dynamic. In doing so, IT/IS has been identified as a key factor in responding to, and proacting with this environment. However, this has only been made possible following the changing role of many IT/IS deployments. Such investments have progressed from being traditional and operationally focused, to ones that are now crossing departmental boundaries, and taking a long-term view of the organisation. As a result, many IT/IS investments are being called upon to deliver strategic transformational changes, with the development of a competitive advantage often seen as an intrinsic part of the 'change process'.

This new focus of IT/IS, together with the increasing 'post-recession' level of IT/IS expenditure, has again identified the inadequacies of many investment decision making processes. As a result, decision makers are being called upon to approve capital expenditure, with what are largely considered inappropriate methods of investment appraisal.

Such inadequate justification processes are further complicated by the changing natures of IT/IS benefits and costs. These benefits and costs are changing from being largely financially quantifiable and achievable in the short-term, to an increasing long-term non-financial and intangible nature. Also, there is a burgeoning awareness of human and organisational issues, and the implications that such factors have on the acceptance, operation and success of an IS. As a result, there would appear to be a need to acknowledge the impact of such implications during the investment decision making process. Therefore, issues such as how organisations effectively justify IT/IS investments needs to be addressed, to ensure the appropriate allocation of competitively sought financial resources. This appears even more crucial, as growing levels of IT/IS expenditure are forecasted over the forthcoming years. In particular, SMEs are increasingly deploying IT/IS in manufacturing, with applications such as MRPII being adopted to improve organisational performance both strategically and operationally. However, the inability of SMEs to identify an analyse the 'full' implications of their investment decisions; human and organisational, are reportedly facilitated by the limitations of traditional appraisal techniques.

In responding to the concerns raised in this chapter, the proposes to address the issue of investment justification from a new perspective. One that advocates the identification of descriptive application specific (MRPII) decision making criteria. Essentially, facilitating SMEs in their wider consideration of MRPII implications, through identifying a range of human and organisational issues that need addressing during the justification of MRPII. Incidentally, MRPII offers itself as a suitable application of IT/IS in manufacturing, as it is being increasingly sought by SMEs as an integrated IS, which supports improvements in business performance. Clearly reflected in the large sums on monies being spent by SMEs on it's adoption. As a result, the identification of MRPII evaluation criteria that transforms into a model now forms the basis of the dissertation, however, it must be emphasised that the results of the thesis may also prove useful to large companies. Although, large companies are likely to have more resources to identify and analyse the wider implications of their planned IT/IS investments, they are not restricted by the same limitations as SMEs. Nevertheless, the development of a frame of reference for MRPII evaluation may also support the implementation of MRPII in large companies.

Chapter 2

Capital Budgeting: A Focus on Investment Appraisal

This chapter begins by describing how competitive advantages are being developed, maintained, or even gained by those companies that strategically invest in IT/IS. In doing so, identifying the characteristics of strategic IT/IS investments. Then, a review of the literature identifies barriers restricting organisational investments in strategic IT/IS, such as MRPII. In doing so, attributing: (i) managements motivation towards short-termism; (ii) the limited generic nature of traditional appraisal techniques; (iii) the changing portfolio of benefits and costs; and, (iv) inadequate and outdated costs accounting systems, as factors towards the slow adoption of strategic applications of IT/IS.

A descriptive analysis of capital budgeting is then presented, which is followed by a focus on the types of investment appraisal techniques available to decision makers. To this end, a novel taxonomy is proposed, which is based on the characteristics of these techniques, together with their respective limitations, when used for the purpose of MRPII appraisal. Thus, establishing that although there are many investment appraisal techniques, their use often supports a number of IT/IS investment barriers, as well as emphasising their inability to identify and capture many of the human and organisational issues associated with deploying IT/IS. As a result, emphasising the need to acknowledge the 'softer' issues associated with developing an IT/IS infrastructure, and exemplifying the inclusion of such factors within a robust investment decision making model. Then, conflicting perspectives on the suitability of traditional appraisal techniques are discussed, where on one hand traditionalists exemplify quantitative financial analysis, and yet others, advocate a more qualitative analysis. Finally, a summary of managements issues and concerns associated with investment decision making are presented, before drawing conclusions from the literature.

2.1 Introduction

Many industrial communities are undergoing the reappraisal of traditional financial analysis techniques. Much of this reconsideration is driven by the large sums of monies being spent of IT/IS, together with the changing nature of such deployments. As section 1.3 discusses, organisational investments in IT/IS are significant and continuing to grow, with management increasingly scrutinising their expenditure through 'tighter' capital budgeting. This increased motivation to evaluate IT/IS has brought to the forefront those issues associated with human and organisational factors, and the impact that such concerns have on the adoption of new technology. Consequently, this is where much of the problem lies, as such factors can not be accommodated within traditional modes of financial analysis. Also, the evolving nature of IT/IS investments is presenting much difficulty, with many IT/IS deployments changing form being operational and process driven, to ones that are increasingly strategically focused. Hence, as the nature of IT/IS investments change, so too does their benefits and costs, with much of the strategic implications associated with IT/IS unable to be accommodated within traditional appraisal frameworks. Also, there is an increased awareness of new cost dimensions associated with deploying IT/IS, with many indirect costs being intangible and non-financial, thus unsuitable for inclusion within traditional appraisal techniques.

2.2 Criteria For Strategic Applications of IT/IS

Many businesses depend on IT/IS to maintain the efficiency of their operations. In fact, Barnatt (1996) claims that many companies could no longer effectively function without their computerised IS. As a result, there is a growing awareness that IT/IS can be used to not only automate mundane tasks but be of strategic importance to a firm. Sabherwal and Tsoumpas (1993) have identified the criteria that determine whether IT/IS is strategic, with the basis of this establishing whether those companies presented in Chapter 5 have strategically deployed MRPII. There appears much consensus that strategic IT/IS addresses two criteria: Firstly, they have a direct link with the business strategy. In some cases, this link influences the business strategy through creating new strategic options (Earl, 1989). In others, it may support the business strategy by playing a role in it's implementation (Sabherwal and King, 1992).

Secondly, strategic IT/IS applications significantly affect organisational performance, either by providing the company with a competitive advantage, or by reducing the advantage held by its competitors (Wiseman, 1988). The effects of such may arise from inter-organisational systems, involving links with suppliers, customers and distributors. Examples drawn from the literature, where manufacturing investments in IT/IS have enabled companies to gain a competitive advantage, include deployments at Digital Equipment Corporation (Strassmann, 1990) and General Electric (Eardley *et al.*, 1996).

Therefore, for an application of IT/IS to be regarded as strategic, it must either influence, or directly support the business strategy, and must either provide an organisation with a competitive advantage, or counter a competitor's advantage. This can be illustrated in the case of a MRPII system, which may be deployed to support the business strategy, if product availability is considered to be a crucial business factor, or if inventory levels are major elements in the pursuit of a low cost strategy. To consider the deployment to be strategic, it must succeed in reducing cost to such an extent that it provides the organisation with a competitive advantage, or offsets a competitor's advantage (Porter, 1984). However, if the system fails to do this, it would not be regarded as a strategic IS, despite it's link with the business strategy. Similarly, if MRPII provides an organisation with a cost advantage over its competitors but, the organisation is neither already pursuing a low cost strategy, (the IT/IS application does not support the business strategy), nor does it intend to shift towards a low cost strategy, owing to the system's success (the IT/IS application does not influence the business), then the system would not be considered strategic. Hence, it would appear that although MRPII has both strategic and operational characteristics, the decision of whether MRPII is a strategic IT/IS application, largely depends on the objective/motivation for its deployment. This is important, as Chapter 5 will discuss case deployments of MRPII, and establish whether they satisfy the criteria of a strategic application of IT/IS.

In using MRPII, many companies are competing in ways that were once not feasible because of technological limitations. Clearly, MRPII has opened up new levels of process efficiency, information availability and data accuracy never before realised. Such benefits and savings are increasingly being strived towards, through integrating their achievements within the business plan(s) of an organisation.

Therefore, this may suggest that the characteristics of traditional IT/IS deployments are changing, with new infrastructures taking a wider strategic view of the organisation, by not just considering the company but also the impact the investment may have on the supply chain. As a result, the adoption of MRPII has allowed many companies to maintain, or even gain a competitive advantage. However, such investments may only provide a firm with a competitive advantage, until it's competitors can address the limitations of their own systems. Clearly, impediments faced by competitors determine the time that early implementors maintain their competitive advantage. Hence, in considering strategic applications of IT/IS, the following definition offered by Remenyi (1991), appears to be the most appropriate in the context of the dissertation:

> *"A Strategic Information System is an IT application which helps a firm improve its long-term performance by achieving its corporate strategy, and thereby directly increasing its value added contribution to the industry value chain."*

Remenyi (1991 p.18)

2.3 Characteristics of Strategic IT/IS

Strategic applications of IT/IS typically exhibit several characteristics (King and Kraemer, 1989; Clemons, 1991; Sabherwal and Tsoumpas, 1993), with the author having summarised the literature in developing figure 2.1, which presents six key attributes of a Strategic Information System (SIS).

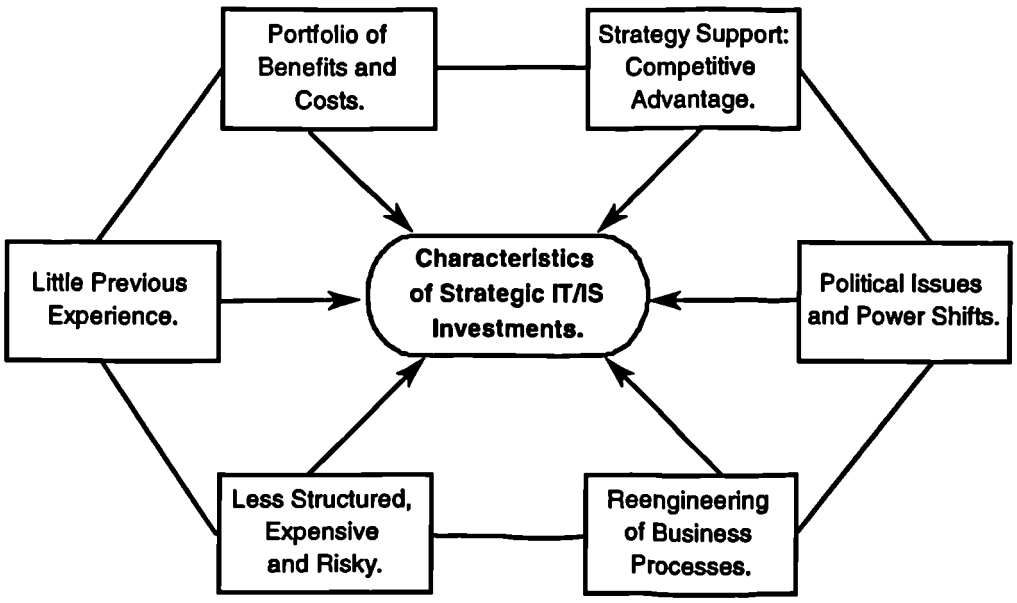


Figure 2.1: Characteristics of Strategic IT/IS Investments

Firstly, strategic IT/IS applications provide a competitive advantage, or overcome a competitor's advantage, through supporting the business strategy. Secondly, the benefits achievable through strategically deploying IT/IS are typically difficult to quantify and manage. The reason for this is that they are often intangible and/or non-financial in nature. Also, many of the benefits may not be planned for, and as a result, occur in the long-term, and as a result, such issues may be overlooked during the justification process. Similarly, the costs associated with strategic IT/IS investments are difficult to identify and quantify (Irani *et al.*, 1997[a]). Thirdly, organisations often have little previous experience of strategic IT/IS, which makes it difficult to make reliable decisions (King and Kraemer, 1989). Such projects typically have 'steep' learning curves, and in the case of MRPII, may take up to 24 months before any results are achieved (Ang *et al.*, 1995). However, early investors are able to capture assets that are not available to followers. For example, single sourcing suppliers, or moving to the best location. Fourthly, strategic IT/IS investments are often less structured, as they need to remain flexible, to allow their rapid response to changes in the market place. As a result, they are often more expensive, in terms of direct costs, as well as opportunity cost and risk (Clemons, 1991). Fifthly, the implementation of strategic IT/IS investments often results in the reengineering of business processes (Gunasekaran and Nath, 1997). The reason for this is that these deployments are more outward looking, and add 'value' within the supply chain. Such investments are considered to 'spread' the benefits of their deployment to customers and suppliers throughout industries. Finally, strategic IT/IS applications may result in greater internal power shifts, which may suggest greater political activity during the development process (Sabherwal and King, 1992). The reason for this might be that there are many intra and inter-organisational stakeholders.

Although the adoption of strategic IT/IS is considered complicated, it has the potential to deliver significant advantage (Remenyi, 1991; O'Brien, 1996; Irani *et al.*, 1999[b]). However, others too are being forced to respond, and implement new IT/IS. As a result, such investments are increasingly becoming paramount for the long-term survival of companies. This suggests that managements input should go beyond the decision of whether to adopt new technology but rather, their involvement should include *how* they should adopt and *manage* these systems. Hence, exemplifying the importance of a robust evaluation process.

2.4 Investment Barriers Restricting The Adoption of Strategic IT/IS

Although there appears to be many advantages achievable through adopting strategic applications of IT/IS, much concern (Bromwich and Bhimani, 1991; Proctor and Canada, 1992; Lefley, 1994) continues to be expressed over the inability of UK and US manufacturers to adequately invest in Advanced Manufacturing Technology[1] (AMT). Consequently, Lefley and Sarkis (1997) report that many companies are lagging behind their counterparts in Japan and Germany. Nicholson (1991) warns that technology driven innovation is vital for the growth of the UK manufacturing industry, and explains that firms need to recognise that today's competitive processes will be tomorrow's high cost operations. Interestingly enough, several reasons have been put forward (Kaplan, 1986; Farbey *et al.*, 1993; Lefley, 1994; Lefley and Sarkis, 1997) as attributes contributing towards the slow adoption of strategic IT/IS in manufacturing. These reasons are considered to include: (i) managements motivation towards short-termism; (ii) the limited generic nature of traditional appraisal techniques; (iii) the changing portfolio of benefits and costs; and, (iv) inadequate and outdated costs accounting systems. The following sub-sections will discuss these factors in detail.

2.4.1 Managements Motivation Towards Short-termism

Lefley (1994) claims that the appraisal of new technology is susceptible to short-term influences. It appears that US (Jacobs, 1991; Lefley and Sarkis, 1997) and UK (Demirag and Tylecote, 1992; Lefley, 1994) management is reluctant to make long-term[2] investments, and prefers to delight share-holders by investing in low risk short-term projects, which show high profits. This however, offers much concern, since many IT/IS investments deliver long-term strategic benefits. As a result, such implications may not be easy to identify and quantify during investment appraisal. Therefore, supporting the slow adoption of strategic IT/IS, as such investments are often made to appear un-profitable. Hence, many investment decisions are being made on the basis of those financially tangible benefits and costs associated with the investment in the short-term.

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[1] AMT is a term applied to any form of manufacturing process, which embraces a computer control system (Lefley, 1994). Therefore, AMT implicitly covers IT/IS deployments in manufacturing, such as MRPII.

[2] The authors offers a time-frame to quantify long-term; greater than 7 years, medium-term; 3-7 years, and short-term; less than 3 years.

It appears that short-termism is part of the US and UK business culture, where managers are under internal and external pressure to produce short-term financial results. Slagmulder *et al.*, (1995) offer a view on why this is the case, and explain that it may be to the financial detriment of managers to undertake long-term projects, when they are rewarded on the achievement of short-term profits. As a result, managers' self interest may be prevalent over the interest of the organisation, when short-term financial measures are used to evaluate managements performance. However, in recent years, there is some evidence (Brownstein and Panner, 1992) to support the suggestion that proactive organisations are now taking a long-term view of managements assessment, by introducing strategic factors into their performance evaluation.

Although, the 'operating core' continues to 'milk' the efficiency benefits of investing in IT/IS, many managers are now beginning to appreciate the wider long-term strategic implications of developing an IT/IS infrastructure. However, this is where much of the complexity lies, as these benefits are considered difficult to assess and financially quantify, and as a result, cannot be included within traditional modes of investment analysis. Therefore, the implications associated with any company that uses traditional appraisal techniques to justify investments of a strategic nature, is that they may have to accept short-term financial paper losses, to reap long-term strategic benefits.

2.4.2 The Limited Generic Nature of Traditional Appraisal Techniques

There appears much concern expressed in the literature over the generality of traditional investment appraisal techniques. Indeed, the premise of such methods is that they act as a generic tools, which can be used to assess the 'full' implications of 'all' types of investment proposals, however, this brief may be considered too broad. The reason for this is that human and organisational factors are increasingly associated with successful IT/IS deployments, with the inclusion of such factors within traditional modes of financial analysis proving difficult. Also, the changing nature of deployments from being operational to an increasing strategic focus, and portfolio of project benefits and costs are complicating the decision making process. As a result, these issues are amongst others, which are questioning the predictive value, and degree of generality inherent in traditional investment appraisal methods.

Farbey *et al.*, (1993) claim that the search for a single 'best' appraisal technique that addresses 'all' project considerations, is proving difficult. The reason for this is that strategic investments in IT/IS are aggregates of complexity, and notably different from each other. The circumstances where an appraisal technique would be applied, is so wide and varied, that no single method can cope.

Clearly, each investment project displays it's own unique characteristics, and offers a diverse range of benefits and costs. Conversely, each appraisal technique displays it's own range of characteristics, which distinguish them from one another (Farbey *et al.*, 1994). Furthermore, every method has it's own set of respective limitation (Irani *et al.*, 1997[a], 1999[a]). Therefore, the development of an 'all embracing' generic appraisal technique that takes account of the wide variety of IT/IS related implications, may be considered too rigid and complex for use.

2.4.3 Changing Portfolio of Benefits and Costs

Farbey *et al.*, (1993) argue that the appraisal of IT/IS, whilst using traditional techniques is inappropriate. It is suggested that although capital acquisition policies based on the use of traditional appraisal techniques have worked well for decisions concerning manufacturing capital equipment replacement, such procedures are regarded myopic for the appraisal of strategic IT/IS applications. The reason for this is that there is a considerable difference in the portfolio of savings associated with strategic IT/IS, which consist of intangible and non-financial benefits. Furthermore, this is complicated by the inability of traditional appraisal techniques to acknowledge and quantify the often significant indirect costs associated with IT/IS (Irani *et al.*, 1997[a], 1998). Hence, the inability to integrate the changing portfolio of benefits and costs into traditional appraisal techniques, is considered to be a contributing factor towards the slow adoption of strategic IT/IS (Hochstrasser 1992, Hogbin and Thomas, 1994; Irani *et al.*, 1999[a], 1999[b]). However, a variety of techniques are claimed to address these limitations, such as those presented in figure 2.3 and discussed in appendix B.

Farbey *et al.*, (1992) reports that those manufacturing companies using traditional approaches to project justification, indicate an uncertainty of how to measure the 'full' impact of their IT/IS investments. Similarly, Hochstrasser (1990) suggests that those justification processes based on standard accounting methods, simply do not work in today's sophisticated IT environment. The reason for this is as Maskell (1991) suggests, where traditional modes of investment appraisal are considered unable to capture many of the 'softer' benefits that IT/IS brings. Yet, Parker and Benson (1989) offer an alternative reason why most Chief Executive Officers (CEOs) are not comfortable with the available set of IT/IS appraisal tools and techniques. It is suggested that such methods lack the preciseness in definition, and presentation of results in the form that CEOs expect. As a result, traditional appraisal techniques are considered imperfect, and secondly, that many organisations feel uneasy, or even dissatisfied with their use, as they are unable to accommodate the changing portfolio of IT/IS benefits and costs.

2.4.4 Inadequate or Outdated Cost Accounting Systems

Inadequate, or outdated financial systems are also claimed to be inappropriate for IT/IS analysis, which is an integral part of investment appraisal. Dhavale (1989) suggests that traditional accounting processes are unable to generate the information necessary for investment justification. However, this issue is considered to have been partially addressed, with the introduction of Activity Based Costing (ABC) and improved operational control systems (Kaplan, 1984). Clearly, through generating more accurate and meaningful costing information, one of the main problems of evaluating strategic IT/IS, that of accurately quantifying certain financial benefits and costs can be partially addressed. However, the underlying nature of performance measuring frameworks is their focus on the measurement of financial business benefits, and direct project costs, and as a result, the quantification dilemma of intangible and non-financial implications remains.

Fry and Cox (1989) identify several problems associated with those manufacturing performance measurements that are built on traditional cost accounting systems, and used to justify MRPII investments. These typically include:

- The batching of orders into large quantities to eliminate set-ups, although often at the expense of higher priority orders;
- Production overruns to produce output, which result in unneeded inventories;
- The 'cherry picking' of easy orders with a lower production priority instead of following the production of orders relative to customer delivery dates etc;
- Maintaining higher inventories to insure that employees are not idle;
- Allowing marginally acceptable levels of quality to pass inspections;
- Delaying scheduled preventative maintenance to maximise plant utilisation;
- Delaying operator training to prevent under-utilising manpower; and,
- Encouraging a buffer of backorders to insure an adequate level of work exists.

This list is by no means exhaustive but does illustrate the limitations associated with those performance measurements based on standard cost accounting systems. Another, perhaps more sever problem is the way traditional performance measuring systems regard inventory, who's reduction is considered a significant benefit resulting from MRPII. In a standard cost accounting system where different departments are treated as profit centres, increases in inventory are treated like sales. This means that each department earns revenue as it produces output, regardless of whether there is any demand. Also, since variances are subtracted from, or added to profit, favourable variances increase profit, while unfavourable variances decrease profit. As a result, a company can often increase profit by simply creating inventory. Conversely, profits normally decrease as a company decreases inventory. Consequently, Fry (1992) points out the sad humour that it is possible for organisations to show a positive profit, without selling a single product to its customers. This is achieved by simply stock piling goods in stores. As a result, Maskell (1994) stresses the importance of identifying suitable performance measures, and identifies the increasing need for a new approach to performance measuring systems, thus identifying appropriate metrics during the decision making process.

2.5 Capital Budgeting: Management Decision Making

Butler *et al.*, (1993) describes capital budgeting is a process whereby organisational resources are allocated in the anticipation of future gains. As a result, the accuracy of such decisions would appear to rank as important. Therefore, it appears that management needs to understand the framework where such decisions are made, and the means that this process can be improved. Slagmulder *et al.*, (1995) describe capital budgeting within many large organisations, as being designed from the 'bottom-up', that is, companies are assumed to let investment proposals 'bubble up' from 'grass root' levels, for review by divisional management. Then, this may be followed by a more detailed analysis at a senior management level. Although in large companies, a limited amount of authority may be delegated to lower management positions, with different spending limits assigned to each hierarchical level. Anthony *et al.*, (1984) identify the following general steps as integral to capital budgeting, with the author having summarised these stages into a flowchart, which is presented in figure 2.2.

- Project innovator(s) identify a project need, which is detailed within an investment proposal.
- Divisional management reviews the proposal and submits their recommendations; along with a project outline, to senior management.
- Investment proposals are then classified and prioritised under appropriate headings; cost reductions, equipment replacement, competitive advantage, etc.
- Investment proposals from each department are then aggregated into a capital budget. This is usually prepared once a year.
- Individual projects are then appraised, and revised if necessary, based on the comments from the decision makers.
- Directors prepare a capital budget, by appraising individual projects as well as identifying the total amount of funds requested.
- Projects are then revised, deleted, or deferred, based on the budget available.
- Authorisation requests are then prepared for the successful project(s).
- Post-implementation audits are carried out once the system has been operational, to identify the level of cost and benefit realisation.

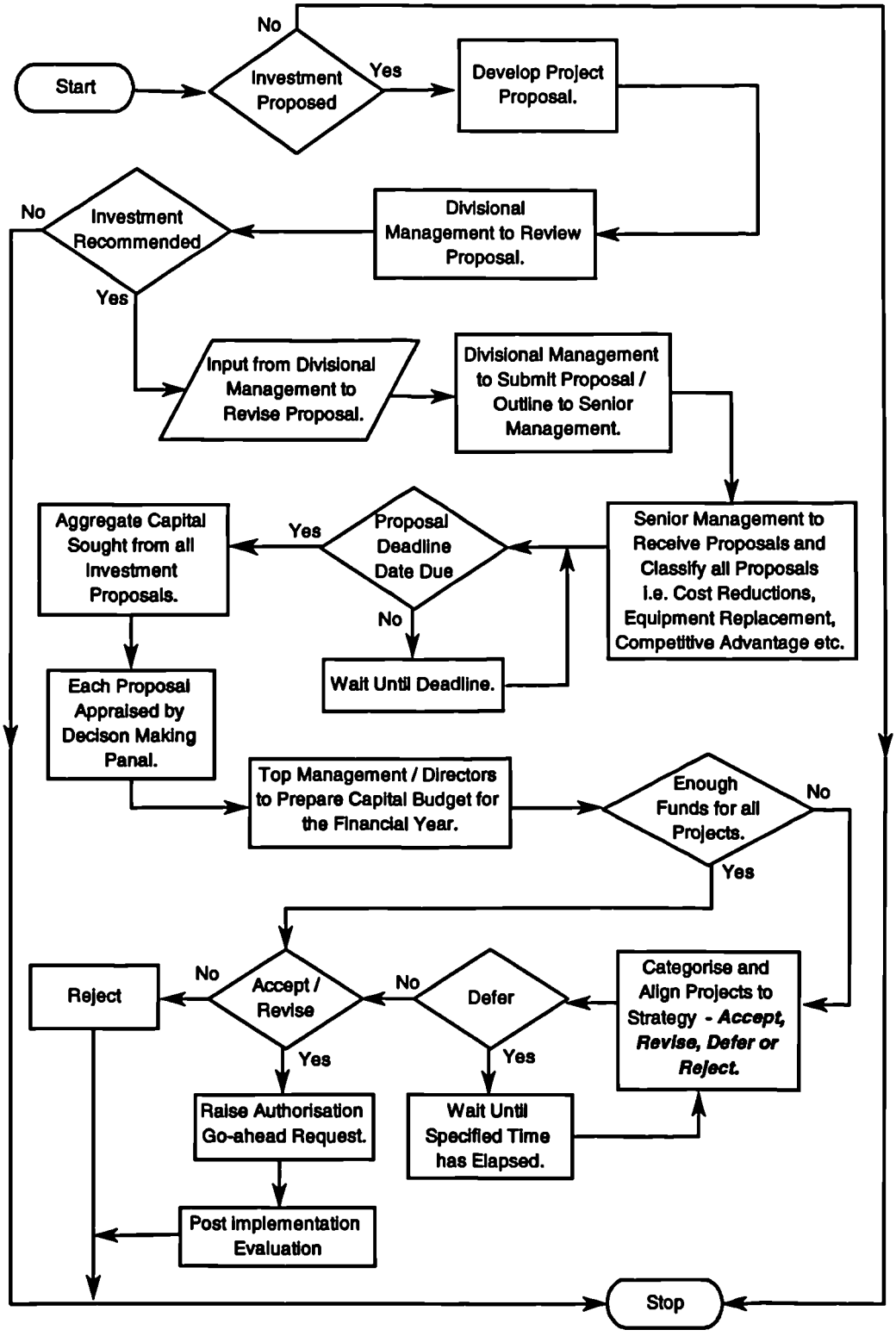

Figure 2.2: Capital Budgeting Process

2.6 Capital Budgeting: A Focus on a Novel Taxonomy of Appraisal Techniques

One of the most widely criticised activities conducted by accountants during capital budgeting, concerns their use of investment appraisal techniques. Whilst many of the problems inherent in traditional appraisal techniques have been touched upon, it is worthwhile to consider the reasons why companies appraise IT/IS investments. Farbey *et al.*, (1992) suggests that IT/IS investment appraisal serves various objectives:

- To justify investments;
- To enable organisations to decide between competing projects, especially if capital rationing is an issue;
- To act as a control mechanism over expenditure, benefits and the development and implementation of projects; and,
- To act as a learning device enabling improved appraisal and systems development to take place in the future.

Along similar lines, Ginzberg and Zmud (1988) and Angell and Smithson (1991) have identified other reasons. These include:

- To gain information for project planning;
- To ensure the system continues to perform well; and,
- To ensure decisions concerning expansion, improvement, or the postponement of projects to be taken.

All of the above reasons place investment appraisal in a positive and constructive light, and portray it as an important part of the decision making process. However before moving on to discuss capital investment appraisal techniques in more detail, the author presents a brief outline describing *how* the term 'appraisal' differentiates from its broader counterpart 'evaluation'. The term 'appraisal' and 'evaluation' are frequently used in an interchangeable way. The reason for this is that there appears to be no general agreement as to their exact meaning.

As a result, in the context of the dissertation, appraisal will be used to imply an *ex-ante* consideration of IT/IS investments, and include activities carried out at the feasibility stage of the systems' development. On the other hand, 'evaluation' is used to imply a much wider consideration of the investment, for example, when the project is being developed, implemented, or after implementation. Hence, appraisal and evaluation are intrinsically linked, and are aspects of the same decision making process.

Primrose (1991) identifies manufacturing industry's perception of investment appraisal as a budgetary process that gives a final 'yes' or 'no' - 'pass', or 'fail' verdict on the success of a projects' proposal. As a result, many managers view project appraisal as a financial 'hurdle' that has to be overcome, and not as a technique for evaluating the projects' worth. This has significant implications, as during the preparation of a projects' proposal, managers spend much time and effort investigating its technical aspects, and become committed to the belief that the project is essential. As a result, team members may be easily susceptible to persuasion by vendors and consultants, and be prepared to accept untypical demonstrations. Hence, project members may focus their efforts on trying to identify and estimate maximum financial benefits and savings, at the expense of overlooking the investments 'full' cost implications (Irani *et al.*, 1997[a], 1998).

In recent years, accountants have been criticised for refusing, being reluctant, or even being slow to adopt more sophisticated appraisal techniques/management guidelines, which claim to address many of the limitations inherent in traditional appraisal approaches. However, the array of appraisal techniques leave many organisations with the quandary of deciding which approach to use, if any. Consequently, there has been much debate about the types of appraisal techniques that constitute meaningful justification. Regardless of limitations, the use of these techniques continues, even though the criteria adopted for selecting payback periods, or discount/hurdle rates are identified as demonstrating 'short-termism', and are clearly counterproductive to those strategic IT/IS deployments that claim long-term flexibility and integration. However, it continues to be argued (Farbey *et al.*, 1993; Lefley, 1994; Lefley and Sarkis, 1997) that those accountants' analysis that favour the use of traditional investment appraisal techniques, handicap management, who advocate the adoption of strategic IT/IS.

Dugdale and Jones (1995) suggest that conventional appraisal techniques mitigate against the adoption of new technology, and that companies using these approaches may be restricting themselves in their ability to compete in world markets. Also, views have been prompted to consider qualitative factors during the justification process, where it is believed that it is the responsibility of decision makers to assess whether such benefits should outweigh the achievement of the required returns. However, Irani *et al.,* (1997[a]) claim that it is not just the benefits that need broader consideration but identify the wider cost implications of IT/IS, and suggest their inclusion during decision making. Clearly, the inability to include many benefits and costs during project justification, is seen as proof in the failure of traditional investment appraisal techniques.

Although, fallible, investment appraisal techniques are critical elements in managements control system, which is designed to channel capital investments in the desired direction. Consequently, much importance is placed on investment appraisal, with many new methods and procedures having been developed in recent years. Indeed, Renkema and Berghout (1997) have identified in no particular structure, a comprehensive list of over 65 appraisal techniques, all of which claim to contribute towards the decision making process. Regardless of such a choice, more complicated methods and prescriptive guidelines continue to be proposed. However, much literature suggests the inappropriateness and oversight of these techniques, while others (Ballantine and Stray, 1998, 1999) report their application. To allow senior managers the opportunity to realise the varying differences, characteristics and limitations that are inherent within many available appraisal techniques, a novel taxonomy has been developed by the author. Figure 2.3 presents this taxonomy in a fishbone diagram, since this tool supports the classification of techniques together with appropriate reference sources within a structured domain. The proposed taxonomy is sub-classified into (i) economic ratio appraisal; (ii) economic discounting appraisal; (iii) strategic appraisal; (iv) analytic portfolio appraisal (v) other analytic appraisal; and, (vi) integrated appraisal.

The purpose of figure 2.3 is to present a novel taxonomy of appraisal techniques, where the methods identified have been classified following an identification of their respective characteristics. This is considered useful as it allowed the author to establish the limitations of each classified techniques, when seen from a MRPII point of view.

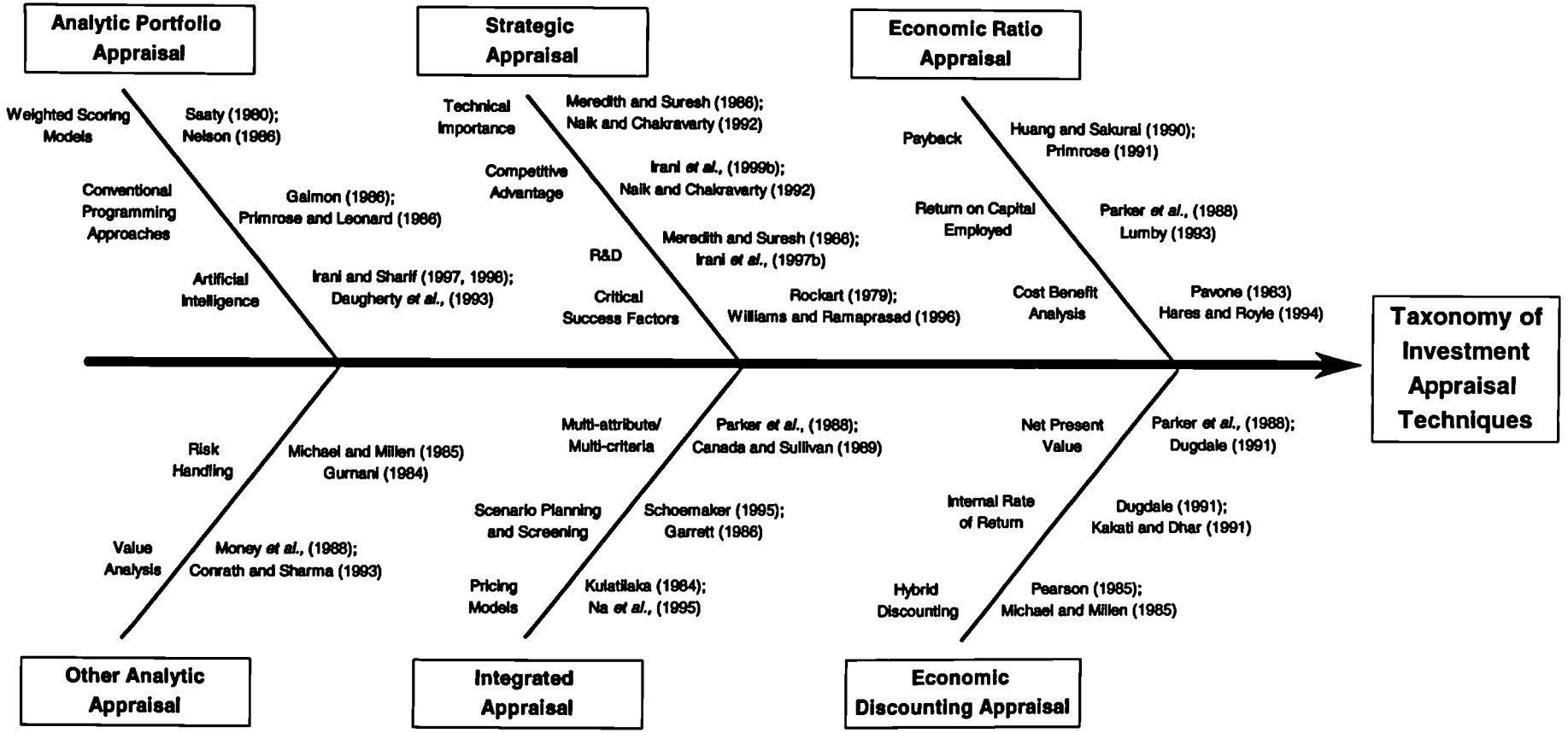

Figure 2.3: Novel Taxonomy of Investment Appraisal Techniques

2.6.1 Economic [Ratio and Discounted] Appraisal

Economic methods of investment appraisal are wholly financial in nature, and classified as either being ratio based, or discounted. Both principles are built on the incoming and outgoing of cash flows, with further similarities including their inability to acknowledge risk, non-financial and intangible benefits, together with indirect costs. Although, hybrid modifications of these approached are claimed to offer an account of such implications, albeit subjectively. Clearly, it appears that traditional economic approaches i.e. none hybrid, are only suitable for the appraisal of those projects that offer *no* uncertainty and are operational in deployment. Table 2.1, 2.2 and 2.3 present three traditional economic ratio appraisal techniques, and detail their characteristics, and limitations from a MRPII perspective. Further details of economic ratio appraisal techniques are presented in appendix B.

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Payback	Quick and simple to calculate but considered ambiguous i.e. when does the payback period start - within outlay period, or after outlay period. Identifies the less risky project in competing project proposals. Evaluates each project on the basis of it's profitability. Purely financial consideration of benefits and costs. Only those within the payback period are considered. No forecasting is made of cash flows after the projects' payback period. No account for 'time value' of money i.e. not discounted. Project risk may be acknowledged through manipulating the payback period sought.	MRPII investments are complex with infrequent cash flows (outgoing and returns) extending beyond the payback period. Payback focuses on recovering direct costs based on short-term financially tangible benefits. As a result, indirect costs and intangible / non-financial benefits are ignored. Thus, selective appraisal occurs, as the holistic implications of MRPII are not accounted for. Promotes capital rationing, thus favours those projects with short-term returns. The implications for MRPII investments are that many benefits are often medium/long-term. MRPII project may be viewed a failure, if it does not achieve the required payback period. Subjective account of MRPII project, or event risk.

Table 2.1: Economic Ratio Appraisal: The Payback Technique

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Return on Capital Employed (ROCE)	Appraisal results more meaningful for management because they are reported as a percentage. However, it is unable to compare the financial size of competing projects. Investment proposals are often evaluated against company's varying requirements on capital returns i.e. ROCE. Evaluates each project on the basis of it's profitability. Purely financial consideration of benefits and costs. Project risk acknowledged through adjusted ROCE. Ambiguous use of ROCE criteria. Difficult to analyse resource allocation, as accounting profit is the focus of analysis, and not cash flows. No account for 'time value' of money.	ROCE is based on financially tangible costs and benefits. Non-financial and intangible benefits, together with indirect costs are not accounted for during investment appraisal. Promotes capital rationing and thus favours those projects with short-term returns. The implications for MRPII investments are that many benefits are often medium/long-term. The MRPII investment may be viewed a failure, if it does not achieve the required ROCE criterion. Subjective account of MRPII project, or event risk.

Table 2.2: Economic Ratio Appraisal: The ROCE Technique

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Cost Benefit Analysis (CBA)	Purely judgmental with arbitrary values assigned to costs and benefits. There is also an artificial nature to surrogate measures allocated. Difficult to compare 'like with like', due to the range of costs and benefits. No account made on the impact of cash flows and their timings. No account for 'time value of money'. Ambiguous use of CBA criteria.	Due to the portfolio of MRPII implications (costs and benefits), it is difficult to gain a management consensus, and assign arbitrary values to benefits and costs identified. No account of MRPII project, or event risk.

Table 2.3: Economic Ratio Appraisal: The CBA Technique

Similar to the above, table 2.4, 2.5 and 2.6 present three economic discounting techniques, with their characteristics, and limitations when appraising MRPII identified. Further details of these appraisal techniques are presented in appendix B.

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Net Present Value (NPV)	Appraisal results reported as a financial investment return figure, thus allowing the comparison of independent and competing projects. Evaluates each project on the basis of it's profitability. Investment proposals are evaluated against company's desired discount/hurdle rate. Purely financial consideration of benefits and costs. No account for project, or event risk.	Focus is on recovering direct costs, based on short-term financially tangible benefits. As a result, indirect costs and intangible / non-financial benefits are ignored. Thus, selective analysis occurs, as the holistic impact of the MRPII investment is not accounted for. Promotes capital rationing and thus favours those projects with short-term returns. The implication for MRPII investments is that many benefits are often medium/long-term. MRPII investment may be viewed a failure, if no positive NPV is produced.

Table 2.4: Economic Discounting Appraisal: The NPV Technique

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Internal Rate of Return (IRR)	Appraisal results more meaningful for management, as they are reported as a percentage. With IRR, the amount invested during the life of the project, and savings produced are known. It is the rate of interest (rate of return) that is calculated. Time consuming and error prone. Purely financial consideration of benefits and costs. No account for project, or event risk.	Focus is on recovering direct costs, based on short-term financially tangible benefits. As a result, indirect costs and intangible / non-financial benefits are ignored. Thus, selective analysis occurs, as the holistic impact of the MRPII investment is not accounted for. Promotes capital rationing and thus favours those projects with short-term returns. The implication for MRPII investments is that many benefits are often medium/long-term. The MRPII investment may be viewed a failure, if it does not achieve the required rate of return (discount/hurdle rate).

Table 2.5: Economic Discounting Appraisal: The IRR Technique

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Hybrid Appraisal	Appraisal results reported as a financial figure, thus allowing the comparison of competing projects. Evaluates each project on the basis of it's profitability. Proposals are subjectively evaluated against a modified discount/hurdle rate. Modified discount/hurdle rate takes account of non-financial, intangible benefits, and indirect costs and risk.	Subjective manipulation of discount/hurdle rate to account for non-financial and intangible MRPII benefits, and costs and risk. No consensus as to a suitable modified discount/hurdle rate for MRPII. MRPII investment may be viewed a failure, if it does not produces a positive NPV, or if it does not achieve the required IRR (discount/hurdle rate).

Table 2.6: Economic Discounting Appraisal: Hybrid Approaches

2.6.2 Strategic Appraisal

Strategic appraisal is non-technical and unstructured in nature. Strategic appraisal claims to offer an account [although maybe not financially] of qualitative project attributes, such as new strategic options, customer demands/service and competitive advantage, and in doing so, offering an alignment of such factors to the business plan(s) of the organisation. Strategic appraisal acknowledges the long-term business goals of the company, and positions proposed investments to such goals. However, Marsh *et el.*, (1988) report that strategic appraisal appears to have made limited impact on the generation and approval of those investment projects with a strategic focus. Although, Ramasesh and Jayakumar (1993) claim that in the case of MRPII, strategic appraisal is reported as bringing 'better' results, when used in conjunction with economic appraisal.

Tables 2.7, 2.8, 2.9 and 2.10 identify investment strategies that may be used by companies, when wishing to adopt strategic approaches to investment appraisal. Their characteristics, and limitations from a MRPII perspective are discussed, with further explanation provided in appendix B.

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Technical Importance	Generic concept although company specific in detail. Scope of appraisal is based on planning, vision and knowledge of decision makers. Investment decision is aligned to the company's strategic plan. No account for 'time value of money'. No structured account is made of project, or event risk. Not financial but an 'act of faith'.	Although MRPII is a technical software, it may have strategic significance. Technical importance offers no generic framework for adopting MRPII. No structure regarding the management of benefits and costs, with MRPII seen as a necessity and inevitable. No acknowledgement of cash flow timings, which is significant for MRPII, as many financially tangible benefits are long-term. Open to risk and abuse as the 'full' portfolio of MRPII benefits and costs may not be identified.

Table 2.7: Strategic Appraisal: Technical Importance

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Competitive Advantage	Generic concept, although company specific in detail. Scope of appraisal is based on vision and knowledge of decision makers. Investment decision is aligned to the company's strategic plan. No account for 'time value of money'. No structured account is made of project, or event risk. Not financial but an 'act of faith'.	No structure regarding the management of benefits and costs, with MRPII seen as a necessity. No acknowledgement of cash flow timings, which is significant for MRPII, as many financially tangible benefits are long-term. Open to risk and abuse as the 'full' portfolio of MRPII benefits and costs may not be identified.

Table 2.8: Strategic Appraisal: Competitive Advantage

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Research and Development	Generic concept, although company specific in detail. Scope of appraisal is based on vision and knowledge of decision makers. Investment decision is aligned to the company's strategic plan. No account for 'time value of money'. No structured account is made of project, or event risk. Not financial but an 'act of faith'.	The nature of MRPII is not as a R&D project.

Table 2.9: Strategic Appraisal: Research and Development

Appraisal Technique	Appraisal Technique Characteristics	Limitations. An MRPII Perspective
Critical Success Factors (CSFs)	Generic concept, although company specific in detail. Scope of appraisal is based on vision and knowledge of decision makers. Strategic emphasis with information flows and resources identified. No account for 'time value of money'. No structured account is made of project, or event risk. Not financial but an 'act of faith'.	No structure regarding the management of benefits and costs with MRPII seen as a necessity and inevitable. No acknowledgement of cash flow timings, which is significant for MRPII, as many financially tangible benefits are long-term. Open to risk and abuse as the full portfolio of MRPII benefits and costs may not be identified.

Table 2.10: Strategic Appraisal: Critical Success Factors

2.6.3 Portfolio [Analytic and Other] Appraisal

Analytic approaches to investment appraisal are reported by Nagalingam and Lin (1997) as being appropriate techniques for the justification of projects that have both quantitative and qualitative benefits. The use of analytical methods allow decision makers to categorise and prioritise the benefits and savings that are identified as achievable through adopting IT/IS. This may be realised through the use of scoring models. Although, such approaches are notorious for their complexity, and considered to neglect many of the 'softer' human and organisational issues that need to be considered during investment decision making. Also, such techniques are limited in scope, as they are based on the constructs of the generic models that underpin them. Prescriptive analytical portfolio appraisal methods typically include two types of techniques, with table 2.11 and 2.12 presenting their characteristics, and limitations from a MRPII perspective. Further detail on the use of these techniques are presented in appendix B.

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Weighted Scoring Models	Scoring technique with a formal structure to a judgmental approach. Scope (benefits and costs) of appraisal is based on the vision and knowledge of decision makers. No guidelines for cash flows. No structured account of risk.	No framework is offered for the specific evaluation of MRPII. Subjective identification and assignment of arbitrary MRPII benefits and costs. Open to risk and abuse as the full portfolio of MRPII benefits and costs may not be identified.

Table 2.11: Portfolio Analytical Appraisal: Weighted Scoring Models

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Conventional and AI Programming Techniques	Many different variations with each approach based around the level of understanding and perceived complexity of the problem domain. Often based around an optimised approach involving analytical formulations to produce numerical solutions.	Constrained by benefits, costs and risks programmed in the software. Parameters subjectively established by programmer and may not include the importance placed on certain factors identified by implementing company. Different results from same set of data. Open to risk and abuse as the 'full' portfolio of MRPII benefits and costs may not be identified.

Table 2.12: Portfolio Analytical Appraisal: Programming Techniques

Other non-analytical portfolio approaches to investment appraisal simply contribute towards a better understanding of the investment proposal. These techniques are not regarded as complete appraisal technique, although, the results may be used at a later stage of the evaluation process, and included during investment justification. Table 2.13 and 2.14 present the characteristics of 'other' non-analytical portfolio techniques, together with their limitations from a MRPII perspective. Similarly, the operational details in these techniques are discussed in appendix B.

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Risk Handling	Generic in nature but judgmental and subjective. Scoring/Ranking technique with a formal structure. Sometimes based around an optimised approach involving analytical formulations to produce numerical solutions. Scope of appraisal is based on the vision of the decision makers. Many different variations with each approach based around the level of understanding and perceived complexity of the problem domain.	No framework is offered for the specific evaluation of MRPII. Complicated and subjective identification of weighting factors assigned to MRPII benefit, cost and risk measures. There is no agreement as to what constitutes MRPII risk, as each deployment is different.

Table 2.13: Portfolio Other Appraisal: Risk Handling

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Value Analysis	Generic in nature but judgmental and subjective. Scoring/Ranking technique with a formal structure. Many different variations with each approach based around the level of understanding and perceived complexity of the problem domain.	No framework is offered for the specific evaluation of MRPII. Complicated and subjective identification of weighting factors assigned to MRPII value measures. No agreement as to what constitutes MRPII value, as perceptions of each deployment are different. The investment may be viewed as not sufficiently 'value adding' if the full range of MRPII benefits are not considered.

Table 2.14: Portfolio Other Appraisal: Value Analysis

2.6.4 Integrated Appraisal

As discussed in section 2.4.3, strategic IT/IS investments have non-financial and intangible implications, together with indirect costs. Indeed, such factors cannot, or may not easily be expressed in monetary terms. This is further complicated, as it is difficult to compare fundamentally different project implications on an equal basis. This, however, would appear to be a prerequisite for the evaluation of an IT/IS investment proposal, together with the prioritisation of competing proposals.

Integrated techniques claim to offer a solution, as these approaches combine financial and non-financial techniques, and are claimed to provide a partial solution for decision makers, when sufficient information is available for multi-attribute justification. However, their complicated and subjective nature may be seen as a contributing factor towards their slow adoption. Also, such techniques are limited in scope, as they are based on the constructs of the generic models that underpin them. Table 2.15, 2.16 and 2.17 present the characteristics, and limitations from a MRPII perspective, of three integrated appraisal techniques. Further detail of the operational aspects of these methods are available in appendix B.

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Multi-attribute Utility Theory	Judgmental scoring/Ranking technique with a formal structure. Integrates strategic and operational measures and, finances into success. Possible mathematical approach, involving analytical formulations to produce numerical solutions. Complex and open to interpretation. Scope of appraisal dependent on vision of the decision makers. Many different variations with each approach based around the level of understanding, and perceived complexity of the problem domain.	No framework is offered for the specific evaluation of MRPII. Complicated and subjective as there are many issues (benefits, costs and risks) associated with MRPII. The same level of analysis can produce different results. MRPII is complex with may variables. It is therefore time consuming and demanding on resources. There is no agreement as to what constitutes MRPII risk, as each deployment is different.

Table 2.15: Integrated Appraisal: Multi-attribute Utility Theory

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Scenario Planning and Screening	Scenarios based on possible retrospective performance. Subjective interpretation of clusters/patterns through judgmental change of multiple variables. Analysis involves analytical formulations to produce numerical solutions. Complex and open to interpretation. Scope of appraisal dependent on the vision of the decision makers. Many different variations with each approach based around the level of understanding and perceived complexity of the problem domain	No framework is offered for the specific evaluation of MRPII. Company may have learnt from previous deployments. The implication being that the technique does not take this into account. Scenario may be based on past results, therefore possibly biasing the justification process. The same level of analysis can produce different results. MRPII is complex with may variables. It is therefore time consuming and demanding on resources. There is no agreement as to what constitutes MRPII risk, as each deployment is different.

Table 2.16: Integrated Appraisal: Scenario Planning and Screening

Appraisal Technique	Appraisal Technique Characteristics	Limitations: An MRPII Perspective
Pricing Models	Integrates strategic and operational measures, and finances into success. Complex and open to interpretation. Scope of appraisal dependent on the vision of the decision makers. Appraisal results reported as a financial figure, thus allowing the comparison of projects and identification of investments return. Evaluates each project on the basis of it's profitability. Modified hurdle rate to account for qualitative factors and risk. Many different variations with each approach being based around the level of understanding and perceived complexity of the problem domain.	No framework is offered for the specific evaluation of MRPII. Subjective reduction in discount/hurdle rate to account for non-financial MRPII benefits. Subjective reduction in discount/hurdle rate to account for intangible MRPII benefits. Subjective reduction in discount/hurdle rate to account for MRPII risk. Subjective reduction in discunt/hurdle rate to account for indirect MRPII costs. No consensus as to what a suitable discount/hurdle rate is for MRPII. There is no agreement as to what constitutes MRPII risk.

Table 2.17: Integrated Appraisal: Pricing Models

2.7 Conflicting Perspectives Revolving Around The Evaluation of IT/IS

Although there appears to be a range of investment appraisal techniques that can be used to justify the adoption of strategic IT/IS, the problem with using these techniques is that they appear prescriptive in nature, claim application generality, considered risky and highly subjective, and lack adequate structure to be used with sufficient confidence. Conversely, in reaction to the shortcomings of traditional appraisal techniques, it is argued that investments in IT/IS should not be justified on their sole basis to create value. Hill (1993) suggests that IT/IS investments should be evaluated on their consistency with the organisations' strategy. Yet, Kaplan (1985) explains that *"if companies, even for good strategic reasons, consistently invest in projects whose financial returns are below its cost of capital, they will inevitably begin to approach insolvency"*. Regardless of this caution, proponents of strategic appraisal claim that any purely financial approach is inevitably short-sighted, and advocate that strategic considerations should override financial arguments. In recent years, there appears to have been a growing awareness that strategy and finance are intertwined, and thus should not lead to conflict. It is considered that any form of comprehensive appraisal requires that strategic and financial considerations be reconciled and integrated. Resulting in an integrated approach to investment appraisal, such as those presented in section 2.6.4. However, the use of such approaches offer much difficulty, regardless of their claim to provide a workable solution. As a result, they should not be seen as panaceas, as their lack of widespread application may be attributed to their limitations, subjectivity and prescriptive nature.

Although, much literature would agree that financial appraisal is too restrictive, to exempt major strategic IT/IS investments from any systematic analysis may be considered just as misguiding. It would therefore appear that the problem of evaluating IT/IS investments revolve around two perspectives. The first is the traditional view of cash flow held by accountants and financial theorists. The second is the more qualitative view that justifies investments on strategic grounds, despite their failure to pass financial rates of return. However, opinions in the IT/IS literature appear to be divided, about which appraisal criterion should prevail during the evaluation of strategic IT/IS investments.

Regardless of stance, Small and Chen (1995) suggest a misalignment between the capabilities of traditional appraisal techniques, and the users' needs and expectations. As a result, it would appear from the literature that companies have a number of investment strategies available to them. These typically include:

- Refusal to undertake IT/IS projects whose benefits and costs are not easily financially quantifiable;
- Invest in IT/IS projects as an 'act of faith'; or,
- Use 'creative' accounting as a means of passing the budgetary process.

2.8 Managements Issues and Concerns Associated With IT/IS Evaluation

The inability of traditional modes of financial analysis to justify strategic IT/IS investments has led a growing number of practitioners to propose abandoning such criteria (Kaplan, 1986). The reason for this is that traditional approaches are considered to offer narrow levels of analysis, through their prescriptive focus on operational project implications. Regardless of limitations, traditional modes of financial appraisal remain in widespread use (Lefley, 1994; Lefley and Sarkis, 1997, Ballantine and Stray, 1998, 1999), especially when the purpose of the investment is to support an operational efficiency drive. In support of this, Finnie (1988) argues that DCF techniques are not inappropriate but are merely improperly used. Kaplan (1986) claims that it is the quality of analysis that fails, and not the constructs of the financial models. However, Van Blois (1983) suggests that many managers have become preoccupied with financial appraisal, insofar as practical strategic considerations have been overlooked. Inevitably resulting in many strategically important projects failing to 'pass' the financial justification stage of the evaluation process. Hence, the following summarise much of managements issues and concerns, when evaluating strategic IT/IS.

- Companies are forced to adopt a myopic approach to project justification. This is further complicated where the strategic IS is modular, and the system is purchased in stages. The implications being that the appraisal methods only consider the benefits and costs associated with the module being evaluated, and are unable to account for benefits that the 'whole' system brings.

However, the holistic implications of the system may only be realised when all modules are purchased but, when each module is analysed in isolation it may be seen to produce insufficient benefits, or misguide the actual cost implications.

- The benefits of 'organisational learning' and resulting confidence that develops from IT/IS cannot be accounted for within traditional appraisal techniques.
- Traditional appraisal techniques are restricted to the use of simple financial measures, and short-term investment goals. Also, the use of 'high' hurdle rates and/or shortened payback periods discourage the adoption of strategic IT/IS.
- There is a quantification dilemma, with many organisations expressing difficulty in assessing the 'full' range of benefits and costs; many of the achievable benefits are considered difficult to quantify because of their non-financial and intangible nature, together with the nature of their indirect costs.
- Traditional appraisal techniques are considered prescriptive in nature.
- A lack of accessible and acceptable guidelines for appraising strategic IT/IS.
- The inability to assess the true performance of a system: as it is diminished, if all benefits and costs are not assessed during the justification process. As a result, capital budgeting may restrict the adoption of IT/IS and affect competitiveness.
- Insufficient resources for the appraisal of strategic IT/IS investments, as there are 'too many inter-related' human and organisational issues.
- Questions raised regarding the generality of appraisal techniques, and whether any single method is capable of capturing the complexity of strategic IT/IS, or whether application specific approaches are preferable.

As a result of such issues and concerns, many companies are left questioning how to compare SIS investments, which deliver a wide range of non-financial and intangible benefits, with those investments whose benefits are more financially quantifiable. Simmonds (1983) suggests a shift in justification emphasis, towards a strategic based review process. Similarly, Hill (1993) explains that focus should be placed on measuring progress against it's contribution towards the corporate strategy, and not how well it meets the criteria laid down by accounting rules and regulations. Along similar lines, Hares and Royle (1994) propose that companies should identify opportunities for making investments in projects pertinent to the objectives of the business, and that investment decisions should not be made on the sole basis of monetary return alone.

Clearly, it appears that traditional justification approaches offer decision makers too narrow a focus. Such techniques are unable to contribute in whole, towards the making of important strategic decisions. Critics such as Dugdale and Jones (1995) claim that the extensive use of DCF techniques has been responsible for the decline in western capital expenditure, which in turn has caused a decline in their competitiveness. Clearly, a new approach is needed to re-address these issues and concerns.

2.9 Conclusions

This chapter of the dissertation has discussed the consequences of the changing emphasis organisations are placing on IT/IS, from it's once operational efficiency driven focus, to it's increasing strategic expectation. This new long-term view of IT/IS as a mechanism that can deliver significant competitive advantage appears to be the momentum behind many corporate investments in strategic IT/IS applications. However, there appears to be a number of barriers that are contributing towards the slow adoption of such technology. These typically include:

- Managements short-term interests;
- The limited generic nature of traditional appraisal techniques;
- Changing portfolio of benefits and costs; and
- Inadequate, or outdated cost accounting systems.

Regardless of such barriers, many of the issues associated with capital budgeting are once again on management's agenda. In this chapter, a number of investment appraisal techniques have been identified, together with a discussion of the issues associated with their application. These methods have been presented in a novel taxonomy that includes:

- Economic Ratio Appraisal
- Economic Discounting Appraisal
- Strategic Appraisal
- Analytic Portfolio Appraisal
- Other Analytic Appraisal
- Integrated Appraisal

During the review of this taxonomy, various characteristics and limitations from a MRPII perspective have been identified. Of the four classifications identified, it appears that various techniques and frameworks have been developed from different view points.

In the classification of economic appraisal, such techniques appear to be structured in nature, and include those commonly used during capital budgeting. These approaches are based on the assignment of cash values, to tangible benefits and costs but largely ignore project, or event risk, non-financial and intangible factors. However, such limitations are increasingly being addressed, with issues such as risk and the consideration of qualitative project implications being acknowledged through the manipulation of the discount/hurdle rate, or payback period. These modified approaches to traditional financial appraisal are often referred to as 'hybrid' but nevertheless, remain subjective in nature. Strategic approaches to investment appraisal appear to be less structured in nature but combine tangible and qualitative implications, with subjectivity. These techniques acknowledge the impact of the project in the long-term, by assessing the alignment of the investment initiative to the business goals of the company. However, such techniques are unable to account for project, or even risk. Analytical approaches to investment appraisal appear to be structured in nature but are considered subjective, judgmental and complicated, with the same data often producing conflicting results. The use of such techniques include the consideration of tangible and qualitative factors, with these methods often being able to acknowledge project risk. Further techniques within the analytic approach to investment appraisal, offer effective management tools for providing a wider perspective of the investments implications, through risk handling and value analysis. Finally, integrated appraisal techniques combine subjectivity with structure. These techniques integrate financial, quantitative and qualitative aspects, through the assignment of weighting factors, to the intangible and non-financial implications of the project. Here again, project risk can be partially acknowledged, albeit subjectively.

In short, writers in the accounting stream of the literature are convinced that traditional capital budgeting analysis is still valuable, and that the expected financial returns of the investment should play a key role in the decision making process.

There appears to be little controversy over this point but, the contentious issue is the degree of involvement financial appraisal should play, and the predictive value that should be drawn from such conclusions. Conversely, the lack of widespread application of many analytical and integrated appraisal techniques, which appear to partly address many of the described shortcomings, may be considered due to their complexity, subjectivity and high dependency on resources for use.

Through critically reviewing the literature, it is suggested that the commonly used economic approaches to investment appraisal overemphasise short-term financially tangible factors, and undervalue long-term intangible and non-financial issues like flexibility, which creates marketplace advantage. These techniques also appear unable to accommodate the dimensions of cost associated with IT/IS deployments. Hence, the drawbacks of traditional approaches appears to be an increasing barrier to the adoption of IT/IS in manufacturing, thus affecting the competitiveness of many organisations. Regardless of the limitations of such techniques, many companies continue to use traditional appraisal methods when justifying their investments in IT/IS, whilst others simply avoid their application. It appears that in the case of the latter, many companies are making significant capital investments as 'acts of faith', in the hope that the project was warranted, and success is achieved. However, increased IT/IS expenditure has again raised the profile of investment decision making, and in doing so, limitations of many decision making processes are again coming to the forefront of managements agenda.

The inability of organisations to assess the 'full' implications of their investments, is increasingly questioning the predictive value of those decision making processes that are totally dependent on traditional modes of financial appraisal. Furthermore, questions are being raised regarding the actual 'successes' of many IT/IS deployments, which have been based on myopic financial justification approaches. Therefore, based on the literature, a genuine need to address some of the shortcomings inherent in investment decision making processes has been established. This is exacerbated by the issues and concerns expressed by senior management.

Hence, as many IT/IS investments change from being short-term and financially quantifiable, to ones that are long-term with an increasing strategic focus, it is suggested that the limitations of conventional justification processes can be partially addressed. This is considered achievable through approaching the problem domain from a new direction. Instead of using generic appraisal techniques that claim to be robust and suitable for 'all' investment projects, the author advocates an application specific approach to IT/IS evaluation. As a result, broadening of the decision making process with human and organisational factors, when seen from an application specific viewpoint. In the case of the thesis, a MRPII perspective is adopted, with this stance described in more detail within Chapter 3.

Chapter 3

Conceptual Model and Research Hypotheses

The chapter begins with a brief review of MRPII, and in doing so, identifies the benefits that motivate the adoption of this manufacturing management system. Then, the need to evaluate the holistic implications of MRPII are discussed, which as a result, allow the efficient and effective management and operation of MRPII.

Issues surrounding investment appraisal are then discussed, form a perspective of broadening the decision making process with a consideration of human and organisational factors. In doing so, a conceptual model is presented, where issues that underpin the proposed model are discussed, thus resulting in the proposition of research hypotheses. The constructs that support the proposed conceptual model focus on expanding three principal areas of the literature. These are: (i) the need to distinguish different types of justification processes; (ii) cost portfolio: direct and indirect costs; and, (iii) benefit planning: strategic, tactical and operational. However, to test the hypotheses, and satisfy the aim of the dissertation, the theoretical conjectures are proposed from a MRPII perspective, which as a result, support the development of a descriptive MRPII evaluation[1] model. Finally, conclusions of the chapter are offered in support of the conceptual model and research hypotheses.

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1 Evaluation is a process incorporating understanding, assessment and sometimes measurement of some sort. This does not necessarily mean financial measurement. Evaluation is either a conscious, or intuitive process whereby one weighs up the value added by a particular act/situation. It can also relate to the determination of the worth of an object (Remenyi and Sherwood-Smith, 1996). In the context of the dissertation, the development of a MRPII evaluation model directly supports the evaluation process.

3.1 Introduction

Many manufacturing companies have implemented, or are considering the implementation of management systems, to support the formal planning and control of business processes. As a result, MRPII is often the natural choice. This may be the case as such systems increasingly offer an integrated approach towards helping businesses reduce inventory holdings (Duchessi *et al.*, 1989), reduce manufacturing lead-times (Vollman *et al.*, 1988), improve long-range planning (Cox and Clark, 1984), increase productivity (Duchessi *et al.*, 1989), improve production scheduling (Wight, 1984), efficiently control work-in-progress levels (Browne *et al,*. 1990), and improve the visibility of information and communication throughout the organisation (Mcallister and Carlisle, 1993). However, the implementation of MRPII can also offer many long-term strategic benefits, which result from it's capability to support improvements in production planning and control, thus leading to enhanced market responsiveness, and gains in asset and labour productivity. Therefore, MRPII may be regarded as an integrated IS, as it crosses intra-organisational boundaries, during the management of data, processing of transactions and making of decisions.

However, limited empirical research continues to be reported on the evaluation of such systems. The reason for this may be that few companies wish to publicise their difficulties and failures. Indeed, the American Production and Inventory Control Society (APICS, 1981) suggests that less than one in four MRPII implementations are successful. Regardless of such failure, large sums of monies continue to be invested in MRPII (Bowman, 1997[b]), although due to the increased availability of packaged software solutions, much emphasis is shifting from MRPII software development, towards a better understanding of it's evaluation. As a result, companies are increasingly expressing a need for suitable mechanisms to acknowledge the portfolio of implications associated with developing a MRPII infrastructure.

3.2 IT/IS Failure

Although the IS function is often regarded as a substantial organisational expense, it continues to be allocated between one and ten per cent of corporate turnover (Willcocks, 1994; Remenyi, 1996).

Despite this substantial financial commitment, many companies express their discontent with the performance of their MRPII deployments. Consequently, Remenyi (1991) claims that there are as many failed IS implementations as there are successful ones, with Booty (1998) recently reporting that upto 33% of attempts to introduce enterprise-wide IT/IS solutions end in failure. Rhodes (1991) reported that 89% of 400 companies surveyed, failed to meet their own criteria for the successful exploitation of IT; 32% admitted that they were unsuccessful. Similarly, Hochstrasser and Griffiths (1991) report that 70% of IS projects fail to deliver the benefits sought, and in many cases, provide no measurable gains at all. Despite this alarming level of failure, IT/IS expenditure and in particular MRPII, continues to rise, with no signs that such expenditure is slowing down (Bowman, 1996[a]). Inspite of investment disappointments, successful deployments can bring many advantages that include enhanced efficiency and effectiveness, as well as a competitive advantage. However, failed systems are costly, not only for hardware and software but also in human and organisational terms (Irani *et al.*, 1999[b]). As a result, Remenyi (1996) suggests that the fear of implementation failure is the primary cause of corporate views to downsize, or outsource their computing facilities.

The OTR Group (1992) presented the results of a survey that reviewed IT/IS projects implemented over the previous 10 years, in 200 organisations. It found that for projects over £660,000, 90% were over budget, 98% has changed specification, 60% were over time and 20% were inappropriate. Similarly, Willcocks (1994) reports less than impressive figures for deployments that are completed on time and under budget. Although, Willcocks and Margetts (1994) suggest that project planning estimates do tend to improve with greater IT/IS experience. This suggests that most IT/IS implementations are systemic with failure, and indeed raises questions regarding *how* SMEs are coping with their deployments, if large companies with substantially more resources, are unable to successfully deploy IT/IS. Willcocks (1994) argues that the overestimation of both time and project cost can be used as a politically astute move, and reports the adoption of a CAD/CAM system that was implemented within it's £2.1 million budget, although outside it's deadline. In this case, the project manager revealed political astuteness, and gained a reputation for effectively delivering project solutions within budget, even though it was late in delivery.

This emphasises the political tone associated with IT/IS evaluation, when establishing performance metrics, control parameters and what amounts to the criteria for success/effectiveness. Willcocks (1994) further points out, that only those successful users of IT/IS continuously measure and control their systems effectiveness, possibly a result of their experiences of being able to identify where project implications may arise, and by managing contentious human and organisational issues.

3.3 Avoiding IT/IS Failure Through Rigorous Evaluation

The general view that emerges from numerous surveys (Turnipseed *et al.*, 1992; Brynjolfsson, 1994; Ezingeard and Race, 1996) is that IT/IS investments are *not* returning the benefits expected. In spite of significant savings, Bessant (1991), suggests that IT/IS rarely lives up to it's promises, and has even lead to reductions in productivity, with evidence from the manufacturing sector seeming to suggest various degrees of dissatisfaction (Burns *et al.*, 1991; Irani *et al.*, 1999[b]). Hochstrasser (1992) argues that the high rate of IT/IS failure is partly attributed to a lack of solid but easy to use set of management tools, for evaluating, prioritising, monitoring and controlling investments. Similarly, Voss (1986) claims that most technology based investments fail, due to organisational problems, and blames economic justification as a significant factor. Therefore, for expenditure commitment to continue, it appears that senior management needs to be convinced of the business justification of such investments, before embarking on a process of IT/IS adoption. In expanding this further, Roberts and Barrar (1992) have identified 15 CSFs that are considered integral to MRPII success. High standards of project evaluation were evident in successful deployments, and their absence noted in unsuccessful ones. Value analysis is also identified as key to MRPII success, although there is much controversy over *how* project value should be measured during evaluation, as there is no agreed framework for value assessment. Proponents who advocate the development of a generic framework, such as Butler Cox (1990), suggest the inclusion of metrics that acknowledge the cost of the technology, together with the added value that the technology delivers to the business. However, Porter (1984) suggests the use of the value chain concept, in identifying value added, although, DeLone and McLean (1992) argue that IS value assessment should be treated as a 'multidimensional construct', and identify six factors in assessing IT/IS success.

As far as avoiding IS failure is concerned, Remenyi (1996) proposes a framework based on ten common IS mistakes. Hence, it appears that as IT/IS investments rise, so too does the degree of uncertainty associated with whether the investment will be a success. As a result, senior management is under increasing pressure to acknowledge the wider implications of developing an IT/IS infrastructure, thus emphasising the need to identify evaluation criteria that can be used by management to avoid IT/IS failure.

3.4 Investment Decision Making: Proposed Research Hypotheses

The efficient management and operation of business processes are considered closely aligned with the development of a comprehensive IT/IS infrastructure. Industry's innovative development of IT/IS in manufacturing is evident in it's evolution, from a limited data processing perspective, to an expanded organisational-wide scope of manufacturing computer-based activities, where information is recognised as a corporate resource, with much potential to improve strategic and operational processes. Therefore, it would appear that during the evaluation process, there is much need for suitable mechanisms that can acknowledge the 'full' implications of an IT/IS deployment. The consideration of such issues; constructs for success, clearly needs developing, as it supports investment decision making, as facilitates a rigorous evaluation process. This is crucial, as the absence of such criteria may be affecting the success of IT/IS deployments. Also, organisations are appreciating the significance of human and organisational factors, and seeking to address such issues, since their contribution is acknowledged as supporting the successful deployment of IT/IS.

In addressing the need for structured evaluation tools, many researchers have approached investment decision making from a variety of perspectives. Much of this effort has been focused on developing a 'single' generic appraisal technique, which can deal with all types of projects, in all circumstances. This has resulted in the development and use of the widely known 'traditional' appraisal techniques, which have already been discussed in Chapter 2. As a result, it would appear that more attention has been focused in recent years on prescribing *how* to carry out investment appraisal, rather than taking a holistic view of the evaluation process, and in identifying those factors that support the rigorous evaluation of IT/IS.

It is in addressing such issues, that the dissertation investigates the phenomenon on MRPII evaluation. There appears to be an increasing need to extend the boundaries of investment justification, beyond it's traditional confines that are based on the use of appraisal techniques. In doing so, considering the effects of human and organisational factors, and integrating such issues into the investment decision making process. The consideration of such issues would appear necessary, as *not* to consider these issues is regarded as a significant contributor towards the failed deployment of MRPII (White *et al.*, 1982; Metzger, 1984; Boaden and Dale, 1990; Irani *et al.*, 1999[b]). This appears even more pertinent when seen from the viewpoint of Small and Medium Enterprises, who as discussed in earlier chapters, have limited funds, and would appear to require the use of a 'simple' descriptive model of criteria. Typically SMEs have an insufficient level of internal skill to appraise SIS, and are largely unaware of the implications associated with the adoption of such technology. In explaining this, it appears that SMEs are traditionally unable to draw upon past experiences, as such companies are only now beginning to see the strategic significance of IT/IS.

Hence, any criteria that supports project evaluation, can only be seen as a positive contribution towards the decision making process. Therefore, acknowledging this, the author proposes the development of an application specific evaluation model, which goes beyond the confines of traditional financial appraisal. It is anticipated that such criteria will take the form of a table of criteria that then translates into a model. In doing so, supporting the rigorous evaluation of MRPII, and supporting the decision making process. However, it must be emphasised that the purpose of the model is not to replace investment appraisal techniques but rather, complement their usage.

The proposed model offers a novel contribution to the decision making process, by identifying a range of implications that investment decision makers may wish to consider during the justification of MRPII. Hence, based on the proposition for an application specific evaluation model, the following hypothesis is offered:

H_1: ***MRPII evaluation criteria that translates into a model will proactively support investment decision making.***

The proposition for developing an application specific evaluation model is considered to be more relevant in identifying, and addressing a wider consideration of factors associated with MRPII evaluation. Such a model will also help improve the efficiency and effectiveness of investment related decisions, by retaining focus during the evaluation process. Also, such a model will identify the constructs that facilitate the successful deployment of MRPII, through identifying largely ignored human and organisational factors. In doing so, ensuring MRPII objectives are achieved by removing investment related barriers, and thus supporting project success.

It is suggested that such a model will need to identify the holistic benefits and costs associated with MRPII, together with the 'softer' human and organisational aspects of adopting such technology. In doing so, expanding the myopia of traditional appraisal techniques, through identifying and describing non-financial management considerations. However, there are a whole host of technology management issues that need consideration during the decision making process but, the proposed hypotheses will focus and expand three principal areas that amongst other, contribute towards the more robust evaluation of MRPII. These issues are:

- The need to distinguish different types of justification processes;
- Cost portfolio: Direct and indirect costs; and,
- Benefit planning: Strategic, tactical and operational.

The increasing impetuses that the above factors contribute in the effective management of technology, are considered to be due to the changing nature of MRPII. The potential realisation of the changing portfolio of project benefits, and wider consideration costs, present many companies with the need to acknowledge these issues, within a robust evaluation model. In doing so, such factors have been incorporated into a conceptual model, and presented in figure 3.1. This model is generic, and can be used in the evaluation of 'any' IT/IS project, however, the research hypotheses that are to be presented, have been developed from a MRPII point of view. This is necessary, to allow their testing, and thus development of a MRPII application specific evaluation model [revisions to the model will follow the empirical enquiry reported in Chapter 5].

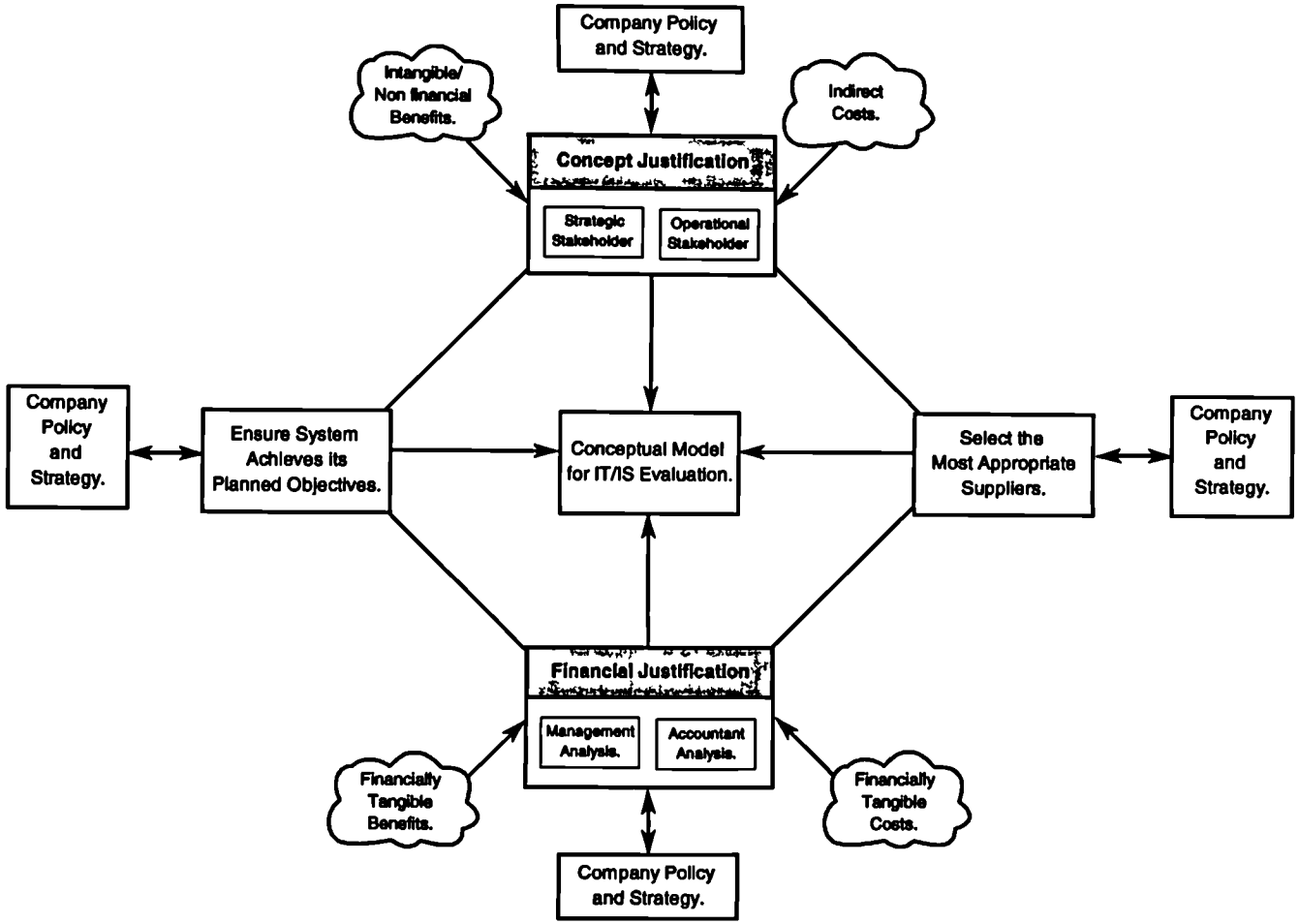


Figure 3.1: Conceptual Model for the Evaluation of IT/IS

3.4.1. Different Types of Justification and their Influencing Factors

The following sub-sections provide a provoking discussion that challenges the constructs of traditional investment decision making, by complementing financial justification with concept justification. Consequently, both approaches to investment justification appear as constructs in the conceptual model presented in figure 3.1.

3.4.1.1 Concept Justification as a Construct to a MRPII Model

When funds are requested for a particular capital project, the term justification usually implies financial justification (Boaden and Dale, 1990). The purchase of physical items of hardware and software are vital parts of any plan to implement IT/IS. It is not, however, the only part of the project that has to be justified; there is the additional aspect of concept justification. The two types of justification are different in the amount and types of information that they require, as well as the methodologies that need to be adopted. Concept justification requires a 'softer' more persuasive approach, and is one that is predominantly qualitative in nature. This type of justification is likely to be sought by those with 'executive responsibilities' for the company, and is one of aligning the projects' proposal with the medium/long-term strategic and financial business plan(s) of the organisation. The concept justification of IT/IS needs to be undertaken to demonstrate to an organisation's senior management team that the investment proposal is a worth while venture. However, to consider concept justification in it's entirety, it is proposed that such a process should go beyond it's analysis by strategic stakeholders. It is suggested that concept justification should be expanded to those operational employees whom are stakeholders in the adoption of the proposed technology. Therefore, concept justification may be regarded as one way of communicating the strategic planning process carried out at the top level of an organisation, to those further down the hierarchy. The benefits of this are self evident, with Bessant (1991) suggesting that organisational communication is the single most effective key to the successful adoption of new technology. As a result, concept justification may be seen as a proactive method of communicating the issues and implications surrounding the implementation of MRPII, to an organisations workforce. However, the ability of stakeholders to 'freely' develop and interact may only be facilitated by their identification, the organisational culture, training and education and management commitment.

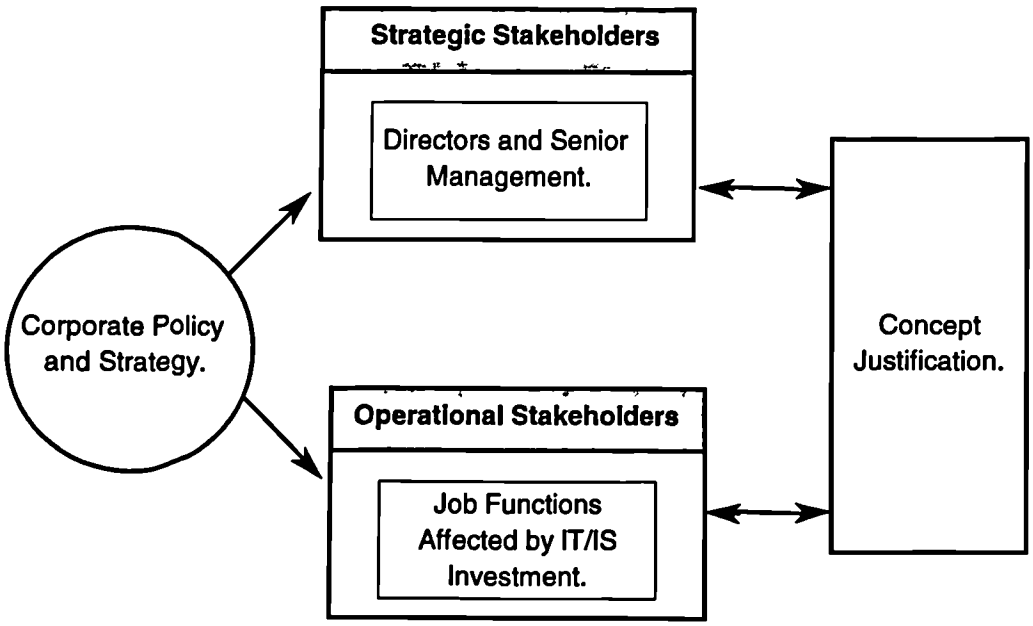


Figure 3.2: Stakeholders in the Conceptual Justification Process

Figure 3.2 identifies those stakeholders with an interest in concept justification, when considered as part of the conceptual model presented in figure 3.1. This figure suggests that directors and senior managers should typically have a strategic focus, when analysing the roles and effects of MRPII. Such stakeholders have the responsibility for developing a long-term future plan for the organisation, and need to foresee the relevance and alignment of the investment towards the success and growth of the company. Therefore, the concept justification of MRPII to it's strategic stakeholders would appear to have a strong alignment with the corporate strategy, and as a result, facilitate a critique of the competitive risks associated *with*, and with *not* investing. The process of concept justification to senior management will also allow for a wider management perspective on the benefits and costs associated with investing in MRPII. In doing so, allowing the identification and analysis of long-term project benefits, as opposed to the traditional myopic focus on short-term financially quantifiable benefits, which are generally integrated into financial appraisal processes. Incidentally, many of the long-term benefits identified may be strategic, and as a result be tangible [financial and non-financial] and/or intangible. Similarly, concept justification also acts as a suitable forum for senior management to identify project costs, which may be both direct and indirect (Hochstrasser, 1992; Irani *et al.*, 1997[a]).

There is also the identification and involvement of operational stakeholders during concept justification. Their involvement makes a positive contribution to the decision making process, through raising the importance of the investment to the organisations success and growth. Hence, concept justification to operational stakeholders can be achieved through promoting and sharing corporate, project and personal goals. Thus, raising the status of the investment proposal, and improving employee commitment through promoting shared ownership. Concept justification may also highlight the impact that the investment has on employees' job functions, and *how* their jobs might be re-designed. Political processes may also be important, as the justification of a new concept to it's stakeholders (strategic and operational) may help to ensure project acceptance and success (Irani *et al.*, 1999[b]). As a result, employee willingness to change is likely to increase following concept justification, thus having a possible affect on the projects' success. However, the process of concept justification can not be considered successful without senior management commitment, with this being facilitated by an 'open' corporate culture that promotes innovation and continuous improvement.

Boaden and Dale (1988, 1990) believe that the reality concerning new concepts is that ideas and enthusiasm will be generated at various levels throughout the organisation; with such being facilitated by MRPII having strategic, tactical and operational implications. Therefore, concept justification to those further down the hierarchy may be regarded as culturally synergetic, thus improving project acceptance. However, as the implications associated with new concepts are considered far-reaching, it may take time for these to be understood and communicated to those who have the responsibility for decision making, implementation and ownership. Hence, concept justification in it's broadest form, may be considered successful, if it gains the 'wholehearted' support of all 'key' stakeholders. However, the issue of who is a stakeholder is one that needs to be addressed at an organisational level, as the author offers no degree of prescription, although, end users form fundamental stakeholders, together with those that generate data, and those that are reliant on the information that is produced by the system. To clarify the concept of stakeholders further, the following definition is offered:

> *"A stakeholder in an organisation is any group or individual who can affect or is affected by the achievement of the organisation's objective."*
>
> Freeman (1984 p. 46)

In support of stakeholder analysis, Bessant (1991) and Burns *et al.*, (1991) reports that MRPII implementation problems are more to do with organisational and human factors, than technological issues. This is considered to be exacerbated by a lack of organisational commitment, which is often facilitated through poor communication and employee involvement/consultation. In furtherance of this, Pinto and Slevin (1987) identify communication as critical in ensuring the successful implementation of new technology. Also, it is proposed that the level of communication necessary for the successful implementation of IT/IS, should go beyond the teams responsible for project evaluation but rather, include other functions/stakeholders throughout the organisation. Similarly, Boaden and Dale (1990) report that employee commitment and involvement during the various stages of project evaluation, results in issues associated with enthusiasm and project acceptance being generated. Similarly, Russell (1987) describes the positive implications associated with employee involvement during project evaluation, although the research does stress the 'rights of management to manage,' with a survey consensus agreeing that the management process was most effective when employees were consulted and participated in decision making.

Human and organisational issues are important factors that need consideration during project evaluation (Irani and Sharp, 1997). However, these issues are commonly excluded from many investment decision making processes (Hochstrasser, 1992). This is often the case, even though the effects of implementing IT/IS in manufacturing may require significant organisational change and restructuring (Boaden and Dale, 1990; Burns *et al.*, 1991; Irani *et al.*, 1997[a], 1998, 1999[b]). In defence of their exclusion, there are widely perceived difficulties in accounting for the effects of such integration, when considering the justification of MRPII. However, this does not mean that such implications should be ignored.

Therefore, in considering those human and organisational factors that contribute towards the successful implementation of MRPII, Voss (1985) raises the following points:

- Successful implementation was found to be linked to thorough pre-planning. This supports the view that project justification (concept and financial) i.e., the identification and analysis of system costs and benefits, are a vital part of a successful deployment.
- Failure to realise the 'full' business benefits of an AMT deployment were attributed to three factors: (i) the lack of strategic view and failure to link with manufacturing policies; (ii) failure to manage the learning process involved with new technology; and, (iii) failure to manage the workforce appropriately.

Clearly, it can be seen that concept justification may lead to organisations gaining the support that they need to successfully evaluate, implement and operate MRPII. As a result, concept justification is included as a construct in the proposed model of figure 3.1. Hence, based on the discussion presented in this sub-section, the following hypothesis is offered:

> **H_2:** *There is a relationship between the concept justification of MRPII to operational stakeholders, and their increased level of commitment.*

3.4.1.2 Financial Justification as a Construct to a MRPII Model

Financial justification may also be considered integral to MRPII evaluation but requires a somewhat different analysis from that of concept justification. As discussed in Chapter 2, financial justification is essentially based on conventional accountancy frameworks, which are specifically designed to assess the 'bottom-line' short-term financial impact of an investment. Therefore, at the genesis of financial justification lie traditional appraisal procedures, which essentially involve the setting of project costs against quantifiable savings and benefits. As a result, during the financial justification of MRPII, the primary concern is with the individual pieces of technology that need to be bought, linked and integrated together. Typical links include amongst others, those between remote 'off-line' part-programming and Computer Numerically Controlled Machinery (CNC). In this instance, financial justification is essentially quantitative in nature, and is generally sought by those with financial responsibilities, such as general management and accountants. However, it could be argued that if the MRPII project is accepted following successful concept justification, it does not need financially justifying.

Although, it is more likely that senior management will want to understand the financial implications of the investment. Financial justification involves the presentation of a monetary case, and may include an identification of the integration links that are required to successfully [financially] adopt the proposed technology. As a result, this process may seem to be a formality, if preceded by successful concept justification. However, in reality, financial justification requires a great deal of work, and can be very time-consuming and demanding on resources. Thus, it could be argued that combining financial and concept justification can lead to a much more thorough analysis of MRPII project implications. Figure 3.3 presents those stakeholders during the financial justification process.

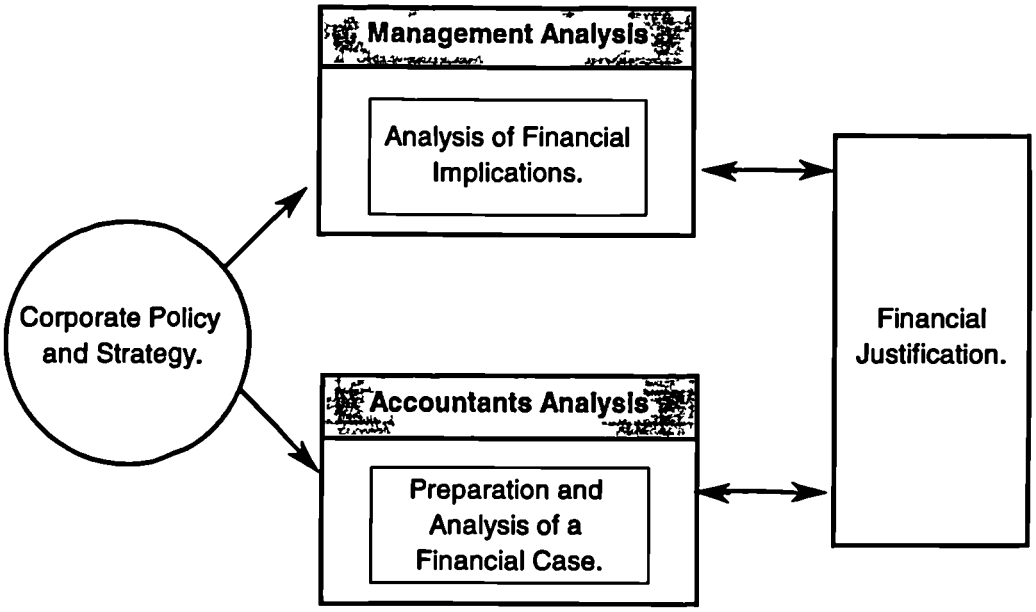


Figure 3.3: Stakeholders in the Financial Justification Process

In presenting figure 3.3, there are management stakeholders who have an interest in ensuring that the investment falls within the financial domain of the organisation, thus determining whether the company is able to offer/secure suitable finances for the project. In certain strategic instances, specific projects may have been planned, with financial requirements having been integrated into capital budgets, therefore supporting the company's long-term corporate strategy. In doing so, resulting in the planning of cash flow fluctuations.

As a result, it is the contribution that management stakeholders make during financial justification that is particularly important, as it supports the long-term success and growth of the company. Other stakeholders as part of this justification process include those with financial responsibilities. In this case, the accountants' analysis is responsible for preparing the investments monetary case, with cash flow fluctuations and risk consequences being reflected in the 'financial' business plan and/or investment proposal.

3.4.2 Cost Portfolio: Direct and Indirect Costs

Now that a differentiation of justification approaches has been established, there is a need to identify those cost factors that can be integrating into financial justification, and those that need to be considering during the broader concept justification of MRPII. Price Waterhouse (1991) suggests an interesting reason *why* a rigorous cost analysis process is essential for proactive management. It is argued that in a recessionary climate, a concern for cost savings and quick returns might be sought, through applying MRPII for the purpose of cost cutting. However, this could pressurise proponents of the project into neglecting a rigorous cost analysis, in way for the perceived need to adopt MRPII for the purpose of reducing organisational costs. Ironically, without a rigorous costing process, MRPII may actually add substantial cost to the organisation before any savings are made, or that the total cost of the project may even exceed the expected benefits sought. Hence, there appears to be a need for a rigorous cost analysis process, and for a framework of cost factors to be established as part of a robust evaluation process.

This need for a holistic analysis of cost implications is exemplified by Farbey *et al.*, (1993), who report the detrimental consequences of project champions; project leaders who are totally committed towards the success of an investment, and who often ignore the 'full' cost implications of their investments. This is further complicated by including optimistic estimates of benefits and savings within the projects' proposal. The failure of a project leader to identify the 'full' cost implications of investments such as MRPII, which typically have high running costs, can seriously limit the success of the project. Indeed, there are significant indirect costs [human and organisation] that need acknowledging during concept justification, to account for the 'full' implications of a MRPII deployment (Primrose, 1990; Hochstrasser, 1992; Irani *et al.*, 1997[a], 1998).

Furthermore, neglecting the holistic costs associated with MRPII, when combined with over optimistic estimates of benefits and savings, may result in several years of extra use, to achieve expected financial returns. As a result, rendering the use of outdated technology to recover earlier investments, and thus having a possible affect on organisational competitiveness. Clearly, the acknowledgement of as many project cost implications as possible, will help present a much more realistic 'picture' of the projects' viability, and increase it's manageability. However, there might be political and/or organisational reasons for underestimating the cost implications of MRPII. These may include the need to gain support for, and acceptance of the project from senior managers, which may then result in securing the projects' budget. Regardless of management motivation to avoid a rigorous cost analysis, there remains many cost factors associated with MRPII, and IT/IS in general, together with different cost natures. These costs and their respective natures are identified in figure 3.4.

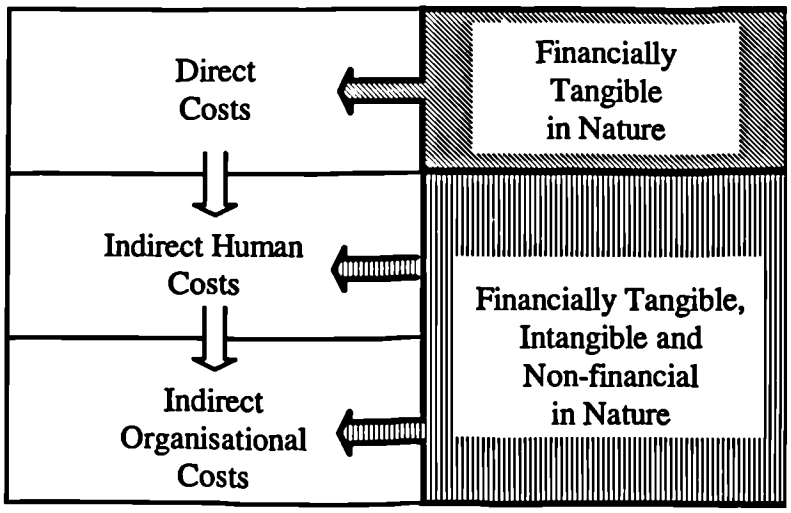


Figure 3.4 IT/IS Costs and Nature

Hence, based on the above presentation of cost portfolios: direct and indirect costs, the following hypothesis is offered:

> **H_3:** *A rigorous MRPII evaluation model needs to identify direct, and indirect human and organisational costs.*

This hypothesis proposes that the costs associated with MRPII can and should be classified as direct, and indirect: human and organisational costs.

3.4.2.1 Cost Portfolio: Direct Costs

The holistic cost implications of an IT/IS deployment can quite often be divided into direct and indirect cost factors (Hochstrasser, 1992, Irani *et al.*, 1997[a], 1998). Direct costs are those factors that can be attributed to the implementation and operation of IT/IS, although, these costs may go beyond the initial user specification of the system. Regardless of managements often detailed analysis of direct project costs, such factors are likely to be underestimated, even though senior management focus much attention on those direct costs considered 'easy' to identify, which ironically, often dictate the projects' budget (Hogbin and Thomas, 1994). Direct costs are often underestimated and go beyond the obvious hardware, software and installation costs associated with an IT/IS infrastructure.

Direct costs may include unexpected additional hardware accessories, such as increases in processing power, memory and storage devices. Installation and configuration costs are also classified as direct costs, and typically include consultancy support, installation engineers and networking hardware/software. Figure 3.5 provides a summary of those direct costs associated with IT/IS such MRPII.

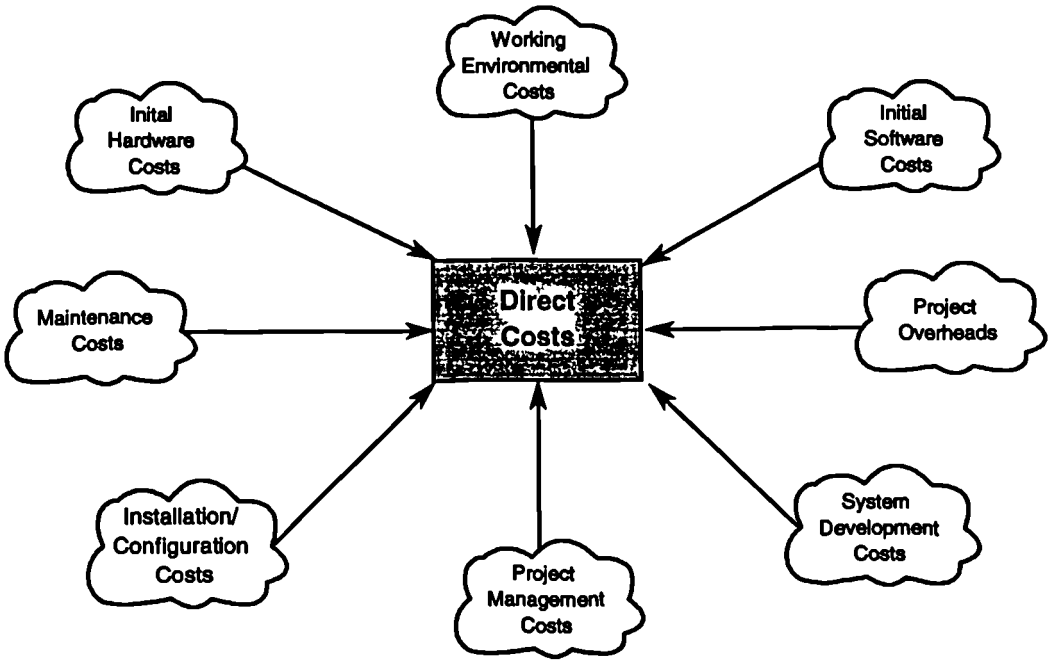


Figure 3.5 Cost Portfolio: Direct Costs

3.4.2.2 Cost Portfolio: Indirect Human Costs

As direct costs such as hardware and equipment continue to fall in price, Wheatley (1997) suggests that IS-related human and organisational costs are set to rise. Strassmann (1992) concluded that at the US Department of Defence, for every $1 spent on IT equipment, a further $7 needed to be spent on human related issues. Alarmingly, Hochstrasser (1992) suggests that human and organisational costs can be as much as three to four times as high as direct project costs. Perhaps not surprisingly, indirect costs are rarely 'fully' budgeted within investment proposals, and as a result, may partially explain the phenomenon of 'cost-creep'. This is considered to occurs over the course of 'most' IS projects (Hogbin and Thomas, 1994).

One of the largest obvious indirect human cost is that of management time. This is the time that is specifically spent on integrating new systems into current work practices. Furthermore, as a result of newly adopted technologies, management may also spend much time revising, approving and subsequently amending manufacturing and IT/IS related strategies. A significant amount of resource will also be used to investigate the potential of the new technology, and in experimenting with new information flows and modified reporting structures. For example, an investment in MRPII affects the whole organisation, with the new system impacting on employees' job functions, and organisational departments. As a result, everybody will need time to absorb the new work practices at both an operational and management level.

Wheatley (1997) suggests that a further indirect human cost that is often overlooked, is that of system support. It is claimed that this indirect human cost factor is the largest part of many IT/IS related expenses. Indeed, many firms are now finding it quicker and more efficient to employ their own technicians to provide this service. This appears to be the preferred option, over the reliance on software vendors, who initially try to solve the problems remotely, and when unable to, then make personal visits that add to the cost of the system. Clearly, system support costs are substantial, with Wheatley (1997) reporting the results of a recent survey that found a third of respondent companies could not estimate the cost of supporting IT/IS, in relation to the technologies original purchase price.

The vast majority of those companies that did venture an estimate, thought the cost to be a small fraction of the original cost of acquisition. However, a quarter of companies thought that IT/IS support costs to be less than 20% of their original purchase price, with only 4% prepared to concede that such costs might exceed the original purchase price. In fact, according to the survey, typical lifetime support costs are at least 400% of the original purchase price, which draws on estimates from industry analysts. Although, it does appear that vendors are starting to perceive the cost of ownership as the new 'competitive frontier', which can offer vendors a sales advantage over others.

Further indirect cost may be a result of employees developing new skills, and therefore, increasing their flexibility/overall contribution. Also, there might be further costs associated with employees' pay and rewards, together with the cost implications of increases in staff turnover; advertising, induction, etc. Figure 3.6 provides a summary of indirect human costs associated with the adoption of MRPII.

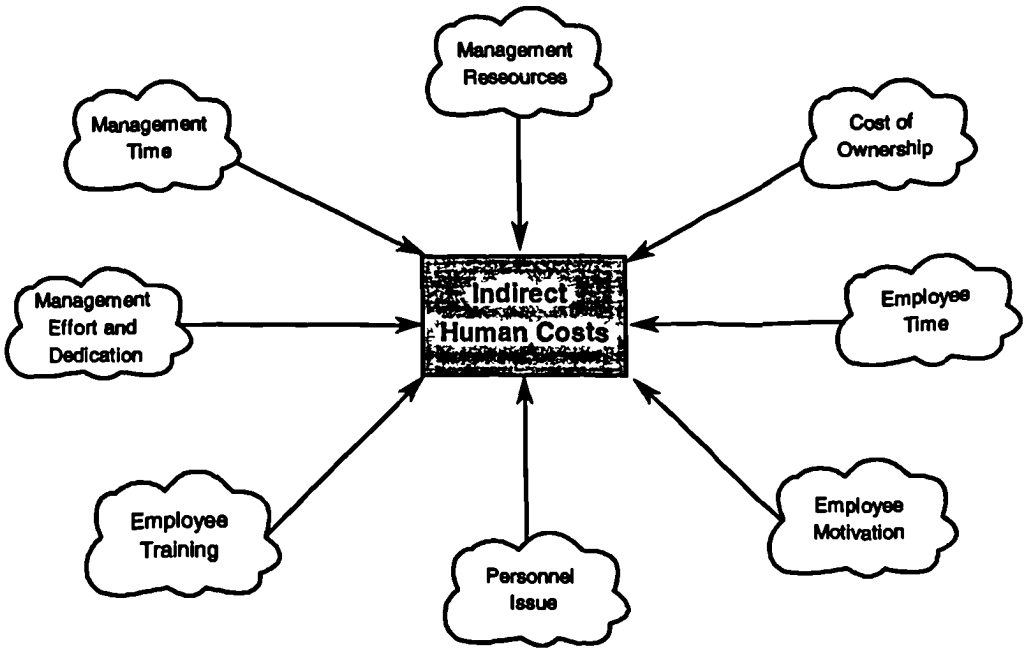


Figure 3.6 Cost Portfolio: Indirect Human Costs

3.4.2.3 Cost Portfolio: Indirect Organisational Costs

Indirect costs are not simply restricted to human factors but encompass organisational issues as well. Organisational costs are a result of the transformation from old to new work practices, based on the impact of the new system. At first, a temporary loss in productivity may be experienced, as all employees go through a learning curve, while adapting to new procedures and guidelines. Additional organisational costs may be experienced once the basic functions of the system are in place. These costs are associated with management's attempts to capitalise on the wider potential of the system; at an enterprise/strategic level. Further costs include management's attempt to integrate information flows and increase it's availability. An example of these costs within a manufacturing environment could be the development of an Electronic Data Interchange (EDI) that links a customer to a suppliers' MRPII production schedule. This additional technology links an organisation to it's customers and suppliers, with this 'openness' in communication allowing a customer to view it's suppliers capacity before raising a purchase order, therefore, preventing unrealistic delivery demands. Alternatively, it may allow a supplier to view stock/buffer records to determine whether a delivery 'top-up' is needed. Hence, the implementation of MRPII may result in the adoption of new 'knock on' technologies, with such cost factors needing to be considered and integrated into the justification process. However, there are also 'knock on' savings in efficiency and effectiveness that need acknowledging, together with additional 'knock-on' costs; direct and indirect. Consequently, such issues will all need to be considered during the decision making process; concept and financial justification. This is essential, as it will allow the complete functionality and potential of the proposed system to be established and later benchmarked. Furthermore, the adoption of MRPII and any 'knock on technology' is likely to result in the re-design of organisational functions, processes and reporting structures, which will all have cost implications.

Hochstrasser (1992) identifies a further indirect organisational cost, and identifies that companies with extensive IT infrastructures in place, tend to change their 'shape', by reducing the number of management levels. This is often achieved by re-defining the role of many management functions, through increasing their flexibility and overall contribution to the organisation, thus establishing the need to consider such costs.

The cost of organisational restructuring, or business process reengineering are also considered to be expensive, particularly if isolated groups within the company resist change, and are unwilling to make the transition. Therefore, these costs need raising during decision making, and identifying within a robust evaluation model. Clearly, it would appear that the way an organisation adopts new technology is central to the degree of success achieved and cost incurred. In particular, it is clear that the larger the technological change, the more the organisation will need to adapt. Yet, the natural tendency of organisations is to resist change, and so success will depend not only on making the necessary adaptations but on how well these changes are identified, communicated, embraced, implemented and managed. Figure 3.7 provides a summary of possible indirect organisational costs associated with the adoption of MRPII.

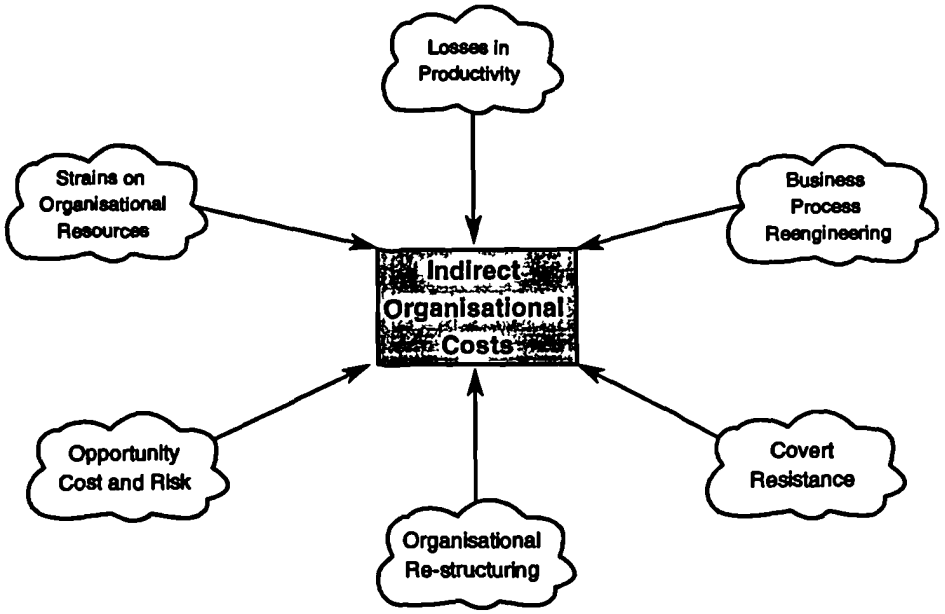
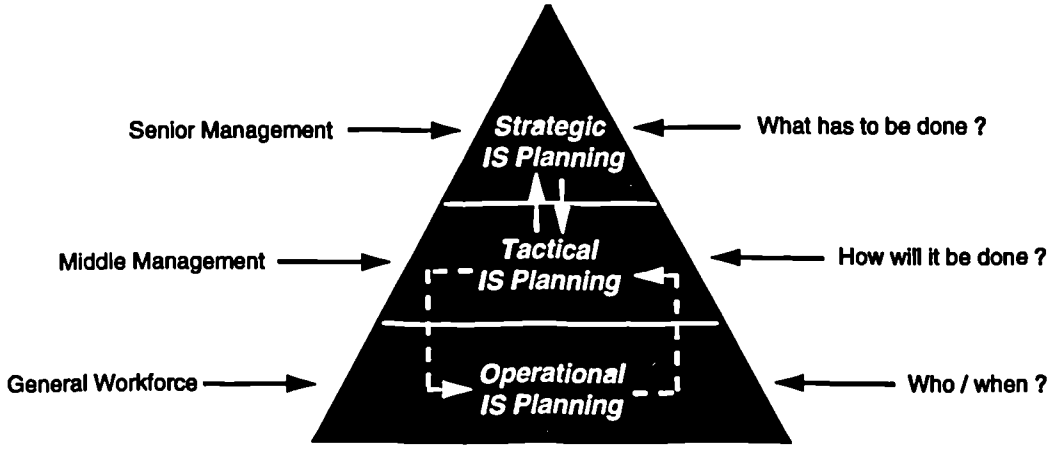


Figure 3.7 Cost Portfolio: Indirect Organisational Costs

3.4.3 IS Planning and Benefit Levels: Strategic, Tactical and Operational

The portfolio of savings and benefits achievable through adopting MRPII suggests that financial justification is nothing more than a capital budgeting formality. However, this is often not the case. Even though MRPII offers many operational benefits and savings that can be 'easily' accommodated within traditional accountancy frameworks, Chapter 2 suggests that management has much difficulty in quantifying; in financial terms, many of the 'softer' benefits of MRPII, which as a result amounts to myopia.

However, Primrose (1990) argue that all MRPII benefits can, and should be quantified in financial terms. Nevertheless, as discussed in Chapter 2, it is the nature of the intangible and non-financial benefits, and indirect project costs, which present much difficulty during financial justification. Interestingly enough, the nature of those MRPII benefits identified, may depend on the level of the manager seeking the benefits, with Anthony (1965) introduced the notion that management can be subdivided into three major levels. These being: (i) strategic management; (ii) tactical management; and, (iii) operational management. These levels are related to the traditional levels of top management, middle management, and operating or supervisory management. Therefore, it is perhaps not surprising that Wysocki and Young (1989) describes IS planning as a process that takes place at three distinct organisational levels: strategic, tactical and operational. These levels address the issue of *'what managers do'*, by emphasising that management consists of planning and control activities, which are determined by the manager's level in the organisation. For example, a simple way of looking at strategic planning is that it is concerned with *'what will be done within the organisation'*; then at a tactical level, with *'how it will be done'*; and, then at an operational level, with *'who will do it and when'*. Figure 3.8 shows how these levels are stacked, what hierarchical level is involved in carrying them out, and their process.



Source: Modified from Wysocki and Young (1989)

Figure 3.8: Levels of IS Planning

In developing this notion further, Harris (1996) suggests that many investment decisions are based on expectations, and as a result, are often made from judgements, intuition, creativity, ideas, opinions and experience, with such guided by management levels.

Hence, such decisions tend to be based on emotive or descriptive information. In considering this, it appears that IS planning levels typically align themselves against strategic, tactical and operational characteristics.

3.4.3.1 Strategic Characteristics

Strategic planning entails the participation in a business-planning exercise. That is, managers may not only be involved in developing specific systems to implement corporate strategy but, also be expected to participate in the actual development of the strategy, as well as monitoring the strategic performance of the organisation. Strategic decisions are often taken by senior management, may be uncertain and therefore risky. They are based on opportunities, often looking far into the future, and may be motivated by the need to improve competitiveness. They need long-term planning for implementation, and are usually made by senior management. An example could be the acquisition of 10% market share within a 10 year period, which is clearly financial in nature, although an intangible strategic benefit example might be to make the company's product brand a house hold name in 5 years.

3.4.3.2 Tactical Characteristics

Once the goals and objectives of the company, or project are clearly understood and priorities have been assigned, it become the responsibility of middle management to decide on *how* to accomplish these goals and objectives. These managers develop short-term and medium-range plans and budgets, and specify the policies, procedures and objectives for the sub-units of the company. Tactical plans may involve the acquisition of resources but, largely involves their allocation to monitor the performance of organisational sub-units, such as departments, divisions and other work groups/projects. Tactical decisions tend to be planned on the resources available/affordable, to meet the objectives set by strategic decisions. They are made more frequently than strategic ones, and are concerned with the *allocation* of resources, and the use of these resources to support strategic goals. An example could be ensuring targets for the year are met within their allocated budget, with such targets being supported through the adoption of a particular technology.

3.4.3.3 Operational Characteristics

Operational decisions are those most frequently made. They have clearly defined rules and given resources. These decisions are often made by line managers, or even operational employees. Essentially, it involves *monitoring* the resource used at a project level, and consists of supervising, controlling, and variance reporting of the *'who and when'* aspects of on-going operations. Line mangers may also direct the use of resources, and advise on the performance of tasks that are 'in-line' with established procedures, and within budgets and schedules determined for work groups. Since there is a structured nature to this type of decision making, it can even be made by a computer. For example, the use of a spreadsheet model to assess cash flow fluctuations following improved throughput production flow.

3.4.4 Linking IS Planning Levels to Benefits

In linking IS planning level characteristics to benefits, an interesting proposition unfolds. This is one that builds on the different planning levels discussed, and identified in figure 3.8. In doing so, proposing that MRPII investment aligns itself to strategic, tactical and operational benefits. Furthermore, there are different natures to these benefits, with figure 3.9 summarising the 'general' nature, and the levels of MRPII benefits.

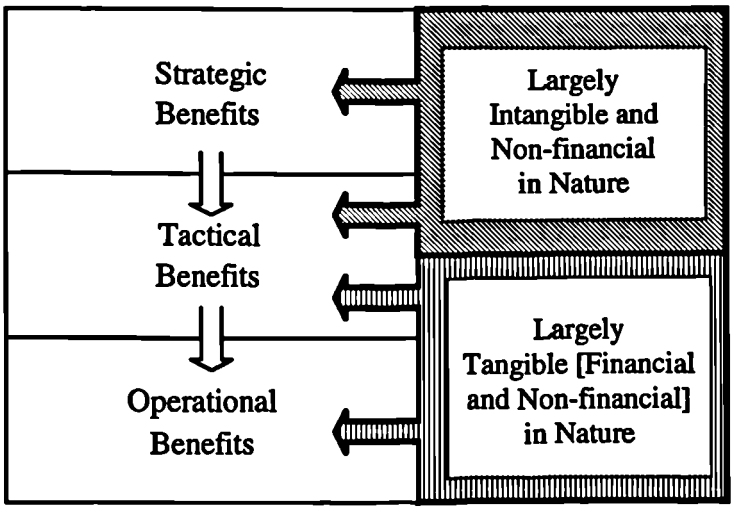


Figure 3.9 Planning and Benefit levels with their Nature of Benefits

However, the notion of benefit classification is not new, with Tayyari and Kroll (1990) having divided the benefits achievable through the adoption of new technology into two categories, namely direct benefits and intangible benefits. Demmel and Askin (1992, 1996) have also identified such issues, and classified the benefits of IT/IS into three categories: strategic, tactical and pecuniary. Similarly, Peters (1994) suggests that the benefits of IT/IS typically fall into three categories: enhanced productivity, business expansion and risk minimisation. However, such taxonomies are considered generic to IT/IS, and have not been addressed from an application specific perspective; MRPII. Regardless of preferred categorisation, Chen and Small (1994) believe that investment justification should include a consideration of 'all' benefits achievable through investing in the new technology. They go onto suggest rigorous investment justification should only be attempted after a company has identified those benefits that are required, and following a consideration of the infrastructural changes that are needed to support the achievement of benefits. Furthermore, it is during this process that suitable performance measures should also be identified and classified as either financially, or non-financially quantifiable, together with appropriate mechanisms for their quantification, although this may be considered prescriptive.

Hence, based on this discussion, the following hypothesis is proposed, which relates to a taxonomy of MRPII benefits. In developing this proposition, not only will it offer a more realistic picture of classified MRPII benefits for investment decision makers but, may also lead on to establishing whether a relationship exists between the levels of MRPII benefits and the level of manager involved in decision making.

> **H_4:** *A robust MRPII evaluation model needs to identify strategic, tactical and operational benefits.*

This hypothesis suggests a need for the benefits achievable through the adoption of MRPII to be classified as strategic, tactical, or operational, and as a result, integrated into a MRPII evaluation model. However, to identify the benefits offered by MRPII, Chen and Small (1994) suggest that firms should first monitor the usage and performance of MRPII in their industry sector. Although in reality, this may present difficulty, especially in SMEs, due to their limited resources. Hence, in considering this, the research addresses the 'industrial perception' of MRPII benefits in Chapter 5.

3.5 Conclusions

The adoption of MRPII is viewed as one of the most expensive, complex and time consuming tasks that a firm can undertake. The level of investment and high degree of uncertainty associated with it's implementation, implies that issues involving project evaluation should assume great importance. However, even though the implementation of MRPII involves a considerable level of initial expenditure, and high ongoing running costs, companies have often avoided the justification of such systems. The reason for this is that the adoption of systems such as MRPII are regarded as complex, with many independent variables affecting it's success. However, IT/IS justification is often restricted by the limitations of investment appraisal techniques, and their inability to accommodate intangible and non-financial benefits, together with indirect costs. However, due to competitive pressures on finite resources, many companies, and SMEs in particular are increasingly calling for a more rigorous analysis of investment implications, which will assist in providing a more 'realistic' picture of MRPII implications, and thus avoiding it's failure.

Hence, there is a growing need for suitable mechanisms to identify the range of implications associated with manufacturing investments, thus supporting their management and control. Therefore, the author has attempted to approach this position from an application specific view point; MRPII.

The problem domain has been addressed through the presentation of a conceptual model, which integrates 'key' technology management concerns that support the development of a MRPII evaluation model. In doing so, facilitating organisations in their process of retaining project focus, and allowing the adoption of MRPII to be managed more effectively, through identifying a broader range of project implications. The proposed conceptual model includes:

- The need to distinguish different types of justification processes;
- Cost portfolio: Direct and indirect costs; and,
- Benefit planning: Strategic, tactical and operational.

However, in developing the proposed model, a number of gaps have been highlighted through a review of the literature. Consequently, hypotheses have been proposed to bridge these gaps, and as a result, offer a further understanding of the phenomenon of MRPII investment decision making. However, to test the hypotheses and satisfy the aim of the dissertation, theoretical conjectures have been developed from an application specific perspective; MRPII. The reason for this is so that the hypotheses can now be empirically tested against the deployment of MRPII. In doing so, supporting the development a MRPII evaluation model, which is presented in Chapter 6 of the dissertation.

Chapter 4

Research Methodology

This chapter identifies the nature of a research methodology and describes the issues and benefits of having a structured framework, within which the research process can be conducted. It distinguishes between a research strategy and research methods, and describes the conditions that supported the authors decision to select a case study research approach. In doing so, a number of case study variants are identified, which include: (i) the case study objective; (ii) the case study approach; and, (iii) epistemological nature of the empirical research.

In describing these variants, the underlying objective of the study is addressed, which is a process of theory testing, through establishing the validity of hypotheses. This is followed by a discussion of different case study approaches, with the author justifying the integration of a single and multiple case approach, into the proposed research methodology. Then, a review is presented of both positivist and interpretivist epistemological stances. Resulting in the justification to adopt an interpretivist approach to the reported research, which favours the use of qualitative research methods.

The author then culminates the research variants, and presents an empirical research methodology, which acts as a framework for conducting the empirical enquiry. Finally, this methodology is operationalised into a protocol, which acts as a data collection tool where data are elicited from case study companies, such that the hypotheses can be validated, and MRPII evaluation criteria identified.

4.1 Introduction

The thesis is concerned with increasing the body of knowledge, in the area of IT/IS investment justification, with a particular focus on MRPII. In doing so, a number of human and organisational criteria that support the broadening of the decision making process will be identified. Such criteria will then be integrated into a model, for use by investment decision makers. However, before such a model can be offered beyond conceptualism, there is much need to generate empirical data. This data will be used to test the hypotheses presented in Chapter 3 and allow refinements to be made to the conceptual model presented in figure 3.1. As a result, a number of conditions affecting the research process will now need to be addressed, with their justification for inclusion within the proposed research methodology forming the basis of this chapter.

4.2 Conditions Affecting the Selection of a Suitable Research Strategy

Although the terms 'research approach (or strategy)' and 'research method' are often used interchangeably, there is a considerable difference between the two. These terms are distinguished by the following definitions:

> *"A research approach (or strategy) is a way of going about one's research, embodying a particular style and employing different research methods with which to collect data."*
>
> Galliers (1992 p. 147)

> Whereas, *"Research methods are simply ways to systematise observation."*
>
> Weick (1984 p. 121)

The decision to select a particular research strategy is a complex one, and should only be decided after considering a number of factors. Yin (1994) poses criteria for selecting a suitable research strategy. These criteria include:

- An identification of the type of research questions posed;
- The extent of control a researcher has over behavioural events; and,
- The degree of focus on contemporary events.

Although Yin (1994) has identified a number of important issues, these factors were not considered in isolation. In furtherance of the criteria identified, the author acknowledged the nature of the broader problem domain. In doing so, a number of additional research conditions influenced the choice of research strategy used to identify the idiosyncrasies of SMEs, when justifying their investments in MRPII. These factors include:

- The need for a research strategy with deductive characteristics;
- The need to empirically test hypotheses;
- Acknowledge that the sensitive issues and idiosyncrasies under investigation may not have been previously identified, studied and recorded;
- The study of complex variables, with participants having different perceptions;
- The need to study the phenomenon in it's natural setting;
- The ability to observe the effects of the phenomenon over time;
- The need to capture 'reality' and detail, with an organisational context;
- The scope and sensitivity of data required: the need for 'rich' primary data;
- The extent of behavioural, cultural and organisational control;
- Resource constraints such as time and financial budget.

Therefore, having considered these research conditions, together with the criteria proposed by Yin (1994), a case study strategy was adopted.

4.3 Case Study Research Strategy

Unlike natural scientists, who manipulate variables to determine their causal significance, or surveyors who ask standardised questions of large representative samples, a case study researcher typically observes the characteristics of individual unit of analysis (Cohen and Manion, 1994). This strategy is one of establishing valid and reliable information, which adds to the accumulation of knowledge about processes, within a unit of analysis. Hence, a case study research strategy may be defined as:

> *"An empirical enquiry that investigates a contemporary phenomenon within its real life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used."*
>
> Yin (1994 p. 23)

4.4 Case Study Variants

Although a case study strategy has been selected, there are a number of variants that this approach can take. To ensure that 'appropriate' variants are selected, a taxonomy has been developed from the work published by Cavaye (1996). Table 4.1 identifies the variants of a case approach, together with examples from the literature. However, it must be emphasised, that these variants are often guided by the underlying nature of the research, which in the case of the thesis, has already been described in section 4.2.

Case Study Constructs	Research Variants	Examples from the IT/IS Literature
Case Study Objective	Discovery & Theory Building	Orlikowski & Baroudi (1991)
	Theory Testing	Markus (1983); Irani *et al.*, (1999[b])
	Discovery, Building & Testing	Remenyi (1991)
Case Study Approach	Single Case	Wheeler *et al.*, (1993)
	Multiple Case	Lyytinen (1988)
Epistemological Nature	Qualitative	(Interviews) Yetton *et al.*, (1993) (Observation) Stephens *et al.*, (1992)
	Quantitative	(Large Scale Survey) Lefley (1994) (Large Scale Comparative Survey) Lefley and Sarkis (1997)
	Qualitative & Quantitative	(Concurrently) Kaplan & Duchon (1988) (Consecutively) Willcocks and Stephanie (1991)

Table 4.1: Taxonomy of Case Study Design Constructs and their Variants

4.4.1 Case Study Objective: Theory Testing

The objectives for choosing a case study strategy can be numerous, for example, it can be considered a suitable strategy to describe a phenomenon, build theory, test theoretical concepts and relationships, or be used for all three. Case studies have a strong tradition of description and theory building, with major proponents such as Remenyi (1991) advocating this objective because of it's inductive characteristics.

However, a case study is also a suitable strategy for testing theoretical propositions, which are concerned with validating hypotheses. In this instance, using it's deductive characteristics, where data are collected pertaining to theoretical propositions. The hypotheses are then tested by comparing the data with the conjectures. This deductive use of a case study for testing theory is strongly advocated by Benbasat *et al.*, (1987, 1988), Lee (1989) and, Yin (1993, 1994) as a valid use of a case study strategy. Indeed, having chosen a case study strategy, it will now be used with the objective of testing those theoretical concepts presented in chapter 3.

4.4.2 Case Study Approach: Single and Multiple Case Paradigms

In the most elementary sense, a research design is a logical sequence of events, which connect the empirical data to the study's research questions. As a result, an integral part of developing a suitable research design is the decision of whether to study a single, or multiple set of cases. Hence, the following sub-sections discuss the rationale for embedding a single case approach within a multiple enquiry, and then integrating this design approach into the proposed empirical research methodology.

4.4.2.1 Single Case Approach

The study of a single case enables a researcher to investigate, and get close to a phenomenon, and study it in depth. It allows for a 'rich' description and identification of 'deep' structures. A single case study enables the 'full' and 'rich' analysis of a phenomenon, which can contribute towards knowledge, through developing theories and concepts. A single case approach may also be used for theory testing, through the confirmation, or rejection of hypotheses. Interestingly enough, it is also possible to develop a research design that uses a single case study but also integrates more than one different unit of analysis (Irani, 1995). However, in considering the nature of the problem domain, a single case study appears to be inappropriate, as the study of a single instance may not allow others to relate their experiences to the case reported. Also, the use of a single case may not allow sufficient data to be generated, thus proving 'risky', as an objective of the dissertation is the development and testing of hypotheses. Therefore, there appears to be a basis for investigating an alternative to a single case approach.

However, before this can begin, it is important to describe *why* a single case study is regarded appropriate for inclusion, in part, within the proposed research methodology. In adopting a single case study as part of a wider enquiry, an environment is created where a pilot case study can be conducted (Irani *et al.*, 1999[c]). In doing so, providing an opportunity to test the research methods used for data gathering, for their effectiveness in generating the data necessary for hypotheses testing.

4.4.2.2 Multiple Case Approach

Herriot and Firestone (1983) consider that the conclusions drawn from multiple case studies are more compelling than those elicited from single case approaches. The reason for this is that the overall study is regarded as more robust. The study of multiple cases may not enable the same 'degree of rich description', as those investigations based around a single case. Although, a multiple case study allows analysis of data across companies, as it enables differences in context to be related to constants in process and outcome. Multiple approaches also allow the investigator to test and 'cross-check' research findings after the development of theoretical propositions, as indeed is the objective of this research. However, the number of cases in a multiple case study are not pre-defined, and usually determined intuitively. Dyer *et al.*, (1991) suggest that the appropriate number of cases should depend on issues such as: *how much is known about the phenomenon,* and; *what new information is likely to emerge from studying further cases.* As a result, the literature is vague when recommending how many cases to study. Eisenhardt (1989) suggests that a multiple case approach requires the study of at least four but no more than 10 cases. However, Gable (1994) suggests a multiple enquiry should include up to 5 companies.

4.4.3 Epistemology: Choosing a Positivist or Interpretivist Approach

The term epistemology refers to the belief about the way knowledge is construed. It questions whether it is possible to identify and communicate the nature of knowledge as 'hard', 'real' and capable of being transmitted in a tangible form. Instead of considering knowledge to be 'soft', subjective, spiritual, or even transcendental, based on the experiences and insight of a unique and essentially personal nature.

The epistemological assumptions in these instances determine extreme positions on the issues of whether knowledge is something that can be acquired, or something personally experienced (Burrell and Morgan, 1979). The view that knowledge is 'hard', objective and tangible, will demand that the researcher offers the role of observer. However, to see knowledge as personal, subjective and unique, imposes on researchers an involvement in their subjects, and offers them a role as participant-observer. Therefore, to subscribe to the former is to be positivist; to the later, interpretivist. Interpretivism and positivism rely on quite different assumptions about the nature of knowledge, and demand considerably different approaches to research, with authors such as Irani *et al.*, (1999[c]) amongst others, having discussed their respective characteristics.

4.4.3.1 Justifying The Use of Qualitative Research Methods

Information systems research is concerned with human beings, and any research methodology that uses quantitative research methods must recognise the variability that is inherent in human behaviour. Allison (1993) suggests that events which form a phenomenon are conditioned by interacting variables, such as time and culture, and as a result, no two situations are identical. Therefore, it appears that quantitative research methods are inappropriate in this instance, as they are unable to take account of the differences between people and the 'objects of the natural sciences'. As a result, the principle of scientific methods to the study of people is questioned, thus suggesting the suitability of a more qualitative approach. In support of this, Remenyi and Williams, (1996) advocate the appropriateness of qualitative methods in IS research. However, before an epistemological stance can be adopted by this enquiry, it is necessary to identify the kind of data that is needed to test the hypotheses. It appears from the objectives of this study, that the issues under investigation are *'soft, confidential and subjective'*, with much context to the data needed. Therefore, this suggests that the selected research methods must be able to take account of such factors, and acknowledge that many management decisions are idiosyncratic and guided by circumstances pertaining to the organisation. Clearly, 'rich' empirical data is required, therefore, the most appropriate[1] epistemological stance to adopt is that of interpretivism, suggesting the use of qualitative research methods.

[1] The author stresses the rhetoric of positivism and interpretivism as appropriate approaches, with the adoption of interpretivism based on the domain and research conditions identified in section 4.2.

4.4.3.2 Qualitative Research Methods

Interpretivist researchers consider that it is impossible to understand and assign meaning to a phenomenon, without describing it's context. Such researchers carry out their investigation within the setting of the phenomenon, through participant-observation. This form of 'direct' and 'in-depth' research is necessary to achieve contextual understanding. As a result, qualitative research methods are associated with 'face-to-face' contact, with persons in the research setting, together with verbal data and observations. Qualitative data can be collected in a number of forms, with methods including interviews that may be recorded and later transcribed. Further methods might include field notes, which describe events. Qualitative data can also be collected from written documents and archives, with Miles (1979) identifying the essence of qualitative data as being 'rich, full, holistic and real'; whose validity is unimpeachable. The details of the qualitative methods used in this research are to be discussed in later sections.

4.5 Empirical Research Methodology

Now that appropriate case study variants have been identified and justified, the author proposes to integrate these factors into an empirical research methodology. This methodology is presented as a model, and is detailed in figure 4.1. Essentially, it is one that is divided into three independent parts. These phases are: (i) research design; (ii) case study data collection; and, (iii) case study data analysis.

4.5.1 Research Design

The first part of the proposed methodology is the research design. This involves a review of the published literature, which allows the development of a 'firm' understanding of the investigative domain, which translates into a research need. A model building process then commences, resulting in the development of hypotheses. A suitable research strategy is then identified, which is followed by a decision regarding the research approach, objective(s) and epistemological stance; research methods. Essentially, the research design integrates a multiple case study approach that uses qualitative research methods for theory testing.

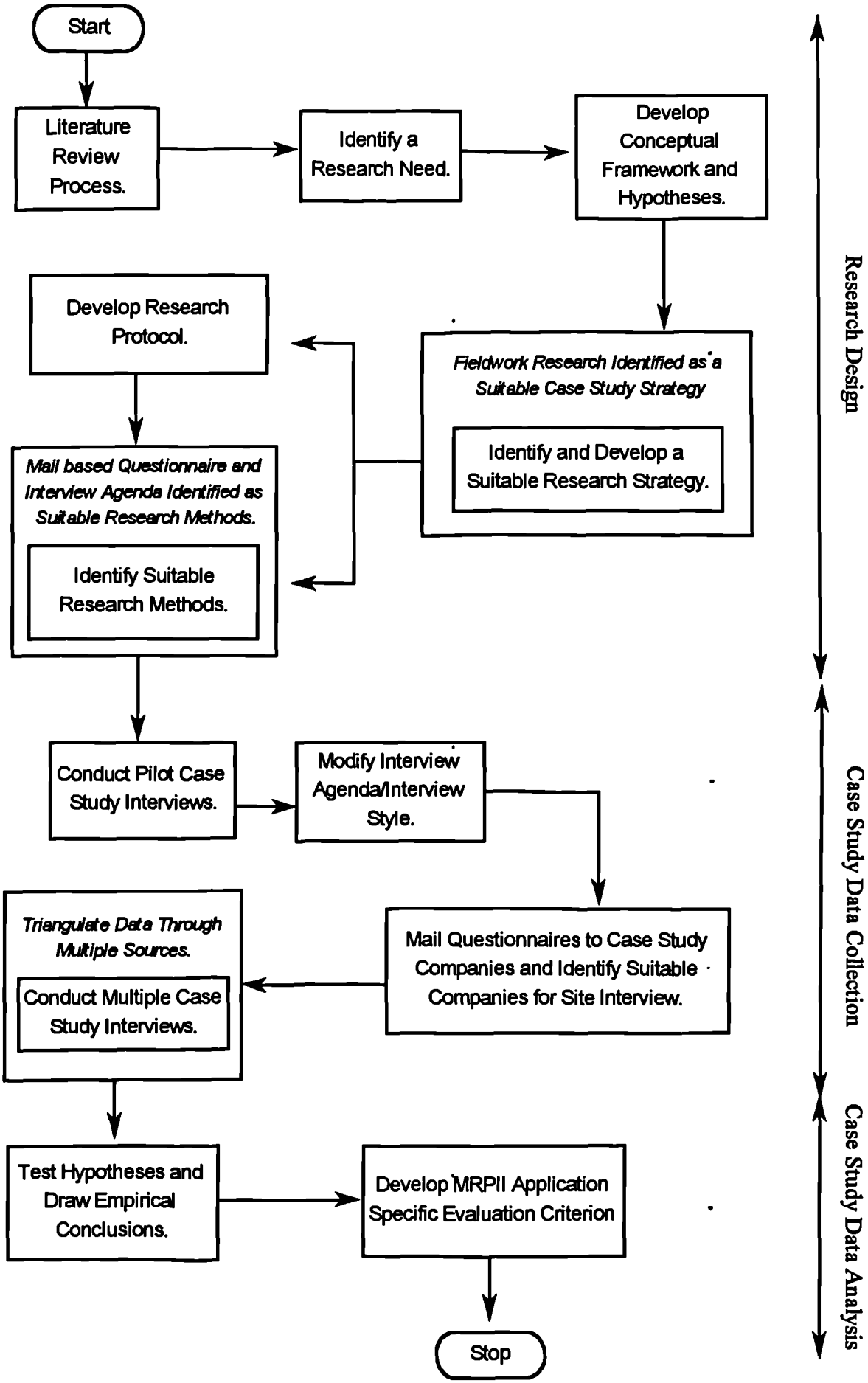


Figure 4.1: Empirical Research Methodology

The research design was then operationalised into a protocol (Friedman, 1987), which served as a mechanism to generate appropriate data to satisfy the aim of the dissertation. As a result, an appropriate qualitative research method was developed; interview agenda, although a quantitative questionnaire was employed in the first instance. A quantitative mail-based questionnaire was initially developed and composed of 'closed-type' questions. This questionnaire is detailed in appendix C, and required respondents to reply in part, with a numerical answer. It served as a research method for collecting 'general' information, details of manufacturing strategies and processes, and established an experience/advantage of implementing MRPII, or IT/IS with MRPII characteristics. In addressing the latter, a great deal of attention has been given to identify case exposure of IT/IS together with it's motivation. Table D.1, which is presented in appendix D, provides a case by case summary of IT/IS infrastructures, thus establishing the suitability of companies for site visits. Such results also contributed towards establishing whether previous experiences of IT/IS evaluation had an impact on their approach, towards idiosyncratic adoptions of MRPII. In doing so, identifying company specific factors that may need investigation during site interviews. Also, respective motivations for adopting MRPII were identified, which are presented as a summary in table D.2, and discussed in section D 2.1 of appendix D.

Having used a mail-based questionnaire, the author was then able to spend the interviewees' time to the utmost, by focusing the interview process on the discussion of sensitive qualitative issues, which contributed towards testing the validity of hypotheses. Further justification for using a mail-based questionnaire was that large amounts of data were needed, which were time consuming to gather; similarly, the types of data varied, and the 'staggering' of data gathering through multiple approaches appeared to be a suitable option. Also, this research method reduced the need for costly return site visits, as it served as an additional data gathering source. Once suitable companies were identified; and use of the mail-based questionnaire fulfilled, the author administered a second questionnaire[2] to 'appropriate' managers/directors. Essentially, this questionnaire served as an agenda during the formal interview process, and is detailed in appendix E.

[2] Although a questionnaire was administered to a number of functional areas within suitable companies, it was used as an agenda for the *formal* interview process and *not* as a quantitative research instrument.

The use of an interview agenda facilitated the collection of 'rich' relevant case study data, by allowing the researcher to 'steer' the interview process, and ask standardised questions. However, it also allowed the interviewee to have sufficient 'freedom' to discuss related issues. Additional data gathering research methods and lines of enquiry included obtaining supporting evidence through informal conversations, archival documents; minutes from meetings and consultancy reports. However, the operational aspects of these approaches are discussed in section 4.6.2.

4.5.2 Case Study Data Collection

The next part of the methodology is the data collection phase. This stage is responsible for establishing the suitability of the mail-based questionnaire and interview agenda. The reliability of the research methods were established through a pilot case study, with the results of this having been reported by Irani *et al.*, (1999[b]). The pilot case study is considered to have improved the quality of the research, as issues such as ambiguity and vagueness represented in the mail-based questionnaire, and detailed in the interview agenda, were able to be addressed. Also, the author was allowed the opportunity to refine interviewing skills and verbal phrasing of questions. Hence, once the suitability of research methods were established, the author posted the mail-based questionnaire to 'seemingly suitable' case study companies.

Such companies were selected because of their classification as small companies, within the SME sector. In choosing the number of cases to study, much emphasis was placed on the criteria proposed by Bassey (1981). It is suggested that the merits of a case study enquiry should be the extent until which case details are sufficient and appropriate for others in similar situations, to relate their experiences to those described. Bassey (1981) goes on to suggest that the reliability of a case study is more important than it's generalisability, and sample size of cases within a multiple enquiry. As a result, the decision of when enough cases had been studied was determined intuitively, on the basis that the enquiry would be stopped when the necessary 'depth' and 'richness' had been obtained, and little new insights could be gained. Incidentally, the sample size of this empirical enquiry was similar to other doctoral studies evaluating IT/IS deployments, such as Ho (1992).

On analysis of the returned postal questionnaires, companies were selected for site visits. The author then carried out a number of visits, where qualitative interviews took place. However, in using a case study strategy, as with other research strategies, there is always the danger of bias affecting the accuracy of data gathered. However, Bell (1996) suggests that this can be addressed through a process of data triangulation. This is a method of cross-checking the existence of certain phenomena and the veracity of individual accounts, by gathering data from a number of informants, and through a variety of channels. The data are then compared by contrasting one account with another, to produce a 'full' and balanced study. Hence, the research methods adopted during this study made use of multiple lines of enquiry, as a variety of views were sought. Therefore, suggesting an increase in the accuracy and reliability of conclusions drawn, however, the operational aspects of this are discussed in section 4.6.2.

4.5.3 Case Study Data Analysis

This final part of the research methodology centres on the testing of hypotheses. As a result, the author proposes a framework, which offers a structure to this process. This framework is presented in figure 4.2, and identifies hypothesis 1 as being the apex, which is underpinned by hypothesis's 2-4. In testing each conjecture, a number of issues present themselves as supporting factors. These issues contribute towards establishing the validity of hypotheses and offer themselves as constructs to the conjectures. It is these constructs that form the basis for the empirical enquiry reported in Chapter 5.

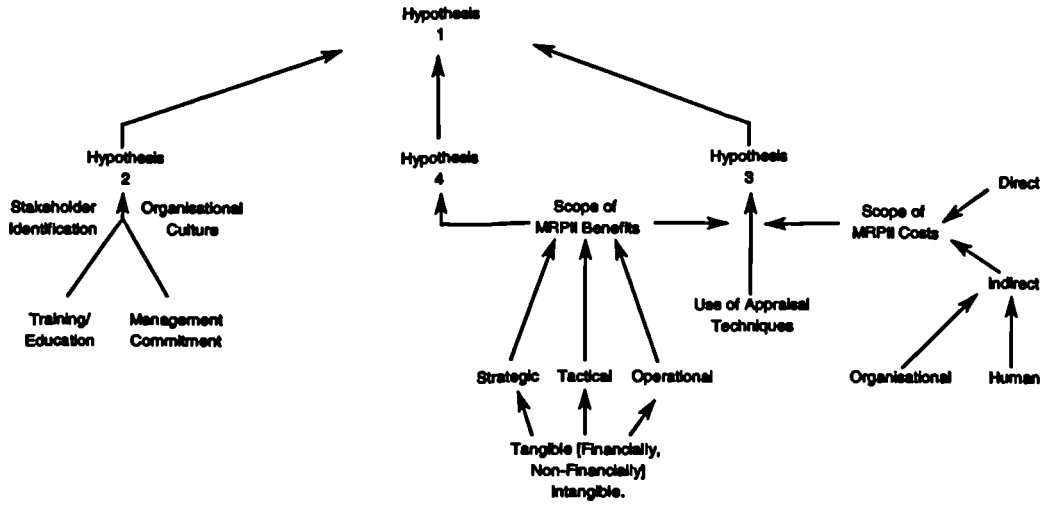


Figure 4.2: Framework for the Testing of Hypotheses

4.6 Case Study Protocol: An Operationalised Action Plan

Although, case study research is often thought to be informal, in fact, a case study strategy requires a distinctively formal approach, where a protocol may be developed (Friedman, 1987; Remenyi, 1991; Sabherwal and Tsoumpas, 1993). A research protocol serves as an instrument that acts as an operationalised 'action plan' for an empirical enquiry (Yin, 1994). A case study protocol presents the investigator with a formal document, which sets out the proposed rules and procedures to be followed when carrying out fieldwork research. The protocol acts as a data collection tool, where data are elicited from case study companies. Remenyi (1991) describes the essence of a research protocol, and describes it as a 'tactic for increasing the reliability and focus of data gathering'. Yin (1994) identifies various levels of questioning when carrying out a multiple case study enquiry, with these results presented in table 4.2. Incidentally, the issues covered by the protocol should only reflect those research concerns at a single case level i.e., as detailed in level 1 and 2 of table 4.2.

Question Level	Research Question	Section Reference
Level 1	Questions asked of specific interviewees.	4.6.2 Appendix C and E
Level 2	Questions asked of an individual case study.	4.6.1 / 4.6.2 / 4.6.3
Level 3	Questions asked across the multiple case enquiry.	4.6.3
Level 4	Questions asked of the entire study.	1.5 / 7.1
Level 5	Questions about recommendations and conclusions beyond the scope of the study.	7.4

Table 4.2: Questioning Levels in a Multiple Case Enquiry

Distinguishing the levels of research questions is crucial, especially when a single case study is part of a multiple enquiry. The reason for this is that there might be up to five levels of questions associated with a multiple enquiry (Yin, 1994). However, only the first two levels are covered in this chapter, with other levels being discussed elsewhere in the dissertation. Yin (1994) suggests the following outline sections as part of a case study protocol: (i) case study overview; (ii) fieldwork research procedures; (iii) questions addressed by the research, and; (iv) the research output format.

4.6.1 Case Study Overview

This section of the protocol covers any background information about the project, and details the substantive issues to be investigated. These are factors that the researcher needs to focus on, to generate data that is needed to test the theoretical propositions. Even though, the aim and hypotheses have already been discussed, the following factors represent the investigative issues associated with this empirical enquiry. The consideration of these issues are crucial, to retain focus during the interview process. The issues of this empirical enquiry are:

- To establish the investment decision making processes used by the case study companies, during their justification of MRPII, i.e. do they use traditional/non-traditional appraisal techniques as part of their decision making process, or responds to other stimuli-structured, or adhoc;
- To identify those human and organisational constructs associated with the justification of MRPII, and identify their suitability for inclusion in a MRPII evaluation model;
- To identify MRPII stakeholders, and establish their contribution to the investment decision making process;
- To identify the portfolio of benefits and costs considered during investment justification; and,
- To identify the predictive 'value' (retrospectively) of organisational decision making, when assessing the achievement of MRPII project objectives.

4.6.2 Fieldwork Research Procedures

The nature of case study research implies the study of events within a 'real-life' context. As a result, data gathering must be capable of coping with 'real-world' events. Such might include respondents dropping out, documents not being available, retrospective forgetfulness etc,. These issues have significant implications during data gathering, thus emphasising the importance of a suitably designed fieldwork procedure. The following are key fieldwork procedures acknowledged during the empirical research conducted:

- Define who should be interviewed. Essentially, managers and where possible directors were formally interviewed. The functional head's sought for interviewing were manufacturing, production control and IT/IS.
- Identify suitable data gathering research methods and establish lines of enquiry. As discussed, a mail-based questionnaire established the suitability of companies for a site visit, with an interview agenda then acting as the research method for gathering 'rich' empirical data, and 'steering' the interview process. The interview process was also tape recorded and later transcribed. Secondary lines of enquiry were informal, with shop floor and other operatives being questioned. Further supporting evidence was sought from archival documents; minutes from meetings; internal memos and consultancy reports;
- Develop a data collection schedule that accounts for contingencies. Where possible, secondary people were identified as 'stand-by' employees for interviewing. However, in reality, this proved difficult to operationalise.
- Develop an interview schedule. A schedule was developed with dates and times agreed with interviewees. All formal interviewees were told that the interview process would take one hour, although in most cases it took considerably longer.
- Identify and discuss additional fieldwork procedure. This involved ensuring that issues associated with confidentiality were addressed. Essentially, companies agreed to the publishing of findings on the basis of their anonymity. As a result, the case study companies are reported as Company A ... B ... C ... etc,.

From a case study research strategy point of view, a case study implies a comprehensive and intensive study of a subject. Thus, thoroughness must be seen as a prerequisite. Interpretations and opinions must be ascertained, and then carefully interpreted. However, these opinions must be carefully 'sifted' and tested to eliminate fictitious and false statements, as well as, where possible, personal rationalisation. As a result, a number of formal and informal lines of enquiry were developed. Since, the nature of this project was to research and extrapolate 'sensitive' data, the author anticipated the impact of interviewee perception to play a considerable part in the accuracy and reliability of conclusions. Therefore, to reduce the impact of bias, and to facilitate the collection of accurate and reliable data, the author triangulated the lines of enquiry, threefold.

Firstly, through not relying on data from one functional source but formally interviewing a number of functional areas within the organisation. Secondly, by informally discussing MRPII evaluation issues with operational shop floor employees. Thirdly, by obtaining opinions from supporting staff on cultural aspects of the company.

Formal data gathering included contact with the IT/IS department, or function(s) responsible for manufacturing related IT/IS implementations. At this point, the appropriate persons (directors/managers) were formally interviewed, using the interview agenda. During this process, an attempt was made to interview all informants in their offices, rather than interview rooms. It was considered that the interviewee would 'feel at ease' in their own environment, and therefore, more forthcoming with information. However, this sometimes proved difficult, often due to constant interruptions. Incidentally, during formal data gathering, interviewees were asked for their permission to be tape recorded, as this was considered to assist in the later analysis of data. However, informal data gathering was somewhat different. This approach included operational shop floor employees being encouraged to raise and discuss relevant issues through informal discussions. Factors considered relevant during informal conversations centred on those implications associated with the evaluation and use of MRPII. Informal data gathering also included discussions with 'other' organisational employees. During this process, the author encouraged as many members of staff; such as secretaries and other support personnel, to 'generally' converse about the organisation. In doing so, allowing views on the company to be developed, and establishing cultural factors. Figure 4.3 summarises the lines of enquiry and data gathering methods employed.

During all informal discussions, the author allowed informants as much conversational 'freedom' as possible, as it was considered critical to ensure that the interviewer did not prejudge in any way, the evidence that the informants offered. However, a list of possible discussion topics that the interviewer could use as an 'informal pointer' were developed. Although, this method was only used during informal discussions with shop floor employees. Also, it must be noted that, it was not the intention of the informal interview pointer to address all research issues but simply complement the formal data gathering process with a wider perspective of the organisation.

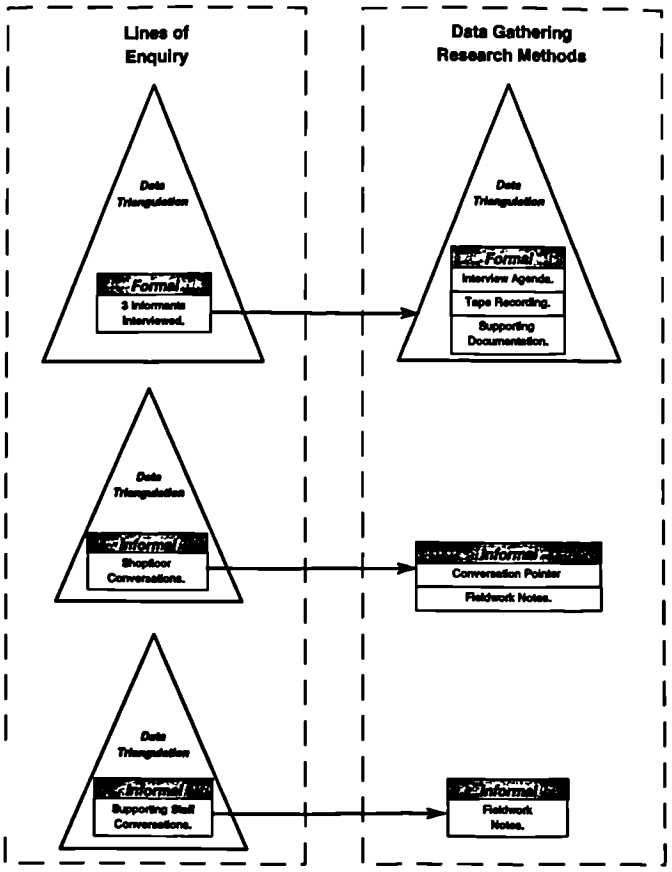


Figure 4.3: Lines of Enquiry and Data Gathering Methods

The informal interview pointer offered itself as a qualitative research method, and acted as a prompt, when the discussion required guidance. The issues explored included:

- Does the company have a formal business plan (strategic and/or financial) and if so, how are these plan(s) developed and communicated to all employees?
- What role does IT/IS play in the organisations' growth and success?
- What operational issues were/should be addressed during MRPII justification?
- Was the adoption of MRPII discussed with stakeholders before implementation?
- Did operatives and managers receive appropriate training on the impact of MRPII, to their job function(s). If so, before, or after implementation?
- Do you consider MRPII to have made an impact on the organisation. If so, how?
- Is the adoption of MRPII contributing towards the achievement of internal/external customer expectations
- **NOTE:** Establish whether the objectives used to justify MRPII have been achieved, and if so, how were/are they measured.

4.6.3 Questions Addressed by the Research

At the centre of the protocol, is a set of questions that reflect the enquiry at an individual case level. It is the characteristics of these questions that distinguish them then those 'echoed' in the mail-based questionnaire, or interview agenda. These questions are set for the researcher, and not for interviewee, and act as a reminder for the researcher, concerning the data that has to be collected, to test the proposed hypotheses. Essentially, the main purpose of the protocol questions are to keep the interviewers focus during the data collection process.

This 'crosswalk' between the question types within the research methods, and those detailed in the portfolio, is of particular use. For example, before starting an interview, the researcher is allowed an opportunity to review the 'major questions' that the interview should address; with these questions forming the structure of the enquiry but, not being used with the intention of acting as the questions to be asked of the interviewee. As a result, three specific questions were developed, to help retain focus during the case enquiry. These questions are summarised in table 4.3 and represent part of question level 2 in table 4.2.

Question Number	Research Question
1	What are the decision making processes used by the case study company, when justifying their investments in MRPII.
2	Identify what human and organisational factors are associated with the evaluation of MRPII.
3	What are the type and nature of benefits and costs that form part of the investment decision making process.

Table 4.3: Questions Addressed by the Empirical Research

4.6.4 Research Output Format

During the development of the protocol, the researcher also considered the format that the research output should take. In the author's case, the research output was the result of the empirical data analysis; Chapter 5.

This consideration of the format that the research output should take proved useful, as it was envisaged that large amounts of data would be gathered during each case study visit. The author addressed issues associated with the large amounts of data likely to be generated, through aligning each question within the interview agenda, with the proposed hypotheses. This alignment is detailed in appendix F. Adopting this approach contributed to the quality of research output, as it focused on the development of an effective interview agenda, for the testing of hypotheses. It was also considered that unless a question within the interview agenda sufficiently contributed, or steered towards the gathering of appropriate test data, it was not 'adding value' towards the research objective. Incidentally, peripheral research issues were addressed using informal research methods, as previously discussed.

4.7 Conclusions

This chapter has identified the importance of having a robust methodology when part of a structured research process. This structure not only provides the research process with a well-developed framework but provides an understanding, in the broadest possible terms, not of the products of scientific enquiry but of the process itself. Also, this chapter has identified the case approach as a highly versatile strategy for IT/IS research, with it's premise including: (i) it's ability to allows the study a phenomenon in its natural setting; (ii) it's ability to test theories; (iii) it's ability to allow the researcher to explore issues that lead to an understanding of the nature and complexity of the processes taking place; and, (iv) it's ability to provide an appropriate way to research a poorly studied phenomenon.

The author then offered a critique of the case approach, emphasising and justifying the variants integrated into the proposed research methodology. One of the variants identified was the range of research objectives available. However, the author justified the case approach with the objective of theory testing, to establish the validity of the proposed hypotheses. The second variant addressed was the decision regarding the integration of a single, and/or multiple-case study approach. The author justified the integration of both paradigms into the research design. The final variant considered, involved the decision of adopting an appropriate epistemological stance.

Consequently, the author justified interpretivism, which favours the development of qualitative research methods. However, a quantitative mail-based questionnaire was initially used to identify suitable companies for site visits. This was then followed with an interview agenda that generated 'soft' subjective contextual data, which was used to test hypotheses. The testing of the hypotheses is presented in Chapter 5, where constructs to the hypotheses are explored, to assess their impact on the evaluation of MRPII. During this process, individual cases will be discussed, as it is not the intention of the dissertation to compare fundamentally different cases, nor to offer the pretence of generality. As a result, idiosyncrasies pertaining to individual case settings will be explored through reporting the results of the interview process, and in many cases, the reporting of direct quotations from interviewees, thus emphasising the context and qualitative nature of the data generated.

Within this chapter, an empirical research methodology has been developed, which offers itself as a 'blueprint' of the research process, and development of a MRPII evaluation model. Furthermore, such a methodology provides a framework that describes the stages and logical flow in the research process. Essentially, the proposed methodology comprised of three independent phases: (i) research design; (ii) case study data collection; and, (iii) case study data analysis. The research design was then operationalised into a protocol, which provides a descriptive 'step-by-step' procedure of the data gathering process.

Chapter 5

Empirical Data Analysis and Hypotheses Testing

This chapter presents and analyses empirical data that is then used to test proposed hypotheses. However, the analysis of empirical data should not be seen as a comparison between cases, as the comparison of different cases offers no ability to generalise. Instead, this chapter offers an empirical analysis of different case study perspectives, which describe idiosyncratic human and organisational behaviour during the case adoptions of MRPII. Therefore, rather than generalising the validity of the hypotheses, the author proposes to test each conjecture, by describing respective approaches to the evaluation of MRPII. In doing so, allowing others to relate their experiences to those reported in this chapter.

Whilst testing the hypotheses, constructs to concept justification are examined, to establish whether they should be exemplified as a prerequisite for MRPII evaluation. Then, case study orientations towards investment justification are described. This is achieved through identifying the use of investment appraisal techniques, and establishing the level and type of benefits sought and cost measures considered/realised. This is then followed by an analysis of case MRPII deployments, before presenting empirical conclusions.

5.1 Increasing Employee Commitment Through Concept Justification

Earlier chapters of the dissertation have established that there is often little distinction between the various aspects of investment justification. Typically, the term justification is implicitly, if not explicitly associated with financial budgeting. Therefore, this process may be restricted to senior management, who are often seen as the only stakeholders during the justification process. However, the basis of hypothesis 2 is to broaden this stance, by testing a range of factors that are considered to shape[1] the justification process. These factors include: stakeholder identification, cultural issues, training and education, and management commitment. To test the validity of the proposed research hypotheses, a framework has already been developed and presented in figure 4.2. In doing so, constructs to the hypotheses have been identified. As a result, the following sub-sections now present case idiosyncrasies that relate to the constructs of hypothesis 2.

5.1.1 Stakeholder Identification as a Construct to Concept Justification

Stakeholder Identification at Company A

During the development of their IT/IS infrastructure, Company A identified those stakeholder processes that were perceived by the management team to be affected by implementing a Production Planning and Control (PPC) system. In doing so, those job functions and software types associated with their adoption of computerised PPC were identified. Furthermore, the management team distinguished those systems that could be developed 'in-house,' and those that would have to be vendor supplied. The reasons for this were to assist in their analysis of PPC implications; direct costs associated with individual modules.

Figure 5.1 identifies those business processes considered to be affected by PPC at Company A, thus presenting their MRPII infrastructure, together with their supporting software types.

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1 Such factors are considered to improve organisational commitment, acceptance, enthusiasm and ownership of the adoption of MRPII.

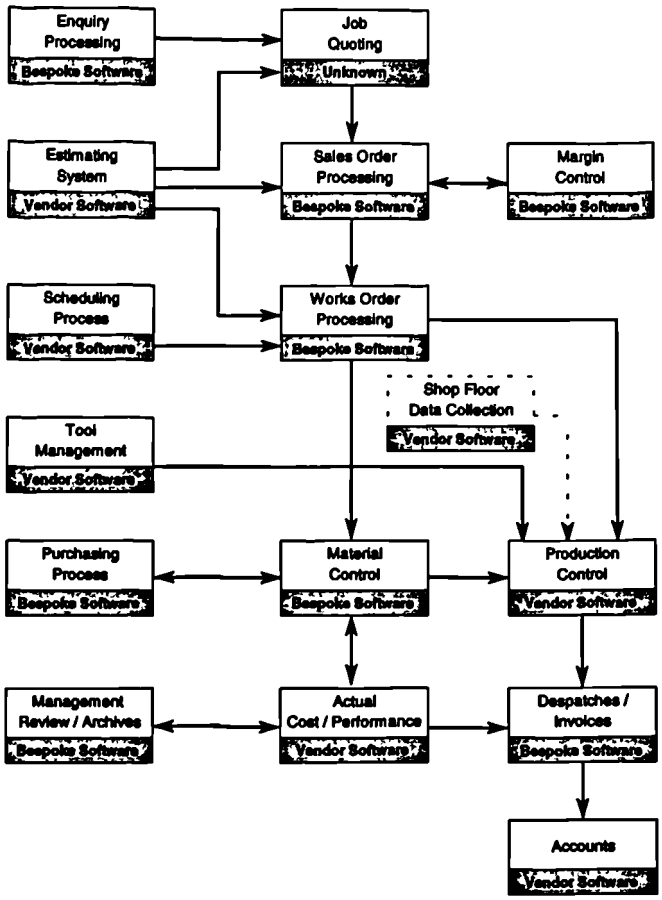

Figure 5.1: Operational Processes Affected by PPC at Company A

Although Company A identified those business processes it considered would be affected by PPC, the management team did not consult, or identify those operational employees [stakeholders] responsible for the business processes identified in figure 5.1. Also, there was no representation, or involvement by any operational employees in the team that was responsible for selecting and implementing vendor PPC.

During the adoption of PPC and Shop Floor Data Collection (SFDC) software, human factors were not perceived by the management team, as having an impact on the success of the project. The issues associated with implementing PPC were addressed from a purely technical perspective, with Company A later realising the consequences of neglecting the 'softer' side of IT/IS implementation. The implications of this were realised during the implementation/operation of SFDC, which are now realised to require shop floor ownership.

The use SFDC technology was resisted by many of the operational workforce, and as a result, limited the success of the PPC project. When asked to comment on the outcome of Company A's PPC/SFDC system, the MD said:

> *"It didn't all go according to plan ... We thought we could make everyone use the SFDC system. Instead, it was manipulated by people on the shop floor ... The whole thing failed."*

There appeared to be a lack of interest and ownership by the operational workforce in computerising business processes, and as a result, they did not accept, or use the 'prescribed' SFDC system. Also, they could not see the relevance, or business need to computerise PPC/SFDC, with attitudes of *'why change things'* prevalent. The operational workforce thought that management had a 'hidden agenda' in implementing SFDC, with a shop floor operative saying during informal conversations:

> *"Shop floor data recording is a sneaky performance measuring system. It compares planned set-up and run times, with those actually achieved. Its just management's way of trying to catch us [the operational workforce] out, and make us work harder."*

Analysis of Stakeholder Identification at Company A

In interpreting from the empirical data, there appears to have been a great deal of employee resistance, which was channelled through their inability to be relied upon to use the new systems, continuously. This may have been a result of a lack of training and stakeholder involvement, during the evaluation and implementation process. However, there were also technical problems[2], as the data generated appeared easily corrupted by shop floor contaminants and double data entry. All these factors had a significant impact on the outcome of the PPC/SFDC project, with none of the operational workforce having been involved, consulted or educated on the importance of such technologies. Although with hindsight, management regrets not educating operational employees and end user stakeholders, on the business need to adopt PPC/SFDC.

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[2] This resulted in unreliable data, which was reflected in the form of Master Production Schedule (MPS) 'noise'. The consequence of 'noise' in Company A's MPS has already been described by Irani *et al.*, (1998), and includes amongst others, additional production costs, falls in productivity, inaccurate management information, and the loss of customers because of inaccurate delivery lead-times being quoted and adhered too.

Hence, it would appear that the lack of commitment by the workforce to accept SFDC, was partly due to the management team neglecting the implications of human factors. As a result, the operational workforce perceived management to have an ulteria motive in their adoption of shop floor technologies. This may be due to a lack of representation by shop floor stakeholders during the evaluation process, resulting in the 'full' potential of the system not being realised, as vital operational aspects and opinions were not expressed/addressed. A possible explanation of this was obtained during discussions with the former software selection and implementation team members, where it was emphasised by a manager that the decision to adopt PPC/SFDC was one that should be made by management, and should not involve operational employees. This opinion appeared 'shaped' by the culture of Company A at that time, which was authoritarian, and did not support the 'free' exchange and flow of ideas; stakeholder involvement.

However, recent changes in organisational structure and culture have lead Company A to adopt aspects of concept justification during their development of bespoke[3] MRPII. Clearly, resulting from their experiences of PPC/SFDC implementation. In learning from the past, the management team has addressed their mistakes, and integrated previously neglected human and organisational issues into their evaluation and development of bespoke MRPII. This has resulted in operational support, acceptance and use from shop floor stakeholders. In particular, the decision to develop bespoke MRPII was communicated and shared with shop floor stakeholders, where employees then played an active role in its development and deployment, thus resulting in the integration and use of bespoke MRPII. Clearly, only achievable after having identified and involved those reliant on using the system, and on the data it generates.

Stakeholder Identification at Company B

Company B appeared to approach its evaluation of MRPII in a structured manner, with the production manager saying:

> *"... I knew we had to change things but it was only through open communication and considering the views of the whole workforce that we can be assured of their acceptance to change."*

[3] The term bespoke is used in the context of developing a manufacturing information system/MRPII system 'in-house'.

When Company B was asked to identify who was perceived to be a stakeholder of MRPII, the MD reported:

> *"... I knew everyone would be affected by MRPII. I thought it would be easier to shut the whole place down and tell everyone how IT can make things easier, before 'cherry picking' key people and sending them off on training courses. It is better to keep everyone informed, otherwise it creates bad feeling."*

The exchange of opinions and ideas between management and the workforce were reported in the minutes of a monthly management meeting, and was used as an opportunity to share opinions. It also allowed for sceptics to be identified, and 'won over'. However, this discussion and exchange of ideas may have been facilitated by the small size of the company, and by the MD consistently showing his level of commitment to the project, through actively communicating the need to 'drive' towards developing a computerised IS. However, the MD did express dissatisfaction with the time it took to attain a 'reasonable' level of employee commitment, and said:

> *"It seemed to take forever before I got everyone switched on to my plans to implement IT."*

This presents a clear management issue, and questions how much employees should be allowed to dictate corporate strategy, with the quality/IT manager saying:

> *"I have always asked myself what we [management] would do if people were really unhappy with my proposals for new technology ... How much say should people with no idea about IT actually have !"*

During informal discussions with operational stakeholders [considered to be anybody who 'drives' production], it appeared that Company B's vendor supplied MRPII system operated with organisational support and acceptance. Although, the management interviewees did consider the acceptance and successful outcome of the MRPII project, to have been facilitated by listening to employees' opinions and their suggestions.

However, the quality/IT manager appeared sceptical to 'open communication', as it was considered to slow down decision making. This view was expressed by saying:

> *"It has been a slow and gradual process to attain a reasonable level of computerisation ... We seem to spend more time talking about it, than getting on with it ... I have never been in a position to make a decision, and get on with it ... There is always someone to discuss my ideas with."*

Everybody at Company B was considered to be a stakeholder of MRPII, as it was considered to impact the whole organisation. As a result, all employees were informed about the project, to gain their support and acceptance.

Analysis of Stakeholder Identification at Company B

The vision for an integrated MRPII system was shared and discussed with the whole organisation. Much of the management team considered that the entire company would be affected by the investment. As a result, there was much effort to gain support and acceptance for the system. However, the success of this may have only been made possible by the small size of the company, and its non-departmental structure.

There appears to be empirical evidence to suggest that the process of sharing and improving ideas with stakeholders, although beneficial, may have hampered Company B's empowerment process. This appears to be the case, as new and innovative ideas appearing to require a long time to communicate, adopt and implement. The reason for this was that the culture within the company promotes the sharing and acceptance of ideas with stakeholders. However this type of culture may be seen as a barrier to employee empowerment, as the workforce appears to feel the need to gain acceptance of their ideas, by discussing and sharing them, before acting on them. It was also considered by the MD that once an idea has been shared and communicated, and as a result, often improved, it is more likely to be embraced by its stakeholders, thus improving the projects' success. Hence, those who considered the 'open culture' within Company B to slow the decision making process down, would appear justified in part.

Communicating the need to adopt new technology is a lengthy and complex process, and requires context to the business plan. As a result, it may be necessary for some of the more strategic issues associated with adopting new technology to be simplified, before management shares them with stakeholders.

However, this simplification may present management with much difficulty, and question the level and 'pitch' of information that should be shared with stakeholders.

Stakeholder Identification at Company C

Manufacturing resource planning at Company C was developed covertly and on a continuous improvement basis. This was a result of their inability to secure suitable finances, as the management team was unable to quantify all benefits and costs, thus rendering the quality/plant manager unable to develop an investment proposal. It would appear that the company did not approach the development of bespoke MRPII in a structured way, even though their development of a manufacturing management system was one that involved the reengineering of business processes, and would ultimately impact many stakeholders.

In developing the system, both the production manager and project champion identified employees that could support bespoke system development, and then addressed their training needs to facilitate the development of MRPII. As a result, specific employees were sent on appropriate training courses. In doing so, resulting in potential from the shop floor being released through their working with office stakeholders, on the computerisation of manufacturing and support business processes. The framework for this 'partnership' involved the flowcharting of MRPII processes, which were then followed by brainstorming sessions with process appropriate stakeholders [managers/support employee involved with the process being computerised]. Proposed revisions with those stakeholders likely to be affected by the new work practices are then raised, where consensus to changes are agreed. Many of the modifications made were a result of the flowcharting process and the reengineering opportunities. In praise of this approach, the production manager responsible for the technical support associated with developing a bespoke MRPII system said:

> *"By taking people off the shop floor and training them, we have been able to convert them into sceptic fighters ... Instead of managers having to fire fight and listen to criticism, we let the guys we took off the shop floor develop the system. We [managers] just make sure they have the tools and resources needed to get on with it."*

In establishing the significance of office stakeholders involvement, it was clear that Company C placed much emphasis on their participation to improve business processes, whilst allowing the office stakeholders to retain ownership. Furthermore, it was widely perceived and expressed by those shop floor employees developing the computerised system that they:

> *"... need to work with the people that own the process, as they are the experts at what they do ... I try to improve their processes through showing them what technology can do, and how it can make their life easier."*

Analysis of Stakeholder Identification at Company C

It appears that many of the human aspects associated with MRPII were addressed through Company C's 'partnership' initiative. Also, as there were only a few operational employees responsible for the development of bespoke MRPII, holistic focus of the project was relatively easy to maintain. The reason for this was that modules were not designed and developed in isolation to stakeholder requirements. Although, there is nothing to suggesting how the operational workforce will receive the adoption of modules such as SFDC, which is considered by the management team to be an integral part of their manufacturing IS.

Also, event though Company C was alien to the term stakeholders, employee involvement in the development of their system was evident. Furthermore, it was Company C's intent that their partnership initiative should facilitate acceptance and commitment to the change process, and result of bespoke development. In doing so, being achievable through identifying those employees who have a 'stake' in the process, and allowing them to work with the system design team on Business Process Reengineering (BPR) and software architectural issue. Clearly, it would appear that system development is enhanced when developers work in partnership with stakeholders. Although, the stakeholders involved should not be restricted to those that use the system but also encompass those that are reliant on the information generated from the system.

Stakeholder Identification at Company D

The development of bespoke MRPII at Company D was shared with the entire workforce. In discussing MRPII with its stakeholders [entire workforce], issues associated with Company D's development of bespoke software were divided into two parts, and championed by an external consultant. Firstly, all office stakeholders were invited to a discussion session, where questions on the implications of computers were encouraged and associated issues discussed. These questions were directed to a steering committee, which was lead jointly by the MD and an external consultant; senior managers adopting a passive role. When asked to describe the outcome of the discussion session, a graduate engineer said:

> *"Nobody had an idea what they [steering committee] were talking about, and it left everyone very confused and bored. They should have started at a basic level describing what computers do and how they can all talk to one another, and make life easier. Instead, they talked about Windows and the mechanics of MRPII."*

As a result, stakeholder introduction to MRPII left a negative impression on the workforce, with many employees expressing a feeling of frustration. The reason for this was explained by a production planner who said:

> *"... the whole thing was boring. I could not see how what I do will change as a result of MRPII. All I knew is that I will have to use computers instead of a planning board."*

There was also a second level of briefing that was carried out by the external consultant. The consultant appeared to champion all discussions on the shop floor, with his credibility having already been established, following the success of earlier projects. However, when the production manager was asked to describe management's involvement with the shop floor stakeholder briefings, there was a reply:

> *"I left him [external consultant] to get on with talking to everyone, he knows more about it [MRPII] than me ... He usually grabs me, and updates me on his progress before I go home ... I am usually getting on with the important stuff like sorting out customers and production."*

Most management and the production manager in particular, appear to have abdicated the responsibility of discussing the implementation of bespoke MRPII to the consultant. The reason for this was that the consultant was considered to be doing a good job in spreading the need to develop a IS infrastructure. Nevertheless, there was an evident lack of management support to the MRPII project, which raises questions regarding management's level of commitment. Regardless of management support, most operational stakeholders appeared willing to embrace the inevitable adoption of new technology, which was a result of the consultant briefing employees. This feeling was expressed by a shop floor operative who said:

> *"Computer are everywhere, so it is only a matter of time before we have computers on the shop floor ... I don't mind using them [computers] as long as someone shows me what to do and doesn't shout at me when things go wrong."*

There appeared to be an acceptance by operational stakeholders, on the need to computerise business processes but there was a distinctive feeling against computerising many business process at a management level, with a senior manager saying:

> *"Computers get rid of people that are expensive and whose jobs can be automated. I am not going to be a sales man for a technology that is going to take over my job."*

The concept of replacing many senior management functions appeared shared by a graduate engineer was said:

> *"We need to get rid of dead wood [implication being particular senior managers], they take too long to make a decision and they aren't willing to change, and use technology. There holding us [Company D] back."*

It appears that senior management discouraged the promotion and acceptance of computers, and the need for business processes to change. However, a graduate engineer challenged much of managements fear, and said:

> *"We need their [senior managements] experience and expertise. They should be planning for our future and not worried about being made redundant by new technology ... All that does is drag us all down by creating instability."*

Analysis of Stakeholder Identification at Company D

Company D's view that everybody is a MRPII stakeholder was one spread by the consultant to the whole organisation. In communicating this, the consultant explained to the workforce that MRPII will affect the way they work. In doing so, explaining that new technology is going to support their jobs. As a result, much of this fear and scepticism was replaced with enthusiasm but, only after it was explained that the technology would change the way Company D does business, thus suggesting it would affect all job functions but unlikely to replace jobs.

Clearly there were many MRPII stakeholders at Company D, with operational stakeholders being 'won-over' to the idea of accepting change, as an opportunity to develop new skills. However, what is also interesting is that there were stakeholders for failure, who appeared to be senior management. They were scared of loosing their decision making power, and even their jobs, to the adoption of new technology. So in acting as a barrier, they adopted a passive role during the momentum of developing stakeholder interest and acceptance.

5.1.2 Cultural Issues as a Construct to Concept Justification

Cultural Issues at Company A

The organisational culture[4] at Company A is one that has undergone significant change. This evolution has progressed from a dominating reactive senior management structure, which had a clear hierarchy and was depended on traditional approaches to manufacturing. Company A now promotes cultural beliefs that are all combined into a mission statement. This is a public commitment that provides a vivid description of what the organisation will be like when success has been achieved. However, this process has only been allowed to follow after the removal of directors that were perceived by the MD to be:

> *"... Holding us back ... It was nothing fancy like a boardroom coupe. They were getting bored, having been in the game [subcontract engineering] for 20 years and they didn't want to change with the times. So, I raised the necessary finances through venture capital ... I then bought them [two directors] out ... When I now want to change anything I don't have to fight with them anymore ... I am now the only person accountable for moving the company forward."*

It might appear from the above comment that the structure of Company A's ownership has simply changed from being a democracy of three directors, to a dictatorship of one. However, this was challenged by the production manager, who said:

> *"The MD is accountable because the buck stops with him but the whole management team is responsible for the success of the company."*

Clearly this statement exemplifies the unity of Company A's management team, in striving for success. In changing the culture of Company A, Manchester Business School (MBS) played a significant role, with the MD praising their input by saying:

> *"They helped switch me and my management team onto the principles of Best Practice. I learnt new ways of managing a business and the importance of a business strategy ... We don't see investing in new technology and systems as a cost anymore but rather, as an opportunity."*

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[4] Smircich (1983) has pointed out that the concept of culture has been borrowed from anthropology where there is no consensus on it's meaning.

The buying out of directors, and their removal from Company A's board, presented the organisation with a management experience void. The MD explained that:

> *"I had to quickly bring up people through the ranks. I gave them more responsibility and empowered them to change things. I even sent them on Manchester Business School accelerated growth courses but, it was all too much for them, and went way over their heads ... So, I had to put on courses for them 'in-house'."*

However, this questions why new managers were not brought into the company to address the management void. In addressing this, the MD replied:

> *"I wanted to do radical things and didn't want to replace 2 former directors who were sceptics with others, who would just be another barrier ... I knew I could mould existing people within the company ... Also, most people are time-served technicians and know our business processes ... I wanted an engineer that could manage, and not a manager that knew a little about engineering."*

As a result, 'in-house' courses were designed and developed by the MD, with a number of industrially sponsored students[5] assisting. These sessions were not just confined to potential managers but also involved work section leaders[6]. As a results of those training and education sessions, the results of the MD's education session soon cascading down the organisational structure. The long-term implications of the MD's efforts were exemplified by the comments of a section leader, who said:

> *"We used to have a very militant union that was always at logger-heads with management ... Just by looking around you can see how much things have changes, we don't have a union anymore ... Everyone works well together, and is proactive and empowered to get on with it."*

When probed for cultural factors that contributed towards Company A's PPC/SFDC system failure, the MD commented by saying:

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5 Students were industrially placed at Company A for a period of 6 months, or 1 year. During their placement each student was academically supervised by a member of University staff, implicitly resulting in technical academic support.

6 Work section leaders are key employees responsible for each work section and cells on the shop floor.

> *"In the past I tried to do it all alone and hit barriers where ever I turned but I quickly learnt that its people and the culture that they create that matters. It is this lesson that I have instilled into my managers ... I have now revised our mission statement from purely focusing on the adoption of new technology, to being a partnership between people, technology, customers and suppliers."*

The MD then described the cultural essence of Company A's previous vendor PPC/SFDC deployment by saying:

> *"People are not machines and need gentle persuasion, they have to buy into the Company's vision ... We have learnt from our mistakes and have now developed a culture based on openness and partnership ... It has taken us years to gain their trust and commitments, which are essential in accepting change and the need to invest in new technology."*

Analysis of Cultural Issues at Company A

Company A remains a privately owned company, whose radical ideas on employee empowerment, and the implementation of continuous improvement makes them stand out from the crowd. They appear to be ahead of the competition in many ways, especially when benchmarked against traditional British subcontract companies (Hobson, 1993). The evidence is that Company A is an award winning 'Inside (UK) Enterprise Demonstration Company', for the Department of Trade and Industry (DTI, 1993), and was described as an 'exemplar company' by the accrediting 'body' of 'Investors in People'.

The culture within Company A appears to have changed dramatically, following their intensive surge to educate employees, together with their removal of director level barriers. As a result, a more proactive corporate culture has been developed, which is based on visionary management and leadership. New ideas are openly encouraged, with employees on the shop floor empowered to make low-cost changes to business processes. Clearly, much of their need to change the culture was exemplified by Company A's failure of PPC/SFDC, which as a result, identified the importance of human and organisational issues in securing project success.

Cultural Issues at Company B

The organisational culture in Company B's is one that has not needed to undergo significant changes. It has benefited from a flat hierarchy and small company size, together with a proactive MD, who has a vision of the best practice management of people. The perceived success of Company B's corporate culture appears related to a number of key enablers, which have proven to be 'ingredients' for their rapid success and growth. At the genesis of these enablers are continuous improvement and innovation. In addition, a horizontal management style, open-door management policy and an empowered workforce, all facilitate their previously aspired culture. The MD of the company has very strong views on the importance of a proactive culture, and said:

> *"We are a small company and because of our size retain a personal feel and friendly qualities ... When there are too many names to remember, I will know that we have grown too big."*

The Company's guiding philosophy forms an integral part of its culture, and drives the organisation forward. This is shaped by the decision makers within Company B, who would appear to be the MD and quality/plant manager. As a result, the organisation is 'driven' by their thoughts, decisions and actions. Company B's mission statement clearly translates its philosophy into tangible business centred goals, with the purpose of moving the organisation forward. As a result, when Company B proposed to adopt MRPII, it did so within the broad framework of its mission. Hence, there was close consultation between its software vendor and workforce. In doing so, Company B took advantage of vendor training, which involved the operational training of those employees responsible for the operation and maintenance of the systems' integrity.

To communicate the impact of MRPII with its stakeholders [the entire company], Company B made use of notice boards, which were used to disseminate information associated with the adoption of MRPII. However, when operational employees were asked about the effectiveness of the notice boards in communicating the companys' business plans and progress, the notice boards were widely considered ineffective. Even though Company B considered communication as a vital part of their 'open' culture, little emphasis was placed on evaluating whether notice boards were effective in communicating the plans of the business to adopt MRPII.

This appears interesting, as on one hand there appeared to be a great deal of communication and awareness of the plans and vision of the organisation, and yet on the other, employees confessed to not reading the notice board. Therefore, the MD was questioned on approaches to organisational communication that support the company's culture, and said:

> *"I like to openly discuss how the company is performing, so, this means combining performance briefings with education sessions ... It is about demonstrating commitment and establishing confidence ... Everybody knows how interest rates affect out cash flow position and overdraft ... So they know when it's a good time to invest and when its not."*

This line of questioning was then developed further, to establish the specific process used to communicate the adoption of MRPII. The MD replied:

> *"We use Employee Action Teams (EAT) throughout the company ... Its their responsibility to identify Specific, Measurable, Achievable and Realistic project deliverables ... The production manager who facilitates the EAT is then responsible for directing the implementation of MRPII."*

The EAT consisted of the software vendor, and those stakeholders responsible for the operation of key modules. The production manager and the software vendor provided the necessary technical assistance, and support that the stakeholders team members were perceived to need. This process was a team effort, with the production manager saying:

> *"We all got a buzz out of working together ... I made sure that everybody on the team got the support that they needed, and I helped translate technical terms into non-technical terms ... I think that it helped having vendor consultancy support ... it gave us all confidence."*

Analysis of Cultural Issues at Company B

A reason why the MD found it easy to communicate the company's business plans for growth and success, might be because the company is small in size. Company B also appears to have been shaped by key people within the organisation, and in doing so, has adopted their ethos. The result of this is their 'ease' to communicate and express their views to follow colleagues.

It is also interesting to note that the MD wanted the company to grow in size but not too big, as there was considered to be an increase in decision making bureaucracy and loss of control, with developing into a medium-sized organisation. As a result, the decision regarding MRPII software was one taken by the MD whilst considering that the company will not grow beyond the parameters of the software.

A human implication resulting from the adoption of MRPII, is that their is the strong belief by the workforce that it will help to develop their personal skills. However, this appears to be considered a substitute by the workforce, as there is no infrastructure to progress to management. The reason for this is that there is a flat hierarchy and no where to progress too within the company. As a result, the workforce is forward thinking and is taking advantage of their new opportunity to update and develop new skills. In doing so, stakeholders of the MRPII investment see the adoption of new technology as an opportunity and not a threat to their jobs. Clearly, stakeholders consider to have been presented with a chance to develop new skills and change business processes, which increases their flexibility and awareness of new technology.

Cultural Issues at Company C

Company C had a proactive MD, who spend much time analysing the company's competitive position, and supporting change initiatives. However, much of this effort was guided with the use of prescriptive corporate management approaches. The reason for this was as the quality/plant manager says:

> *"... There needs to be some form of structure to everything but its the structure that's sometimes questionable and he [MD] doesn't realise that. So, I use my initiative and common sense, which sometimes means working around guidelines ... I always get what I want because it is about how you word things and show that you can't do without the equipment or technology that you want."*

Although the management value the need to change, it is the pace of this change that is causing much concern. The reason for this is that the company's reporting processes demand the use of certain procedures, and format for their presentation. When this was investigated, the marketing manager said:

> *"We used to be part of a big group that had certain procedures, which all need maintaining ... this is so that they could be compared, and kept in the same format. The problem is that we are no longer part of a big group, and can't maintain that level of bureaucracy because we don't have the infrastructure to support it."*

Clearly, many of the procedures within the company were previously prescribed by their 'head office'. However, even though they are no longer part of a corporate group, Company C have maintained many of their previous values, beliefs and processes. Although, members of the management team now identify the need to change the company. As a result, the quality/plant manager said:

> *"I am a renegade around here because I don' let what I am supposed to do stop me doing what I want to do ... that usually means working on projects covertly and with little support. The MRPII project is a typical example ... just those that have the skills to help me are involved. When we [bespoke development team] have anything interesting, or need more help, we will recruit others by showing them our progress."*

The nature of Company C's manufacturing processes are complex, largely because the company offers a whole range of precision production services. As a result, the workforce needs to be flexible and capable of moving around the factory from sections with spare capacity to other work areas with no capacity, or resource constrained. Much effort has since been placed on developing a culture that promotes flexibility, which involved much training and education. Consequently, the culture within the company now reflects this, with a shop floor operative saying:

> *"We are appreciated for knowing our job and being flexible, you need both of these skills ... if you're a specialist in one area and that section is not busy, then you end up getting laid off, which no one can afford. I am both a conventional turner and CNC machinist, as well as a production line fitter, so there will almost always be work for me ... I am flexible."*

When asked about the perceived impact of IT/IS in manufacturing, the shop floor operative said:

> *"Computers were almost always confined to offices at one time but are now appearing everywhere, even on the shop floor. I guess I will have to learn how to use one to make me more flexible."*

Analysis of Cultural Issues at Company C

The core values and beliefs within Company C are such that they have been developed while being part of a big group. As a result, much of the management guidelines and procedures remain unchanged and are those that were previously described by 'head office'. For example, traditional appraisal techniques remain in use within the company, even though their limitations are well established. Clearly, the culture of 'not questioning' the 'status quo' remains, although, this is said to be slowly changing.

It would appear that the nature of Company C's culture is such that their is a demand for highly flexible employees, who are capable of moving around the company. In doing so, working in capacity constrained areas and relieving 'wandering bottlenecks'. As a result, the company is continuously learning, evolving and developing its employees and technology to accommodate and react to business change. This appears to have contributed towards developing a culture that is based on flexibility, and the need to develop new skills. Therefore, it could be argued that through embedding flexibility into people, new ideas for innovation and continuous improvement are encouraged. The reason for this is that employees may work in many different work sections, resulting in inspiration for technology based process improvements. However, many management procedures, such as process improvement funding, appear as barriers that are unable to support the company's changing culture.

Cultural Issues at Company D

The culture within Company D is based on traditional management approaches, with a direct 'chain' of command and hierarchy. However, the MD is making positive moves towards breaking down departmental barriers, with a view of reducing the organisations hierarchy. Initiatives to achieve these were being developed with an external consultant, who is responsible for giving the company support and reassurance, on projects such as the adoption of IT/IS. However, it soon became clear that although the directors were encouraging a change of culture, their was a void between the MD and graduate engineers; who appear to share a common vision, and the rest of the senior management team who appear not to support and encourage new IT/IS initiatives.

As a result, direct moves made by the graduate workforce to implement new technology were resisted by senior management.

During discussions with the graduate workforce, it appeared that new and innovative ideas for change, were often received by senior management with much resistance. The reason for this was that there appeared to be the widespread perception that the market place was a static environment, where the companys' brand name was well established. Therefore, views that Company D needed to develop a culture that embraced change were alien.

Most deployments of IT/IS within Company D existed within the finance department, and as a result, was considered an isolated technology. There was little knowledge of such technology beyond accounting and administration, and therefore nobody had confidence in IT/IS, as there was a lack of exposure, experience and usage. When the graduate engineers were probed on the lack of IT/IS adoption, there appeared a perception by the management team that the workforce was unable to absorb too much change. The reason for this was that the organisational culture was considered not to promote continuous improvement. However, it was the MD's and production managers' view that the gradual development of bespoke MRPII would facilitate the change process, thus contributing towards developing a new culture that promotes continuous improvement and innovation. Also, it was considered a 'cheaper' option, as it allowed the enlistment of technical expertise, from the graduate engineers within the company. These engineers were perceived to have the necessary skills to develop the system, and were going to be stakeholders of the system and encourage its success. However, there were serious implications with developing bespoke MRPII, with elements of Company D's senior management team resisting its development, by not releasing the necessary production resource to support MRPII development.

Analysis of Cultural Issues at Company D

The MD of Company D is adamant to change the organisation, and in doing so, has enlisted the support of a consultant, to motivate the management team, which will then be encouraged to motivate others.

However, this appears to be a time consuming process, with new change initiatives such as bespoke MRPII only having received support from the graduates within the company. The reason why this small group of employees have endorsed the MD's and consultant's change initiative, is that they appear to associate with a culture based on the principles of 'best practice'. Whereas senior managers consider such changes to result in losses of authority, and decision making power. However, it is important to appreciate that the consultant and graduates do appreciate that the development of bespoke MRPII is considered to give the organisation more control over the speed of change.

5.1.3 Training and Education as a Construct to Concept Justification

Training and Education at Company A

Company A had done little training and education before their implementation of PPC/SFDC. The implications of this are considered severe, and thought by the management team to have contributed towards the failure of their system. When Company A purchased their PPC software, the company got 5 day's worth of vendor training, which was predominantly confined to office end user stakeholders. Within this time, vendor consultants also supported the tailoring of the system to accommodate company idiosyncrasies. However, the later implementation of Company A's SFDC system, was done in isolation to vendor support, although it involved the full-time focus of a sponsored post-graduate student. The team responsible for the adoption of PPC/SFDC had not considered the impact of human and organisational factors. Consequently, when the system became 'operational', there was much resistance to its use, and as a result, its stability questioned. As a result, when the system failed to deliver its anticipated benefits, the focus of the software selection and implementation team suddenly changed, from one of great expectation, to a process of blame apportioning. Many of the problems that 'real-time' shop floor data collection was intended to alleviate, appeared to be complicated by this technology. The production manager claimed that the failure of the SFDC module was because:

> *"We had not sat down in the first place and formalised our systems ... People were not informed of the impact the SFDC system would make to their job function(s) ... Nobody on the shop floor bought into ensuring the success of the system ... they needed educating not disciplining."*

It soon became clear that training and education were regarded as significant voids that need addressing, to ensure project acceptance and success of investment initiatives. However, employees appeared reluctant to adopt the principles of SFDC, when attempts to discuss the benefits of the system were raised. Clearly, the adoption of Company A's SFDC system did not have the operational support necessary for its successful operation. The reason for this was that operational stakeholders had not been identified, and educated on the business need to adopt SFDC. Furthermore, they were unaware of the link between SFDC and PPC, which resulted in a unreliable MPS. Hence, together with other business issues[7], Company A set about developing their 'own' business solution[8], as it was considered to give management another opportunity to generate project acceptance and result in a system that the workforce would use.

Essentially, the company went back to basics and drew on their past experiences. It was decided by the MD to enlist the support of a consultancy company, as help was needed to facilitate the design, development and implementation process. Also, there was much need to educate and train the workforce on the implication of MRPII. However, before such processes could begin, Company A reassessed its strategic direction, organisational strengths and weaknesses, and revised their business plan.

Company A then instigated a series of intensive education sessions and workshop training days. All managers were educated on the importance of MRPII, and on the impact that the investment would make to their job function(s). A simplified course was also developed for shop floor stakeholders. This course not only addressed the educational issues associated with MRPII but also looked at the practical implications of the system on their job function(s). Education and training were used to promote teamwork and 'win over sceptics', with all employees mixed and grouped together to create a cross-functional stakeholder teamwork environment.

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7 Company A decided to abandon the use of their SFDC module, due to the disappointing results obtained. This decision was because of: (i) poor data reliability; (ii) swipe hardware terminal problems; (iii) a lack of employee support and discipline to consistently use the bar code system; (iii) a lack of management interest to continue the implementation process; (iv) a misalignment between the strategic technological direction of the vendor and the organisation; (v) falls in productivity; and, (vi) lack of clear project focus and leadership.

8 This investment was partially financed by two government sponsored grants.

All employees were encouraged to take part in workshop exercises, as there was the belief that the whole company would be affected by the changes resulting form bespoke MRPII. All workshops and training session had meaning associated with MRPII, such as throughput production flow, communication, Just in Time (JIT), inventory management and Total Quality Management (TQM). During these sessions, interested stakeholders were identified and 'invited' to join a system design and development team. Where necessary, these employees [subject to their acceptance] were sent on external training courses to develop new skills, such as developing databases. Also, software engineers were employed, who were post-graduate students on industrial placements. This recruitment policy helped to keep system development costs down, thus reducing the need for expensive contract engineers. Additional benefits of having students on the bespoke development project, was to bring educated and trained people into the team, and maintain a constant 'stream' of innovation, inspiration and motivation.

Analysis of Training and Education at Company A

Most of the 5 days consultant support received by Company A's software vendor, were spent training office employees on the technicalities of the bought scheduling package. The view of wider stakeholders, those reliant on using the output generated from the system were not highlighted. As a result, when the system was 'rolled out', many business processes had changed, and the operational workforce were not prepared for such changes, as they had not received appropriate training and education. For example, job reports not previously generated began to be produced by the system, with employees expected to interpret meaning. As a result, such changes were resisted and not welcomed, with those new reports often going unread and unused.

Company A appears to have approached the adoption of their PPC/SFDC system form a technical perspective, with people and their needs not being considered. However, much of this appears to have been 'driven' by the organisational culture at that time, which was one of being told to use PPC/SFDC, instead of identifying who is affected by PPC/SFDC, and giving them the training and education that they need to embrace it. Clearly, training and education were voids that have since been addressed, in Company A's attempt at developing a bespoke MRPII system.

Training and Education at Company B

The small size of Company B is considered to have facilitated the MD's ability to bring employees together, and discuss why, and in what way MRPII supports Company B in facing the challenges of the future. In achieving this, the MD took the lead but was adamant in distinguishing between employee training and education by saying:

> *"... Everyone gets educated on major initiatives that affect the company but only those directly affected [stakeholders] get training as well. I distinguish between the education and training, in that education is about knowledge building and developing as a person, whereas training is about learning new job skills."*

When it come to educating and training employees about MRPII, the MD said:

> *"I had a limited budget but managed to get vendor training support with the package that I bought. I needed this support to give training to specific people affected by the system ... So I took it upon myself to brief [educate] everyone about MRPII, before I bought and implemented the system."*

When a shop floor operative was asked to evaluate the education that was received about the company's plans to adopt MRPII, it was commented that:

> *"The training [this would suggest that the employee was unable to distinguish between education and training] that I [operational stakeholders] received was good, and taught me a little bit about MRPII, and why we are buying it ... I like being kept informed."*

The education that was received by all employees was non-technical in nature, and as the MD commented:

> *"There is no need to teach everyone the in's and out's of MRPII. All they need to know is why we need to adopt the system, and how it will change the way we do business ... how they [employees] can contribute ... I know it costs us lots of money to educate people because production stops but I try to combine education sessions with other things like filling in motivation surveys, performance briefings and other things that help me manage the company ... Open communication is the key."*

Interestingly, strategic issues did not form part of Company B's educational brief on MRPII because as the MD said:

> *"We have strategies but it is really for management purposes. I have put out business plan on the notice board for everyone to read but I try to avoid waving the strategic banner when I talk to the shop floor. This isn't to say that it doesn't concern them but I try to make our briefings more relevant to their needs, by describing how what I am talking about affects them ... They [operational workforce] just want to know how it makes their job easier ... I try to simplify things, not complicate them."*

Analysis of Training and Education at Company B

It would appear that Company B first educated the whole workforce on the impact of MRPII, and in doing so, supporting the principles of concept justification. However, in reality, this must have proved expensive in terms of lost throughput and time. Specific stakeholders were also trained, which gave them the skills that they need to use the system effectively. This training was done partly by the vendor of their system, and by sending appropriate employees [stakeholders] on 'other' external training courses.

Training and Education at Company C

The bespoke system development of MRPII at Company C was covert, and as a result, there was limited project specific training and education opportunity/resource. However, in selecting appropriate employees from the shop floor to develop their MRPII system, the production manager said:

> *"I didn't have large funds to take a chance on sending people on training courses ... So, I found out who knew something about programming by asking around, and then I guessed on who might have the aptitude and interest to work on developing a new system ... It was then less of a chance when spending money and sending them on courses."*

The training and education associated with MRPII at Company C, was focused on developing the knowledge, skills and ability of three employees. These employees then worked with end user stakeholders to develop a computerised manufacturing IS solution.

These stakeholders used their knowledge of idiosyncratic business processes, when it came to designing the databases and infrastructure needed. Regarding the training of end user stakeholders, much of this was carried out by the system development team, who described the use of the system during its development, and offered operational support when modules were 'rolled out'. When office end users of MRPII were asked to describe their training, a production controller said:

> *"I worked with the programmers and described what information I need, and how I want reports produced ... I got help with training, on things like how to switch between menus and systems, and what to do if the system crashes and I loose my data ... Its nice to have someone who will always be able to help."*

Analysis of Training and Education at Company C

There was no formal training or education of those end user stakeholders responsible for using Company C's system. The reason for this is that the development and pilot introduction of the bespoke system was covert. As a result, it could be argued that Company C did not address educational issues associated with developing bespoke software, as there was much fear that the project would cease being covert. Hence, questions associated with project finances might be asked by those managers not aware of the systems development.

Also, there was no mention in the business plan of the technology in supporting the business's future objectives. This offers much interest, as the marketing manager who is an active supporter of the MRPII project, identified the changing information needs of jobbing shops. Therefore, it is interesting that in the business plan there was no mention of the need for a new IS, or the need to address production related IT/IS tactics. This therefore suggests that the focus of training and education was from a purely operational day-to-day point of view, with no strategic intent. On the other hand, this might be explained by the covertness of the project.

Training and Education at Company D

In developing the commitment of Company D's MRPII stakeholders, all employees were educated on the impact that the new system would have on the organisation. However, as discussed in section 5.1.1 it was the level of briefing and its delivery that were considered inappropriate, and responsible for not establishing much commitment for the project. Essentially, the MD described the impact of MRPII, and the technological aspects of its adoption. This was regarded inappropriate, and as a graduate engineer said:

> *"I have studied MRPII and know what its all about but others have never heard of it, and really didn't need to know about the type of technology involved. That level of information should be described to a few, and not to people that are going to simply use the system, or the information that is produced."*

Most of the graduate engineers consulted, considered that the level of education delivered was wholly inappropriate. The reason for this was that it did nothing to educate stakeholders on issues such as how the technology will re-define their jobs. Instead, it is thought to have complicated the adoption of MRPII, by creating scepticism at a senior management level. Consequently, management and the general workforce regarded the adoption of such technology as just another management panacea that offers more than might deliver. Regardless of its poor start, there was a second level of training and education, which was carried out by the external consultant. This appears to have been 'better' received, with many operational stakeholders accepting its adoption, on the premise that it will make their jobs easier, and help them make better decisions. This form of briefing involved identifying stakeholder needs, and then matching their needs with what MRPII was considered able to deliver. It appeared to work, and created a feeling of optimism, such as that expressed by a section leader:

> *"I have to make decisions everyday about production, and occasionally get things wrong. If MRPII can help me make better decisions quicker, then I am happy to support it."*

This demonstrates a positive and proactive approach to the adoption of MRPII, after having been educated on its implications.

Analysis of Training and Education at Company D

Employee training and education on the issues associated with adopting MRPII were adopted with two objectives. Firstly, it was used as an opportunity to inform employees and stakeholders of the consequences of computerising systems. Secondly, it was used as an opportunity to contribute towards changing the corporate culture. In doing so, it allowed the MD with support from an external consultant, to gain employee attention and support through communicating people centred organisational issues.

Clearly, in extrapolating meaning from the data, there appears evidence to suggest that it is necessary to 'pitch' employee training and education appropriately to the audience. This appears to be the case, as employees considered their first encounter of MRPII issues to have been technical and irrelevant. However, when the education was 'toned done' by the consultant, and tailored towards stakeholder job function(s), those being education could see the relevance, and appreciate the consequences of developing a bespoke system.

5.1.4 Management Commitment as a Construct to Concept Justification

Management Commitment at Company A

Initially, there was considerable management commitment in Company A's implementation of vendor PPC/SFDC software. The project was championed by the MD, and when asked why other more directly affected managers were not responsible for leading the project, the MD replied:

> *"I was the main visionary leader and could see the long-term strategic implications of my decision to invest ... It was up to me to set the standard, and lead the way."*

In the early stages of the PPC/SFDC project, there was much enthusiasm from the MD.

However, when the SFDC pilot scheme finished, and the system was 'rolled out', difficulties began to be experienced. As a result, the MD/project champion quickly turned his attention, appearing to have either lost interest, due to implementation problems, or a lack of success, or being 'driven' by other organisational improvement initiatives. Responsibility of the remaining implementation was then delegated to others, hoping that the by then well established production manager would take up the challenge. Interestingly, the production manager was not a key member of the vendor PPC/SFDC implementation team but nevertheless, operated as an honouree, advising on technical issues when consulted.

The production manager was expected to take the lead, in his role as head of the production department. This new responsibility for the success of a 'half' implemented PPC/SFDC system, of which little consultation with the production manager had been sought, was not readily welcomed. Although the production manager acknowledged the contribution the PPC/SFDC system was making/could make towards the streamlining of the production function, the production manager said:

> *"It was never my project. No one wanted to involve me ... So I didn't want to get involved in it [PPC/SFDC] ... Even more so, when its costs were rising and the system was proving not to deliver the benefits sought."*

However, the MD expressed an alternative opinion and said:

> *"He [production manager] never fully got behind it [PPC/SFDC] because he was always 'fire fighting' and reacting to day to day customer demands ... He was unable to detach himself and take a long-term strategic view of the company."*

It can be seen that there was much 'bad' feeling between the MD and production manager, with the production manager commenting:

> *"All the glory has been had, and when it came to the real hard work of getting the system accepted, and working on the shop floor, where was the MD then ... There were mistakes made and it is very difficult to go back and correct them, you are dealing with people ... that's why I didn't want to get involved ... If nothing else, we learnt from the experience."*

Clearly, there was much senior management commitment from the MD, which took the form of project leadership. However, as the MD needs to be aware of the broader business issues, this raises the question of whether the MD was the most appropriate person to champion the project. This concern was exemplified when the system began to fail and the rest of the team felt that they lacked leadership, with the MD abdicating responsibility. A project engineer at the time, recalls:

> *"We [vendor software team] didn't know what to do, things seemed to be falling apart. We couldn't get people to use the bar code terminal and yet all our production schedules depended on it ... The production manager was frantic as customers were demanding their parts, and in most cases the job hadn't even been started ... Overdues just kept on mounting."*

However, when Company A decided to abandon the project and began developing bespoke MRPII, many of the problems associated with management commitment were addressed. In doing so, the new project of bespoke system development was this time supported by the MD, with the production manager now leading the project. This project was also facilitated through an external consultant.

Analysis of Management Commitment at Company A

A number of management commitment issues appear to emerge as a result of Company A's adoption of PPC/SFDC. Firstly, the empirical evidence presented appears to questions whether the MD was the most appropriate person to lead the PPC/SFDC project. The reason for this is that PPC/SFDC is a long-term project that requires much dedication and commitment, with the project leader needing to have sufficient authority to make decisions and then see them turn into reality. In the case of Company A, it is considered that the MD was trying to express his enthusiasm about the project in the form of leadership, when in reality the appropriateness of the MD leading the project of this nature is debatable. The consequence of this was that when problems began to be experienced, the MD was unable to give the project appropriate attention but also, the rest of the team felt uneasy to take the lead from a pragmatic MD. There were also sensitive political issues, as the production director was reluctant to get involved, as his opinions were initially ignored. Clearly, there are project management issues associated with leading and managing a project of this nature in a SME.

Management Commitment at Company B

There was significant management commitment at Company B, regarding the adoption of vendor MRPII. Much of this commitment came from the MD, who saw his role as:

> *"Chief motivator and communicator ... I keep people updated on the performance of the company and on key projects."*

Whereas technical[9] aspects of vendor MRPII were taken care of by the production manager, who regarded his role as:

> *"... Person to take care of the technicalities of the system, and make sure it meets the needs of the business and its users."*

Interestingly enough, the quality/IT manager had a passive role in the MRPII project, and was only responsible for general issues, such as advising on the selection of hardware and software. Although, the quality/IT manager did get more involved when it came to developing specific quality modules. Such modules included inspection, calibration, customer complaints etc., which are required by BS EN ISO 9000 (BSI, 1994). The quality/IT manager was also responsible for the implementation of the IT, i.e. networking but, played no role in its evaluation once operational. However, the production manager actively supported MRPII as it was considered to be:

> *"... Software that was designed for manufacturing and therefore, required a production engineer to tailor."*

Also, the production manager considered that:

> *"I will be using the system and relying on what it says, so it makes sense that I should not only support it but tailor it."*

However, MRPII embraced other functional departments, such as finance, so it was sought to establish the involvement and commitment of others, when tailoring financial aspects of the system, such as invoicing.

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[9] The MD was regularly updated on the technical performance of the project, where it was evaluated at monthly management meetings. However, this evaluation was with the objective of identifying problems and establishing means of overcoming them, thus combining a proactive and reactive management style.

When questioning the MD, it soon became clear that the company did not employ a full-time finance manager but rather, employed a part-time book keeper that visited the company two days a week. It appears that the company adopted many of the prescriptive routines within the vendor software, and as a result, changed many of their traditional financial procedures. On questioning the finance manager, it was mentioned that:

> *"We have changed many of our internal financial reporting procedures, some for the better and others well, we had to change them to suite the software ... the system relies on data being entered in a particular way, so we had to change what we did, we had no choice."*

It appears that the management of Company B were enthusiastic in the adoption of MRPII, with much 'drive' and effort to communicate its effects coming from the MD's interest in the project. However, technical issues were supported by other managers such as production, who were more reliant on the information being developed from the system.

Analysis of Management Commitment at Company B

There appears to have been much interest and commitment from the management team within Company B, regarding the adoption of MRPII. There appears to have been specific roles for each manager to perform, and as a result, clear responsibility. For example, the MD formally reviewed the progress of the project at each monthly management meeting, where technical problems were raised and possible solutions discussed. The results of this were then disseminated to the rest of the company through briefing sessions.

It is also interesting to note that Company B changed many of their idiosyncrasies to accommodate the adopted software, regardless of whether the reengineering improved the business process. Hence, it would appear that the MRPII software was prescriptive in nature.

Management Commitment at Company C

The development of bespoke MRPII at Company C had management commitment, insofar as the project was instigated by the quality/IT manager, with secondary support from the production and marketing managers. Company procedures required all request for capital funding in a prescribed format, however, the MRPII project was regarded as not 'easily' fitting into traditional investment proposal templates. The reason for this is that the project instigator [quality/plant manager] was unable to identify the resources necessary, and quantify the implications of the project. As a result, it was decided by the project initiators to develop the system covertly, on a continuous improvement basis, as the company's funding procedures were able to be manipulated, and thus support the financing of the MRPII project. However, the quality/plant manager said:

> *"We [development team] won't be able to show the system off to the MD ... Its my job to support production, and if that means working with the production manager to develop a software solution, then that's what I will do ... Its just that I could do it better and quicker if I didn't have to do it under cover and on a shoe-string budget."*

When the marketing manager was asked about his commitment towards bespoke MRPII, and how a manufacturing management system might support marketing's functional needs, the marketing manager replied:

> *"I don't know much about IT but I support the development of a system that can tell me what I need to know ... I am always on the road, and when I get back most people have gone home. So, I want to be able to jump onto a computer and find out certain things ... what our order book level is ... They [MRPII development team] have designed a menu for me so that I can easily find things out ... Yes, I do support the development of this system, it makes life easier."*

Clearly, there was much management support for the system. The reason for this was that there were many benefits sought. Although, most of these benefits were only visible at an operational level. Regardless, the Quality/Plant manager exploited this to generate end user support.

However, the quality/plant manager could see the wider implications of the system but resisted enticing the MD, until the system was well developed. To maintain the covertness of the project, a decision was made by the author not to request an interview with the MD, as it may have provoked the MD's interest, and compromised the quality/plant manager's endeavours. However, the production manager endorsed his own management support and commitment to the project by saying:

> *"I am in favour of developing a system that will make everyone's job easier. We had a lot of manual processes and even repetitive data entry ... Some of the menu's have now gone on-line and everybody likes them but there is along way to go ... I am sure many problems lie ahead, before we have a fully integrated system."*

When the quality/plant manager was asked to summarise the overall level of management commitment, and the techniques used to generate this support. He replied:

> *"It wasn't that hard ... I asked them [managers] what aspects of their jobs were difficult, and told them that if we [managers] developed systems that linked together, then many of there difficulties could be overcome ... I then won people over by developing a few simple databases for them [managers] to demonstrate my point ... They could then easily see what I was trying to do."*

To illustrate this, and win over an initial sceptic, a simple database was developed for the sales and marketing manger. The database detailed the customers' unique code, part number, job quantity, batch price and delivery date, and allowed the logging of sales enquiries. This database was then linked to the sales order database, which had already been developed, thus reducing the need for double data entry. Also, it was demonstrated that not only did the database make the job easier and quicker but also paperless. Furthermore, it allowed the sales and marketing manager to have instant access to the information that his job function required during sales visits, as the database was regularly saved and loaded onto a lap-top computer.

Analysis of Management Commitment at Company C

The strategy adopted by those developing the bespoke system in gaining management commitment, was to provide a workable solution to the problem of those who's help was needed.

This approach appears to have worked, as was demonstrated when the marketing managers commitment was required.

It is also interesting to note that the range of benefits used to gain and maintain management commitment, were generally operational. A possible reason for this is that management wanted to physically see the tangible benefits the system could deliver in transforming their job functions. However, since the MD and other directors were not involved in the project, many strategic benefits were ignored, therefore, having possible long-term implications with an opportunity cost.

Management Commitment at Company D

The MD of Company D demonstrated management commitment towards the development of bespoke MRPII, by instigating the development of a steering committee. However, this steering committee appears to have only demonstrate verbal commitment to the project. This committee focused their attention on office end users of the proposed system, and were not used to deliver confidence and reassurance at an operational level. Also, although the MD played a proactive role, much of the project leadership appeared delegated to the external consultant.

When the production manager was asked about the degree of involvement that production had in developing and supporting the bespoke system, there was a reply:

> *"I was always around to discuss the project, and got involved when I could but I really couldn't devote all my time to managing, or developing a new system ... But involvement was more than others [senior management]."*

It was clear that although the steering committee had been set up to support the essence of concept justification, the same members were not involved in the development of the system, however, this was with the exception of the external consultant. Furthermore, there was a senior management contingency as part of the steering committee that resisted the development of MRPII. The reason for this is that it was perceived to replace much of their job function, and take away their decision making power, and therefore, considered that the system would render them redundant.

This resistance was demonstrated in their passive role as steering committee members. However, of those employees that actively encouraged and supported the development of bespoke MRPII, i.e. graduate engineers, there was no representation, other than through supporting the external consultant. During the development of MRPII, a graduate engineer said:

> *"There are a few of us who studied MRPII at University and know its value. If we didn't support and develop the system with the consultant, who would? ... It would definitely fail."*

There appeared much resentment by the graduate workforce, which stemmed from their inability to advise and 'sit' on the steering committee, with a graduate engineer saying:

> *"I am one of those that should have been involved in the steering committee, I actually know what I am talking about. We [graduate engineers] know the most about MRPII, and at the end of the day have to develop and use it [MRPII] ... I should be involved in decision making."*

Regardless of their exclusion, the system has continued to develop, with little more than steering committee endorsement through 'lip service'.

Analysis of Management Commitment at Company D

It would appear that although the MD of Company D had good intentions regarding his commitment and enthusiasm for the project, the management team who took the form of a steering committee let the project down. Furthermore, it would appear that their motivation for not being committed to the project was a result of their self-interest. Nevertheless, the project has continued with the support of graduate engineers, who recognise the value and contribution that MRPII can make to the organisation.

Also, it is interesting that an external consultant appears to 'unofficially' lead the project, although final authority comes from the MD. However, the self-interest of the steering committee members may continue to jeopardise the project.

Finally, political issues appear important, with the graduates who consider themselves knowledgeable about MRPII feeling left out, since they are not involved in the steering committee, thus generating resentment.

5.2 Investment Strategy and Method Used to Appraise MRPII

Chapter 2 has already provided a literature review and presented a novel taxonomy of appraisal methods. In doing so, their respective characteristics and limitations have been discussed. As a result, it is not the intention of the following sub-sections to explore such issues but rather, discuss the operational implications of those techniques being used by the case study companies. However, in circumstances where no techniques are being used, issues associated with their omittance will be discussed.

Idiosyncrasies that address issues such as why particular techniques have been adopted over the use of others are investigated. Also, those issues and concerns associated with applying technique to appraise MRPII are discussed, from a practitioners' point of view.

Investment Strategy and Method Used to Appraise MRPII at Company A

Many of Company A's previous investments have been subjected to financial analysis. Such projects include the adoption of Computer Numerically Controlled equipment, which had been financed through loan-agreements, where cash flow projections and sensitivity analysis had been used to assess the financial impact and risk associated with such projects. However, Company A soon discovered that such accountancy frameworks were not suitable for investments such as the adoption of PPC/SFDC, which had significant intangible and non-financial benefits, together with indirect costs. Therefore, Company A's prescriptive justification process soon proved itself inappropriate, during the evaluation of vendor PPC/SFDC. In particular, much concern was expressed in their inability to assess the impact of those benefits that are not readily convertible into cash values. This issue, together with a new and inexperienced management team that was unaware of non-traditional appraisal techniques that could acknowledge, albeit subjectively, qualitative benefits and costs advocated to the use of a simplistic CBA.

The use of a CBA provided a framework for identifying those benefits and costs associated with PPC/SFDC. However, there was no structure to the analysis of those benefits and costs identified. Also, there was no assignments of financial values to the investment implications identified. When the MD; who was the project leader in the adoption of vendor PPC, was asked to explain why no quantification, classification, or assignment of arbitrary values were made, there was a reply:

> *"... because it seemed to complicate the issue, and looked very time consuming. We just wanted to get on with it ... There was no way that everyone was going to agree with the cash figures we set ... The scope of benefits appeared enormous and only restricted by my imagination ... Anyway, I was sure the benefits would far outweigh the costs."*

Company A identified much concern over their inability to calculate accurately the projects' financial returns, as they had been used to appraising previous investments in a traditional manner. As a result, an 'act of faith' investment appeared to be the only option available. Interestingly enough, the British CIMA/IProdE (1987) suggest that some benefits of IT/IS cannot be quantified, and states that *"an act of faith that such systems are necessary may be required"*. Therefore, the British CIMA/IProdE appears to advocate the adhoc justification strategy used by Company A. However, as discussed in section 5.1.1, Company A later conceded the failure of their vendor PPC/SFDC system, and as a result, then set about developing their 'own' business solution.

It was perceived that the company would be more satisfied with the results of their 'own' bespoke system, rather than the implementation of what later appeared to be 'rigid' vendor software. Also, the development of bespoke MRPII software was considered by the management team to give them a 'new' opportunity to gain operational support, which was later identified as essential for the successful adoption of MRPII. In doing so, embracing many of the principles of concept justification discussed in Chapter 3. Hence, it would appear that human and organisational issues; which were perceived to have contributed towards the failure of vendor PPC/SFDC, played a crucial part in Company A's decision making process to develop a bespoke software solution. Clearly, when considering to develop bespoke software, a new range of factors were considered that were also not accountable in traditional appraisal frameworks but, had been omitted from their earlier CBA.

The decision by Company A to develop its 'own' software was seen as a significant turnaround by many within the organisation. However, the majority of benefits originally envisaged as deliverables from implementing PPC software, appeared to have still remained relevant. However, the scope of costs associated with developing bespoke MRPII were considered greater than those identified originally in their earlier CBA of vendor PPC. Therefore, as part of a revised CBA, Company A identified a new dimension of costs that it perceived would be incurred during the development, implementation and operation of bespoke MRPII software.

Driven by the limitations of CBA and the complexity of developing a bespoke MRPII system, the management team was unable to assess the financial commitment necessary to develop a bespoke system. As a result, the company modified their earlier CBA based on their experiences, and were again forced to develop bespoke MRPII as an 'act of faith'. Although, there was now a wider appreciation of the projects' human and organisational implications.

Regardless of being unaware of the projects' costs, there remained much motivation by the management team to 'try again', after having learnt from their previous mistakes. It was appreciated that many of the problems associated with the failure of their earlier attempt to adopt PPC/SFDC were human centred, with such implications not being quantifiable within traditional appraisal frameworks. However, the company now recognised that it had established a wider appreciation of such issues, and saw the management of such factors as contributing factors towards the success of the project and organisation.

Hence, Company A developed bespoke MRPII as an 'act of faith' in part because they were unable to quantify its benefits and costs. However, the management team was also motivated to adopt this strategy because they saw the development of MRPII as a facilitator for BPR, which would support the cultivation of a corporate culture based on the sharing of information, through empowered teamwork. Clearly, the implication of such are not suitable for inclusion in traditional appraisal paradigms. Although, the importance of human and organisational issues were highlighted after the failure of their earlier vendor system.

Investment Strategy and Method Used to Appraise MRPII at Company B

Company B approached the justification of its vendor MRPII system with much concern, having acknowledged the limitations of traditional appraisal techniques. Company B's concern was in their inability to financially quantify their MRPII systems' functionality, which directly supported their pursuit of a sustainable long-term competitive advantage. As a result, Company B sought reassurance and guidance on issues associated with the justification process, through the partially funded support of a management consultant. This external consultant was considered instrumental in highlighting those issues associated with the decision making process. In doing so, an *'enterprise initiative project report on the development of a management IS'* was commissioned. The contribution that this report made to the decision making process was explained by the MD:

> *"We knew relatively little about IT but had the opportunity to get government funding ... We got a consultancy company to give us some advise ... We had an idea of what we wanted but didn't quite know how to get it, so the consultant was defiantly valuable in confirming our plans ... He gave us guidance and structure."*

As pointed out, the opportunity to gain external consultation was partially funded through a Department of Trade and Industry (DTI) Enterprise Initiative grant, which contributed towards consultancy costs. However, when the MD was asked whether Company B would have still made use of a consultant, if there had been no external funding, there was a reply:

> *"... Doubtful, I knew we needed some help but it's difficult for a small company like us to afford a consultant. They are too expensive."*

On perusal of the enterprise initiative report, there was an established commitment by the consultancy company to provide Company B with guidance on how 'best' to meet its corporate aim of a totally integrated IT/IS infrastructure. Such a system was sought to embrace all aspects of their business, and encapsulating where feasible, the expert knowledge of key members of staff. The report identified its 'strategic' objectives as:

- Produce a blue-print for systems development and implementation for the next five years;
- Examine the feasibility of practical expert systems;
- Establish training and management development objectives; and,
- Conduct a CBA and identify performance targets.

Specific 'operational' objectives included:

- Specify integration of existing systems to reduce data entry;
- Identify gaps in current systems;
- Define procedures and rules for job release, batch splitting and priority setting;
- Define policy and timetable for producing information from existing and proposed systems (fixed, variable and ad-hoc); and,
- Identify performance measures to allow the effective use of the systems.

The outcome of the consultancy support was that it supported decision making with investment related information, which generated confidence. The report also provided an agreed[10] action plan, together with 'operational' advice on a range of manufacturing related IS issues.

However, this section is concerned with identifying the use of appraisal techniques, and establishing the contributions made by these techniques. As a result, focus remains on their use of CBA. Regarding the issues surrounding those benefits included in Company B's CBA, these are discussed in section 5.3.5., 5.3.6 and 5.3.7. Similarly, the range of investment related costs identified by the consultancy company, and which were later integrated into a CBA are subject to discussion in section 5.4.4., 5.4.5 and 5.4.6.

The MRPII investment was perceived by Company B [under the guidance of the consultant] to involve small amounts of expenditure with outside software suppliers. However, substantial on-going expenditure was identified as a major cost. As a result, an investment case was prepared by the consultant, and involved the identification of likely benefits and costs, which resulted in a CBA.

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[10] This agreement was within the project team; MD, production and quality/IT managers and consultant.

The purchase of MRPII software that embraced many of Company B's idiosyncrasies, was regarded by the project team to be 'absolutely crucial to their business strategy'. This was considered the case by the management team, as they regarded the ability to achieve production control through a management IS, as being essential in facilitating the development and expansion of the company. Additional business objectives supported by MRPII included the creation of Company B clones, with the objective of creating a franchising opportunity. It was on these strategic bases; with the investment supporting Company B's business plans, that resulted in the project being instigated. Hence, in this case, an 'act of faith' appeared to be the investment strategy adopted.

There was considerable debate within Company B, regarding whether they could afford the cost of the project. Interesting enough, it was the analysis of financially quantifiable direct costs that were not regarded as significant but rather more attention was given to indirect cost factors. Clearly, a result of the detail given by the consultant involved in developing the CBA, which was detailed in the enterprise initiative report. It is also interesting to note that no assignments of arbitrary cash values were given. Instead, only acknowledgement of their occurrence was established.

The timing of the project was also considered crucial in the CBA, as Company B experiences periodic cash flow problems, due to the seasonal nature of their products. This is complicated by their network of distribution outlets, which it supplies on a 'sale or return' basis. In adopting this sales strategy, it is not surprising that it may take up to several months before a payment is received from an agent. Hence, although a strategic focus was seen as the main motivation to justify MRPII, its adoption was also motivated by short-term requirements to improve cash flow, through achieving those financially tangible benefits and savings identified in section 5.3.5., 5.3.6 and 5.3.7. As a result, Company B could have benefited from analysing the consequences of cash flow fluctuations. This might of been achieved through the use of traditional appraisal methods, such a discounting techniques.

Investment Strategy and Method Used to Appraise MRPII at Company C

The inherited justification procedures within Company C were such that the organisation required all proposals for 'considerable' capital expenditure, or of strategic importance to be presented in a prescribed format. In doing so, the MD was responsible for determining whether capital funds should be allocated. However, the problem was with using their prescribed appraisal technique; which was the payback method. When the quality/plant manager was asked to describe whether the payback approach was appropriate for appraising MRPII, there was a reply:

> *"I use the payback method when appraising plant equipment, its quite easy to use ... but struggled when it came to calculating the payback of MRPII."*

This was then investigated further, with the quality/plant manager then being asked to describe the difficulty experienced:

> *"... I didn't know where to start, I knew the benefits that I wanted from the system but the payback method couldn't cope with many of them ... It was a guess when it came to putting cash figures to some of the benefits. It was even worse when it came to costs ... I knew I would be way out in quantifying the costs and benefits, so why bother."*

When asked to describe the limitations of payback, the quality/plant manager said:

> *"I have always been honest in the past when I've had to calculate the payback period on a CNC machine. More often than not the benefits were largely financial and always outweighed the costs. So the investment looks good on paper ... Intangibles just make it look better. Investments in plant equipment are easy to assess, they're physical ... And you can easily measure their impact but its a different case when it comes to IT."*

The quality/plant manager was then asked why the payback approach was not used:

> *"... Rather than fantasising with figures, I decided to try and develop a system that I would be happy with ... I used my authorised spending limit to buy things that we [system development team] need. Other costs will just have to be absorbed."*

However, there are serious implications with this investment strategy of 'investing as an act of faith', as although funds are allocated for continuous improvement projects, all this money will be absorbed by the development of bespoke MRPII software. Therefore, there is an opportunity cost, as there will be almost no funding to support non-MRPII innovations and improvement ideas. This may have a detrimental consequence on the culture of the company, with new ideas no longer being developed, as their is no finance to support them, even though they are acknowledged as giving benefit, or generating saving.

Clearly, there was little confidence in the ability of the payback approach to give an accurate account and analysis of the financial implications of the proposed MRPII investment. When asked for factors that motivated their decision to invest as an 'act of faith', the quality/plant manager replied:

> *"I can't ask for resources as I don't know what I need ... How much does it all cost ? ... Its hard to make a descriptive list of benefits and savings ... Who will be affected by the system ... I don't know where to start ... these are reasons why MRPII has not been justified in the normal way."*

Investment Strategy and Method Used to Appraise MRPII at Company D

The adoption of MRPII at Company D was justified on its basis of delivering short-term tangible benefits and savings, although the company did acknowledge the transformational changes achievable in the long-term. After having experienced much difficulty following an earlier use of ROCE, little value now appearing associated with the results generated from using this method. When investigated, there was considerable scepticism associated with the use of ROCE, as the results generated were considered to be based on a myopic analysis of the projects' benefits and costs. When explaining this, a project engineer said:

> *"ROCE is not a tool to make a serious investment decision with... investments are more complicated than that. We spent a lot of time and effort using ROCE to give us an idea of likely returns but the results can be so varied, and depend on how you assess the benefits ... Forget the costs, they are just impossible to assess ... These techniques are rarely going to give an accurate picture, and we have learnt that they will almost always be wrong ... Benefits and costs still emerge, even when you think you have planned everything well."*

The project engineer was then asked about the methodologies that were used during decision making, if traditional approaches were considered inappropriate. He replied:

> *"... Combination between common sense and guess work ... To buy a full MRPII system, you are talking about lots of money, not only can we not afford this but such a system would complicate things, as its got too many functions ... We would have functions that we just never use. Moreover, we do not need such complexity, we are only now just beginning to integrate IT into our business processes ... Such a big system would most certainly fail to gain support."*

The project engineer knew that the company desperately needed a management IS but also knew the culture within the company was unlikely to support the major reengineering, or tailoring of business processes. There were also questions regarding how much tailoring the vendors' system would require, to modify the system to reflect idiosyncrasies.

As a result, a simplistic CBA was carried out, which compared vendor MRPII against the 'in-house' development of a management IS, which only appeared to automate current systems. The development of an 'in-house' solution appeared preferable, from the view point of the steering committee. The reason for this was that the steering committee considered there to be significantly less change to business processes, and it was also thought to be a 'cheaper' option. However, possible motivation resulting in the steering committee making this decision has already been highlighted: stakeholders for failure through covert resistance to change.

5.3 Scope and Analysis of MRPII Benefits

The following sub-sections contribute towards the testing of hypotheses 4, and explore stakeholders' perceptions of the scope of MRPII benefits. In achieving this, those benefits considered to result from MRPII are identified, when seen from a multiple-stakeholder view. These views were seen from those managers involved in the adoption of MRPII, as it was not possible to interview all MRPII stakeholders. Then, a taxonomy of benefits is presented, which classifies those savings and benefits management stakeholders associated with the adoption of MRPII.

In doing so, an attempt at categorising the scope of benefits identified by the case study companies as being either strategic, tactical or operational is proposed. The benefits included within these taxonomies were identified as 'important'/'very important' implications resulting from the decision to adopt MRPII. The basis of such classifications is an extension of the types of decision making processes discussed in section 3.4.3. The following sections also correlate the job functions [management stakeholders] to each benefit identified within the proposed taxonomies. Clearly, in presenting the following sub-sections, it is suggested that the case study companies considered multiple levels of business benefits in their decision making process to adopt MRPII.

Then, the nature of case MRPII deployments are determined by evaluating their deployment against the criteria identified in section 2.2 for SIS. Essentially, MRPII only becomes strategic when it directly supports the business strategy, and provides an organisation with a competitive advantage, or counters an advantage being sought by a competitor. Hence, MRPII may be deployed with strategic potential, or simply with the objective of providing operational process improvements. Interestingly enough, the empirical evidence reported in this chapter presents both these natures. To establish a 'deeper' understanding of whether case deployments of MRPII are strategic, factors that motivated their adoption have been correlated against the criteria for SIS. Therefore, it is the intention of the analysis to establish the nature of case MRPII deployments.

5.3.1 Scope of Strategic Benefits Identified by Company A

The decision taken by Company A to develop bespoke MRPII was one influenced by many of the same benefits identified in their CBA of vendor PPC/SFDC. However, there were a number of additional benefits that were considered to have been neglected in their earlier CBA. Also, the company was developing a business strategy in close alliance with MBS, and therefore, sought to align the development of bespoke software with broader strategic and tactical issues. In considering the additional scope of benefits achievable, which were regarded as largely non-financial and intangible in nature, pertinent issues such as the following were included in a revised CBA of bespoke MRPII development:

- Improved response to customer changes;
- Improved product and service quality;
- Offer new strategic option of product management and development;
- Improved organisational teamwork;
- Promotion of the concept of an 'open' proactive culture, and;
- Improved integration with other business functions.

In identifying these benefits, it was evident that the new scope of benefits proved invaluable in strengthening management's case for the justification of bespoke software. The reason for this was that human and organisational issues were identified as CSFs in the company's business plan, following their learning process.

There appears to be a similarity by stakeholders in the perception that MRPII can deliver the range of strategic benefits identified in table 5.1. However, this similarity appears only between the two directors[11], although it may not be surprising that the two directors share the same vision of the strategic contributions that MRPII can offer. The reason for this is that the directors are the main visionary leaders of the company, and responsible for setting its strategic direction. However, the production manager, who is responsible for implementing and tailoring many of the issues associated with MRPII, did not place too much emphasis on the strategic benefits of MRPII. The reason for this might be that this job function is more aligned to the tactical/operational aspects of the project, and therefore the production manager did not take a holistic, or long-term view of the project, and its effects on the organisation.

Classification of MRPII Benefits	Managing Director	Production Manager	Purchasing Director
Strategic Benefits			
Improved growth and success.	✓	✓	✓
Leader in new technology.	✓		✓
Improved market share.	✓		✓
Market leadership.	✓		✓
Offer new strategic option.	✓	✓	✓
Competitive advantage.	✓	✓	✓

Table 5.1: Taxonomy of Strategic MRPII Benefits at Company A

[11] The production manager is the champion responsible for bespoke MRPII development, and a main stakeholder of the bespoke project.

It is interesting that the strategic advantages identified are both financially tangible, and intangible in nature. The benefit of improved growth and success combines both financially tangible and intangible benefits, with growth being a business indicator that is easily measured; an increase in turnover, whereas corporate success is regarded as more subjective and is largely intangible. However, being a leader in new technology is intangible, although it is questionable how Company A considers that the technology it is using contributes towards establishing themselves as a leader of new technology. When investigated, the production manager said:

> *"Our system is essentially built on the foundations of Delta 5 [4th generation relational database], whilst also utilising a production control and scheduling module ... We've had to do this, as there isn't a complete system for jobbing shops, most are developed for OEMs."*

The strategic advantage of improved market share is financially tangible, with Company A having a very small 'slice' of the subcontract market. Although, it is aspiring to developing 'clone' companies based on its generic 'best practices', which it considers to be developing. Regarding market leadership and competitive advantage, these are more intangible and difficult to quantify, although the use of Porter's 5-forces and the value chain (Porter, 1984), may offer a 'deeper' understanding of value adding processes. Finally, as discussed in appendix D, there is the business issue of the new strategic option that the adoption of MRPII is considered to offer Company A.

5.3.2 Scope of Tactical Benefits Identified by Company A

Strategic benefits are considerably different to tactical benefits, in a similar way to how Harris (1996) distinguishes between strategic and tactical decision making. Supporting this differentiation, is the increase in number of benefits identified by the production manager further down the benefit scale. The reason for this might be his association and ability to relate more closely to such benefits. Even so, the two directors also identified many implications of MRPII, which involved establishing 'production' related tactics[12] that support strategic benefits. These translate into project objectives, with table 5.2 providing a summary of the tactical benefits identified at Company A.

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[12] This may have been facilitated with both directors having been experienced 'time-served' engineers. Therefore, having a wider appreciation of production related issues.

In establishing the nature of these benefits, and emphasising the difficulty that they present decision makers with, it can be seen that they share tangible; financial and non-financial, and intangible characteristics. For example, benefits such as, improved flexibility, better data management and the ability to make more accurate decisions, are all largely intangible, and difficult to quantify. Whereas improved response to changes is tangible but not financially quantifiable. On the other hand, improved product and service quality combines financially quantifiable characteristics; reduced scrap and rework, together with intangible aspects, such as improved customer service. Similarly, improved manufacturing control combines intangible with tangible; financial and non-financial characteristics.

Regardless of their different natures, it was the focus and inclusion of tactical benefits such as improved teamwork, facilitating an 'open' culture, improved integration with other business functions, which were identified by the interviewees as very significant tactical resultants from investing in MRPII. The result of this is considered to contribute towards the strategic benefits of improved success and growth.

As discussed earlier, the failure of the PPC/SFDC project was in part, a result of not considering these tactical benefits. However, such factors are now considered to have been addressed and integrated into the development of bespoke MRPII. For example, the management within Company A consider that issues such as improved teamwork is promoted through developing bespoke software. In doing so, developing an open proactive culture, where ideas are encouraged yet failure not stigmatised.

Classification of MRPII Benefits	Managing Director	Production Manager	Purchasing Director
Tactical Benefits			
Improved flexibility.	✓	✓	✓
Improved response to changes.		✓	
Improved product and service quality.	✓	✓	✓
Improved organisational teamwork.		✓	✓
Promotes concept of open proactive culture.	✓		✓
Improved integration with other functions.	✓		✓
Improved data management.		✓	
Improved manufacturing control.	✓	✓	✓
Reduced manufacturing costs.	✓		✓
Reduced manufacturing lead-times.	✓	✓	✓
Improved accuracy of decisions.	✓	✓	✓
Platform for efficient and effective business processes by recording specific transactions.		✓	
Improved management information and analysis to assist with performance monitoring.			✓

Table 5.2: Taxonomy of Tactical MRPII Benefits at Company A

5.3.3 Scope of Operational Benefits Identified by Company A

In distinguishing between the different types of MRPII benefits and savings, operational benefits are generally achievable in the short-term and affect, or result from changes in day-to-day operations. It is interesting to note the diverse spread of benefits identified in table 5.3, and that certain benefits were not considered by all interviewees as areas of substantial operational saving. Typically, this includes reduced raw material inventory, which is not identified in the following table.

As described earlier, Company A is a jobbing shop, and as a result, orders raw material stock based on generated sales orders. Therefore, there is relatively little stock to be reduced. Hence, the benefit of reduced raw material was not identified as a substantial area of cost saving. However, the benefit of improved capacity planning was mentioned by all interviewees as an area of significant saving. Interestingly, the MD identified this operational benefit as essential, and said:

"Our whole survival relies on making the right parts, in the right quantity, of the right quality and on time ... Improved production planning and control allows us to do that. It's core to our business."

Classification of MRPII Benefits	Managing Director	Production Manager	Production Director
Operational Benefits			
Information availability to customer facing staff.		✓	✓
Improved capacity planning.	✓	✓	✓
Improved stability of MPS.		✓	
Increased productivity.	✓		
Increased plant efficiency.	✓	✓	✓
Reduced delivery lead-times.	✓	✓	✓
Reduced levels of WIP.	✓	✓	✓
Reduced labour costs.	✓		✓
Increased throughput.	✓		✓
Improved data availability and reporting.		✓	✓
Improved communication through part tracking.		✓	
Improved product traceability.		✓	
Formalised production.		✓	
Enhanced, or speeding up of data entry.		✓	✓

Table 5.3: Taxonomy of Operational MRPII Benefits at Company A

It is interesting that many operational benefits were identified by both directors. Although, there appeared to have been much more emphasis by the directors on identifying operational benefits that are financially quantifiable, and therefore, offer themselves as cash savings. These typically include benefits such as reduced WIP, increased productivity and reduced labour costs.

A possible reason for the focus on such benefits might be that they easily translate into performance measures that can be financially quantified, to assess operational project success. However, the production manager, who is the day-to-day user of the system, and whose job function relies on the data generated, appears to have paid particular attention to the increased control of daily operations.

In paying a non-financial focus to the benefits that MRPII offers, issues such as the degree of formality that MRPII brings, as well as improved data availability and reporting structures were all identified. Also, there was much emphasis on improvements to tractability, with the production manager saying:

> *"A lot of our work is for the aerospace industry, so we need to keep all job information, which might range from where we bought the material, right down to who checked the 1st off and machined the job. They may want this information 10 years from now."*

5.3.4 Analysing the Nature of Company A's MRPII Deployment

A bespoke MRPII system was developed by Company A for its ability to deliver long-term strategic transformational changes. Although, tactical and operational benefits were also identified and included in the investment's justification case.

Company A had already tried to implement a vendor PPC/SFDC system, without much success but nevertheless, learnt from their mistake, and integrated a number of 'learning issues' into their later development of bespoke MRPII. In doing so, Company A took a strategic view of their industry, and as a result, was motivated by perceived changes, and the belief that jobbing shops of the future will not only provide single component manufacture but, will also offer complete product development and manufacturing. As a result, their strategic business plan[13] identifies bespoke MRPII as supporting strategic business objectives. Clearly, one of the key criteria has already been achieved in establishing whether Company A's bespoke MRPII system is a SIS. A link has been identified between the MRPII project and the company's strategic business plan. This alignment is where the development of a bespoke MRPII system supports the achievement of a key strategic business objective. In this case, MRPII will improve Company A's production flexibility, and ability to increase product variety and complexity, thus supporting their strategic business objectives, i.e. tactics have been developed.

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13 It is interesting to note that Company A has two very different business plans. The first is financially motivated, and offered for perusal to the bank. The second is strategically motivated and addresses: where the company is; where it is going; and, how they are going to get there. It was also interesting to note that this second business plan resulted from the bank manager expressing too much non-financial detail in their 'original' business plan. This suggests that Company A's bank is only interested in financial performance and *not* strategic issues.

As a result, Company A has established themselves as being proactive in planning for their ability to respond to the perceived changes in their industry. Clearly, giving Company A significant competitive advantage over those 'traditional' jobbing shops that do not have the infrastructure or vision to predict market place changes. Hence, changes within industries would appear as factors motivating the adoption of MRPII.

It is also important not to forget the new strategic option that has emerged following Company A's development of bespoke MRPII. This new opinion identifies itself in the form of Company A not just restricting itself to the design, development and manufacture of sub-assemblies/complete products for their sub-contract customers but, also identifies the prospects of Company A being able to develop their 'own' products. As a result, offering the prospects of a move away from the dependency on the 'famine and feast' of sub-contract manufacturing, with a complement of their own product portfolio. Hence, in establishing the nature of Company A's MRPII deployment, there is clearly a direct link between their investment and the company's strategic business plan. As a result, supporting the exploitation of a strategic business objective: a move away from single component manufacture, towards the management of customer product portfolios. In doing so, offering Company A a competitive edge, as they will be able to respond to market place changes, through having developed an infrastructure to support these 'shifts'. There is additional evidence to support Company A's deployment of MRPII as being strategic in nature, with the company being less dependent on the demand fluctuations of sub-contract manufacturing capacity. This will be achieved through exploiting the development of their an 'own' product range, where Company A will be able to diversify and generate additional income. Therefore, empirical evidence suggests that Company A's MRPII system is a SIS.

5.3.5 Scope of Strategic Benefits Identified by Company B

There were a number of strategic advantages identified by Company B during the interview process. It soon became clear that there was a 'real need' to adopt MRPII in-line with the company's pursuit of being a leader in the use of new technology. This motivation for improved competitiveness stemmed from the price sensitive market for Company B's products.

As a result, and as discussed in appendix D, Company B was motivated to adopt MRPII for strategic reasons, with being a leader in the use of new technology considering to offer the company a competitive advantage. Therefore, it is not surprising that all interviewees paid much focus to the strategic benefits resulting from the adoption of vendor MRPII. However, there appeared to be a disagreement in the need to improve organisational growth. The quality/IT manager and the production manager, both emphasised the need for organisational success and growth, and were personally motivated by the strategic benefits offered by MRPII.

The reason managers paid considerable attention to the strategic issues associated with MRPII, was that they wanted the company to have a strategic advantage over others. The motivation for this was that if the company had a competitive advantage and substantially grew, it would employ more people. Hence, there would be a clear progression to a directorship level, as they considered a new space in the hierarchy would be created. Therefore, empirical evidence appears to suggest that personal progression following organisational growth, motivated the manager's consideration of strategic benefits. Hence, the adoption of MRPII may be motivated by managers, through their need to progress up the management hierarchy, following the success and growth of the company.

It is interesting to note that the MD clearly distinguished between growth and success, expressing that there was a need for corporate success but growth needed to be carefully managed. As a result, it was this belief that directed the MD's consideration of strategic MRPII. This appears to be reflected in some of the cultural issues discussed in section 5.1.2, where the MD expressed the desire for organisational success without growing too large. Clearly, there appears to be organisational issues that need addressing, with substantial disagreements, on the vision of the company. Nevertheless, there remains a collectively agreed range of strategic benefits identified by Company B, which are presented in table 5.4.

Classification of MRPII Benefits	Managing Director	Quality/IT Manager	Production Manager
Strategic Benefits			
Improved organisational success.	✓	✓	✓
Improve organisational growth.		✓	✓
Leader in new technology.	✓	✓	✓
Improved market share.	✓	✓	✓
Competitive advantage through product and service quality, and flexibility.	✓	✓	✓
Increased profits.	✓	✓	✓
Supports the business plan.	✓	✓	✓

Table 5.4: Taxonomy of Strategic MRPII Benefits at Company B

5.3.6 Scope of Tactical Benefits Identified by Company B

Regarding tactical benefits, there was a great deal of emphasis expressed by all interviewees on the ability of vendor MRPII to increase the organisations flexibility. This was emphasised by the production manager, who said:

> *"We need to switch our production lines around almost immediately, to cope with different product demands ... This is happening more often, as our overseas customers want a 'spread' of our products ... We need to be flexible in satisfying our distributors 'home' needs and meeting our export orders."*

Also, much emphasis was placed on the ability of MRPII to improve integration with other business functions. However, this was seen as a need to improve integration from a technology perspective, rather than from a human and organisational view. This was addressed with comments from the quality/IT manager, who said:

> *"The office manage the wages and chase up invoices, with the MD sorting out most of the other finances ... They use computers but there isn't a link between these computers and anything else. MRPII will make a link between, say, the generation and invoices and delivery notes."*

Clearly, it is the technology that offers this integration, which in turn produces many tactical and operational benefits. In doing so, improving technological integration with other business functions. Interestingly enough, the quality/IT manager and production manager identified improved management control as a significant tactical benefits that can be achieved through the development of a modular 'open' system.

This suggests a hierarchy of benefits, with strategic benefits being made up of many tactical benefits, and with individual tactical benefits comprising of many operational benefits. Table 5.5 provides a summary of those tactical benefits sought through adopting MRPII at Company B.

Classification of MRPII Benefits	Managing Director	Quality/IT Manager	Production Manager
Tactical Benefits			
Improved flexibility.	✓	✓	✓
Improved response to changes.		✓	✓
Improved product quality.		✓	✓
Improved integration with other functions.	✓	✓	✓
Improved 'open' data management.		✓	
Improved manufacturing control.	✓		✓
Reduced manufacturing costs.	✓		✓
Reduced manufacturing lead-times.	✓	✓	✓
Improved management control through the development of a modular 'open' system.		✓	✓
Support technology based leadership through implementing AMT.			✓
Improved debt collection.	✓		
Routing information through business processes to speed them up.		✓	✓

Table 5.5: Taxonomy of Tactical MRPII Benefits at Company B

5.3.7 Scope of Operational Benefits Identified by Company B

In presenting table 5.6, which identifies those operational benefits considered to result from MRPII, the MD attached much concern to the range of financially measurable benefits achievable. However, this was at the expense of ignoring many non-financial/intangible benefits.

A possible reason for this might be that the MD is responsible for managing the cash flow of the company, and in doing so, reliant of factors that 'smooth' this process and control of the overdraft.

As a result, reductions in raw material inventory, increases in productivity, improved cash-flow position; resulting from financial savings, reductions WIP, increased throughput, all add to the financial 'bottom line', and appear to suggest that the MD pays considerable attention to those factors that affect finance.

Classification of MRPII Benefits	Managing Director	Quality/IT Manager	Production Manager
Operational Benefits			
Reduced raw material inventory.	✓		✓
Improved capacity planning.			✓
Increased productivity.	✓		
Reduced delivery lead-times.	✓	✓	✓
Improve cash-flow position.	✓		
Reduced levels of WIP.	✓	✓	✓
Buying JIT.			✓
Increased throughput.	✓		✓
Improved data availability and reporting.		✓	✓
Improved schedule adherence.		✓	✓
Improved communication with suppliers.		✓	✓
Formalised BOM.		✓	✓
Formal procedures for making design changes.		✓	✓
Formal procedures for manufacturing changes.			✓
Formal procedures for making product changes.	✓		
Vendor rate suppliers.		✓	
Reduce number of BS EN ISO 9000 audits.		✓	
Enhanced, or speeding up of data entry.		✓	✓
Enhanced, or speeding up of data entry.	✓		

Table 5.6: Taxonomy of Operational MRPII Benefits at Company B

On the other hand, this is not to say that the MD should detach himself from the broader operational issues of MRPII. However, as the MD explained:

> *" ... Amongst other things, I manage the cash positions of the company but have a competent management team that is responsible for their own function ... They do double up, so that we are never totally dependant one any one person ... For example, the quality/IT manager knows how to manage production, and is responsible for ensuring its smooth operation but is not accountable for it, the production manager is ..."*

It was also interesting to observe that both managers seemed to focus on the ability of MRPII to improve procedures within the organisation, thus supporting the 'smooth' operation of the company. For example, the quality/IT manager said:

> *"Now I have a computerised quality system that is easy to manage and maintain, it makes my life a lot easier when we have our British Standard [BS EN ISO 9000] audits ... having the system helps with product traceability."*

Also, the quaity/IT manager was keen to emphases the wider implications of MRPII, and how it improved product quality through better managed suppliers. The quality/IT manager said:

> *"We've recently changed many of our suppliers because we now have a system where we can assess their delivery and quality performance."*

Similarly, the production manager emphasised the ability to manage design changes, and quickly update BOMs, through global updates, rather than having to make manual entries, or changes to paper drawings. Therefore, rather than focus on financially tangible benefits, both managers identified non-financial tangible and intangible benefits as being resultant operational benefits of MRPII.

5.3.8 Analysing the Nature of Company B's MRPII Deployment

The market sector where Company B competes is 'very' price sensitive, however, they are attempting to penetrate a developing niche market. In doing so, offering differentiation based on product and service quality, together with a limited product number supplied to the market place. In support of this, are the company's relatively small manufacturing batch sizes, where the product range is hand crafted, and as a result, offer's product exclusivity. Manufacturing resource planning is making a significant contribution towards increasing Company B's manufacturing performance. This is being achieved through reducing the products manufacturing cost, and therefore, increasing margins, although, this may not necessarily translate into product price cuts.

The reason for this is that Company B is offering a product to the 'top-end' of the market, and as a result, any price reductions would not be in support of their sales and marketing strategy. The reason for this is that Company B is not attempting to compete on cost differentiation but rather offer exclusivity, and a high standard of product and service quality. Much of Company B's anticipated savings and benefits are expressed through improving their efficiency and effectiveness, which is facilitated through improved management information. It is also important to note that Company B placed considerable attention to the short-term operational benefits achievable, in part, to support the medium/long-term funding/survival of the company and improve cash flow. However, perhaps more importantly, MRPII is considered to offer Company B a new strategic option, as it supports a flexible production capability, and proactive 'open' management style. As a result, Company B is now planning to penetrate the large-scale marginal end of it's product market. Hence, resulting in the rise of the products' image, through supplying a modified version of its current product, to 'trade' customers.

Company B also appreciates that MRPII supports the development and manufacture of new and innovative products, which it identifies as a strategic CSF within the company's business plan. There are also technological issues surrounding Company B's adoption of MRPII. Such considerations were addressed when Company B identified the need for both OS and vendor software to perform longitudinally, as the organisation develops and grows in the long term. Therefore, offering an advantage over the competition, as they are unlikely to be subjected to productivity losses, which may result from the frequent software upgrades/re-implementation of a new system. The implications are therefore no significant replacements in the short-term. Hence, in establishing the nature of MRPII at Company B, it has a direct link with the company's business plan, which as a result, has allowed the exploitation of a strategic objective; the development and future growth of the company's product portfolio. In doing so, offering Company B a competitive edge, in exploiting the burgeoning opportunities in the consumer market that it competes in, whilst also having the vision to adopt appropriate technology. It must also be stressed that operational benefits were sought to finance the project and improve cash flow. Hence, Company B's MRPII deployment falls into the category of being a SIS, and an operational deployment, with different motivations.

5.3.9 Scope of Strategic Benefits Identified by Company C

As discussed in appendix D, Company C was motivated to adopt MRPII by the perceived needs of the business, which amounted to the long-term strategic ability of MRPII to offer transformational changes, and satisfy its future jobbing shop requirements. However, there was also much attention given to the non-strategic range of MRPII benefits achievable, as these were used to gain support from operational employees. As discussed earlier, the quality/plant manager expressed great difficulty in identifying the 'full' range of resources needed to develop a bespoke MRPII system. Also, much concern was expressed regarding the 'full' range of business benefits and investment related costs. As a result, it appeared that such issues were dismissed in way for the larger business case for adopting MRPII, which was to offer a wider range of jobbing shop services to perspective future customers. However, there appears to be serious implication in Company C offering a new manufacturing capability that is supported by MRPII, as they will need to have further business systems in place to support customer requirements. In expressing this new strategic option, the marketing manager said:

> *"We have to be realistic, if we don't plan for the capability to compete in the future, then IT benefits are short-term because we will be pushed out of business ... I will soon be able to not just sell machining capacity but the capability to design and manufacture customer products ... MRPII is helping to make it a reality."*

As discussed earlier, the development of Company C's bespoke MRPII system was covert, and although the marketing manager was a stakeholder and committed to the MRPII project, Company C has a significant way to go in developing their computerised systems. However, the development of a bespoke MRPII system is a process that requires innovation, and as a result, issues such as identifying those skills that employees need in developing new ideas, establishing an environment where new ideas can be cultivated, all have to be considered and developed. Although, it could be argued that the nature of jobbing shops is such that there is generally always a 'good' degree of flexibility and creativity, as they traditionally manufacture a diverse range of customer required products (Irani *et al.*, 1996[a], 1996[b]).

In identifying the strategic benefits of MRPII, which are presented in table 5.7, there was almost unanimous agreement on the importance of these benefits. By offering a new strategic option, a competitive advantage was considered to be created, which in turn increases the company's market share. Also, it is not surprising that the marketing manager identified the adoption of MRPII as significant in improving the professional image of the company.

Classification of MRPII Benefits	Marketing Manager	Quality/Plant Manager
Strategic Benefits		
Offer new strategic option.	✓	✓
Improved market share.	✓	✓
Competitive advantage.	✓	✓
Improve the professional image of the company.	✓	

Table 5.7: Taxonomy of Strategic MRPII Benefits at Company C

5.3.10 Scope of Tactical Benefits Identified by Company C

The interviewees appear to have paid little attention to the tactical benefits resulting from MRPII, with the bespoke development process often being played down by comments from the quality/plant manager:

> *"Developing MRPII is just best practice and common sense. Unfortunately, common sense is not common to everybody !"*

It appeared that little prior consideration had been given by the interviewees to the tactical benefits achievable from MRPII. The reason for this is that the management stakeholders superseded the tactical and operational benefits with the prospects of MRPII offering a new strategic option.

However, it is interesting to note that although both managers were stakeholder and committed to the success of the project, their almost unanimous agreement on the range of strategic benefits did differ, when issues associated with tactical benefits were pursued.

It is not surprising that much of the marketing managers' focus was from the perspective of new product development, as well as improved management effectiveness. The reason for this is that the marketing manager regarded his function as being the interface between the company and their customers. As a result, those tactical benefits identified in table 5.8 complimented the list of Unique Selling Points (USP) used by the marketing manager, when coaxing new/existing customers into giving Company C a purchase order. Also, the marketing manager was clear to stress the importance that the new system would make towards improving management's effectiveness, such that they could divert their attention from the day-to-day reactive operation of the company. In doing so, management could give their wholehearted support to the proactive development of new initiatives and products.

Classification of MRPII Benefits	Marketing Manager	Quality/Plant Manager
Tactical Benefits		
Improved flexibility.	✓	✓
Improved response to customer demands.	✓	
Improved product quality.		✓
Improved integration with other business functions.		✓
Supports management's effectiveness.	✓	
Improved communication.		✓
Improved manufacturing control.		✓
Reduced manufacturing costs.		✓
Reduced manufacturing lead-times.	✓	✓
Reduced new product development lead-times.	✓	

Table 5.8 Taxonomy of Tactical MRPII Benefits at Company C

5.3.11 Scope of Operational Benefits Identified by Company C

Table 5.9 gives a list of operational benefits identified by the interviewees of Company C, regarding their perceived importance of such benefits.

Classification of MRPII Benefits	Marketing Manager	Quality/Plant Manager
Operational Benefits		
Support JIT purchasing strategy.		✓
Improved capacity planning.		✓
Increased productivity.	✓	
Reduced delivery lead-times.	✓	✓
Reduced levels of WIP.		✓
Increased throughput.	✓	✓
Improve product traceability.	✓	✓
Improved schedule adherence.		✓
Improve data availability and reporting structure.		✓
Support capacity planning scenario's.		✓
Support complicated BOM.	✓	✓
Formalise procedures.		✓
Support BS EN ISO 9000.	✓	
Automate manual tasks.		✓

Table 5.9: Taxonomy of Operational MRPII Benefits at Company C

Although this list is somewhat short, it is not a reflection of the myopic consideration of operational benefits achievable but rather, it was the achievement of the strategic benefits that were considered more crucial. Also, as the development of MRPII was covert, no proposal was developed, and as a result, the quality/plant manager expressing his difficulty in acknowledging the 'full' range of benefits. However, this does raise questions regarding whether Company C would have developed a bespoke MRPII system, if there was not such strategic significance attached to the project by management stakeholders.

The marketing manager was keen to express much of the benefit of improving financial performance. This is not surprising, as marketing within Company C is guided by financial measures, such as obtaining customer orders, customer visits, sales order level, number of enquiries. As a result, much emphasis is placed on financially/non-financially quantitative benefits, with such benefits being sought at an operational level and with little appreciation for other qualitative benefits. However, this is with the exception of those benefits that can be turned into USP.

Although, on the other hand, when discussed with the quality/plant manager, a number of operational benefits were identified as resultants from MRPII. These include benefits that demonstrate quantifiable; financial/non-financial, and intangible natures.

5.3.12 Analysing the Nature of Company C's MRPII Deployment

The development of Company C's bespoke MRPII system, was in part, motivated by the perceived changes taking place in the sub-contract jobbing shop industry. Predicting a similar direction of the jobbing shop industry, to that of Company A, Company C identified the need to develop an IT/IS infrastructure. In turn, supporting increased flexibility, and the ability to offer a new 'one-stop shop' service: the development and management of complete products. However, Company C was also motivated by the need to reduce manufacturing costs, which were sought through increases in efficiency and effectiveness. Company C also considered that the development of an IT/IS infrastructure will give them a sufficient technological advantage over their competitors, and used the adoption of MRPII as an opportunity to upgrade its manufacturing management systems. The management team of Company C have a very clear vision of where they are, and know where they want to go to. However, the company has been unable to develop a plan that details how they are going to get there because of its covertness. Hence, there is no documented strategy within the company, which can be used to operationalise their vision. The implication being that each manager is trying to support the company's vision of the future, in an 'ad-hoc' unstructured way. Nevertheless, Company C has remained proactive in anticipating the trends of the sub-contract jobbing shop industry, and as a result, are using MRPII to support its strategic aspirations. However, it could be argued that these aspirations are somewhat unstructured.

There appears to be a widespread belief within Company C that the whole sub-contract market will be re-defined and re-divided[14]. As a result, Company C sees itself using MRPII as a mean of improving its market share in the long-term, thus supporting aspects of certain managers strategic vision. Therefore, it appears that Company C is trying to use MRPII to facilitate an improvement in its future market share.

[14] This definition and division of the jobbing shop industry is expected to be lead by those that can offer the service of new product development.

This is considered achievable, since MRPII offers Company C a new strategic option in the form of an integrated IS that supports the 'open' and structured development of new products, in a structured way. The result being a competitive advantage, which supports their pursuit of improving their market share. Hence, the development of Company C's MRPII system would appear to fulfil the criteria for SIS, although there is no alignment to a 'formal' business plan.

5.3.13 Scope of Strategic Benefits Identified by Company D

As discussed earlier, the MD's knowledge of MRPII was mechanistic[15], with no alignment of the project, to the corporate goals of the company. As a result, the MD focused attention on the ability of MRPII to deliver significant tactical/operational benefit and saving. Therefore, it is not surprising that there was relatively little attention paid to the range of strategic benefits possible, as the implications of MRPII were largely seen from a tactical/operational point of view.

It soon became clear that the project was driven by the external consultant, who as a 'preacher' of MRPII, would be expected to be aware of the wider strategic implications of MRPII, although, when approached, declined to be interviewed. Of those job functions interviewed, the production manager adopted a passive 'fire fighting' role within the company, appearing thankful at anything that simplified day-to-day production routines, thus it is not surprising that little attention was paid to the strategic benefits of MRPII.

During interviews, it soon became clear that the graduate engineers were aware of the wider strategic implications of MRPII, and as a result, attempted to raise the profile of such benefits. However, much of this was in vain, as the graduates were not involved in the decision making process, or represented on the steering committee. A 'general' projects engineer was interviewed, and although not a member of the steering committee, did offer a perspective on the strategic implications of an organisational-wide MRPII system.

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15 This was the term used by a graduate engineer to describe the level of knowledge the MD had about MRPII. During further discussions, this was because the MD saw MRPII as an operational investment, and did not align the investment to the strategic needs of the business.

Hence, although table 5.10 provides a diverse scope of strategic MRPII benefits, it must be noted that there were many management stakeholders of MRPII. Almost all were reliant on gaining knowledge from the MD, and as a result, knew relatively little about its wider strategic implications. Also, there was no strategic business plan that the investment could be aligned too. As a result, the investment was viewed for its ability to deliver tactical/operational benefits.

Classification of MRPII Benefits	Production Engineer	Graduate Engineer	Projects Engineer
Strategic Benefits			
Improved market share.		✓	✓
Competitive advantage.	✓	✓	✓
Enhance company image.		✓	
Promotes innovation.		✓	
Concept of zero defects/ Total Quality	✓	✓	
Organisational wide system that can be extended to accommodate the supply chain.	✓	✓	

Table 5.10: Taxonomy of Strategic MRPII Benefits at Company D

5.3.14 Scope of Tactical Benefits Identified by Company D

As a result of Company D's management team/steering committee being unaware of the wider implications of MRPII, many of the benefits being sought from developing their IS were tactical/operational in nature. Many of the benefits sought from MRPII were positioned at this level because the management team within the company was unaware of the wider implications of MRPII. Table 5.11 presents a summary of the tactical benefits sought by Company D from MRPII.

Of those tactical benefits identified, there appears to be a widespread agreement on the importance of such implications. Although, the graduate engineers stressed the significance of MRPII in establishing a compatible IS, which could be extended to both customers and suppliers. When asked why this was considered a significant benefit, a graduate engineer said:

"MRPII standardises procedures within a company, so that there is only one way, or the wrong way. If we can then extend this out to our customers and suppliers, we can reduce delays and problems in the supply chain ... Say, if we can help our customers plan their production, then actually, we are planning our own production better ... We can them plan our capacity requirements more effectively by not anticipating but guaranteeing our suppliers delivery."

Classification of MRPII Benefits	Production Engineer	Graduate Engineer	Projects Engineer
Tactical Benefits			
Improved flexibility.	✓	✓	✓
Improved response to changes.	✓	✓	✓
Improved product quality.	✓	✓	✓
Provide efficient and effective customer service.	✓	✓	
IS compatibility within the supply chain.		✓	
Improved accuracy and reliability of information.	✓		✓
Formalised accountability and responsibility.	✓		
Improved manufacturing control.	✓	✓	
Reduced manufacturing costs.	✓		
Reduced manufacturing lead-times.	✓	✓	✓

Table 5.11: Taxonomy of Tactical MRPII Benefits at Company D

Clearly, the results of establishing IS compatibility within the supply chain 'spreads' up and down the hierarchy of benefits, with better capacity planning, and reduced delivery dates being operational benefits achievable amongst others. Yet, closer alliances with customers and suppliers is a strategic benefit, which can result in partnership sourcing with key customers and suppliers. Hence, although many within Company D had a myopic view of the benefits resulting from MRPII, the adoption of MRPII can offer significant strategic advantage.

5.3.15 Scope of Operational Benefits Identified by Company D

When asked to identify the range of operational benefits resulting from MRPII, there was much attention identified from the stakeholder interviewees. Establishing the operational focus given to the adoption of MRPII.

As a result, table 5.12 identifies those operational benefits considered as resultants from MRPII. As discussed earlier, these comprise of benefits and savings that demonstrate a quantifiable; financial/non-financial, and intangible nature.

Classification of MRPII Benefits	Production Engineer	Graduate Engineer	Projects Engineer
Operational Benefits			
Increased plant productivity.	✓		✓
Increased employee productivity.	✓		
Reduced raw material inventory.	✓	✓	✓
Improve data archiving.			✓
Improved capacity planning.	✓	✓	✓
Increased productivity.	✓	✓	✓
Reduced delivery lead-times.	✓	✓	
Reduced levels of WIP.	✓	✓	
Increased throughput.	✓	✓	
Improved data availability.		✓	✓
Increased stock turn.	✓		
Improved schedule adherence.	✓	✓	
Improved communication with suppliers.		✓	
Formalised BOM.	✓	✓	
Improve batch traceability.	✓		
Formal procedures for making design changes.	✓	✓	
Formal procedures for making changes.	✓	✓	✓
Performance measurement of supplier performance.		✓	
Reduce number of BS EN ISO 9000 audits.		✓	
Automate manual tasks.	✓	✓	
Enhanced, or speeding up of data entry.	✓	✓	

Table 5.12: Taxonomy of Operational MRPII Benefits at Company D

5.3.16 Analysing the Nature of Company D's MRPII Deployment

The needs of the business did little to motivate Company D's development of bespoke MRPII. Much of the momentum and enthusiasm to adopt MRPII came from the MD and an external consultant, with the responsibility for bespoke system development then abdicated to a number of graduate engineers.

In developing the system, the graduate engineers were managed by an external consultant and assisted by a projects engineer. Many of the generic strategic benefits that companies seek from MRPII, were considered not applicable to the business activities of Company D, for reasons already discussed, i.e. a well established brand name. Instead, Company D was motivated by specific factors, such as those discussed in appendix D and presented in table D.2. However, project related benefits were also sought, such as those presented in table 5.10., 5.11 and 5.12 respectively. In interpreting from the benefits, it appears that Company D adopted MRPII for its potential to deliver short-term operational process improvements, which are largely financially quantifiable. As a result, it would appear that the company is not achieving the 'full' range of business benefits possible for MRPII. Therefore, it appears that Company D may be jeopardising the achievement of many long-term business benefits and savings, by not focusing on the strategic issues associated with MRPII. The reasons for this may be due to the myopic focus of the MD, and the needs of the consultant to show short-term savings to justify his cost.

In addition, it is interesting to note that Company D is the only company that identified themselves as being motivated by others in the industry, and by an external consultant, thus identifying themselves as being reactive to the market place. Clearly, Company D is an industry follower rather than being proactive and leading the market place. Although in their defence, the company did stress that they had much of the market share, and had relatively few competitors. However, care must be taken, as there were few visible barriers[16] preventing competitors from entering their market place.

The development of MRPII encountered much resistance by Company D's senior management team, who perceived the system to contribute towards a loss of their 'decision making power'. Regardless of this power shift, the decision for software development was given, with much 'drive' from the graduate contingency. However, management resistance presented Company D with serious problems. The reason for this is that many senior managers were not interested in contributing towards the systems' development.

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16 Possible barrier may be that Company D's supply and distribution strategy was to enter partnership agreements with its customers and suppliers, which 'tied' them into medium/long-term contractual agreements.

As a result, there is no strategic management focus, with no mention of the MRPII project in the companys' business plan. Therefore, it appears that the development team has been forced into taking a myopic view of the MRPII project. Furthermore, by not taking a holistic perspective of MRPII, and identifying how it supports the business, Company D has not planned for the exploitation of strategic business benefits. Indeed, this point is exacerbated in table 5.10., which identifies that it is only the graduate engineers who perceive MRPII to have much strategic potential. Also, there was much resentment expressed by the graduate engineers who perceive themselves as being totally committed towards the success of the project, and yet, excluded from the steering committee; which makes important project decisions. To complicate matters, the graduate development team regard the steering committee to be comprised of stakeholders for ensuring the failure[17] of the project.

Hence, although Company D's MRPII system is at an early stage, it appears not to satisfy the criteria for SIS, and is therefore considered operational in nature.

5.4 Scope and Analysis of MRPII Costs

During interviews, it soon became clear that stakeholders had not given much attention to the costs of MRPII [compared to MRPII benefits], other than to identify direct MRPII project costs. As part of the analysis of MRPII cost factors, an attempt at categorising those costs identified by the interviewees in the case study companies, as being either direct, or indirect: human and organisational has been made. In doing so, contributing towards the testing of hypotheses 3.

Hence, it is not the intention of the following sections to show inconsistent cost expectation/realisation but rather, identify cost factors within proposed taxonomies.

[17] When the graduate engineers were asked to describe how they quantified project failure in this context, there was the widespread perception that by not exploiting the full potential of the system, it would be a failure.

5.4.1 Analysis of Direct Costs Identified by Company A

As discussed earlier, Company A was in a much better position to identify bespoke project implications, following the failure of their vendor PPC/SFDC. This resulted in identifying a much more realistic 'picture' of the potential costs resulting from bespoke MRPII, and was only made possible having gone through a 'learning process'. In doing so, their earlier identification of project costs, were acknowledged as only being the 'tip of the iceberg' of the holistic cost implications associated with MRPII.

Even though table 5.13 categorises a comprehensive list of direct project costs, it must be stressed that a number of items are not identified, as they had already been bought during the earlier adoption of PPC/SFDC. Regardless of not presenting a 'full' picture of direct project costs, table 5.13 provides a list of those direct costs attributable to bespoke MRPII development.

Classification of Direct Project Costs	Direct Project Costs Identified
Environmental Operating Costs.	Un-interuptable power supply.
Hardware Costs.	File server.
	Dumb terminals.
	Backup tape streamer.
	Network printer.
Software Costs.	Key vendor software module.
	Relational database software.
	Additional networking software.
Installation and Configuration Costs.	Consultancy support (partially grant funded).
	Network wiring, junctions and connectors.
	Installation hardware.
	'In-house' customising time.
	Re-engineering of business processes to suit software.
Overheads.	Running costs: electricity; insurance premium rises.
	Consumables: Toner cartridges; disks; and paper.
Training Costs.	Database software course.
Maintenance Cost.	Yearly service Contract (Hardware).
	Database user group fees.

Table 5.13: Taxonomy of Direct MRPII Costs at Company A

As part of Company A's learning experience, there were a number of direct costs that had not been included in their earlier CBA of vendor software. These were later included in the CBA of bespoke MRPII development. As a result, the MD described the CBA exercise associated with the development of bespoke MRPII as:

> *"More realistic ... In our earlier investments, we had no idea of what project costs were and where they might exist ... I dread to put a figure to what our old systems [vendor PPC/SFDC] really cost us."*

It was later agreed that those responsible for vendor PPC/SFDC had taken a myopic view of the projects' costs, and in doing so, only identifying direct project costs. Although, in identifying those new direct project costs associated with bespoke MRPII, a new dimension of costs were to emerge. It soon became clear that indirect project costs amongst other organisational issues, played a considerable part in Company A's realisation of vendor PPC/SFDC project failure. Additional costs include circumstances when Company A was forced to undertake modifications of their business processes and procedures. These modifications were carried out as there is considered to have been no complete system [MRPII] developed for the perceived unique needs of jobbing shops. Similarly, a manufacturing project engineer who was a member of the vendor selection and implementation team said:

> *"We were convinced that there was no complete system suited for subcontract jobbing shops ... Most systems are developed for original equipment manufacturers ... Although we share common needs, there are fundamental differences in our requirements."*

During the implementation of the core PPC module; production control and scheduling, it became evident that the vendor supplied system required the data to fulfil it's [the software] 'needs', rather than the way Company A operated. To overcome this, business processes had to be changed but this was considered expensive, time consuming and would cause serious disruptions to production performance. All these had cost implications, and resulted following Company A's learning experience. The MD added by saying:

> *"We knew we would have to change things but not almost everything! ... We've experienced a lot and learnt from it ... We tried so much to avoid major change but couldn't, the software was dictating the way we should do things ... Hindsight is a great thing !"*

Furthermore, these cost implications appeared significant and had not been acknowledged in their original CBA but, were unavoidable, if the improved functionality of the PPC system was to be achieved. When discussed with the MD:

> *"We had to make modifications to both software and business processes before achieving functionality of the system. This proved to be expensive and time consuming ...I dare not put a figure to this cost."*

There were additional consequences expressed by the quality/IT manager, who said:

> *"We had serious problems with vendor supplied software upgrades because we made modifications to earlier software versions. These software modifications were based on the business processes that we chose not to change, so we changed the software code."*

Clearly, there were major additional costs resulting from the adoption of vendor software, which needed funding. When investigated, the MD said:

> *"We had to just absorb the extra cost ... Most of it was in the form of peoples' time; my time, management and the workforces ... Also, processes needed changing and these changes took time to get used to ... For example, other costs include when we started using work to list*[18]*, throughput levels fell, people were used to being told which jobs to do next but all of a sudden, they had to make decisions for themselves."*

Therefore, it appears that Company A underestimated the cost implications of MRPII. As a result, an opportunity is offered to categorise deployment costs of MRPII as being direct and indirect: human and organisational.

5.4.2 Analysis of Indirect Human Costs Identified by Company A

Table 5.14 identifies those indirect human costs considered as part of Company A's revised CBA, when developing bespoke MRPII. Most of the operational sections within Company A reported to the production controller, and as a result, were allocated jobs. However, one of the impacts that vendor PPC had, was in the development of a MPS. This monthly list of production targets, identifies jobs that must be completed, and is based on available resources and customer required delivery dates.

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18 Work to lists are weekly schedules of work section production targets which have to be achieved in order to satisfy the Master Production Schedule (MPS); a monthly schedule of production targets.

However, as discussed in section 5.1.2, the culture within the company was such that decision making was an 'office' function, with operational employees being told what to do. As a result, there was much resistance and indecisiveness to operational decision making. Such cost implications are often in the form of time; the deliberation of *'shall I, or shan't I', 'what if I do this job first but what if I do that first'.* Also, operational employees often got things wrong, as they were not used to making production related decisions.

Classification of Indirect Human Costs	Indirect Human MRPII Costs
Management/Staff Resource.	Integrating computerised production planning and control into work practices.
Management Time.	Devising, approving and amending business plans(s).
Cost of ownership: System Support.	Consultancy support/trouble shooting costs.
Management Effort and Dedication.	Exploring the potential of the system.
	Linking and integrating new systems together, e.g. CAM, DNC.
Employee Time.	Detailing, approving and amending the computerisation of product BOMs. Production planning and control of each job release.
Employee Training.	Being trained to manipulate vendor software and training others.
Employee Motivation.	Interest in computerised production planning and control reduces as time passes.
Changes in Salaries.	Pay increases based on improved employee flexibility.
Staff Turnover.	Increases in interview costs, induction costs, training costs based in the need for skilled human resource.

Table 5.14: Taxonomy of Indirect Human MRPII Costs at Company A

5.4.3 Analysis of Indirect Organisational Costs Identified by Company A

The implementation of PPC/SFDC presented Company A with the introduction of performance indicators. This presented Company A with my problems and associated organisational costs. For example, one of the performance indicators that presented much problem, was that of value added.

However, employees soon realised how to increase their work section productivity and qualify for a performance related bonus, by 'cherry picking' those jobs that added the most values[19]. Although, this was often at the expense of those jobs more urgently needed and which add less value. The result of this is a cost implication that is reflected in a loss of customer base due to poor customer deliveries. For example, Company A is a jobbing shop, and specialises in the manufacture of small batch quantities, which often take the form of parts for production line machines. As a result, with such jobs, it is not the value added but rather, the urgency of their requirement, and the ability of Company A to manufacture within relatively short-leadtimes that establishes their customer base and reputation. However, this was not acknowledged by operational decision makers, who were only interested in those jobs that added relatively more value. Clearly, there was an organisational cost associated with the introduction of performance measurement, which resulted in a loss of customer confidence and damage to the professional image of Company A. Table 5.15 identifies a number of organisational costs that were considered as part of Company A's revised CBA, when analysing the affects of bespoke system development.

Classification of Indirect Organisational Costs	Indirect Organisational MRPII Costs
Productivity Losses.	Developing and adapting to new systems, procedures and guidelines.
	Cost of subcontract or overtime to avoid lost production.
Strains on Resource.	Maximising the potential of the new technology through integrating information flows and increasing information availability.
Business Process Re-engineering.	The re-design of organisational functions, processes and reporting structures.
Poor Decision Making	Measure of wrong performance measures that result in incorrect decisions being made.
Dame to Company Name	Reduced customer confidence due to poor reliablity.

Table 5.15: Taxonomy of Indirect Organisational MRPII Costs at Company A

[19] Operational employees appear to have considered that adding value was choosing those jobs that require a lot of machining time (reducing wasted time in machine set-ups), have large batch sizes, and who's customers are paying large sums of money.

5.4.4 Analysis of Direct Costs Identified by Company B

As discussed in section 5.1.2, there was an EAT responsible for the implementation and management of the MRPII adoption. As a result, this identified a clear starting point for the adoption process, and for establishing the importance of cost control. However, this was only made possible following the documentation of a consultants' report, which detailed a range of business objectives.

At Company B, a number of management stakeholders were interviewed, to identify their perception of MRPII costs. Firstly, direct project costs were discussed, however, it soon became clear that interviewees could not distinguish between direct and indirect project costs, and as a result, a great deal of analysis and grouping had to take place. Table 5.16 identifies those direct project costs resulting from the adoption of MRPII, with all these factors having been identified in Company B's enterprise initiative report.

Classification of Direct Costs	Direct Project Costs Identified
Hardware Costs.	Fileserver.
	Complete PCs (incl. monitors and processor)
	Printers.
Software Costs.	MRPII software.
	Windows NT.
	Novell Software.
Installation and Configuration Costs.	Consultancy support and advise (Enterprise initiative grant).
	Installation engineers.
Training Costs.	Vendor Training (MRPII and Windows NT).
	Education sessions associated with employee briefings.
	External Training of development personnel.

Table 5.16: Taxonomy of Direct MRPII Costs at Company B

5.4.5 Analysis of Indirect Human Costs Identified by Company B

In developing Company B's CBA, operational development[20] costs were identified as a substantial on-going expense. The reason for this is that 'in-house' routines needed adding to the core modules bought, with the quality/IT manager playing an active role in making such modifications. In doing so, additional databases were developed to increase the systems functionality and to accommodate idiosyncrasies. However, this presented many problems, with the quality/IT manager saying:

> *"... Adding routines to the system just eats time ... But not just my time, I had to get someone else to enter all the historical data. I didn't want to waste my time ... We needed to put data into the system to test that it worked ... Then we needed to fill the database."*

Clearly, the integration of additional modules to the vendor system was seen as a good idea but, was regarded as time consuming. Also, the quality/IT manager felt the need to enter historical data, to establish the systems' validity, which further required resources. It would appear that not only does the cost of developing additional modules need to be considered but also the data entry that follows. The reason for this it that it requires much resource and investment of effort. In emphasising this, the production manager said:

> *"Once we had implemented the system, we needed to enter lots of data into product libraries and databases. But the things was, we didn't have the information that was needed ... or it wasn't in the right format. We needed to have proper BOMs for our products ... We really should have tightened up our procedures before developing systems ... We needed formality ... I can see how we should have pooled all the information together first ... Agreed on a format ... We didn't even have consistent part numbers, with the right number of letters and digits."*

Hence, it would appear that there was more to deploying vendor MRPII than was envisaged, and documented in the consultants' report. Table 5.18 identifies a range of indirect human costs associated with Company B's MRPII deployment.

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[20] There were salary costs associated with those employees directly involved with system development. There are also the costs of those 'peripherally' involved, including a substantial investment in director time.

Classification of Indirect Human Costs	Indirect Human MRPII Costs
Management Time.	Developing additional modules to support those MRPII vendor modules purchased.
	Revising the business plan(s) based on technology based progress. Identifying strengths, weaknesses, opportunities and threads within the company and marketplace.
	Establishing a format for cataloguing BOM, etc.
Cost of Ownership: System Support.	Vendor agreement to purchase upgrades and support.
	On-going system development to maintain a competitive advantage. The operational development of the system to continuously accommodate new technology.
Management Effort and Dedication.	Exploring the potential of the system to achieve its maximum performance.
Employee Time.	Converting product structures from paper based systems into a computerised form.
	Entering data into product libraries and databases before the system is operational.

Table 5.17: Taxonomy of Indirect Human MRPII Costs at Company B

5.4.6 Analysis of Indirect Organisational Costs Identified by Company B

Once implemented, the management in Company B spent much time exploring the functionality of it's MRPII system. The reason for this is that they wanted to achieve it's optimum performance but this presented Company B with an indirect organisational cost. The MD said:

> *"When we first bought the system everyone wanted to get involved, and see how it could make their jobs easier. We used to spend hours and hours playing with the system, changing parameters and measuring its effects. All this actually cost us a lot of money, both in terms of time and lost productivity."*

In identifying Company B's indirect organisational costs, table 5.18 presents a summary of indirect organisational costs now considered attributable to their vendor MRPII system.

Classification of Indirect Organisational Costs	Indirect Organisational MRPII Costs
Business Process Re-engineering.	The re-design of business processes based on the prescriptive information requirements of the adopted MRPII software.
Productivity Losses.	Losses in organisational performance because of the adjustment of system parameters, to optimise production performance.

Table 5.18: Taxonomy of Indirect Organisational MRPII Costs at Company B

5.4.7 Analysis of Direct Costs Identified by Company C

Section 5.1.1 has already discussed why and in what way Company C developed a bespoke MRPII system covertly and, as a result, did not make use of prescriptive investment appraisal methods. The reason for this is that they were unable to identify the resources necessary to support the development of MRPII, together with the resulting benefit and investment related costs. However, the quality/plant manager did say:

> *"I found it easy to list benefits but when it came it costs, I had no idea ... I can now see why, as they only start appearing once the project has started ... They seem to just spiral out of control."*

When discussed, the quality/plant manager with hindsight, was able to identify a number of investment related indirect costs, with such funding not coming from the companies continuous improvement projects' budget. However, before these indirect costs are discussed, table 5.19 identifies a number of direct project costs that the quality/plant manager did attribute towards the MRPII project. Interestingly enough, all the funding to support the costs identified in table 5.19 came from the Company's continuous improvement fund, where the quality/plant manager had a 'reasonable' spending limit. This limit was regarded as sufficient, to absorb the direct costs of the project. However, Company C now realises that to improve performance and accommodate its anticipated growth, additional direct costs will have to be realised. In which case, small continuous improvement funds may not be sufficient. Hence, political issues may have to be overcome, or at the very least, system development issues discussed with the MD, thus taking away the covertness of the project. Therefore, this suggests that the marketing and quality/plant managers may have to share their strategic vision of the changes within the jobbing shop industry, with the MD.

Although table 5.19 identifies a number of direct costs, it must be stressed that the quality/plant manager had no idea of project costs, until the project was initiated. As a result, those direct costs identified in table 5.19 are based on the development of the project so far, with additional direct and indirect costs now appreciated.

Classification of Direct Costs	Direct Project Costs Identified
Hardware Costs.	Complete PCs (incl. monitors and processor)
	Printers.
Software Costs.	MRPII software.
	Operating Systems.
	Novell software.
Installation and Configuration Costs.	Network wiring, Junctions and Connectors.
Training Costs.	External training of database development.
	External training on MRPII.
	External training of development personnel.
Project Overheads.	Running costs: electricity.

Table 5.19: Taxonomy of Direct MRPII Costs at Company C

5.4.8 Analysis of Indirect Human Costs Identified by Company C

Regarding the general view of project costs, the quality/plant manager was rather concerned, as there were limited amounts of money available for system development. In expressing this concern, quality/plant manager said:

> *"I can easily spend my budget on the IT but there's quite a lot of cost involved in developing a system ... but it all seems hidden in the form of peoples' time and effort ... the company will have to somehow absorb these additional costs."*

The quality/plant manager explained that indirect costs were now easier to identify, even though these costs were not aligned with the development of bespoke software. Hence, there was the view that others would consider the system to have delivered significant savings, with a relatively minimal 'visible' budget. Therefore, appearing to present a political advantage when the covertness of the project is removed. Clearly, in this case, the quality/plant manager seemed to consider the intangibility of indirect MRPII costs to be a political advantage.

The quality/plant manager identified a number of indirect costs, which have been classified as indirect human costs. These have been presented in table 5.20.

Classification of Indirect Human Costs	Indirect Human MRPII Costs
Management Time.	Prioritising the developing additional modules.
	Developing a plan that maintains the projects' strategic focus, which viewed the system as a long-term project (strategic management time).
	Project management time.
Cost of Ongoing Ownership.	Continuous development until the company has an integrated system.
Employee Time.	Development personnel exploring the potential of the system to achieve its maximum performance.
	The time it takes to work with stackholders in mapping business processes and removing non-value adding activities before developing code (Partnership initiative)
	Training personnel to train others.
Motivations and Morale.	As there will be less resources to develop ideas for continuous improvements there might be a loss of motivation and morale, resulting in less ideas being proposed. Resulting in an adverse cultural affect.

Table 5.20: Taxonomy of Indirect Human MRPII Costs at Company C

5.4.9 Analysis of Indirect Organisational Costs Identified by Company C

The cost of developing bespoke MRPII were not restricted to those identified in table 5.19 and 5.20. In addition, the quality/plant manager identified costs that have been grouped as indirect organisational costs. These are presented in table 5.21, and include the cost of BPR, opportunity cost and the short-term management focus.

As discussed earlier, Company C had to make significant changes to their business processes, based on the partnership initiative with stakeholders. As a result, new procedures were developed and computerised, and the way the business operated dramatically changed. Also, the quality/plant manager expressed much concern over the opportunity cost of developing the new system. Even though the benefits of MRPII were acknowledged as being significant, there was considered a possible loss in confidence by the workforce.

The reason for this is that the funding that supports the development of bespoke software has absorbed the majority of monies allocated to continuous improvement projects. Hence, ideas generated by the workforce for process improvements would have to be delayed, until more money became available in the next financial year. An implication of this might be that fewer ideas are generated in the future, as the workforce become sceptical about the management taking their ideas serious. Finally, the short term focus held by management were considered to be a cost to the organisation, as it promoted covertness and restricts growth. The reason for this is that the capital budgeting procedures within the company do not support the adoption of modern technology that has qualitative implications.

Classification of Indirect Organisational Costs	Indirect Organisational MRPII Costs
Business Process Re-engineering.	The cost of developing and modifying business processes.
Opportunity Cost.	Allocating the majority of vital continuous improvement funds to one single project, thus resulting in wasted opportunities regarding other projects.
	Allocating [albeit covertly] resources to the development of a system that may not be in line with the business plan.
Short-term Management Focus.	Unable to exploit the full potential of new technology, as many management procedures do not support AMT.

Table 5.21: Taxonomy of Indirect Organisational MRPII Costs at Company C

5.4.10 Analysis of Direct Costs Identified by Company D

As discussed in section 5.1.1, the steering committee involved in the 'in-house' development of MRPII, considered it to be a 'cheaper' option. However, there remained much debate within the graduate contingency, whether they had the necessary skills to develop the required system. Yet, it was the steering committee that considered the graduates to be suitably qualified and skilled to develop the required system. Nevertheless, the challenge appears to have been taken, with three of the graduate engineers attending external courses to develop new programming skills.

In using 'in-house' talent and expertise, the steering committee wanted to save some of the direct project costs associated with buying vendor software. Instead, graduates were used to develop a bespoke solution, which makes use of their own employees.

The steering committee gave responsibility to the graduate engineers, for the development of an integrated IS. In developing such a system, an external consultant championed the project, with assistance drawn from a projects engineer who through previous experience, identified a more 'realistic' range of project related costs. In doing so, the projects engineer said:

> *"... I am responsible for buying and installing machinery, who's benefits and costs are easy to identify ... but even then there are intangibles. I showed the team [consultant and graduate engineers] that costs ... are everywhere and that someone has to pay for them some where."*

It appears that Company D had little experience of software development, however, under the guidance of the external consultant and projects engineer, particular attention was given to identifying cost factors. As a result, table 5.22 identifies the range of direct costs identified by Company D.

Classification of Direct Project Costs	Direct Project Costs Identified
Hardware Costs.	File server and Terminals.
	Development PCs.
	Printer.
Software Costs.	Key vendor software module.
	Project management software.
	Spreadsheet and database software.
	Networking software.
Development Teams' Costs.	Graduate development engineers time.
	Consultancy fees.
Installation and Configuration Costs.	Installation accessories.
Training Costs.	Database software course
	Stakeholders 'In-house' Training.
	Stakeholders 'Education'.
Maintenance Cost.	Site licences.

Table 5.22: Taxonomy of Direct MRPII Costs at Company D

5.4.11 Analysis of Indirect Human Costs Identified by Company D

There was relatively little attention given to the issues associated with indirect project costs, although the projects engineer did identify a number of issues. These and others have been categorised and presented in table 5.23 and 5.24, where a distinction is made between indirect human costs and indirect organisational costs.

Classification of Indirect Human Costs	Indirect Human MRPII Costs
Management Guidance.	Steering Committees' time.
Development Teams' Time.	Project management time involving non-development teams.
Cost of Ongoing Ownership.	Continuous development until the company has an integrated system.
Personnel Costs.	Pay increases based on improved employee flexibility.
	Increases in staff turnover..
Employee Time.	Stakeholders time in explaining business processes to be computerised.
	Non-development personnel exploring the potential of the system and developing new ideas.
	Training personnel who then train others in the use of the system.

Table 5.23: Taxonomy of Indirect Human MRPII Costs at Company D

Even though the commitment and dedication of the steering committee are somewhat questionable, much time was spent by these managers discussing issues associated with the new system, and as a graduate engineer said:

> *"Time is money ... There was a lot of talking about the project but they [steering committee] didn't really help us ... in terms of support."*

Regarding further indirect human costs, the projects engineer was keen to stress the cost associated with people working together, through explaining and mapping business processes before their computerisation. In describing this, the projects engineer said:

> *"When you write a database you need to know what the system requirements are ... Well, the best person to tell you that is the person that has to do it for real. So you end up having him and the person that is writing the programme working together ... That at the very least two lots of wages are costs ... Never mind any losses in production."*

The graduate engineers were also keen to spend much of their time planning and managing the project. In doing so, using the skills that they had developed at university. There was also non-development staff involved in project management, with the projects engineer and MD playing an active role. In doing so, providing a formal planning environment before programming, thus much time was set aside discussing proposed plans, schedules and deliverables. Interestingly enough, the graduate engineers were keen to discuss the views of stakeholders that were having their processes computerised. As a result, development staff were asked by stakeholders whether learning new skills [MRPII] translated into increases in salary. Hence, it was considered possible that managers may be asked to pay extra salaries to reward increases in employee flexibility to both stakeholders and development team members. The implications of this are far reaching, in that extra wages may have to be paid, to prevent increases in staff turnover; the latter adding cost to recruitment, induction and training.

Also, there was the perception by the graduate engineers that once the project had been initiated, it was like a 'roller costa', in that the system would grow and continuously develop into all business functions. As a result, there will be an on-going cost that spirals, unlike other projects that have a start and finish. Therefore, management's financial commitment of resources would have to be long-term.

5.4.12 Analysis of Indirect Organisational Costs Identified by Company D

The projects engineer also stressed an indirect cost of training stakeholders in the use of their computerised system, who might then train others. Although this is an indirect human cost, there is an organisational dimension. There was the perception that training costs cascade down the organisation, with development staff giving much time and attention to using the computerised system but then, having less qualified staff train others. Hence, there is not only an indirect training cost associated with employee time but organisational costs associated with losses in productivity. The reason for this is that employees are not focusing on doing their job, rather training others to be more flexible. Furthermore, a graduate engineer identified that there might be a cost of inappropriately trained staff doing certain jobs, which then result in system crashes and failures, and as a result, reduces productivity.

Table 5.24 presents a summary of organisational costs identified by development and project management staff associated with MRPII development.

Classification of Indirect Organisational Costs	Indirect Organisational MRPII Costs
Losses in Productivity.	Losses in organisational performance resulting from changes to work practices.
	Losses in organisational performance resulting from inappropriate trained employees using the system.
	Poor performance from the possibility of new people being recruited following an increase in staff turnover.
System Failure and Crashes.	Conflicts resulting from people wishing to be flexible and using the system in an inappropriate.

Table 5.24: Taxonomy of Indirect Organisational MRPII Costs at Company D

5.5 Conclusions

There has been much empirical data reported in this chapter, with the enquiry now being able to draw conclusions. However, before any conclusions can be presented, it is important to appreciate the positioning of such conclusions within the context of the dissertation. Section 4.6 has distinguished the various levels of research questions sought within the dissertation, with the conclusions presented in this chapter now forming question level 3, as presented in table 4.2. As a result, the following represents those conclusions derived from the empirical research presented in this chapter.

There is evidence to suggest that stakeholder commitment towards the success of MRPII increases with improved communication. However, the 'free' exchange of communication may only be possible if supported by an 'open' corporate culture, non-departmental hierarchy and a small company size. The evidence reported also suggests that much care needs to be taken when developing a corporate culture, as it appears that an 'open' culture can act as a barrier to employee empowerment. The reason for this is that employees may feel the need to gain acceptance of their ideas by discussing and sharing them before implementation. As a result, the identity and momentum of change might be affected, with a slowing down of decision making.

However, education and training can be used as strategies for developing a culture that promotes responsive decision making. Empirical research also identifies that organisational cultures might be shaped by the industry sector of the company. For example, evidence suggests that culture constructs such as much flexibility is visible in jobbing shops as they suffer from peculiar characteristics, i.e. wandering bottlenecks, and month end syndrome.

The cases presented in this chapter also suggest that companies considered there to be a difference between employee training and education. Employee training was regarded as a strategy for broadening technical skills that can be applied to job functions, whereas employee education is considered closely aligned with developing ones' knowledge. As a result, when considered in relation to MRPII justification, employee training and education can be used as strategies to support a broader awareness and acceptance of the implications surrounding MRPII, and assists in the process of 'winning' over sceptics. Empirical evidence identifies that management support and commitment towards adopting MRPII can be demonstrated through developing a steering committee. However, a lack of shop floor representation on the steering committee may result in resentment, as operational issues associated with decision making may not be suitably raised/addressed. Conversely, a lack of shop floor stakeholder representation during the justification process, may results in the 'full' potential of the system not being identified/achieved. Regarding the implementation process, evidence indicates that the successful adoption of MRPII is facilitated by a project team that comprises of stakeholders that have specific, measurable, achievable, and realistic deliverables.

It appears from the empirical evidence reported in this chapter that senior management consider the adoption of MRPII to remove their decision making power, and as a result, they may resist its justification. Clearly, this suggests that the adoption of MRPII may have stakeholders for failure, with much of senior management's resistance towards adopting MRPII being covert. Interestingly enough, further factors supporting project failure include inconsistent project leadership and poor project planning. For example, if the project leader for adopting MRPII is the MD, then evidence indicates that there might be an abdication of leadership during the projects' life-cycle.

However, on the other hand, the involvement of a management consultant in project leadership and management may lead senior managers to abdicate project responsibility. Management support and commitment are considered to facilitate MRPII project success, and improve with a broader understanding of the benefits and saving achievable. In considering the range of benefits possible, there are multiple levels of business benefits resulting from the adoption of MRPII, with all benefits having differing natures. Such benefits can be classified as being: strategic, tactical and operational, and are identified as being: financially tangible, non-financially tangible and intangible. Interestingly enough, there appears to be a relationship between the level of benefit considered during decision making, and the level of management making the investment decision. For example, directors tend to focus on strategic/tactical benefits, whereas, managers pay greater attention to tactical/operational benefits.

It would appear from the evidence reported in this chapter that management is often unaware of the range of non-traditional appraisal techniques available for MRPII justification, even though they acknowledge the limitations inherent in traditional modes of financial analysis. As a result, management may consider common sense and guess work as suitable alternatives. The reason for this is that management regard MRPII appraisal to be complicated, with much subjectivity, thus management often forced into advocating an 'act of faith' investment strategy.

Empirical evidence also suggests that perceived cost savings often motivate the development of MRPII, when in reality, evidence has suggested that MRPII adoption costs often spiralled out of control as the project matures. This suggests that management have more problems identifying the costs and resources associated with MRPII. There is also evidence to suggest that there are multiple levels of costs that need considering during the justification of MRPII. These cost factors include direct costs and indirect costs: human and organisational. Incidentally, indirect costs are considered to be larger than direct costs, yet empirical evidence indicates that more attention is paid to identifying direct project costs during the justification process. However, there is also evidence to suggest that indirect project costs become clearer as the project matures. As a result, it would appear that management's commitment to securing resources for developing a MRPII system needs to be long-term.

Chapter 6

MRPII Evaluation Criteria and Model

This chapter begins by emphasising the need to identify MRPII evaluation criteria that then transform into a model. In doing so, providing managers with a descriptive tool for investment decision making. Such criteria is then presented, and has resulted from the empirical evidence reported in Chapter 5. Having developed a broad range of criteria that supports MRPII evaluation, modifications are then made to the previously presented conceptual model. Therefore, satisfying the aim of the dissertatiion, by offering investment decision makers a frame of reference during the evaluation of MRPII. The chapter then discusses the implications associated with developing a descriptive MRPII evaluation model.

6.1 Introduction

The decision making process of whether to adopt IT/IS is inherently fuzzy, both in theory and practice. This is complicated by IT/IS having to cope with changing organisational needs, which are compounded by human and organisational factors. As a result, complex interaction between the use of IT/IS and its changing organisational setting, requires that companies address *how* such investments should be evaluated.

6.2 Replacing Management Concern with MRPII Evaluation Criteria and a Model

There has been much discussion on the lack of suitable management tools to acknowledge the wide range of investment implications associated with MRPII. Indeed, the literature presented in Chapter 2 has emphasised this, with the empirical evidence reported in Chapter 5 exemplifying this further. As a result, the dissertation has culminated management concerns, with the thesis proposing the identification of MRPII evaluation criteria and development of an evaluation model. Therefore, contributing towards a better understanding of MRPII evaluation. The identification of such criteria and development of a model appears timely, as the adoption of MRPII is gaining pace, especially by SMEs. However, as a result of limited management frames of reference, many companies are being forced to adopt an investment strategy that is nothing more that an 'act of faith'. Further factors promoting this investment strategy include the limitations inherent in traditional appraisal techniques, and an insufficient knowledge by management, of those human and organisational factors associated with MRPII. Clearly, such issues present management with much concern, as their effects are far reaching, and may have an affect on the outcome of the project. Firstly, management might lose interest and withdraw their support if the level, nature and implications of MRPII benefits are not identified. This is important, as previous chapters have already identified the adoption of MRPII as having implications at a strategic, tactical and operational level. In layering such benefits, it must be appreciated that their natures also differ, and range from being tangible; financially and non-financially, to intangible. Also, each benefit will have different implications on the organisation and as a result, different stakeholders will be effected. Such issues have been identified as important in Chapter 5, and included within the proposed evaluation criteria and model.

Secondly, managers need to have a clear identification of project management issues, which can then be translated into objectives. Clearly, project management affects the success of MRPII adoption, with Chapter 5 presenting empirical evidence to identify this claim. Also, the thesis has established that broader ranging projects may need to be instigated, to improve the success of MRPII, and as a result, need consideration during MRPII evaluation. For example, there might be a need to develop more 'openness' and teamworking within the company, before a system that requires such facets is implemented.

Thirdly, without project planning and objectives, the type of system selected, and the time scale for implementation may be subjectively decided. However, in considering the proposed criteria and model, the scale of MRPII implementation can be reviewed during the decision making process, by identifying the far reaching implications of MRPII. In doing so, replacing subjectivity with structure, focus and objectivity.

Fourthly, the implementation of MRPII involves significant expenditure, in terms of direct and indirect costs, therefore, a timetable for implementation should take account of financial returns and cash flows. Clearly this is now possible and considered to be more accurate, as the proposed criteria and model developed, identify a comprehensive range of MRPII benefits (strategic, tactical and operational) and costs (direct and indirect: human and organisational).

Fifthly, MRPII requires long-term commitment; in terms of resources and infrastructure. This is evident in identifying the complexity of factors within the criteria and model, which contribute towards the decision making process. As a result, projects that underpin MRPII but are not directly related, may have to be commissioned in the first instance. In terms of the financial resources that may be required, Chapter 5 has identified a taxonomy of costs that would appear to occur during the projects' life-cycle.

Finally, in the absence of project leadership and stakeholder commitment, MRPII might become vulnerable to management changes. However, it has been identified through empirical data that even with 'strong' project leadership, the adoption of MRPII can fail.

Clearly, any company considering the adoption of MRPII is faced with a number of decisions. The first is whether to invest, or to concentrate resources on improving other aspects of the business. Assuming that MRPII is identified as the required area of investment, the development of a MRPII evaluation model will be of particular use to management decision makers, in addressing those concerns outlined above. This model will also support the robust evaluation of MRPII, through presenting a broader 'picture' of human and organisational implications; beyond managements traditional financial myopia. Hence, the proposition for a MRPII evaluation model appears justified, as it supports decision making, through identifying those issues associated with the adoption of MRPII.

6.3 MRPII Evaluation Criteria and Revised Model

Chapter 5 has offered much empirical data that has been used to test the hypotheses proposed in Chapter 3. However, rather than proving the validity of the hypotheses, the author has identified factors that support each conjecture, and described these constructs against idiosyncratic approaches to MRPII evaluation. In doing so, allowing others to relate their experiences to those reported in Chapter 5. Supporting this, are a list of empirical conclusions that have been extrapolated from the data, and presented in section 5.5. However, it is not the intention of this section, or indeed the aim of the dissertation to offer prescriptive guidelines on MRPII evaluation but rather, describe case study perspectives that allow others to relate their experiences to those reported. As a result, offering a broader understanding of the phenomenon of MRPII evaluation. In doing so, presenting table 6.1 and figure 6.1 as frames of references during the evaluation of MRPII.

The ability to carry out an evaluation process that acknowledges the criteria identified in table 6.1, and works within the boundaries of the model presented in figure 6.1, has important implications. However, before these implications are discussed, it is necessary to appreciate the evolution of figure 6.1, which represents revisions to the generic conceptual model presented in figure 3.1.

The process of developing figure 6.1, which is MRPII specific, has only been made possible after having carried out the empirical research reported in Chapter 5. As a result, following hypotheses testing and the identification of idiosyncratic human and organisational issues, a revised model is now presented in the form of figure 6.1.

In presenting table 6.1, a number of criteria have been extrapolated from the data and identified as constructs, or criteria that need addressing during a robust evaluation of MRPII. This in turn has resulted in revisions being made to the previously presented conceptual model. In considering both criteria and model, decision makers can now establish whether they have the 'ingredients' in place to embrace and acknowledge the 'full' impact of MRPII.

If however, companies find that the relevant criteria have not been considered, or are not in place, then actions can be instigated to develop an infrastructure that supports the adoption and exploitation of MRPII, thus facilitating its success and value added. For example, if an organisations' culture is 'closed' and does not promote innovation, then empirical evidence presented in Chapter 5 identifies that the company is unlikely to be in a position to 'successfully' develop a bespoke system. Since it may require an interactive cross-functional team approach, with multiple stakeholder interaction. However, on the other hand, identifying such a void will allow the development of cultural issues before MRPII is adopted.

MRPII Evaluation Criteria	Company A (Bespoke Development)	Company B	Company C	Company D
Manufacturing Sector	Subcontract Jobbing Shop	Small Batch Hand Manufacture	Subcontract Jobbing Shop	Large Scale Batch Manufacture
Nature of Deployment.	SIS	SIS / Operational	Operational	Operational
Type of MRPII Software.	Bespoke	Vendor	Bespoke	Bespoke
Factors Motivating MRPII	Business/Technology	Technology	Business	Business/Technology
Strategy Available to Support MRPII.	Yes	Yes	No	No
Financial Appraisal Technique.	CBA	CBA	None	None
Teamwork Approach.	Dedicated/Flexible	Dedicated	Dedicated	Dedicated
Level of Management/Employee Education.	Management Course:Time Served	Management Course Time Served	Technical·Semi-Skilled	Technical:Non-Engineering Graduates
MRPII Project Leader.	Production Manager	Unclear	Quality/Plant Manager	MD/Consultant
Training and Education on MRPII.	Entire Workforce	Entire Workforce	Limited to team members	Operational Stakeholders
Investment Strategy.	Act of faith	Act of faith	Act of faith	Act of faith
External Consultancy Support.	Yes	Yes	No	Yes
Elements of Concept Justification.	Yes	Yes	Yes	Yes
Corporate Culture.	Open and Proactive	Open and Proactive	Open and Reactive	Closed and Reactive
Stakeholder Analysis.	Entire Workforce	Entire Workforce	Stakeholders of manufacturing	Office Staff/Stakeholders of processes
Management Commitment.	Yes	Yes	Covert MRPII Development	Covert Management Resistance
Financing.	Corporate Funding	Corporate Funding	Continuous Improvement	Corporate Funding
Formal Project Management.	Yes	Yes (following establishing its importance)	No	Yes
Academic Involvement.	Industrial Student Placements	No	No	No but graduates developed the system
Continuous Project Evaluation.	Monthly Progress Meetings	Monthly Progress Meetings	Adhoc	Weekly Project Meetings
Risk Consideration.	Competitive Risk	Competitive Risk	No	Opportunity Cost
Company Exposure to IT.	High	Medium	Medium/Low	Low
Consider Multiple Levels of MRPII Benefits.	Strategic, Tactical, Operational	Strategic, Tactical, Operational	Strategic, Tactical, Operational	Strategic, Tactical, Operational
Consider Diverse Nature of MRPII Benefits.	Tangible [financial & Non-financial] and Intangible	Tangible [financial & Non-financial] and Intangible.	Tangible [financial & Non-financial] and Intangible.	Tangible [financial & Non-financial] and Intangible.
Consider Multiple Types of MRPII Costs.	Direct and Indirect [Human and Organisational]	Direct and Indirect [Human and Organisational]	Direct and Indirect [Human and Organisational]	Direct and Indirect [Human and Organisational]
Consider Diverse Nature of MRPII Costs.	Tangible [financial & Non-financial] and Intangible	Tangible [financial & Non-financial] and Intangible	Tangible [financial & Non-financial] and Intangible	Tangible [financial & Non-financial] and Intangible

Table 6.1: MRPII Evaluation Criteria: A Summary of Empirical Evidence

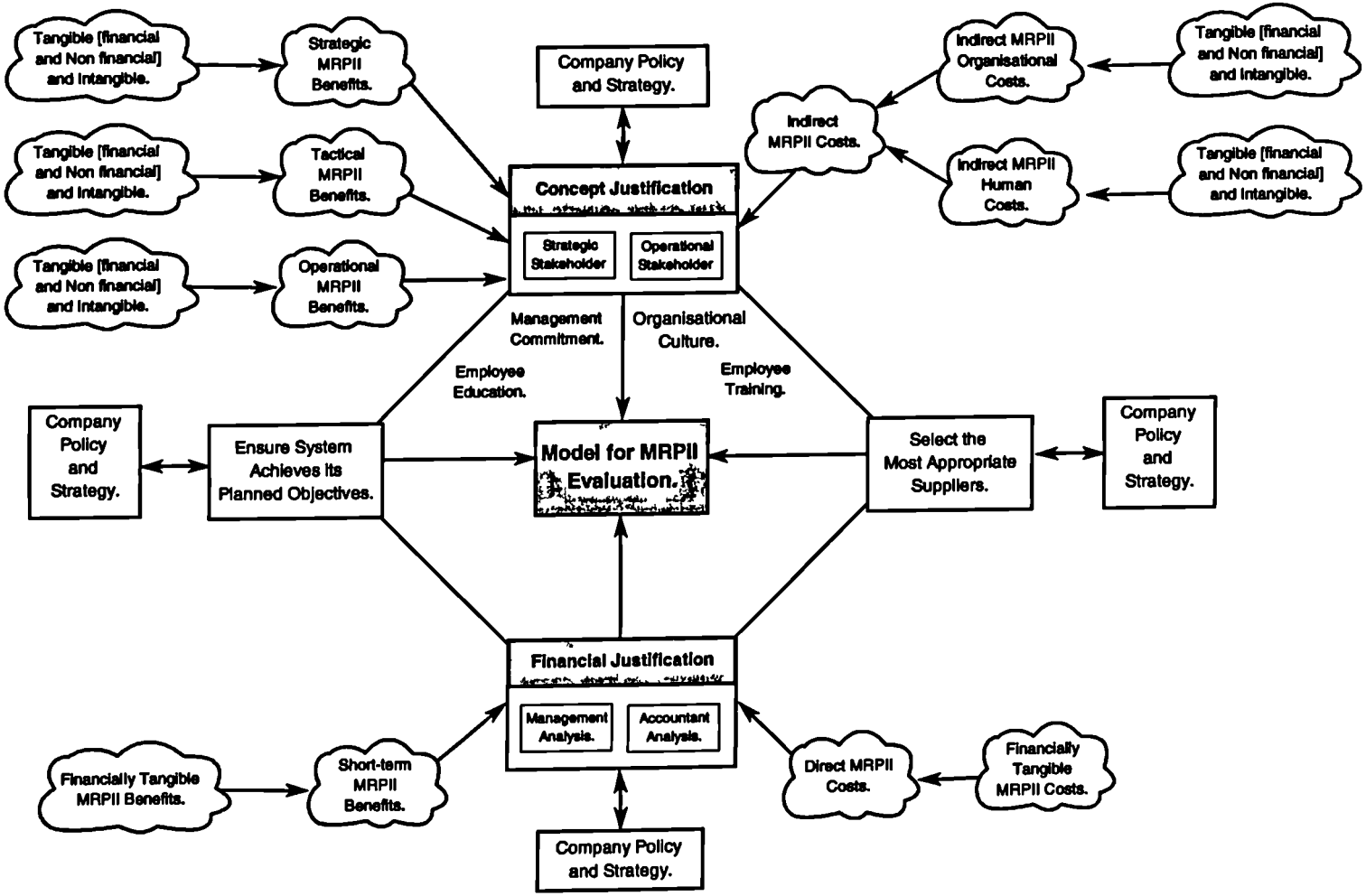

Figure 6.1: Model for the Evaluation of MRPII

6.4 Implementation Issues for MRPII Evaluation Criteria and Model

Much of the dissertation, and in particular this chapter has emphasised the identification of criteria that supports the evaluation of MRPII. There is also an advantage in evaluating a system periodically, after its justification. In doing so, not only can the initial estimates and criteria for success be improved and developed but, as experience is gained, additional factors may be identified that had not been foreseen at the justification stage. In addition, since it may take several years to install a complete MRPII system, the company's market place may change during that period. As a result, original priorities may need to be revised. Therefore, there are very clear implications resulting from the development of a MRPII evaluation criteria and model. These implications are numerous but are summarised as:

6.4.1 Decision Making Implications

- The identification of MRPII evaluation criteria and development of a model provides investment decision makers with a proactive frame of reference.
- Concept justification of MRPII allows for the alignment of the investment with the corporate strategy, through gaining the support and sharing of goals with internal and external stakeholders.
- Financial analysis enables management to view MRPII in understandable terms (company specific use of appraisal techniques may be used).
- An opportunity is provided to show that the investment may be financially profitable. This has the potential to increase management support.

6.4.2 Project Management Implications

- An evaluation process supports project management, where a framework is offered to ensure that the project aim and objectives are achieved.
- The identification of project objectives and indicators will allow progress to be evaluated; thus facilitating benchmarking.
- Templates of achievable benefits, and cost control factors are identified from a viewpoint of multiple stakeholders.

- Implementation can be planned to ensure that the greatest benefits are achieved at the earliest date, and without major disruptions to the organisation.
- Implementation can be planned to ensure that the lowest possible costs are incurred; thus can be achieved through cost analysis and management.

6.4.3 Benefit Analysis Implications

- Establishes a wider appreciation of the different levels of MRPII benefits; strategic, tactical and operational. These benefits may also occur at different stages during the systems' life-cycle.
- There is an acknowledgement of different natures of MRPII benefits; tangible [financial and non-financial] and intangible.

6.4.4 Cost Analysis Implications

- Establishing an appreciation of the different types of MRPII costs; direct and indirect [human and organisational]. Also, acknowledging that these costs may occur at different stages during the systems' life-cycle.
- Acknowledges that there are different natures of MRPII costs; tangible [financial and non-financial] and intangible.

6.4.5 Stakeholder Involvement

- A wider understanding of the company-wide implications associated with the adoption of MRPII; an enterprise-wide system that impacts many people and departments within the company; multiple stakeholders.
- Raising the significance of human and organisational factors as constructs that support the successful deployment of MRPII.
- Emphasises that the successful adoption of MRPII is facilitated by a flexible multiple-stakeholder teamwork approach.

6.4.6 Organisational Issues

- Raising the importance of an 'open' proactive culture that promotes innovation and continuous improvement.
- Promotes a culture of continuous evaluation where progress is monitored and improvement opportunities identified.
- Employee education and training are exemplified as constructs that support employee acceptance of MRPII.
- Management commitment is improved through their active involvement in the evaluation process.

6.5 Conclusions

The case for the identification of evaluation criteria and development of a model, which provides investment decision makers with a frame of reference has been argued, justified and presented. This has been proposed from the viewpoint of an application specific approach. This is considered preferable over the development of a generic tool that claims to be 'all things to all people'. Although, it is appreciated that there may be underlying generalities, nevertheless, it is for further research to identify where these generic qualities lie, and is beyond the scope of the presented research.

In identifying MRPII evaluation criteria and developing a model, it has been necessary to determine those human and organisational factors that support it's development, together with identifying the resultant effects of it's implementation; types of costs and benefits. Furthermore, previous chapters have shown that these two issues are important, and form constructs within the robust MRPII evaluation model because they affect decision making. Therefore, this chapter clearly offers companies a descriptive frame of reference during the evaluation of MRPII. In doing so, strengthening the prospects for managing the adoption, implementation and continuous evaluation of MRPII. The results of this are considered to facilitate the successful development of a MRPII infrastructure and support the exploitation of investment funds to their utmost, as well as impacting: (i) decision making; (ii) project management; (iii) benefit analysis; (iv) cost analysis; (v) stakeholder involvement; and, (vi) impact organisational issues.

Chapter 7

Conclusions and Recommendations

This chapter begins by presenting conclusions drawn from both the literature and empirical research reported in the dissertation. Then, acknowledging that all research is fallible, a critical evaluation of the research process is discussed. Following this, the research novelty claimed in the dissertation are summarised. Finally, recommendations for further work are proposed.

7.1 Research Findings

In drawing findings from the research reported, there are two dimensions of conclusions. The first set of conclusions represent those from the published literature, and have been extensively reported in section 2.9 of the dissertation. The research then advanced to a multiple case study enquiry, where empirical conclusions were drawn and presented in section 5.5. Although different ends of the same continuum, these sets of conclusions represent a body of research associated with the phenomenon of investment decision making. However, it is not the intention of this section to discuss these conclusions further but rather, to address the findings of the entire study; question level 4, as presented in table 4.2. As a result, the remainder of this section presents those conclusions that can be drawn from the research.

It has been identified in the literature and empirically confirmed that decision makers are often unaware of the diverse range of non-traditional appraisal techniques available. This is the case, even though they acknowledge the limitations inherent in traditional modes of financial analysis. Such limitations go beyond the inability of these techniques to capture the diverse range of IT/IS benefits and costs. In addition, include managements concern over the inappropriateness of these methods when applied to the appraisal of projects that add 'value', through creating new knowledge, or providing opportunities for 'knock on' investments. It has also been identified in the literature and confirmed with empirical data, that the limitations and concerns over the use of such techniques may force management into adopting one of the following strategies: (i) invest as an 'act of faith'; (ii) do not invest at all; or, (iii) manipulate project costs and benefits to produce a desired economic argument that supports the adoption of IT/IS.

The research has also identified in the literature and confirmed with empirical data that decision makers continue to be biased towards short-term projects, which have financially quantifiable benefits. Even though this may be at the expense of long-term strategically important investments. As a result, companies are often unable to make long-term strategic IT/IS commitments, which inevitably forces them to face a future decline in net cash-flows. The reason for this is that the competition will absorb their market share, if they are not more competitive, or compete for technological leadership.

It has also been empirically identified that capital budgeting processes may require different levels of authorisation, depending on the size of the expenditure[1]. This kind of procedure may create an incentive for lower level managers to propose 'small' projects, to avoid certain decision making channels. The empirical data reported has identified a further reason for adopting this approach, which centres around lower level managers wanting to avoid resistance from senior management decision makers; stakeholders for failure. However, a consequence of this is that interdependencies between investment projects can not be accounted for within traditional appraisal paradigms. For example, independent MRPII components [small projects/modules] may not meet required returns but, when the system is viewed as a whole, it's wide range of benefits may satisfy the required returns. This has serious implications for SMEs, as empirical evidence reported in the dissertation identifies that MRPII is being adopted by such companies in independent components, for it's ability to be implemented in 'small' manageable modules. In doing so, allowing companies to absorb organisational change at their own pace.

The need to consider initial and follow-on investment levels have also been identified in the research, as being important when choosing MRPII planning horizons. For example, the use of NPV will always favour buying new MRPII modules rather than the purchase of an entire system. The reason for this is that less investment is required, and the returns are more immediate, however in the long-term, this strategy can lead to the use of obsolete technology and loss of competitive advantage.

Empirical research reported in the dissertattion has identified that during the decision making process, there is a need to consider not just system end-users as stakeholders but, also those that are responsible for generating the data that goes into the system. This is in addition to users that are reliant on the data that comes out of the system. The empirical evidence presented, suggests that a multidisciplinary teamwork approach is synergetic to decision making, as without it, all areas of potential benefit and probable costs may not be identified. Also, the use of a cross-functional stakeholder teamwork approaches may help to prepare the organisation for future business process integration, by increasing the interaction of departmental functions.

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1 It is interesting to note that the literature focused on large companies, whereas the sources for the empirical data were SMEs.

The literature has identified and it has been empirically confirmed that management needs to offer a long-term commitment to securing resources for MRPII. The reason for this is that the evidence has identified many of the benefits resulting from MRPII as being strategic and tactical, which suggests that they are achievable in the long-term.

It has been empirically identified that although perceived cost savings are considered to motivate the adoption of MRPII, in reality, MRPII cost analysis is often myopic, with many costs only appreciated as the project matures. It has been empirically identified that these costs may *not* be financially quantifiable, as they are likely to be made up from human and organisational factors. Similarly, the research has confirmed that some of the benefits resulting from the adoption of MRPII may *not* be financially quantifiable, as they may have intangible and non-financial dimensions. The acknowledgement of such factors has important implications during decision making, as it promotes a more rigorous evaluation process. In doing so, identifying investment related issues that cannot be integrated into traditional appraisal methods. As a result, emphasising the need for a more holistic approach, which has resulted in the identification of MRPII evaluation criteria, and development of a model that integrates human and organisational factors into the decision making process. In doing so, providing decision makers with a rigorous assessment model for evaluating investments in MRPII.

7.2 Research Evaluation

The author has argued that the use of prescriptive generic investment appraisal techniques is myopic, and inappropriate for strategic investments in IT/IS. The reason for this is that they are unable to accommodate the complexity of interacting variable that are associated with SIS. As a result, the author was directed towards broadening the decision making process. Hence, it was proposed that an application specific evaluation model should be developed, and in the case of the thesis, MRPII was chosen as a suitable application. Even though there might be much overlap in developing further application specific evaluation models, the identification of MRPII evaluation criteria and development of a model is relevant, when identifying those human and organisational factors that support the adoption of MRPII. As a result, emphasising the need to consider such factors during the decision making process.

In developing a MRPII evaluation model that essentially acts as a frame of reference for investment decision makers, there was a need for a robust research methodology. As a result, care was taken, as the author acknowledged that the aim of the dissertation was reliant on a suitable research methodology. Furthermore, such a methodology could be used as a framework for developing *other* application specific evaluation models. Therefore, two aspects of novelty were reliant on developing an appropriate research methodology. As described in Chapter 4, the use of qualitative data gathering methods were justified for gathering the necessary data. The reason for this is that such methods allow the generation of 'soft,' 'rich' contextual data, which is associated with human and organisational issues. However, in spite of it's strengths, qualitative research methods do have inherent weaknesses (Miles, 1979), with a number being encountered during the reported research process. In conducting this research, the collection and analysis of qualitative data did prove time-consuming and demanding, and in the case of the data generated, resulted in the researcher at times, being 'overwhelmed' by the sheer volume of data. However, the relative difficulty of analysing such data did not invalidate any conclusions drawn, as cluster analysis was applied to the verbal data obtained.

A number of additional issues have also been acknowledged by the author, regarding the use of qualitative research methods. Firstly, the inability of the researcher to interpret events from the subjects point of view, is questioned, without some degree of bias. However, to try and address this, the author used a multi-method approach [data triangulation] to data gathering. Although, the author continues to consider that there will always be elements of bias inherent in qualitative data analysis, due to it's subjective nature. Secondly, the relationship between theory and research might be considered weak and unstructured, as qualitative research approaches maybe criticised for not instilling theoretical elements. However, in the case of this research, the author sought to partially address this concern through developing conceptual models, proposing theoretical conjectures, and building a framework for the testing of hypotheses. Although retrospectively, the author considers that a lack of structure and theory can actually add to the diversity and 'richness' of qualitative data gathered. As a result, the appropriateness of grounded theory is now appreciated and acknowledged as a suitable research methodology for investigating MRPII investment decision making.

Finally, there is much concern regarding the extent that qualitative research can be generalised beyond the confines of the enquiry, as the sample of companies used are often relatively few. Even though the number of companies used during this study was 4, to extend this enquiry further would not have increased it's external validity. Indeed, qualitative case study research does not offer the pretence of replication, as controlling the research setting destroys the interaction of variables, and therefore, affects the underlying philosophy of interpretivism. In re-assuring sceptics of interpretivism, the study was conducted within a structured methodology, and guided by theoretical concepts and models, with a number of data gathering methods and processes having been used. However, the methodology presented in Chapter 4 was developed because it was considered 'safer' to identify and test independent variables following a review of the literature. Having now evaluated the research process, such concern needed not of been considered important, as a grounded theory approach may also have been suitable, and yet, still provided 'freedom' and scope for: (i) discovery and theory building; (ii) theory testing; or, (iii) discovery, theory building and testing.

7.3 Research Novelty

The most important element of a doctoral dissertation is concerned with aligning the importance of the thesis, to the development of the discipline being researched. As a result, it is here that the contribution that the thesis makes to extending the boundaries of knowledge is presented. As a result, the research novelty claimed is:

- Firstly, in describing capital budgeting, a focus has been made about the types of investment appraisal techniques available. To this end, a novel taxonomy has been proposed, which is based on technique characteristics together with their limitations when used for the purpose of MRPII appraisal. Thus, establishing that although there are many appraisal techniques, their use often supports a number of IT/IS investment barriers, as well as emphasising their inability to capture many human and organisational factors. As a result, underlining the need for decision makers to acknowledge the 'softer' issues associated with developing an IT/IS infrastructure, and exemplifying the inclusion of such considerations within a robust MRPII evaluation model; and,

- Secondly, in addressing investment decision making from a new approach, by extending the boundaries of traditional prescriptive generic appraisal techniques. The novelty of the criteria and model presented, is it's integration of human and organisational factors from an application specific point of view. As a result, a model that extends the limitations of traditional financially-based appraisal frameworks has been developed, for the purpose of evaluating the adoption of MRPII, thus resulting in the testing hypothesis 1.

7.4 Recommendations for Further Work

The identification of MRPII evaluation criteria and development of a model has established those issues that appeared crucial within the companies studied. To refine such criteria and model may be considered to further substantiate the research presented. As a result, rather than continuing with an interpretivist case study approach, the author now suggests that the criteria identified may be transformed into a large-scale survey questionnaire. Clearly, this approach would not have been possible previously, as such criteria did not exist but, the integration of this criteria into a large-scale survey will offer the opportunity to establish the generic significance of such criteria. In surveying a representative sample of SMEs, such criteria can thus be developed into a generic application specific evaluation model.

Another interesting research proposition is to establish whether there is a relationship between the criteria identified as a result of this study [focusing on SMEs], and that criteria offered by large[2] companies. Therefore, it is suggested that an interesting area for further research could be to test this hypothesis. It is proposed that this can be achieved by using a similar methodology to that presented in Chapter 4 but, whilst considering the size of the company as an independent variable in the analysis.

A further anecdotal finding that emerged from the research, and as a result warrants investigation, is organisational perception of 'what constitutes MRPII value, risk and success'. These three concepts are subjective, and perhaps an identification of their constructs would contribute further criteria to the evaluation of MRPII.

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[2] Large companies employ over 500 employees (Storey, 1994).

Finally, it appears that there are a large range of benefits; possible 30, or 40, resulting from the adoption of MRPII. Therefore, a further area of research could be to assess whether a pareto affect occurs, whereby only a small number of benefits will have a major effect on the perceived success of MRPII adoption. Similarly, to investigate whether the same rationale applies to MRPII costs.

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Appendix A - Manufacturing Resource Planning (MRPII)

- MRPII Overview

Functional modules of MRPII therefore not only include the MPS but encompass MRP, capacity requirements planning, production monitoring and control, as well as the more traditional, accounting, financial and marketing functions (Burns *et al.*, 1991; Mcallister and Carlisle, 1993). Unlike Just in time (JIT) which 'pulls' goods through a factory, MRPII is considered a 'push' system, in the sense that a forecast, or sales order has been generated at the outset, and a manufacturing plan developed to meet those demands. It is this plan that drives the issue of work orders. These computer-based systems can process a large number of transactions daily, to maintain data on many end items, and track the status of customer, purchase and work orders. Hence, MRPII has the potential to provide managers with the capability to control complex business processes, whilst operating within an ever intensifying competitive environment.

Manufacturing build requirements and forecasts are then calculated in terms of quantity and delivery dates, and exploded into a Bill of Material (BOM) file, which breaks down a product into it's constituent parts. Net requirements are then calculated by deducting the available inventory from the gross requirements. Finally, a schedule is produced, which enables the user to decide on variables such as lot sizes. The system then issues work orders to relevant work centres throughout the plant. The term 'closed loop' refers to the changes being directed back into the system, to ensure that the manufacturing plan is accurate and constantly updated. The concept of MRPII is represented in figure AA.1, which details it's constituent modules.

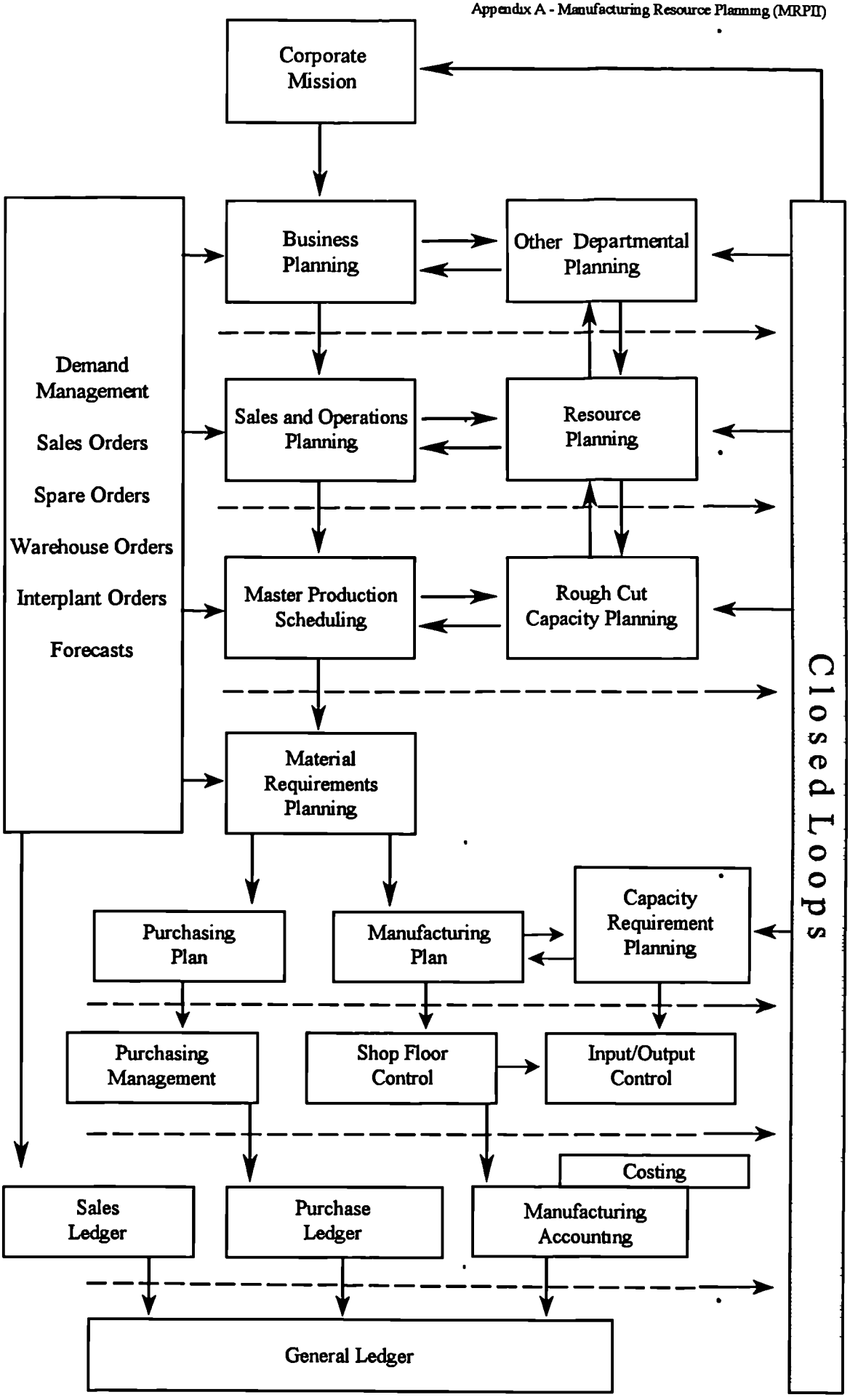

Figure A.1: Modular Components of MRPII

Clearly, MRPII is complex but nevertheless, offers the opportunity to improve their efficiency and effectiveness, which can then provide a competitive advantage. However, this raises the question of *how* MRPII success can be evaluated. In addressing this, Wight (1993) proposes the use of a checklist. In adopting this method, a grade is awarded to the implementing company, depending upon the answers supplied to the checklist. Table AA.1 provides a summary of class A, B, C and D user characterisics.

Oliver Wight Classification	Planning and Control Processes	Continuous Improvement Process
Class A	Effectively used company-wide; generating significant improvements in customer service, productivity, inventory and costs.	Continuous improvement has become a way-of life for employees, suppliers and customers; improved quality, reduced costs and inventory are contributing towards a competitive advantage.
Class B	Supported by top management; used by middle management to achieve measurable company improvements.	Most departments participating and active involvement with suppliers and customers; making substantial contributions in many areas.
Class C	Operated primarily as better methods for ordering materials; contributing to better inventory management	Processes utilised in limited areas; some departmental improvements.
Class D	Information inaccurate and poorly understood by users; providing little help in running the business.	Processes not established.

Source: Wight O.W. 1993. The Oliver Wight ABCD Checklist for Operational Excellence.

Table A.1: Oliver Wight Class A, B, C, D User Characteristics

After developing the ABC classification system, the Oliver Wight Companies carried out a survey to investigate the relative successes of MRPII implementations, against the classification established. During their evaluation, four key indicators, or performance measures were identified as part of a post implementation evaluation process. These include: inventory levels, customer service, productivity and purchasing costs. Unsurprisingly, the survey reported the Oliver Wight 'proven path' method as the recommended process for 'successful' project implementation. However, the 'proven path' appears *not* to integrate a post implementation evaluation process within the systems' life-cycle. Interestingly enough, although the 'proven path' for MRPII implementation was proposed in the 1980s, the number of failures is still thought to be as high (Duchessi *et al.*, 1989; Burns *et al.*, 1991; Ang *et al.*, 1995).

Appendix B - Taxonomy of Appraisal Techniques

- Economic Ratio and Discounting Appraisal Techniques
  - *Traditional Payback*
  - *Return on Capital Employed*
  - *Cost/Benefit Analysis*
  - *Net Present Value*
  - *Internal Rate of Return*
  - *Hybrid Discounting*

- Strategic Appraisal Techniques
  - *Technical Importance*
  - *Competitive Advantage*
  - *Research and Development*
  - *Critical Success Factors*

- Analytic and Other Portfolio Appraisal Techniques
  - *Weighted Scoring Models*
  - *Conventional and Artificial Intelligence Programming Approaches*
  - *Risk Handling*
  - *Value Analysis*

- Integrated Appraisal
  - *Multi-attribute or Multi-criteria Analysis*
  - *Scenario Planning and Screening*
  - *Pricing Models*

B1.1 Economic Ratio and Discounting Appraisal Techniques

Traditional Payback

The payback investment appraisal approach is one of the most commonly used techniques available. It involves determining the period of time that is required to recover the initial cost of the project. The payback period can be determined using the following decision rule - *if the calculation of time is less than the required payback period, then the decision is given to invest in the proposed project* - and it is calculated using the following formula:

$$Payback\ Period = \frac{Capital\ Cost}{Annual\ Savings - Annual\ Costs}$$

The payback approach can be used to appraise both single and competing projects. In the case of competing projects, it is the shortest payback period that is regarded as the best alternative, with the least risk.

Return on Capital Employed

The second traditional investment appraisal technique is the Return on Capital Employed (ROCE), although it is often referred to as Return on Investment (ROI). In it's basic form, it is determined as the ratio of accounting profit generated by an investment, based on the required capital outlay. The result obtained is then expressed as a percentage. There are many variations in the way that the accounting profit and capital outlays are calculated, although, normal practice is to calculate profit after depreciation but before any allowance for taxation. It is also necessary to include in the capital employed figures, any required increases in working capital (Lumby, 1993). The following are ROCE expressions:

$$Return\ on\ Initial\ Capital\ Employed\ (ROICE) = \frac{Annual\ Profit}{Initial\ Capital\ Employed} * 100$$

$$Return\ on\ Average\ Capital\ Employed\ (ROACE) = \frac{Annual\ Profit}{Average\ Capital\ Employed} * 100$$

Regardless of the ROCE reporting format i.e. ROICE, or ROACE, such criteria can be used to appraise single and competing projects. First, a decision criterion is set, in terms of a minimum acceptable level of ROCE (the figure used often reflects the required return on capital sought by the firm). Then, for a single project to be considered acceptable, it's ROCE must at least equal the required return. In appraising competing projects, the best of the alternatives is the one with the highest ROCE.

Cost Benefit Analysis

Cost Benefit Analysis (CBA) can adopt many forms i.e. the inclusion, or exclusion of intangible and non-financial benefits, together with indirect costs. Regardless of format, it remains one of the most widely used techniques for investment appraisal. In using this approach, financial estimates are made of the project's benefits. Such estimates are then compared with the project's costs. Inevitably, where competing projects are evaluated, it is the one with the greatest cost/benefit that is accepted (Pavone, 1983). Incidentally, CBA is not considered a complete science, for a 'full' and proper evaluation. The reason for this is that issues such as project and event risk, and the ability to offset cost with flexibility is not addressed. In practice, the recommendations coming from CBA are often overturned by decision makers, who may not agree with the measures determined by those attempting to justify the projects' proposal (Pavone 1983).

Net Present Value

The Net Present Value (NPV) is an economic appraisal technique that considers not only the magnitude of cash flows but also their timings. The starting point in understanding the basis of NPV is in it's regard for the discount rate required. The NPV of an investment is achieved by discounting future cash flows to present value, and summing them together. Essentially, all the project's cash flows are discounted back to when the project started; year 0. However, it's use in practice implies that decision makers judge a project by an absolute number, and while it is easy to use this rule - '*the generation of a positive NPV is an acceptable project*' - decision makers will be interested in not only the final NPV payoff but also in the size of the initial investment, and the length of time before the project matures (Dugdale, 1991). The discount/hurdle rate used during the appraisal process, is the minimum return required by the company, for the project contemplated. The formula for calculating the NPV is:

$$NPV = \sum_{n=0}^{n} \frac{C_n}{(1+r)^n}$$

Where C_n is the total cash flow in year n, and r is the discount/hurdle rate.

Internal Rate of Return

The Internal Rate of Return (IRR) is similar to NPV, and shares discounted principles. It is a process of determining the value of the discount/hurdle rate that makes the NPV of the project zero. In essence, this method can be seen as the arithmetic result of the NPV method. In general terms, the IRR is the value for r that satisfies the expression:

$$\sum_{n=0}^{n} \frac{C_n}{(1+r)^n} = 0$$

Where C_n is the total cash flow in year n, and r is the discount/hurdle rate.

The decision rule now becomes - '*accept the project if it's IRR is greater than the cost of capital, and reject it if the IRR is less than the cost of capital.*' Interestingly enough, if a decision has to be made about a single project, with conventional cash flows (single outlay followed by a series of inflows), the use of IRR will lead to the same decision as NPV. Conversely, in more complex circumstances, such as in the appraisal of MRPII, the use of IRR and NPV can lead to different decisions being made. The reason for this is that there are often different views expressed by the decision makers, together with the level of detail within the investment proposal.

Hybrid Discounting

Although the extensive use of DCF techniques have been criticised (Meredith and Suresh, 1986; Farbey *et al.*, 1993; Lefley and Sarkis, 1997), attempts are being made to modify these approaches; to address their respective limitations. Such techniques are discussed by Irani *et al.*, (1997[a], 1999[a]). The increasing need for a new perspective of traditional investment appraisal is one that has been driven by the advent of technological advances, and the changing portfolio of IT/IS benefits, costs and risks.

As a result, hybrid techniques, such strategic discounting is proposed by Pearson (1985). This approach adjusts the discount/hurdle rate in those projects that have many non-financial and intangible benefits, and indirect costs. Also, project and event risk play a considerable part in adjusting the hurdle/discount rate. Similarly, Michael and Millen (1985) propose the use of non-quantitative strategic justification, if a project fails to clear the usual DCF discount/hurdle rate. Essentially, the discount/hurdle rates are manipulated to represent the degree of risk and qualitative benefits and costs perceived associated with the project. However, these hybrid approaches are considered to present much controversy, as they are largely judgmental and based on subjective opinions. Hence, much care needs to be taken, as varying and often conflicting results can be obtained from the same financial data, due to it's inherent subjectivity (Kakati and Dhar, 1991; Primrose, 1991).

B2.1 Strategic Appraisal Techniques

Technical Importance

This involves the justification of an investment based on it's technical importance to a firm, and assumes that a desired goal of the company cannot be achieved unless the project is executed (Meredith and Suresh, 1986). For example, the development of an 'open system' that can be achieved through developing a compatible company wide local-area network, which integrates stand alone systems from different departments.

Competitive Advantage

Similarly, with competitive advantage, a project is undertaken only if it is essential in meeting the desired goals of the business. However, the achievement of these goals should provide an advantage over the competition (Sabherwal and Tsoumpas, 1993). For example, the adoption of MRPII with the objective of achieving the 'full' portfolio of benefits, is reported as resulting in a significant competitive advantage, over those companies yet to adopt such a system (Wight, 1984; Primrose, 1990; Irani *et al.*, 1999[b]).

Research and Development

The appraisal method of Research and Development (R&D) involves treating a project proposal as a R&D investment. In this type of appraisal, it is assumed that the project holds sufficient long-term potential, although it may be regarded as costly and highly risky. In this case, the development of an 'own' product range, by a company that is typically a subcontractor, may be classified as a R&D investment (Irani *et al.,* 1997[b]).

Critical Success Factors

Project appraisal that uses Critical Success Factors (CSFs) emphasises the importance of information, to achieve management control in furtherance of key business objectives. Therefore, CSFs may be defined as:

> *"The limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organisation ... They are the few areas where timings must go right for the business to flourish."*
>
> Rockart (1979 p. 85)

In other words, CSFs may be regarded as being necessary and sufficient for success; each factor is necessary and the set of factors sufficient for business success (Williams and Ramaprasad, 1996). Critical success factors identify 'critical' areas within the business that could on their own, improve the performance of the organisation. Their respective information requirements are then identified, with issues such as inputs, outputs information flows and reporting structures being specified. However, it is considered difficult to prioritise the list that emerges, with the assessment of benefits/implications often acting as an after thought, as they are seen as an intrinsic part of maximising business performance (Peters, 1989).

B3.1 Analytic and Other Portfolio Appraisal Techniques

Analytic portfolio appraisal techniques include a vast array of methods, with examples including: weighted scoring models, conventional programming approaches and those based on artificial intelligence principles. Meredith and Suresh (1986) advocate the use of analytical portfolio techniques for the justification of IT/IS projects in manufacturing.

Weighted Scoring Models

These investment appraisal techniques have a rational underlying principle, and their practical application has been reported by authors such as Nelson (1986). An example of a weighted scoring model is one that has been developed by Saaty (1980), and is called the Analytic Hierarchy Process (AHP). It offers a multi-objective decision making approach that employs pairwise comparisons to determine the weights and priorities of a variety of factors, attributes, elements and alternatives. Their basic assumption is that decision makers are able to structure a complex problem in the form of a hierarchy, where each element and alternative can be identified and classified into levels that are then evaluated with respect to other related elements. By making paired comparisons of the elements in each level, with respect of the elements in the next higher level, it is possible to decide on an appropriate choice of element in the higher level. However, when the elements of a level cannot be compared, except in terms of a finer criteria, a new level is created. Thus, the analytic aspect of the hierarchy process would appear to serve as a stimulus for the creation of new dimensions for the hierarchy. Therefore, it can be seen as a process of inducing cognitive awareness, with a logically constructed hierarchy, resulting as a by-product of the entire AHP approach. This approach to investment decision making has the advantage of providing a structure to a judgmental technique. However, effects of uncertainty can still 'creep' into the decision making process. The AHP has been used to address various decision making problems, regardless of their multitude of quantitative and qualitative factors. More recently, Nagalingam and Lin (1997) advocate the use of AHP as a suitable technique for the decision making of AMT.

Conventional and Artificial Intelligence Programming Approaches

These approaches to investment appraisal involve using a computer program to subjectively quantify project benefits and costs. Typical examples include integer and goal based programmes. In using integer programming (Gaimon, 1986), each project task is formulated as a 0-1 integer variable, and those projects that maximise the total weighted factor scores (which could be the same as those used in a scoring model) are selected. However, with goal programming, the investment criteria can be treated as goals to be attained, and involves some of the characteristics of CSFs.

An alternative programming approach is offered by Primrose and Leonard (1986), who claim to have alleviated the problems of costing AMT projects, with their computer program IVAN[1]. This technique allows companies to re-examine the relationship between AMT, and the range of benefits achievable. This approach is based on the premise that intangible benefits can be 'broken down' into several quantifiable benefits. For example, Primrose and Leonard (1986) suggest that the benefits of 'better product quality' can be broken down and quantified to mean some, or all the following: (i) reduced scrap; (ii) reduced rework; (iii) reduced disruptions; (iv) reduced warranty costs; (v) reduced cost of inspection; (vi) reduced cost of design changes; (vii) reduced cost of documentation change; (viii) reduced need for safety stock; and (ix) increased sales of better quality products. However, the issue of quantifying intangible benefits is somewhat contentious, and challenges in the normative literature.

Also, as a progression of conventional programming techniques, are those based on Artificial Intelligence (AI). Interestingly enough, Irani and Sharif (1997, 1998) and Sharif and Irani (1999) offer an investment justification framework that is modelled using fuzzy logic. This AI approach considers investment justification to consist of a broad set of optimisation criteria, and suggests the use of an evolutionary approach using Genetic Algorithms (GAs), as a further possible AI technique for the justification of IT/IS in manufacturing. Similarly, Daugherty *et al.*, (1993) present an expert system for the justification of AMT. This AI approach uses an expert system shell, and evaluates the investment proposal based on several attributes. The decision making criteria includes: project suitability, system capability, performance and productivity.

Risk Handling

Slagmulder *et al.*, (1995) explain the notion of risk, in the context of capital budgeting. It refers to the uncertainty about whether cash flows will be generated by the project. Similarly, Jurison (1995) explains that risk, with regard to business decisions, is typically referred to as the chance of loss associated with a given managerial decision. A consequence of this may involve undesirable financial losses. Essentially, risk is perceived by management as the probability of *not* achieving a given return, or the degree of downside deviation from the expected return.

[1] IVAN, Investment Analysis Computer Program Organisation Development Ltd, Altrincham, Cheshire, UK.

Risk handling methods in capital budgeting can take two forms. One is the simple 'risk-adjustment' method, which is based on deterministic estimations and intuitive adjustments, to either the underlying cash flows, or the evaluation criteria. Examples include: decreasing expected cash flows, increasing the discount/hurdle rate, or shortening the payback period. The second approach is borrowed from the management literature, and is generally referred to as 'risk analysis'. The risk analysis approach suggests that the extent of possible differences between the activities and expected value, reflect the magnitude of project risk (Remenyi and Heafield, 1995). It implies an evaluation of the uncertainties associated with critical variables, through assigning probabilities to possible outcomes. A range of results are then produced that can be evaluated for acceptability. Commonly employed techniques include sensitivity analysis, comparative analysis at optimistic, pessimistic and most likely estimates, simulation based on probability distributions of cash-flows, and certainty equivalent. However, Gurnani (1984) suggests that the majority of firms rely on intuitive judgement to account for risk, largely because of the complexity of employing sophisticated prescriptive risk analysis techniques. Similarly, Lefley (1994) reports managements slow adoption of risk analysis technique, during the appraisal of IT/IS investments in manufacturing.

Value Analysis

Value analysis proposes an approach that uses conjoint measurements to determine the value of significant intangible and non-financial benefit. Value terms are used to quantify the benefits' significance. A decision rule is then created to determine the appropriateness of the proposed system, however, this is where the subjectivity lies. Money *et al.*, (1988) suggest that the conjoint method tends to be highly subjective and cumbersome in the area of data recapture. This limitation becomes more acute, as the number of benefits within each grouping and number of groupings increase. However, Sethi *et al.*, (1993) question whether IT/IS value can really be measured, therefore, appearing to suggest value analysis as a method for providing a better understanding rather than as a technique for the appraisal of IT/IS.

B4.1 Integrated Appraisal

Multi-attribute or Multi-criteria Analysis

Multi-attribute, or multi-criteria techniques use financial and non-financial investment appraisal approaches, during the justification of new technology. These methods address investment appraisal through creating a single measure for each investment. Canada and Sullivan (1989) report the use of multi-attribute utility theory for the justification of AMT. Different variants of these methods exist but many follow a prescriptive format that typically includes:

- Design a number of goals, or decision criteria;
- Assign a score to each criterion;
- Establish the relative importance of each criterion by means of weights; and,
- Calculate the final score my multiplying the scores of the different decision criteria with the assigned weights.

Similarly, in the field of IT/IS investment evaluation, Parker *et al.*, (1988) propose a multi-criteria approach known as 'information economics'. However, Tomkins (1991) considers scoring models of this kind to be of little value because they are considered too general, and offer nothing more than a broad checklist of financial and non-financial implications. Therefore, suggesting the basis for an application specific approach.

Scenario Planning and Screening

Scenario planning and screening stands out for it's ability to capture a whole range of project possibilities in 'rich' detail. By identifying basic trends and uncertainties, decision makers can construct a series of scenarios that may help to compensate for the usual error in decision making: overconfidence; and, myopia (Schoemaker, 1995). Garrett (1986) presents a generic approach that suggests a combination of strategic and financial analysis, and proposes the use of a three-level screening approach. Scenarios are first analysed at a strategic level, and those proposals that are accepted at this level, go through another screening process at an operational level. This includes technical and organisational considerations. Finally, those passing the test at this stage, are subjected to a financial analysis, which typically involves a DCF approach.

However, if at any level no satisfactory scenario is found for further screening, new scenarios are generated, by relaxing some of the constraints and requirements. The process is then repeated. It therefore appears that this framework suggests that it is *not* a problem to compare proposals on the basis of finance, when contending projects clear the first two levels of screening.

Pricing Models

Logue (1981) is among those who recognise the promise that pricing models might hold for evaluating investments that create themselves assets. Kulatilaka (1984) proposes a pricing model where expected future cash flows are carefully identified and estimated. Three categories of cash flow are considered: Firstly, those related to the initial purchase and installation costs; secondly, those related to operational costs and benefits (as a function of time over the project); and, thirdly, those related to tax effects. Then a financial technique, such as capital asset pricing model (Na *et al.*, 1995) arrives at a discount/hurdle rate, which commensurate with the risk and qualitative implications of the different components of cash flow. The method proposed by Kulatilaka (1984) advocates the consideration of project, or event risk, and strategic implications, although subjectively. However, the financial process only follows once strategically attractive projects have been selected for analysis. Therefore, appearing to involve a degree of subjectivity.

Appendix C - Mail-based Questionnaire

- Mail-based Questionnaire

Study of the Investment Decision Making Processes used by SMEs When Justifying MRPII

This questionnaire is divided into 3 parts, with section A, B and C being mail based.

The questionnaire aims to address the following issues:

- To obtain general company information.
- To establish the alignment between an MRPII[1] investment and a manufacturing strategy.
- To establish the manufacturing performance of a perspective case study company.

Company Name: _____

Company Address: _____

_____

Respondents' Name: _____ **Position:** _____

Questionnaire Sections

Section A - General Company Information;

Section B - Manufacturing Strategy, and;

Section C - Manufacturing Performance.

[1] The term MRPII is an abbreviation for Manufacturing Resource Planning and is an example of a computer based integrated business system.

Section A - General Company Information.

A1. How many people are employed at your site in the following core business functions:

☐ Shop floor Employees	☐ Maintenance	☐ R&D	☐ Marketing
☐ Production Planning	☐ Quality	☐ Finance	☐ Project Eng.
☐ Manufacturing Eng.	☐ IT/IS	☐ Admin.	☐ General Mgt.
☐ Purchasing	☐ Design	☐ Sales	☐ Personnel

A2. What is your current turnover (per. Year): .....:.....(£ Million)

A3. What is your average (per. week) value of:

£ ☐ WIP	£ ☐ Bought Out Parts
£ ☐ Finished Goods in Stock	£ ☐ Raw Material Inventory

A4. What are your key manufacturing processes:

.....

.....

.....

.....

A5. What is the principal type of manufacturing system used: Please ✓

Jobbing Production -	Most job batches are 'one-off's' with each batch sharing plant resources.	
Batch Production -	Producing more than one at a time in discrete batches.	
Flow Line -	Discrete items made repetitively.	
Continuous Process -	Products inseparable in an endless flow.	

A6. How would you characterise the production of your products, in terms of end product variety and average lot size: Please ✓

End Product Variety.	☐	1-10	☐ 11-49	☐	50-99	☐	>100
Average Lot Sizes.	☐	1-10	☐ 11-49	☐	50-99	☐	>100

A7. How many different components are there in the product with the largest sales (excluding packaging): ☐

Y/N

A8. Is your production performance influenced by the delivery of free-issue customer material e.g. castings, forgings etc: ☐

A9. How many customers do you have (approximately): ☐

A10. How many raw material suppliers do you have (approximately): ☐

Do you measure their delivery performance: Please ✓

Yes	
No	

Is this performance measured as a result of your MRPII system:

Yes	
No	

A11. What significant (greater than 2% of turnover) capital investments have been made over the last 3 years: Please indicate the total project cost where possible.

(i) Building & Layout:

.....
.....
.....
.....

(ii) Plant and Equipment:

.....
.....
.....
.....
.....

(iii) IT (Hardware/Software):

.....
.....
.....
.....
.....

(iv) Material Storage and Handling:

.....
.....
.....
.....

(v) Training and Education: .....
.....
.....
.....

A12. In your opinion, how would you assess the industry sector within which you operate: Please circle.

Industry Sector Growth:	Declining 1		Stable 2		Growing 3
Forecast Demand for End Product:	Totally Unpredictable 1	2	3	4	Totally Predictable 5
Profitability of the factory relative to the industry average:	Low 1	2	3	4	High 5

Section B - Manufacturing Strategy.

B1. Which of the following manufacturing strategies have/are currently being undertaken and what has been their level of success:

	Undertaken ✓	Future Plans ✓	Please circle: Disappointing				Successful
Total Quality Management (TQM)	☐	☐	1	2	3	4	5
Just in Time (JIT)	☐	☐	1	2	3	4	5
Material Requirement Planning (MRP)	☐	☐	1	2	3	4	5
Manufacturing Management System (e.g. MRPII)	☐	☐	1	2	3	4	5
Business Process Reengineering	☐	☐	1	2	3	4	5
Concurrent Engineering	☐	☐	1	2	3	4	5
Cellular Manufacture/Group Technology	☐	☐	1	2	3	4	5
Benchmarking (internal/external)	☐	☐	1	2	3	4	5
Partnership Sourcing (customer/supplier)	☐	☐	1	2	3	4	5
Education/Training	☐	☐	1	2	3	4	5
BS5750/BS EN ISO 9000	☐	☐	1	2	3	4	5

B2. What are your key business performance measures and indicate whether procedures are in place for their quantificatation:

	Quantifiable		Quantifiable		Quantifiable
(i)	☐	(iii)	☐	(v)	☐
(ii)	☐	(iv)	☐	(vii)	☐

B3. How important were the following tangible benefits and motivating factors in the adoption of your manufacturing management system (e.g. MRPII).

Tangible Benefits	Not Important	Please circle:			Very Important
Increased plant productivity	1	2	3	4	5
Increased employee productivity	1	2	3	4	5
Increased throughput	1	2	3	4	5
Increased stock turns	1	2	3	4	5
Increased ROI	1	2	3	4	5
Improved cash flow position	1	2	3	4	5
Increased profits	1	2	3	4	5
Reduced production costs	1	2	3	4	5
Reduced overhead apportion	1	2	3	4	5
Reduced finished goods stock levels	1	2	3	4	5
Reduced WIP	1	2	3	4	5
Reduced raw material inventory holdings	1	2	3	4	5
Reduced 'direct' labour	1	2	3	4	5
Reduced 'indirect' labour	1	2	3	4	5
Reduced warranty claims	1	2	3	4	5
Reduced scrap and rework	1	2	3	4	5
Other:	1	2	3	4	5
Other:	1	2	3	4	5

B4. How important were the following intangible benefits and motivating factors in the adoption of your manufacturing management system (e.g. MRPII).

Intangible Benefits

	Not Important	Please circle:			Very Important
Increased capacity utilisation	1	2	3	4	5
Increases in employee effectiveness	1	2	3	4	5
Improved responses to variations in product mix/volume	1	2	3	4	5
Improved product quality	1	2	3	4	5
Increased opportunities to innovate	1	2	3	4	5
Improved due-date reliability	1	2	3	4	5
Increased product traceability	1	2	3	4	5
Improved ability to respond to design/engineering changes	1	2	3	4	5
Increased flexibility:	1	2	3	4	5
Improved production planning and control	1	2	3	4	5
Improved availability of management information	1	2	3	4	5
Improved information flow/reporting structures	1	2	3	4	5
Improved accuracy and reliability of information	1	2	3	4	5
Improved integration between departments	1	2	3	4	5
Next step in organisational strategy	1	2	3	4	5
Enhanced company image	1	2	3	4	5
Competitive advantage	1	2	3	4	5
System/technology upgrade	1	2	3	4	5
Reduced manufacturing leadtimes	1	2	3	4	5
Reduced new product introduction leadtimes	1	2	3	4	5
Flexible production capability	1	2	3	4	5
Provide efficient and effective customer service	1	2	3	4	5
Other:	1	2	3	4	5

Section C - Manufacturing Performance.

C1. Which manufacturing performance criteria do you use and how often are they reported: Please ✓

☐ Machine Utilisation (Monthly, Weekly, Daily) ☐ Throughput Prod. (Monthly, Weekly, Daily)

☐ Schedule Adherence (Monthly, Weekly, Daily) ☐ Other: .....(Monthly, Weekly, Daily)

C2. What proportion of your plant's output is supplied to your customers:

Off-the-shelf	%
On a quoted delivery leadtime	%

C3. Do you monitor schedule adherence: Please ✓

Yes	
No	

Please specify (purchase, production or delivery): .....

Why: .....

.....

C4. What proportion of sales (%) are:

	% Late	On Time	% Early
Adherence against Customer Quoted Due Dates			
Adherence against Master Production Schedule			
Adherence against Raw Material Purchase Schedule			
Adherence against Free-Issue Material Schedule			

C5. How significant are the following factors in contributing towards the *instability* of your MPS:

	Not Significant	Please circle:			Very Significant
Internal/External employee communication problems	1	2	3	4	5
Availability of accurate information	1	2	3	4	5
Manpower availability	1	2	3	4	5
Bottleneck machines	1	2	3	4	5
Machine breakdowns	1	2	3	4	5
Poor capacity planning	1	2	3	4	5
Poor material planning	1	2	3	4	5
Poor sales forecasting	1	2	3	4	5
Supplier performance	1	2	3	4	5
Customer changes	1	2	3	4	5
Unrealistic customer leadtimes	1	2	3	4	5
Rework/Scrap/Concessions	1	2	3	4	5
Other:	1	2	3	4	5

C6. Is goods inwards/stock room access restricted: Please ✓

Yes	
No	

C7. What factors have influenced your machine capacity levels over the last 3 years:

(i) ..... (iii) ..... (v) .....

(ii) ..... (iv) ..... (vi) .....

Machine capacity volumes have (Please Estimate):

Decreased by:	%	
Remained the same		Please ✓
Increased by:	%	

C8. What factors have influenced your raw material inventory profile over the last 3 years:

(i) ..... (iii) ..... (v) .....

(ii) ..... (iv) ..... (vi) .....

Average inventory volumes have (Please Estimate):

Decreased by:	%	
Remained the same		Please ✓
Increased by:	%	

C9. What factors have influenced your WIP profile over the last 3 years:

(i) ..... (iii) ..... (v) .....

(ii) ..... (iv) ..... (vi) .....

Average WIP has (Please Estimate):

Decreased by:	%	
Remained the same		Please ✓
Increased by:	%	

C10. What factors have influenced your changeover/setup time profile over the last 3 years:

(i) ..... (iii) ..... (v) .....

(ii) ..... (iv) ..... (vi) .....

Average changeover/setup time has (Please Estimate):

Decreased by:	%	
Remained the same		Please ✓
Increased by:	%	

Estimated capacity used for changeover is: %

C11. What factors have influenced your delivery due-date reliability (for items on customer quoted leadtimes) over the last 3 years:

(i) ..... (iii) ..... (v) .....

(ii) ..... (iv) ..... (vi) .....

Due date reliability has (Please Estimate):

Decreased by:	%	
Remained the same		Please ✓
Increased by:	%	

Average overdues as a % of MPS: %

C12. What factors have influenced your finished goods stock profile over the last 3 years:

(i) ..... (iii) ..... (v) .....

(ii) ..... (iv) ..... (vi) .....

Average finished goods stock profile has (Please Estimate):

Decreased by:	%	
Remained the same		Please ✓
Increased by:	%	

Appendix D - IT/IS Exposures and Motivations to Adopt MRPII

- Level of IT/IS Exposure in Case Study Companies
- Factors Motivating the Adoption of MRPII in Case Study Companies
- Motivated to Adopt MRPII by the Predicted Future Needs of the Business
- Strategies for Addressing the Predicted Needs of the Business
- Motivated to Adopt MRPII by New Technology
- Strategies in Place for Addressing the Adoption of New Technology
- Concluding Comments on Motivations to Adopt MRPII

D 1.1 Level of IT/IS Exposure in Case Study Companies

A great deal of attention has been given to the level of IT/IS exposure within each case study company. In doing so, establishing that not all companies had implemented 'full' MRPII[1]. However, as discussed in section 4.5.1, it was only those companies that had implemented, or were in the process of implementing MRPII or some form of manufacturing management system with MRPII characteristics, which were considered for this enquiry. Therefore, an identification of case study's IT/IS infrastructures appears essential, in establishing their suitability for site visits. Table D.1 provides a case by case summary of IT/IS infrastructures. The results of this contribute towards establishing whether previous experiences of IT/IS evaluation had an impact on their approach towards the adoption of MRPII.

Company / Application of IT/IS	Company A	Company B	Company C	Company D
MRP	✓	✓	✓	Manual
MRPII with management feedback	Formal	Informal	Informal	
CAD		✓		Manual
CAM	✓			
Costing/Quoting	Not Operational			
Shop floor data collection	✓			
Sales order processing	✓	✓	✓	✓
Purchasing	✓	✓	✓	✓
Inventory control	✓	✓	✓	✓
Production planning	✓	✓	✓	Manual
Production scheduling	✓	✓	Manual	Manual
Accounting system	✓	✓	✓	✓
Financial planning model	✓			
Internet/E-mail	✓			

Table D.1: Case by Case Summary of IT/IS Infrastructure

[1] MRPII comprises of a multitude of modules that are often given different operational names. However, users of a manufacturing management system with significant MRPII characteristics (reference appendix A) were regarded as user of MRPII (Wight, 1984; Wight, 1993).

D 2.1 Factors Motivating the Adoption of MRPII in Case Study Companies

In describing the evaluation of MRPII, it is necessary to identify those factors motivating it's deployment. As a result, all those companies that took part in this study were asked to identify their motivating factors. The results obtained essentially fall into 12 motivating factors, and are summarised in table D.2.

Company / MRPII Motivating Factors	A	B	C	D
Address competitive pressures	✓	✓		
Improve efficiency and effectiveness	✓	✓	✓	✓
Reduce costs	✓	✓	✓	
Improve management information	✓	✓		✓
Improve customer service	✓			✓
Copying the market place				✓
Product variety/complexity	✓	✓	✓	
System/technology upgrade		✓		✓
Increase production flexibility	✓	✓	✓	
Part of strategic plan	✓	✓	Ad-hoc	
Previous experience and confidence	✓	✓		
Anticipated changes in respective industries	✓		✓	

Table D.2: Case Study Factors Motivating the Adoption of MRPII

There is evidence to suggest that the majority of respondents indicated a business need, rather than technological developments, as the 'driving force' behind investing in MRPII. This was determined after having considered the range of benefits identified as motivating the adoption of MRPII.

D 2.1.1 Motivated to Adopt MRPII by the Predicted Future Needs of the Business

Most companies identified the needs of the business as the reason for adopting MRPII, with only Company B and D having been motivated to adopt MRPII by opportunities to invest in new technology. In emphasising the needs of the business, the MD of Company A said:

> *"We were under tremendous competitive pressure by our customers to offer year on year cost reductions ... So, there are risks associated with not utilising new technology to satisfy our customers needs ... which provides us with a competitive advantage."*

Interestingly enough, increases in product variety and the need for a manufacturing management system that can cope with such complexity, were expressed by nearly all companies as motivating factors. However, this was with the exception of Company D, where there was perceived no need to exploit the ability of MRPII to increase product variety/complexity. When the production manager was asked why this factor did not feature as a motivating concern, there was a reply:

> *"Most of our products have a relatively simple Bill of Materials (BOMs) and are not complex ... We don't need a system loaded with functions that we won't use."*

On analysis of Company D's product range, the number of components that contributed towards its end products, was admittedly relatively few and uncomplicated. Similarly, Company A and C who are jobbing shops, reflect such product characteristics.

Jobbing shop companies manufacture components and assemblies that are although diverse, tend to have uncomplicated BOMs and product structures. Nearly all those products manufactured by jobbing shops are made to specifications supplied by Original Equipment Manufacturers (OEM), with jobbing shops making no contribution to the design process. As a result, jobbing shops may not be motivated by the ability of MRPII to increase product variety/complexity, as their production requirements are generally limited to single component manufacture with 'simple' BOMs. However, Company A and C view the ability of MRPII to improve product variety/complexity as increasing the organisation's flexibility, which establishes its responses to the challenges of the future. In expressing this, both companies emphasised a future long-term need for a manufacturing management system that can cope with increases in product variety/complexity, and thus, identified the predicted future needs of the business as motivating their adoption of MRPII.

Although, the ability to increase product variety/complexity were not 'current' business issues, Company A and C did consider MRPII as crucial in supporting their future requirements: the manufacture of multiple components and assemblies. This establishes a progression from their current single/multiple component level of manufacture. As a result, the adoption of MRPII appears to have become a strategic[2] issue, as it is now considered to be a prerequisite for the future long-term 'survival' of jobbing shops. The MD of Company A pragmatically described this view by saying:

> *"Many of our larger OEM customers are beginning to single source their second tier suppliers, so we need to demonstrate that we have the systems to cope with these changes. This means having an IS to manage their products ... We'll need to implement new systems and develop new skills to cope with these changes."*

Similarly, the marketing manager at Company C said:

> *"OEMs will in the future not subcontract single component manufacture but the complete manufacture of their small products and sub-assemblies ... Jobbing shops will have to start getting used to not just being part of the supply chain but for developing and managing their own supply chain ... You need good systems as well as good suppliers."*

Therefore, there is evidence to suggest that Company A and C were motivated to adopt MRPII by their strategic views of the re-engineering taking place within their industry. This clearly demonstrates a progression of the enterprise model described in section 1.4, with organisations coming together in the management and development of new products, through the sharing of information and other resources.

D 2.1.2 Strategies for Addressing the Predicted Needs of the Business

When Company A and C were asked about the strategies they had, or were developing, to support their predicted market place changes, the responses obtained from the two companies were quite different.

---

2 As well as MRPII supporting Company A's expectations for the design and manufacture of customer required products/sub-assemblies, it is interesting that Company A has started to formulate a strategy for the development of their 'own' products, which they intend will market and sell directly. Clearly, such a strategy is supported by a MRPII system, and demonstrates Company A's strategic move away from their complete dependence on the 'famine' and 'feast' of single component jobbing shop manufacture.

Company A had already implemented vendor Production Planning and Control (PPC) software, and a Shop Floor Data Collection (SFDC) system, which was able to maintain production volumes of single components that have 'simple' BOMs. Company A did however, identify significant voids in their IT/IS infrastructure to support their future requirements, which were based on the predicted changes in their industry. Hence, the company had a dilemma of whether to continue developing a vendor supplied system, or develop a bespoke infrastructure. In the end, Company A was influenced by the limitations of their system, and by the significant human centred resistance that was expressed by those stakeholders using/reliant on SFDC/PPC (Irani *et al.*, 1998[c]). As a result, Company A was discouraged to continue with the long-term development and operation of their vendor PPC and SFDC system. They decided to learn from their previous mistakes in adopting vendor systems, and advocated the development of bespoke MRPII; although it retained the core scheduling module from the vendor PPC system. Further issues associated with the development of Company A's bespoke MRPII system, and lessons learnt are described in section 5.3. Hence, it would appear that strategic issues together with human and organisational factors, motivated Company A's development of bespoke MRPII.

The case of Company C is quite different, and although they considered the long-term direction of the jobbing shop industry to be the same as Company A, Company C was left with a quandary of deciding what to do. The quality/plant manager was concerned that there was a lack of strategic IT/IS focus within the company, with this hindering the adoption of MRPII. The quality/plant manager expressed this by saying:

> *"I think that I am doing the right thing in going for MRPII but the problem is that there is no clear action plan at a strategic level."*

The issue of why no strategy had been developed began to unfold, during an interview with the production controller, who said:

> *"To get project money you need to show how the project will affect turnover. Its difficult to show how a piece software can have a major affect on production, and increase turnover ... Management wants to see savings as pound notes."*

It appears that organisational procedures within Company C forced a myopic view of the benefits and savings achievable through adopting MRPII. The performance measures used were limited to financially quantifiable indicators. As a result, Company C required financially tangible benefits and savings from MRPII. In doing so, directing decision makers to assess the impact that MRPII will have on the organisations' turnover. However, the quality/plant manager, who was the project champion for the development of bespoke MRPII, expressed great difficulty in identifying how to adopt MRPII, and in financially quantifying many of its benefits. As a result, MRPII become a continuous improvement initiative, as this strategy would not require the quality/plant manger to 'formally' write a project proposal, detailing the project and identifying the resources necessary. Indeed, the quality/plant, and production managers preferred to adopt MRPII from a continuous improvement perspective, as both managers are authorised to raise purchase orders, for hardware/software. The production manager stressing the advantage of this, by saying:

> *"We are pretty much left to my own devices, project funding is not a major issue, as the direct costs are relatively small, or hidden. Any funding is signed off/authorised by us."*

D 2.1.3 Motivated to Adopt MRPII by New Technology

Company B emphasised a great deal of attention on the technological ability of their proposed MRPII system, to support their long-term 'growth'. In doing so, it was evident that the management team were being proactive in retaining a strategic technological focus, whilst purchasing suitable software and hardware that were considered able to support the companys' business plans. As a result, preventing the implementation of technology that renders itself redundant in the short-term. Also, a great deal of effort was taken to ensure that the most suitable Operating System (OS) to support the MRPII package was adopted. Similarly, the management team ensured that the preferred MRPII package was able to run on the required OS. In expressing this concern, the interviewees' response linked to technology driven motivation, with the MD saying:

> *"New technology has allowed companies to do great things. Most of our old systems were wooden and antiquated ... We need to gain an edge by taking full advantage of advances in technology ... We need to use technology to stay ahead of the competition."*

Previous deployments of software at Company B had been considered successful but eventually limited the range of savings possible. Company B even considers that their earlier piecemeal adoption of IT/IS may have lead to productivity losses, through double data entry and integration problems. This opinion was expressed by the quality/IT manager, who said:

> *"Our original MRP package was DOS based, with other systems running on Windows 3.1. This provided real integration problems and significant double data entry ... Modules didn't talk to each other."*

Company B considers that any advantages achievable through adopting new technology could give them a clear edge over their competition. This was expressed by the comments of their production manager who said:

> *"We have paid considerable attention to streamlining production by investing in new machinery. We have also focused a lot of attention on developing our people but only now appreciate the missed opportunity of not investing in IT ... It is a 'cut-throat' industry out there, and any advantage we can have over the competition can only be a good thing."*

D 2.1.4 Strategies in Place for Addressing the Adoption of New Technology

When asked to elaborate on the benefits resulting from the learning process of adopting new technology, all interviewees within Company B stressed the importance of taking a holistic view of technology management, and the need to review and update IT policies. Also, the management team stressed the need to consider how new technology can contribute towards the long-term 'success' and 'growth' of the company. In particular, the MD emphasised this by saying:

> *"We need to work on our strategy for technology based improvements[3], and review our plans at regular management meeting. That way we will not have to accept the limitations of outdated technology ... We need to share information and develop a common vision."*

Clearly, the advantage of this are considered by the MD to:

> *"... allows us to stay ahead of the competition."*

[3] This was an idiosyncratic term within Company B that broadly implied technology management.

D 2.1.5 Concluding Comments on Motivations to Adopt MRPII

On review, Company A and C predicted the jobbing shop industry to be moving towards an environment where such companies need to have an IT/IS infrastructure, to support the design and manufacture of sub-assemblies/complete customer products. Also, both companies identified the strategic need to move away from being 'traditional' jobbing shops, which simply manufacture a single, or multiple component. As a result, both companies were being proactive in strategically implementing MRPII, and were motivated by the predicted future needs of their business.

Company A addressed it's vision by developing a bespoke MRPII system, which followed earlier disappointment from their vendor PPC/SFDC software. Similarly, Company C developed bespoke MRPII, although there was no strategy to support its plans. Indeed, it's decision to develop bespoke software was made following their inability to financially justify vendor MRPII, and resulted in a process of manipulating capital budgeting.

There is evidence to suggest that Company B is pursuing technology based leadership, through strategically upgrading it's IT/IS systems. In turn, this is considered to offer them a competitive advantage. However, even though the motivation to adopt vendor MRPII was 'driven' by the need to upgrade technology, it is also acknowledged that in doing so, broader business issues will be addressed. These are identified as resulting benefits from investing in MRPII, and are discussed in section 5.3.5., 5.3.6., and 5.3.7. Regarding their strategies to support new technology, it was evident that much emphasis was placed on communication, and in developing an 'open' forum where information can be exchanged thus, allowing flexibility to react to changes in technology.

Hence, in considering the adoption of MRPII, all companies appeared strategically motivated, although Company A and C's approach was somewhat ad hoc, regarding the strategies in place for addressing the predicted future needs of their business.

Appendix E - Interview Agenda

- Interview Agenda

Study of the Investment Decision Making Processes used by SMEs When Justifying MRPII

This questionnaire is divided into 4 parts, with section D, E, F and G being qualitative in nature, and acting as a comprehensive agenda for each case study visit.

The questionnaire aims to address the following issues:

- To identify the investment decision making processes used during the generation, justification, implementation and post-implementation evaluation of an MRPII system.
- To identify the perceived and realised benefits, costs and risks associated with an MRPII investment.

Company Name: _____

Company Address: _____

_____

Respondent's Name: _____ **Position:** _____

Questionnaire Sections

Section **D** - Development of Investment Proposal;

Section **E** - Investment Justification and Software Evaluation;

Section **F** - The Implementation Process; and,

Section **G** - Post-implementation Evaluation Process.

[1] The term MRPII is an abbreviation for Manufacturing Resource Planning and is an example of an integrated business system.

Section D - Development of Investment Proposals.

D1. Do you differentiate between 'operational' investments (e.g. purchasing capital plant) and strategic investments: Please ✓

	Costs	Benefits
Yes - We do differentiate		
No - We do *NOT* differentiate		

How are such differentiations made (e.g. modified payback periods/rates of returns): .....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

D2. Is it management practice to develop an investment proposal before significant investments are made: Please ✓

Yes	
No	

D3. Was an investment proposal developed for the MRPII project: Please ✓

Yes (formal/informal)	
No	

.....Please go to Section E.

D4. Was a project team established to develop the investment proposal and was there a project champion: Please ✓

	Team Established	Project Champion
Yes		
No		

If **No**, who developed the proposal: ..... (Position)
Please go to Section E.

If **Yes**, was the team full-time or part-time: Please ✓

Full-Time	
Part-Time	

D5. Which of the following functions were involved in developing the investment proposal: Please ✓

	Managerial	Technical
Manufacturing		
Accounting/Finance		
Sales & Marketing		
R&D		
Production Control		
Purchasing		
IT		
Suppliers		
Consultants		
Other:		

D6. What level of support was offered during the development of the investment proposal by : Please ✓

Directors	
Senior Management	
Middle Management	
Junior Management	
Supervisory Level	
Shop Floor	

D7. Which of the following activities were the team responsible for: Please ✓

Strategic Evaluation		Benefit Evaluation	
Technical Evaluation		Cost Evaluation	
Financial Evaluation		Risk Evaluation	

D8. What differentiation was made regarding employee training and educational requirements in the investment proposal:

.....
.....
.....
.....
.....
.....
.....
.....

D9. At the time of proposal generation was there a perceived need for: Please ✓

Training of Production/Manufacturing Management	
Training of General Management/Administration	
Training of 'operational' employees	

Section E - Investment Justification and Software Evaluation

E1. What level of expenditure was sought by this investment: ..... *Budget* (K)

E2. What was your criterion for capital expenditure :

	Yes ✓	Expected Measure %		Achieved Measure		Preferred Criteria
Net Present Value (NPV)	☐	Hurdle Rate %:	☐	Hurdle Rate %:	☐	☐
Internal Rate of Return (IRR)	☐	Hurdle Rate %:	☐	Hurdle Rate %:	☐	☐
Return on Investment (ROI)	☐	Hurdle Rate %:	☐	Hurdle Rate %:	☐	☐
Payback	☐	Years	☐	Years:	☐	☐
Cost/Benefit Analysis (CBA)	☐					☐
Cash-flow Analysis	☐					☐
None	☐					☐
Other:	☐					☐

E3. What importance was assigned to the technique (in **E2**): .....
.....
.....
.....

E4. What other argument(s) played important roles during the decision making process: Please ✓

☐ Investment fits with manufacturing strategy
☐ Technological know-how of management
☐ Intangible project benefits
☐ Intangible project costs
☐ Committed project champion
☐ Availability of grants

E5. How did you account for the risk and uncertainty associated with the investment: Please ✓

☐ No risk was taken into account
☐ Shortened payback period/increased hurdle rate
☐ Cash-flow analysis adjustment
☐ Other: .....

E6. What were the major risks associated with this investment project:

(i) .....
(ii) .....
(iii) .....
(iv) .....

E7. What was the result of 'What if Scenarios' regarding future sales and cost structures if the investment *did not* go ahead: Please ✓

☐ No consideration was made
☐ Cost structure will remain unchanged
☐ Cost structure will (increase/decrease)
☐ Future sales will remain unchanged
☐ Future sales will (increase/decrease)
☐ Other: .....

E8. Did you justify your MRPII investment to the workforce. If so, why and how: .....

.....

.....

.....

.....

E9. Describe your actual decision making process when evaluating your MRPII investments:

.....

.....

.....

.....

.....

.....

E10. How much time elapsed between generation of investment proposal and the final decision:

.....

E11. What was the extent of the agreement within the project team/individual that developed the proposal on the benefits, risks and difficulties of the investment: Please ✓

		High	Medium	Low
Project Team	Benefits			
	Risks			
	Costs			

E12. Was the proposed software and hardware actually implemented: Please ✓

	Software	Hardware
Yes		
No		

If **No**, Why not: .....

.....

.....

.....

Was the MRPII software customised or off the shelf: Please ✓

Off the Shelf		please specify:
Customised		
Other		please specify:

E13. What criteria determined your decision to select your MRPII software and hardware:

.....

.....

.....

.....

.....

.....

Section F - The Implementation Process.

F1. Where BOMs, drawing issue levels and inventory holding formalised before implementation: Please ✓

	BOMs		Issue Levels		Inventory Holding
Yes		Yes		Yes	
No		No		No	

F2. Was a project team established to implement the MRPII system: Please ✓

Yes	
No	

.....Full-time/Part-time

If **No**, who implemented the system:

.....

If the implementation process was outsourced, what prompted this decision: .....

.....

.....

.....

F3. Was there a project mission statement developed: Please ✓

Yes	
No	

F4. How was the implementation of the new system done and what support was there from outside contractors: Please ✓

Implementation entirely done by supplier(s)/Turn Key contract.	
Implementation done in co-operation with supplier(s)/consultant(s).	
Implementation entirely done 'in-house'.	
Other:..... ..	

F5. What representation was made in the implementation team by: Please ✓

	Managerial	Technical
Manufacturing		
Accounting/Finance		
Sales & Marketing		
R&D		
Production Control		

	Managerial	Technical
Purchasing		
IT		
Suppliers		
Consultants		
Other:		

F6. How was everybody in the company informed about the project and its progress: .....

.....

.....

.....

F7. What were the most serious problems experienced during implementation:

(i) After 6 Months:

(ii) After 18 Months:

(iii) After 3 Years:

F8. How long did it take to fully implement the project (from date of approval) and was there any contingency time allowed within the implementation process: .....

.....

.....

.....

Was the project completed within the required *time* and *budget* parameters: Please ✓

	Time		Budget
Yes		Yes	
No		No	

F9. What project planning tools/quality standards were used during the implementation process e.g. BS EN ISO9000, Milestones, Gantt Charts:

.....

.....

.....

F10. What type of training/education was carried out following implementation: .....

.....

.....

.....

.....

F11. What was the staff-turnover of the implementation team during the project: .....

.....

.....

.....

.....

F12. What changeover methods from old to new system were used e.g. pilot project: .....

.....

.....

.....

.....

.....

F13. What profile did the implementation team have within the company and how did it change:

.....

.....

.....

.....

F14. What functions carried out the project review process during implementation:

	Managerial	Technical
Manufacturing		
Accounting/Finance		
Sales & Marketing		
R&D		
Production Control		

	Managerial	Technical
Purchasing		
IT		
Suppliers		
Consultants		
Other:		

Section G -Post-Implementation Evaluation Process.

G1. In what stage of implementation is your MRPII system, and what are your hardware and software specifications ?:

.....

.....

.....

G2. Do you consider the useability of the system to be in-line with the way the organisation is managed (open/closed system): Please ✓

Yes	
No	

Please ✓

G3. Have you undertaken *formal* post-implementation evaluations of your MRPII system: Please ✓

☐ No post-implementation audit has been done *

* Go to **G3**.

☐ Post-implementation audit has been done *

* Go to **G5**.

G4. Why has no post-implementation evaluation been done and does the company plan to evaluate their system in the future: .....

.....

.....

.....

.....

G5. Do you feel the organisation should consider outsourcing the post-implementation evaluation process. If so, Why: .....

.....

.....

.....

....Go to **G8.**

G6. How did the level of support offered by management change during the project's life-cycle:

.....

.....

.....

.....

.....

G7. Which functional areas were involved in the post-implementation evaluation process and why: Please ✓

	Managerial	Technical
Manufacturing		
Accounting/Finance		
Sales & Marketing		
R&D		
Production Control		

	Managerial	Technical
Purchasing		
IT		
Suppliers		
Consultants		
Other:		

G8. How long after project implementation did the evaluation study start and what were the main study objectives: .....

(i) ..... (iii) .....
(ii) ..... (iv) .....

G9. How did the investment meet the financial assessment criteria set: Please ✓

Exceeded Criteria: ☐

- ☐ Exceeded criteria where intangible benefits where acknowledged but intangible costs ignored.
- ☐ Exceeded criteria where intangible benefits where ignored but intangible costs acknowledged.
- ☐ Exceeded criteria where intangible costs and benefits were both ignored.
- ☐ Exceeded criteria where intangible costs and benefits were both acknowledged.

Just Met Criteria: ☐

- ☐ Just Met criteria where intangible benefits where acknowledged but intangible costs ignored.
- ☐ Just Met criteria where intangible benefits where ignored but intangible costs acknowledged.
- ☐ Just Met criteria where intangible costs and benefits were both ignored.
- ☐ Just Met criteria where intangible costs and benefits were both acknowledged.

Failed Criteria. ☐

- ☐ Failed criteria where intangible benefits where acknowledged but intangible costs ignored.
- ☐ Failed criteria where intangible benefits where ignored but intangible costs acknowledged.
- ☐ Failed criteria where intangible costs and benefits were both ignored.
- ☐ Failed criteria where intangible costs and benefits were both ignored.

Don't Know: ☐

G10. Do you perceive your MRPII system to be a success, if so, what is your criteria for success:
.....
.....
.....
.....

G11. To what extent has duplication of effort been reduced as a result of MRPII (indicate Job Functions affected): .....
.....
.....
.....

G12. How have manpower levels changed as a result of MRPII (indicate job functions affected):
.....
.....
.....
.....

G13. How would you rate the following benefits resulting from MRPII: Please ✓

Exceeded ✓	Achieved ✓	Under Achieved ✓	
☐	☐	☐	Increased plant productivity
☐	☐	☐	Increased employee productivity
☐	☐	☐	Increased throughput
☐	☐	☐	Increased stock turns
☐	☐	☐	Increased ROI
☐	☐	☐	Improved cash flow position
☐	☐	☐	Increased profits
☐	☐	☐	Reduced production costs
☐	☐	☐	Reduced overhead apportion
☐	☐	☐	Reduced finished goods stock levels
☐	☐	☐	Reduced WIP
☐	☐	☐	Reduced raw material inventory holdings
☐	☐	☐	Reduced 'direct' labour
☐	☐	☐	Reduced 'indirect' labour
☐	☐	☐	Reduced warranty claims
☐	☐	☐	Reduced Scrap and rework
☐	☐	☐	Increased capacity utilisation
☐	☐	☐	Increases in employee effectiveness
☐	☐	☐	Improved responses to variations in product mix/volume
☐	☐	☐	Improved product quality
☐	☐	☐	Increased opportunities to innovate
☐	☐	☐	Improved due-date reliability
☐	☐	☐	Increased product traceability
☐	☐	☐	Improved ability to respond to design/engineering changes
☐	☐	☐	Increased flexibility: .....
☐	☐	☐	Improved production planning and control
☐	☐	☐	Improved availability of management information
☐	☐	☐	Improved information flow/reporting structures
☐	☐	☐	Improved accuracy and reliability of information
☐	☐	☐	Improved integration between departments
☐	☐	☐	Next step in organisational strategy
☐	☐	☐	Enhanced company image
☐	☐	☐	Competitive advantage
☐	☐	☐	System/technology upgrade
☐	☐	☐	Reduced manufacturing leadtimes
☐	☐	☐	Reduced new product introduction leadtimes
☐	☐	☐	Flexible production capability
☐	☐	☐	Provide efficient and effective customer service

G14. How significantly did the following factors impact on your organisation:

	Significantly Under Estimated				Significantly Over Estimated
The use of project management tools/techniques	1	2	3	4	5
The level of training/education given to all employees	1	2	3	4	5

What were the implication regarding cost factors:

	Insignificant Implications				Significant Implications
Environmental costs	1	2	3	4	5
Initial hardware costs	1	2	3	4	5
Initial software costs	1	2	3	4	5
Installation/Configuration costs	1	2	3	4	5
System development costs	1	2	3	4	5
Project overheads	1	2	3	4	5
Training/education costs (External)	1	2	3	4	5
Training/education costs (Internal)	1	2	3	4	5
Maintenance costs	1	2	3	4	5
Start-up costs	1	2	3	4	5
Unexpected Hardware/Software Costs	1	2	3	4	5
Security costs	1	2	3	4	5
Consumables	1	2	3	4	5
External engineering and/or consulting	1	2	3	4	5
Internal engineering and/or consulting	1	2	3	4	5
Management/Staff time	1	2	3	4	5
System support	1	2	3	4	5
Changes in Wages/Salaries	1	2	3	4	5
Staff turnover	1	2	3	4	5
Productivity losses during Implementation/Start-Up	1	2	3	4	5
Demands on *other* organisational resources	1	2	3	4	5
Reengineering business processes	1	2	3	4	5
Organisational restructuring	1	2	3	4	5
Other:	1	2	3	4	5
Other:	1	2	3	4	5

Appendix F - Relationship Between Hypotheses and Interview Agenda

- Relationship Between Hypothesis 2 and Interview Agenda
- Relationship Between Hypothesis 3 and InterviewAgenda
- Relationship Between Hypothesis 4 and Interview Agenda

Hypothesis 2: *There is a relationship between the concept justification of MRPII to operational stakeholders, and their increased level of commitment.*

Section/Question Number	General Guiding Comments
A1: How many people are employed at your site in the following core business functions: (a) shop-floor employees, (b) production planning, (c) manufacturing eng., (d) purchasing, (e) maintenance, (f) quality, (g) IT/IS, (h) design, (i) R&D, (j) finance, (k) admin., (l) sales, (m) marketing, (n) project eng., (o) general mgt., (p) personnel.	This question investigates the logistics involved in justifying the MRPII investment to those job functions affected.
A11: What significant (greater than 2% of turnover) capital investments have been made over the last 3 years: (a) building and layout, (b) plant and equipment, (c) IT (hardware and software), (d) material storage and handling, (e) training and education.	This question is investigating specific capital expenditures on factors that may contribute towards the success of the MRPII investment.
B1: Which of the following manufacturing strategies have/are currently being undertaken and what has been their level successes: (a) TQM, (b) JIT, (c) MRP, (d) computer integrated business systems, (e) BPR, (f) CE, (g) CM/GT, (h) benchmarking, (i) partnership sourcing, (j) training /education, (k) BS EN ISO 9000.	This question will identify current/future implementation plans of other manufacturing strategies, and their relative success. It will also assess the perception of the workforces views, on success of these manufacturing strategies.
C5: How significant are the following factors in contributing towards the *instability* of your MPS: (a) internal/external communication problems, (b) availability and accuracy of information, (c) manpower availability, (d) bottleneck machines, (e) machine breakdowns, (f) poor capacity planning, (g) poor material planning, (h) poor sales forecasting, (i) supplier performance, (j) customer changes, (k) unrealistic customer leadtimes (l) rework/scrap/concessions, (m) other.	This question seeks to establish the significance of human factors in manufacturing and identify their contribution on production performance. The question will implicitly reflect the skills and educational ability of the workforce in acknowledging their contribution towards the success and growth of the company.
C7: What factors have influenced your machining capacity profile over the last 3 years ? Average capacity volumes have decrease by, remained the same or increased by ?	This question identifies those variables that have contributed towards any changes in machining capacity profile. The question then qualifies the benefit by estimating the degree of change.
C8: What factors have influenced your raw material inventory profile over the last 3 years ? Average inventory has decreased by, remained the same or increased by ?	This question identifies those variables that have contributed towards any change in inventory profile. The question then quantifies the benefit by estimating the degree of change.
C9: What factors have influenced your WIP profile over the last 3 years ? Average WIP has decrease by, remained the same or increased by ?	This question identifies those variables that have contributed towards any change in WIP profile. The question then quantifies the benefit by estimating the degree of change.
C10: What factors have influenced your changeover/setup times over the last 3 years ? Average changeover/setup times have decrease by, remained the same or increased ?	This question identifies those variables that have contributed towards any changes in changeover/setup times. The question then qualifies the benefit by estimating the degree of change.

C11: What factors have influenced your due-date reliability over the last 3 years ? Due date reliability has decrease by, remained the same or increased by ?	This question identifies those variables that have contributed towards any change in due-date reliability. The question then qualifies the benefit by estimating the degree of change.
C12: What factors have influenced your finished goods stock profile over the last 3 years ? Average finished goods stock profile has decrease by, remained the same or increased by ?	This question identifies those variables that have contributed towards any change in finished goods stock profile. The question then quantifies the benefit by estimating the degree of change.
D6: What level of support was offered during the development of the investment proposal by: (a) directors; (b) senior managers; (c) middle managers; (d) junior managers; (e) supervisory level; (f) shop floor.	This question established the level of commitment offered during the development of the investments' project. It identifies whether senior management had the systems concept justified to them. Thus resulting in an increased level of commitment.
D8: What differentiation was made regarding employee training and educational requirements in the investment proposal ?	Identifies the differentiation between training (skills based) and education (personal development needs).
D9: At the time of proposal generation was there a perceived need for: (a) training for production/manufacturing management, (b) training for general management/admin., (c) training for 'operational' employees.	This question establishes whether the organisation considered the impact of the IS before implementation, and planned/ budgeted for sufficient user resources training.
E8: Did you justify your MRPII investment to the workforce. If so, why and how ?	This question asks whether project implications were discussed with the workforce, and if their comments were acknowledged before implementation. The question tests the supposition that project justification to the workforce has an implicitly impact on the success of the investment. Mechanisms for the dissemination of project implications are then questioned.
E9: Describe your actual decision making process when evaluating your MRPII investment ?	This question identified the organisations idiosyncrasies involved in justifying the MRPII investment. This question will also identify the phase at which any 'concept' justification to the workforce is carried out.
E11: What was the extent of the agreement within the project team/individual that developed the proposal on the benefits, risks and difficulties of the investment ?	This question identifies whether any additional costs, benefits or risks were raised by the workforce during any 'concept' justification. These 'missing' factors are then identified, together with their relative significance.
F4: How was the implementation of the new system done and what support was there from outside contractors: (a) implementation entirely done by suppliers /turn key contract, (b) implementation done in co-operation with suppliers /consultants, (c) implementation entirely done 'in-house'.	This question will identify the implementation processes adopted by each case study company and the perceived level of success achieved. This question will also identify any relationship between implementing MRPII 'in-house', it's 'concept' justification and it's perceived level of success.
F5: What representation was made in the implementation team by: (a) manufacturing; (b) accounting/finance; (c) sales and marketing; (d) R&D; (e) production control; (f) purchasing; (g) IT; (h) suppliers; (i) consultants; (j) other.	This question establishes those managerial and technical functions involved in the implementation of the system. It identifies any correlation between these functions and the support the project got following *any* concept justification process.
F6: How was everybody in the company informed about the project and its progress ?	This question investigates whether any 'concept' justification processes were carried out. The interviewer also investigates the communication processes used during any project progress updates.

F7: What were the most serious problems experienced during implementation: (a) after 6 months; (b) 18 months; (c) 3 years.	This question identifies whether the level of support / commitment from management, or team members faded as the project was implemented and problems experienced. Assuming the project had a champion as per **D4**, and senior levels of support were obtained as per **D6**.
F9: What project planning tools/quality standards were used during the implementation process. e.g. BS EN ISO 9000, milestones, Gantt Charts ?	This question investigates the timings and resources allocated towards any 'concept' justification processes.
F13: What profile did the implementation team have within the company and how did it change ?	This question investigates any change in profile of the implementation team, together with the factors that influence that change. The interviewer will also investigate from an 'operational' perspective, whether employees views' of the project would changed following any 'concept' justification. The investigator will identify whether any significant change can affect a projects' success.
G2: Do you consider the usability of the system to be in-line with the way the organisation is managed (open/closed) ?	This question investigates whether the 'openness' of an MRPII system integrates into the organisational culture.
G10: Do you perceive your MRPII system to be a success, if so, what is your criteria for success ?	This question investigates the users' perception of qualitative constructs that define success.
G14: How significantly did the following factors impact on your organisation: (a) project management tools/techniques, (b) the level of training and education, (c) environmental costs, (d) initial hardware costs, (e) initial software costs, (f) installation/configuration costs, (g) system development costs, (h) project overheads, (i) training/education costs, (j) maintenance costs, (k) start-up costs, (l) unexpected hardware/software costs, (m) security costs, (n) consumables, (o) external consulting, (p) internal consulting, (q) management/staff time, (r) system support, (s) changes in salaries, (t) staff turnover, (u) productivity losses, (v) demands on *other* resources, (w) reengineering business processes, (x) organisational restructuring.	This question will identify any additional costs associated with the 'concept' justification of the project, to the workforce.

Table F.1: Relationship Between Hypothesis 2 and Interview Agenda

Hypothesis 3: *A rigorous MRPII evaluation model needs to identify direct, and indirect human and organisational costs.*

D9: At the time of proposal generation was there a perceived need for: (a) training for production/manufacturing management, (b) training for general management/admin., (c) training for 'operational' employees.	This question establishes whether the organisation considered the impact of the IS before implementation, and planned/ budgeted for sufficient user resources training.
E8: Did you justify your MRPII investment to the workforce. If so, why and how ?	This question asks whether project implications were discussed with the workforce, and if their comments were acknowledged before implementation. Also, it seeks to establish if these suggestions had costs attatched to them. The question tests the supposition that project justification to the workforce has an implicitly impact/cost.
F10: What type of training/education was carried out following implementation ?	This question is examining whether there were unforseen training costs that arose after implementaion that had not been considered. Also, establishes whether falls in productivity resulted from increases in training after implementation.
F11: What was the staff-turnover of the implementation team during the project ?	This question establishes whether there were increases in staff turnover, and as a result, whether extra resources were required to fill a void. Therefore identifying the resources and costs of increases in turnover/new additons to the team.
G14: How significantly did the following factors impact on your organisation: (a) project management tools/techniques, (b) the level of training and education, (c) environmental costs, (d) initial hardware costs, (e) initial software costs, (f) installation/configuration costs, (g) system development costs, (h) project overheads, (i) training/education costs, (j) maintenance costs, (k) start-up costs, (l) unexpected hardware/software costs, (m) security costs, (n) consumables, (o) external consulting, (p) internal consulting, (q) management/staff time, (r) system support, (s) changes in salaries, (t) staff turnover, (u) productivity losses, (v) demands on *other* resources, (w) reengineering business processes, (x) organisational restructuring.	This question will identify any additional costs that had not been accounted for in the investment proposal.

Table F.2: Relationship Between Hypothesis 3 and Interview Agenda

Hypothesis 4: *A robust MRPII evaluation model needs to identify strategic, tactical and operational benefits.*

Section/Question Number	General Guiding Comments
A10: How many raw material suppliers do you have (approximately) ? Do you measure their delivery performance ? Is this performance measured as a result of implementing MRPII ?	This question investigates whether the 'operational' benefit of delivery performance is measured as a facility available within an MRPII package.
B1: Which of the following manufacturing strategies have/are currently being undertaken and what has been their level successes: (a) TQM, (b) JIT, (c) MRP, (d) computer integrated business systems, (e) BPR, (f) CE, (g) CM/GT, (h) benchmarking, (i) partnership sourcing, (j) training /education, (k) BS EN ISO 9000.	This question identifies those manufacturing strategies adopted by the case study company and their degree of success. In doing so, the investigator is identifying other factors that may have contributed towards strategic and operational benefits.
B3: How important were the following tangible factors in motivating the adoption of a computer integrated business system: (a) increased plant productivity, (b) increased employee productivity, (c) increased throughput, (d) increased stock turns, (e) increased ROI, (f) improved case flow position, (g) increased profits, (h) reduced production costs, (i) reduced overhead apportion, (j) reduced finished goods stock levels, (k) reduced raw material inventory holdings, (l) reduced 'direct' labour, (m) reduced 'indirect' labour, (n) reduced warranty claims, (o) reduced scrap and rework, (p) other.	This question identifies the motivation behind the selection of a computer integrated business system. These factors are restricted to tangible benefits. This will therefore allow the investigator to develop a taxonomy of enablers that act as 'driving forces' behind the adoption of MRPII.
B4: How important were the following intangible factors in motivating the adoption of a computer integrated business system: (a) increased capacity utilisation, (b) increases in employee effectiveness, (c) improved responses to variations in product mix/volume, (d) improved product quality, (e) increased opportunities to innovate, (f) improved due-date reliability, (g) increased product traceability, (h) improved ability to respond to design/engineering changes, (i) increased flexibility, (j) improved production planning and control, (k) improved availability of management information, (l) improved information flow/reporting structure, (m) improved accuracy and reliability of information, (n) improved integration between departments, (o) next step in organisational strategy, (p) enhanced company image, (q) competitive advantage, (r) system/technology upgrades, (s) reduced manufacturing leadtimes, (t) reduced new product introduction leadtimes, (u) flexible production capability, (v) provide efficient and effective customer service, (w) other.	This question identifies the motivation behind the selection of a computer integrated business system. These factors are restricted to intangible benefits. This will therefore allow the investigator to develop a taxonomy of enablers that act as 'driving forces' behind the adoption of MRPII.
C3: Do you monitor schedule adherence ? Why ?	This question seeks to identify the type of schedule adherence measured and the reasons/benefits behind this performance indicator.

C4: What proportion of sales (%) are late, on-time and early: (a) adhered against customer quoted due dates, (b) adhered against MPS, (c) adhered against raw material purchase schedule, (d) adhered against free-issue material schedule.	This question acts a measure before a further questioning behind the reasons of any late, on-time and early performance, against the measures (a), (b), (c) and (d).
C5: How significant are the following factors in contributing towards the *instability* of your MPS: (a) internal/external communication problems, (b) availability and accuracy of information, (c) manpower availability, (d) bottleneck machines, (e) machine breakdowns, (f) poor capacity planning, (g) poor material planning, (h) poor sales forecasting, (i) supplier performance, (j) customer changes, (k) unrealistic customer leadtimes (l) rework/scrap/concessions, (m) other.	This question identifies factors that may influence the attainment of MRPII benefits. The interviewee is asked to rate the significance of each causal influence relative to their organisation.
C7: What factors have influenced your machining capacity profile over the last 3 years ? Average capacity volumes have decrease by, remained the same or increased by ?	This question identifies those variables that have contributed towards any changes in machining capacity profile. The question then qualifies the benefit by estimating the degree of change.
C8: What factors have influenced your raw material inventory profile over the last 3 years ? Average inventory has decreased by, remained the same or increased by ?	This question identifies those variables that have contributed towards any change in inventory profile. The question then quantifies the benefit by estimating the degree of change.
C9: What factors have influenced your WIP profile over the last 3 years ? Average WIP has decrease by, remained the same or increased by ?	This question identifies those variables that have contributed towards any change in WIP profile. The question then quantifies the benefit by estimating the degree of change.
C10: What factors have influenced your changeover/setup times over the last 3 years ? Average changeover/setup times have decrease by, remained the same or increased ?	This question identifies those variables that have contributed towards any changes in changeover/setup times. The question then qualifies the benefit by estimating the degree of change.
C11: What factors have influenced your due-date reliability over the last 3 years ? Due date reliability has decrease by, remained the same or increased by ?	This question identifies those variables that have contributed towards any change in due-date reliability. The question then qualifies the benefit by estimating the degree of change.
C12: What factors have influenced your finished goods stock profile over the last 3 years ? Average finished goods stock profile has decrease by, remained the same or increased by ?	This question identifies those variables that have contributed towards any change in finished goods stock profile. The question then quantifies the benefit by estimating the degree of change.
D4: Was a project team established to develop the investment proposal and was there a project champion ?	The investigator seeks to establish whether an investment proposal was developed with the synergy of a team (with the ability to look at the full benefit, cost and risk implications) and lead by a committed project champion, dedicated to the success of the project.
E4: What other arguments) played important roles during the decision making process: (a) investment fits with manufacturing strategy, (b) technological know-how of management, (c) intangible project benefits, (d) Intangible project costs, (e) committed project champion, (f) availability of grants.	This question seeks to identify whether other less tangible benefits were acknowledged as achievable following an MRPII deployment. These intangibles were then explored for their characteristics.

F1: Were BOMs, drawing levels and inventory holdings formalised before implementation ?	The significance and benefit of formalising BOMs, drawing levels and inventory holdings is examined. Their impact on the attainment of other benefits is also examined.
G9: How did the investment meet the financial assessment criteria set: exceeded criteria, just met criteria, failed criteria, don't know.	This question establishes the success of the investment against the financial criteria identified. It also identifies the nature of other factors (benefits and cost) considered during the investment decision making process.
G10: Do you perceive your MRPII system to be a success, if so, what is your criteria for success ?	This question investigates the users' perception of qualitative constructs that define success.
G12: How have manpower levels changed as a result of MRPII ?	This question serves to identify those job functions that have been automated, following MRPII. The question will also quantify any manpower savings.
G13: How would you rate the following benefits resulting from MRPII: (a) increased plant productivity, (b) increased employee productivity, (c) increased throughput, (d) increased stock turns, (e) increased ROI, (f) improved case flow position, (g) increased profits, (h) reduced production costs, (i) reduced overhead apportion, (j) reduced finished goods stock levels, (k) reduced raw material inventory holdings, (l) reduced 'direct' labour, (m) reduced 'indirect' labour, (n) reduced warranty claims, (o) reduced scrap and rework, (p) increased capacity utilisation, (q) increases in employee effectiveness, (r) improved responses to variations in product mix/volume, (s) improved product quality, (t) increased opportunities to innovate, (u) improved due-date reliability, (v) increased product tractability, (w) improved ability to respond to design/engineering changes, (x) increased flexibility, (y) improved production planning and control, (z) improved availability of management information, (aa) improved information flow/reporting structure, (ab) improved accuracy and reliability of information, (ac) improved integration between departments, (ad) next step in organisational strategy, (ae) enhanced company image, (af) competitive advantage, (ag) system/technology upgrades, (ah) reduced manufacturing leadtimes, (ai) reduced new product introduction leadtimes, (aj) flexible production capability, (ak) provide efficient and effective customer service.	This question identifies whether the pre-defined tangible and intangible benefits have been exceeded, achieved or under-achieved. These benefits offer a partial benchmark against which the success of the investment can be measured. This can be done through determining whether the objectives used to justify the expenditures have perceived to of been achieved.

Table F.3: Relationship Between Hypothesis 4 and Interview Agenda