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THE USE OF PROJECT MANAGEMENT PROCEDURES BY CONSTRUCTION CONTRACTORS

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ABSTRACT

Research into the use of project management procedures has mostly been directed at the private sector of the construction industry, despite the fact that the public sector contribute almost half of the UK's construction output, in the repair and maintenance sector of the construction industry. Indeed, since the introduction of compulsory competitive tendering (CCT) in 1980, the public sector has had to carry out a continually increasing proportion of their work under competitive conditions, bidding for work along with private sector construction contractors.

This thesis focuses on the use of project management procedures in both private and public sector construction contractor organisations, looking at the utilisation of a number of different project management procedures, including organisation profile, project planning and control, quality management, and human resource considerations. It is believed that all these aspects must be considered together, if an accurate picture of an organisation's approach to the management of projects is to be achieved.

The argument employed throughout this study is that where project management procedures are adopted in the management of projects, a project manager will have the potential to better manage the project, than would otherwise be the case.

Empirical research was carried out using both a quantitative approach (structured mail questionnaire) and a qualitative approach (semi structured interviews). 100 responses were received in all, 80 to a questionnaire for construction contractors, 63 in the private and 17 in the public sector. Personal interviews were carried out with 20 project managers.

Analysis of the data investigated the use of a number of different project management procedures and identified differences in their use between private and public sector contractors. The results showed that despite tendering for and carrying out work in the same market area, there were notable differences in the use of project management procedures between private and public sector construction contractors.

In the main, private sector construction contractors utilised project management procedures to a greater extent than contractors in the public sector; however, in many instances the use of such procedures could hardly be described as extensive. For example, planning in many instances did not extend to the monitoring and control phase once projects were underway; the 'baseline' plan was effectively disregarded for updating project status, particularly so in the public sector. Despite the powerful nature of performance monitoring techniques, such as 'earned value analysis', little use was made of them. This general lack of project control was further exacerbated because both private and public sector construction contractors tended to operate separate 'stand alone' project costing systems, remote from those used for project planning and control purposes.

There was a strong commitment to quality in both the private and public sectors. However, a noticeable difference was that the private sector tended to apply their quality management systems to all areas of their business, whereas, the public sector normally only operated such systems for restricted areas of work, when compared to the 'overall' project.

Of further concern was that both private and public sector construction contractors took account of the 'human' element to a much lesser degree than issues of time, cost or quality, even though they said they viewed it as important.

Notwithstanding the existence of project management procedures for many years, there was a common lack of awareness and under utilisation of all but the most straightforward procedures in both sectors of the industry. This was especially so within the public sector.

Essentially, private and public sector construction contractors must initiate familiarisation and training programmes within their organisations to enable their project managers to access the best project management 'tools' available to assist them in the management of their projects.

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Preface

0.1 PURPOSE OF THE STUDY

The main purpose of the study is to examine the use of project management procedures by private and public sector construction contractors, to identify differences in approach between them and to put forward recommendations on how such procedures may be adopted to assist an organisation in going about their business.

The challenges that Local Authority Direct Labour Organisations (DLOs) have been subjected to since 1980 in terms of compulsory competitive tendering (CCT) legislation have had a tremendous influence upon how they undertake their works in order to achieve successful and profitable results in a competitive environment. Essentially DLOs must now be considered in exactly the same manner as construction contractors in the private sector, in view of the fact that the majority of their works are carried out in direct competition with them.

Other studies previously carried out with regard to the use of project techniques have, in the main, tended to concentrate solely on the use of a particular procedure, for example, project planning. This study will investigate the use of a number of project management procedures which the researcher believes must be considered together in order to ascertain how a particular organisation has integrated these important procedures into the manner that they carry about their business.

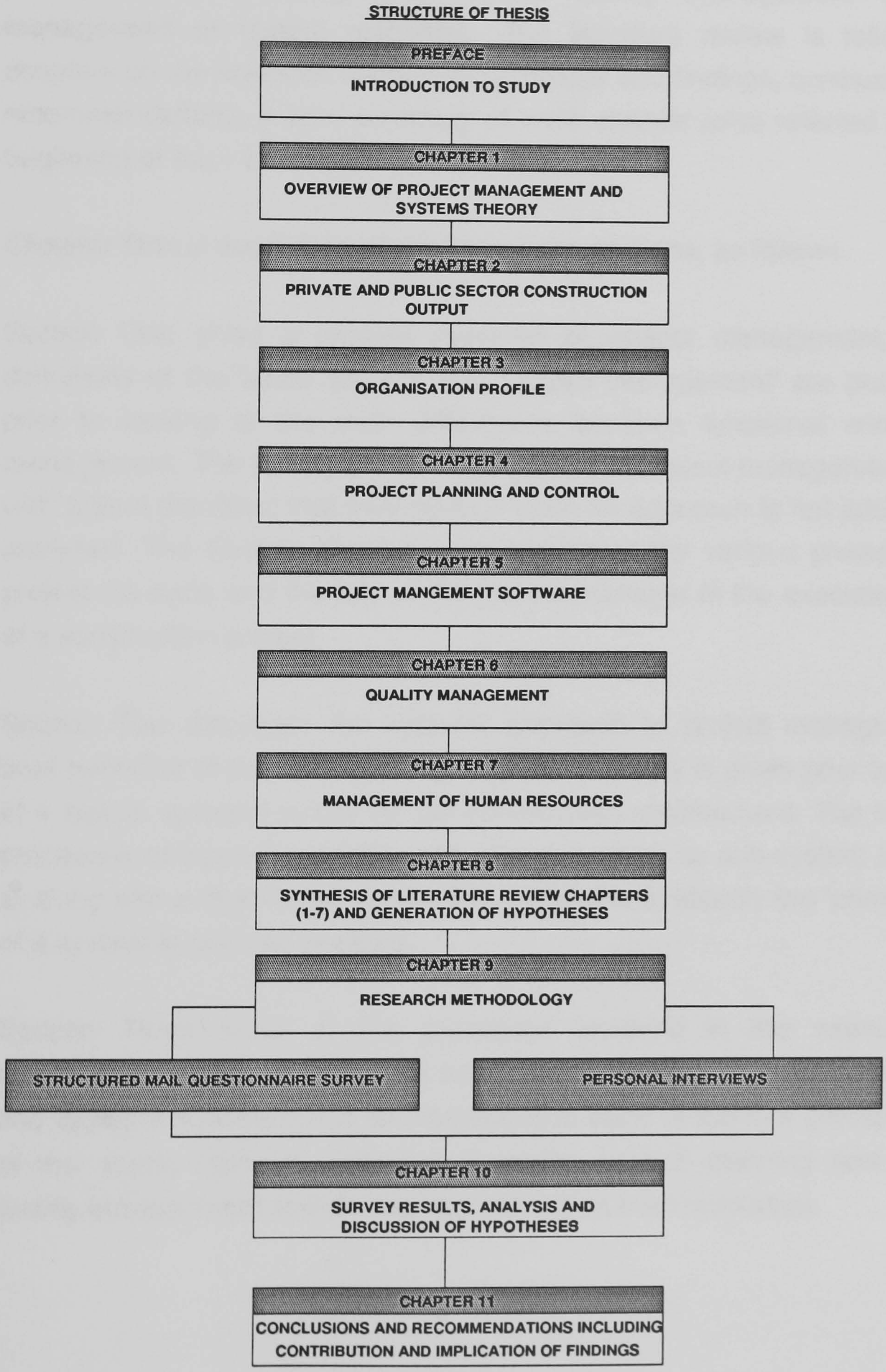
The study employs the argument throughout that where project management procedures are adopted in the management of projects, a project manager will have the potential to better manage the project, than would otherwise be the case.

A systems approach was chosen for the research and a systems model for each area is put forward in Section Three of Chapter One.

0.2 STRUCTURE OF THE THESIS

The structure of the thesis is shown in Figure 0.1.

Figure 0.1 : Structure Of Thesis



0.3 SUMMARY OF CONTENTS

The literature review which follows consists of seven chapters ranging from an introduction to systems theory and project management, to a review of several important project management procedures including organisation profile, project planning and control, quality management and the management of human resources. The literature review is followed by chapters on the research methodology, results and findings, conclusions and recommendations. A brief summary of each chapter (also referred to at the beginning of each chapter) is now given.

Chapter One is essentially divided into three sections, as follows.

Section One gives a general overview of project management. Initially definitions of the terms 'project' and 'project management' are put forward prior to looking at the main differences between functional and project management. The history of the development of project management, along with typical problems that may occur if such an approach is not adopted are analysed. The Section concludes by looking at the various phases of the project life cycle and the role of the project manager in the execution phase of a construction project.

Section Two discusses the systems approach to project management. A brief overview of the development of systems theory is given prior to looking at a typical systems model for the construction environment. The important processes of input-conversion-output for a system, or sub-system is looked at along with a description of how it is preferable to identify the 'primary task' of a system in such an analysis.

Section Three looks at the processes involved in the execution, or construction phase of projects. A systems approach is adopted for the study and systems flow diagrams are discussed in each of the four principal areas of the study, namely, organisation profile, project planning and control, quality management and the management of human resources.

Chapter Two is essentially divided into two sections.

Section One looks at the private and public sector construction output within the UK. The breakdown of construction output between the two sectors, as a result of compulsory competitive tendering (CCT) legislation in the public sector is analysed in detail to demonstrate in detail the stark changes that have arisen since the initial piece of legislation in 1980.

The functions carried out by Local Authorities and the need for Direct Labour Organisations is discussed prior to looking at some of the legislation which has caused the changes referred to. Comments from both sectors on the 'fairness' of the legislation conclude this section of the chapter.

Section Two comprises a case study of the Direct Labour/Direct Service Organisations within Lothian Regional Council. After a brief overview of all the Direct Labour Services provided, an in-depth investigation into how the Highways DLO Section addressed the changes imposed by CCT legislation over the period 1981-1991 is undertaken to demonstrate how one such organisation has managed the changes necessary to survive in a competitive environment.

Chapter Three begins by looking into the reasons why construction contractor organisations undertake projects. This is followed by a brief analysis of the strategic considerations, including looking at different approaches to strategy and strategic behavioural types, that have to be taken into account in the overall management approach to projects.

Various types of cultures which may exist within organisations, including task and role cultures are also looked at in an attempt to identify typical classes of culture akin to private and public sector construction contractors.

The chapter concludes by looking at the organisational environment of projects and several of the more common types of organisational structures including functional, project and matrix forms.

Chapter Four is essentially divided into three sections, namely, section one dealing with project planning, section two with work breakdown structures and linear responsibility charts and section three with project control.

Section One begins by looking at the purpose of planning and how projects can be represented in plan form after a modelling process has been carried out. Planning techniques currently in use are briefly studied followed by a more in depth analysis of the bar chart and network planning techniques. The project network is considered with respect to logic constraints, time parameters and resource/cost parameters. The simple computations involved in the various processes are referred to throughout. Project schedules, which are the end result of the 'baseline' planning process conclude this section of the chapter.

Section Two looks at the pricing out of the work. The development of a work breakdown structure (WBS) and the establishment of costs for each WBS element are discussed prior to outlining the subsequent pricing out procedure. The use of linear responsibility charts, or matrices, to facilitate depicting in greater detail than a mere organisational structure diagram, the responsibilities, authorities and reporting structures in the project environment conclude this section of the chapter.

Section Three looks at project control. The principles of effective project control are discussed and methods commonly used in the construction industry for control are analysed including 's' curves, performance analysis and the 'earned value' concept. An analysis of management and cost control systems (MCCS) concludes the chapter.

Chapter Five initially discusses the various types of applications software relative to Project Management which are discussed from their evolution to their current state of development. During this process the development of computer hardware is also considered to illustrate its impact on software development.

The complete planning process is analysed from the point of view of carrying it out using a microcomputer, including the formulation of 'baseline' schedules and subsequent monitoring and control.

A basis for the evaluation of the many project management planning and control software packages that are available is put forward prior to looking at various surveys on software analysis, which have been carried out.

A brief look into recent research on how microcomputers have influenced the planning process in the construction industry concludes the chapter.

Chapter Six is essentially divided into two sections.

Section One stresses the need for satisfying quality requirements within a project as well as satisfying time and cost objectives. The balance between schedule/cost/quality is discussed and the history and development of quality standards along with an in depth look at the quality standard BS 5750 concludes this section of the chapter.

Section Two looks at planning and implementing a Quality System within an organisation. The planning aspects consider Quality System Documentation with the implementation phase looking at how assessment is carried out to assess an organisation in terms of quality. A brief look into Total Quality Management (TQM) concludes the chapter.

Chapter Seven looks at several of the most important aspects of human resource management including various management theories, motivational theories, team building and leadership.

The chapter begins by looking at various approaches to management which put forward general management theories, or principles to the process. Motivation can have an important effect on the performance of individuals associated with a project. This subject area is considered in detail by looking at the work of various motivation theorists and also extensive research that has been carried out in this area in the construction industry.

The role of teams and leadership in the project environment complete the chapter.

Chapter Eight puts forward a synthesis of the literature review chapters one to seven, and develops a number of hypotheses which will be tested after the research survey data has been collected.

Chapter Nine discusses the research methodology adopted for the study. Details of how the structured mail questionnaire and semi structured interviews are carried out is included. The chapter concludes by looking at the response rate to the surveys.

Chapter Ten initially discusses the methods used in the analysis of survey data, including the use of statistical techniques. A comprehensive resume of the results of both the quantitative (structured mail questionnaire) and qualitative (semi structured personal interviews) surveys is carried out, including analysis and discussion in relation to hypotheses.

Chapter Eleven gives an executive summary of the results followed by conclusions and recommendations including contribution and implication of the findings.

CHAPTER ONE : OVERVIEW OF PROJECT MANAGEMENT AND SYSTEMS THEORY

1.1 SUMMARY OF CHAPTER ONE

This Chapter is essentially divided into three sections, as follows.

Section One gives a general overview of project management. Initially definitions of the terms 'project' and 'project management' are put forward prior to looking at the main differences between functional and project management. The history of the development of project management, along with typical problems that may occur if such an approach is not adopted are analysed. The Section concludes by looking at the various phases of the project life cycle and the role of the project manager in the execution phase of a construction project.

Section Two discusses the systems approach to project management. A brief overview of the development of systems theory is given prior to looking at a typical model for the construction environment. The processes of input-conversion-output for systems are looked at, along with a description of how it is preferable to identify the 'primary task' of a system in such an analysis.

Section Three looks at the processes involved in the execution, or construction phase of projects. A systems approach is adopted for the study, and systems flow diagrams are discussed in each of the four principal areas of the study, namely,

- Organisation profile
- Project planning and control
- Quality management
- Management of human resources.

SECTION ONE : OVERVIEW OF PROJECT MANAGEMENT

1.2 BACKGROUND

Most civil engineers (and indeed many other professions) are involved in projects of some shape, or form. Usually the primary objective is to produce a finished article which will be fit for its intended purpose. In civil engineering terms this might involve the design, maintenance or construction of a road, bridge, power station or reservoir to meet a client's requirements. The Institution Of Civil Engineers is the professional body which regulates the standards expected of professional Civil Engineers and their Royal Charter (1975) describes the reasons and purpose for forming themselves into a society as being : [1]

" ...the general advancement of Mechanical science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a Civil engineer, being the art of directing the great sources of power in Nature for the use and convenience of man..."

Perhaps before discussing the role of project management in the execution, or construction phase of projects it is worthwhile looking at the definitions of the terms 'project' and 'project management'.

1.3 DEFINITION OF PROJECT AND PROJECT MANAGEMENT

BS 4335 (1992), the British Standard Glossary of terms used in project network techniques, which is a document referencing standard terminology for terms and symbols used, states the following definitions for the terms 'project' and 'project management'. [2]

project : *" an enterprise (activity or set of inter-related activities) that has a definable start and a definable completion "*

project management : *" the mobilisation and management of resources (including the technical, time and cost aspects) for the purpose of completing a project "*

These definitions, however, do not portray the essential fact that a project is almost always undertaken to achieve an important pre-stated objective(s). The Association Of Project Managers (1984) [3], Levine (1986) [4], Kerzner (1992) [5] and Oberlender (1993) [6] provide more meaningful definitions of the terms 'project' and 'project management' in Tables 1.1 and 1.2 respectively.

Table 1.1 : Definitions Of The Term 'Project'

	DEFINITION OF THE TERM 'PROJECT'
Association Of Project Managers (1984)	" the task of creating an outcome with pre-determined objectives. It involves the complex interaction of resources, services and organisations. The objectives involve the key parameters of time, cost and performance "
Levine (1986)	" likely to be unique, have a life cycle with a specific start and end, have definable tasks, have a budget, requires the use of resources and requires the establishment of a particular organisational structure to carry out the project "
Kerzner (1992)	" having a specific objective to be completed within certain specifications, have start and end dates, have funding limits and consume resources "
Oberlender (1993)	" consists of three components : scope, budget and schedule " where, scope = quantity and quality of work budget = management of costs schedule = logical sequencing and timing of work to be performed

There appear to be a number of common features in the definitions of the term 'project'. These include having a pre-stated objective(s), specified time, cost, performance parameters and requiring the use of resources. Grennberg (1993) describes the main goals in projects as satisfying time, cost and quality objectives. [7]

Table 1.2 : Definitions Of The Term 'Project Management '

	DEFINITION OF THE TERM 'PROJECT MANAGEMENT'
Association Of Project Managers (1984)	" requires the application of management methodology, systems and skills to the accomplishment of a project "
Levine (1986)	" the planning, organising, directing and controlling of resources for a specific time period to meet a specific set of one-time objectives "
Kerzner (1992)	" achieving the project objectives within time, within cost, at the desired performance/ technology level while utilising the assigned resources effectively and efficiently "
Oberlender (1993)	" the art and science of coordinating people, equipment, materials, money and schedules to complete a specified project on time and within approved cost "
Chartered Institute Of Building (CIOB)	" the overall planning, control and coordination of a project from inception to completion aimed at meeting a Client's requirements and ensuring completion on time, within cost and to the required quality standards "

These definitions have, in the main, the common theme of applying a management methodology, or style, to the characteristics of a project.

Morris (1989) describes the traditional definitions of project management as the accomplishment of a stated objective, on time, within budget and to technical specification as a 'contractors' one.' [8] Barnes (1985), in a similar fashion comments that the success of any construction project can be determined by monitoring performance against a pre-determined balance of cost, time and quality. [9]

It is therefore appropriate to consider a construction project usually to have the following common properties :

- A unique undertaking
- Identifiable time parameters
- Resources consumed
- Identifiable budget
- Prestated objective(s)
- Specified levels of quality, or specification

Project management can simply be looked upon as the management of these parameters to successfully bring a project to a satisfactory completion of both the Client and the construction contractor.

Another useful way of describing project management is that it is the calculated use of proven techniques to,

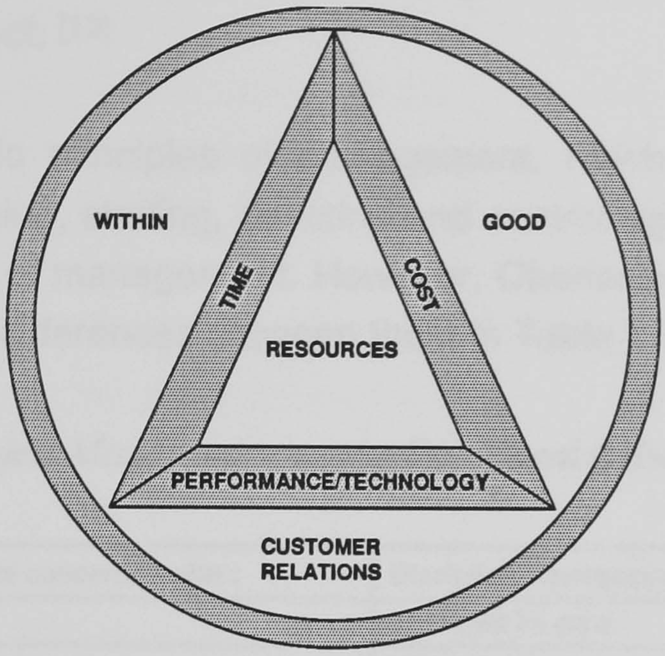
- Plan
- Implement
- Control
- Adjust

project activities to ensure a successful outcome. [10] This (PICA) cycle can be applied to all aspects that require to be managed within a project, including, time, cost, quality or performance standards.

Kerzner (1992), as per his definition of project management defines successful project management as having achieved the project's objectives within time, within cost, at the desired performance or technology level whilst utilising the assigned resources effectively and efficiently. [11]

A widely used representation of this important 'vision' of the potential benefits of adopting a project management approach is shown in Figure 1.1.

Figure 1.1 : Successful Project Management



Source : Adapted From Kerzner H. : Project Management - A Systems Approach To Planning, Scheduling And Controlling - Fourth Edition - 1992

Having considered many definitions, at this point it is appropriate to point out that this research incorporates the following perspective :

' where project management procedures are adopted in the management of projects, a project manager will have the potential to better manage the project, than would otherwise be the case '

1.4 FUNCTIONAL VS PROJECT MANAGEMENT

Management can normally be divided into two types, namely, functional and project management. Functional management involves work which can be described as being repeatedly of a similar nature, for example, an estimating department. On the other hand, project management involves the management of 'one-off' projects, such as those often undertaken in the civil engineering construction industry. Jackson (1986) comments that the difference between project management and the management of other activities is, in fact, this element of 'uniqueness'. [12]

Project Management differs from functional management in that it involves the planning, organising, directing and control of a company's resources for a relatively short-term period within a project. Informally, functional personnel (the vertical hierarchy) are consigned to a specific project (the horizontal hierarchy); however, unlike classical management the project manager does not staff the project. [13]

Clearly, the basic principles of management, which normally involve the planning, organising, staffing, directing and controlling of resources apply to both these types of management. However, Oberlender (1993) identifies the following distinct differences between them in Table 1.3. [14]

Table 1.3 : Project Management versus Functional (Discipline) Management

Project management is concerned with :	**Discipline management is concerned with :**
What must be done	How it will be done
When it must be done	Who will do it
How much it will cost	How well it will be done
Co-ordinating overall needs	Co-ordinating specific needs
Multi-discipline focus	Single-discipline focus
Reliance on others	Providing technical expertise
Project quality	Technical quality
Administrative viewpoint	Technical viewpoint
A generalist's approach	A specialist's approach

Source : Adapted From Oberlender G.D. : Project Management For Engineering And Construction - 1993

Cleland and King (1975), in a similar fashion, distinguish the differences in roles between the two management types by looking at the roles of the project manager and functional manager, as follows [15] :

Project Manager

- What is to be done?
- When will the task be done?
- Why will the task be done?
- How much money is available to do the task?
- How well has the total project been done?

Functional Manager

- Who will do the task?
- Where will the task be done?
- How will the task be done?
- How well has the functional input been integrated into the project?

The introduction of a project management culture into an organisation which is typically functionally structured is, however, not without its difficulties. Payne (1993) comments that [16] :

" problems are commonly experienced with the introduction of project management into a functionally structured organisation as the need for it may not be perceived by all those who will be affected by its introduction "

Heredia (1993) takes this a stage further for the public sector, by concluding that they, in particular, have generally not understood the concept of management and furthermore, that the project concept is not yet well understood by technical levels of such organisations. He goes on to state that [17] :

" to create more effective and efficient public administrations, an extensive use of project management should be made "

Costello (1989) lists two important objectives which must be achieved when first implementing project management into an organisation. [18] Firstly, it is important to ensure that participants perceive value in the change process. Secondly, the implementation process must be seen to function as a catalyst for changing or reinforcing existing attitudes and behaviour.

1.5 HISTORY AND DEVELOPMENT OF PROJECT MANAGEMENT

Jesus Christ in Luke 14 : 28-29 recognised the need for project management when he stated [19] :

" If one of you is planning to build a tower, he sits down first and figures out what it will cost, to see if he has enough money to finish the job. If he doesn't, he will not be able to finish the tower after laying the foundation; and all who see what happened will make fun of him "

Projects have been in existence since the beginning of mankind. However, as is often the case it has taken two world wars in current times to highlight the problems encountered in the management of many projects. In the post war period, a series of reports were put forward identifying problems within the construction industry. The Phillips Report (1950) [20], Emmerson Report (1962) [21], Banwell Report (1964) [22], 'Action Of Banwell Report' (1967) [23], Tavistock Report (1965) [24] and the Wood Report (1976) [25] are among the most notable. The content of these reports covered a wide range of problems in the industry from the lack of education, late issue of information, placing of contracts, lack of a coherent and integrated service, poor communications, fragmentation, inappropriate tender methods and a lack of integrated project control.

Further reports by the National Economic and Development Office (NEDO) looked into other areas of the construction industry including large construction sites (1970) [26], before you build - what a client needs to know about the construction industry (1974) [27], construction for industrial recovery (1978) [28], faster building for industry (1983) [29] and co-ordinated project information (1987) [30].

Recognition of the principles of project management, according to Barnes and Wearne (1993) came into effect only in the last 25 years, and much of which can be attributed to the many reports and studies previously referred to. [31]

Knoepful (1992) comments that construction is a key sector of every society, economy and culture and that building up the infrastructure is the basis for working, living and leisure facilities. [32] Each construction project has its own peculiarities and needs capable management and engineering.

1.6 WHY PROJECT MANAGEMENT?

There are a number of apparently different reasons for utilising a project management approach to the management of projects. The common theme through them, however, is that construction projects generally cost a great deal of money and therefore require an effective organisational structure to be put in place to manage them, along with the adoption of a management methodology akin to the unique nature of projects.

Fabi and Pettersen (1992) state that [33] :

" project management is a particularly appropriate management approach for operations with a single, pre-determined final product "

With specific reference to the construction industry, Oberlender (1993) describes the construction phase of projects as being particularly significant in view of the fact that some 90% of the cost of a project is normally associated with its construction. [34] In the 1990's O'Connor and Reinsborough (1992) stress that the adoption of a project management approach will be vital to all organisations with critical projects to complete. [35] Harrison (1985) states that the principal reason for adopting a project management approach to the management of projects is [36] :

" that the traditional forms of organisation structure and management techniques do not handle project type work effectively "

He advocates a range of measures including a need for different organisational forms, managers skilled in the techniques of project planning, financial management, control and human resource considerations.

In order to deal with increasing business complexity, Gareis (1991) describes how organisations use projects as an organisational form to perform unique and complex tasks. [37] He believes that companies want to ensure the following :

- Organisational flexibility
- Decentralisation of management responsibility
- Concentration on complex problems
- Goal - orientated problem - solution processes
- Quality and acceptance of problem solutions
- Chances for individual and organisational development

Above all, Badiru (1988) points out that : [38]

" companies that consistently deliver quality products and service in a timely fashion succeed mainly because of the effort they commit to project management "

Planning and control of time, resources, costs and quality along with the management of people are the basic concepts of the project management process. It is essential to bear in mind that these aspects are clearly inter-related and that each is dependent on the others.

1.7 PROJECTS WITHOUT PROJECT MANAGEMENT

Gibble (1986) narrates that engineering failures are not always catastrophic and furthermore, more failures are due to improper management of projects rather than actual physical failures. [39] Warren (1978) describes how personnel involved in projects become discouraged when the implementation phase does not achieve the established objective. [40] The phases in such projects, in order of succession, are summed up by him somewhat pointedly as :

- Enthusiasm
- Disillusionment
- Panic
- Search for the guilty
- Punishment of the innocent
- Praise and honours for the non-participants

Project management is recommended as a means of reducing the possibility of not meeting desired objectives. Likewise, Phillips and Pugh (1987) comment on the psychological effects that can be experienced by researchers working towards a PhD which is a kind, or form, of project management. [41] These include :

- Enthusiasm
- Isolation
- Increasing interest in work
- Transfer of dependence of supervisor to the work
- Boredom
- Frustration
- A job to be finished

There are many similarities between these factors and those associated with the topsy turvy environment prevailing on many construction projects!

Kharbanda and Stallworthy (1983) analysed a number of important projects which have been completed with the utmost technical expertise but which have been failures for one reason or another. [42] The authors advocate simple common sense procedures, such as taking the time to get things right at the beginning of a project.

Graham (1985) gives a summary of the consequences that may occur without sufficient project management. [43] These are shown in Table 1.4.

Table 1.4 : Problems Encountered In Projects Without Project Management

	PROBLEMS ENCOUNTERED IN PROJECTS	**REMEDY**
1.	Sufficient time is rarely allocated when the project is first formulated	Project Management
2.	Time schedules seem to slip in large chunks when in fact they slip one day at a time	Project Management
3.	When schedule slips, project manager often seeks a culprit	Project Management
4.	People from various departments start to blame people from other departments for the delay	Project Management
5.	Additional people are added to the project to bring it back to schedule ("crashing")	Project Management
6.	The project is over budget due to crashing and may be : (a) on time, but shoddy (b) well done, but late (c) both shoddy and late; or (d) abandoned	Project Management

Source : Adapted From Graham R.J. : Project Management - Combining Technical And Behavioural Approaches For Effective Implementation - 1985

Williams (1993) [44] draws attention to the large amount of literature relating to project 'failures', including Marshall and Meckling (1959) [45], Baum and Tolbert (1985) [46] and Morris and Hough (1987). [47]

Morris and Hough (1987) look at several major projects which have failed in either terms of time, cost or specification or a combination of them. [48] Their conclusions on several major projects undertaken in the United Kingdom are shown in Table 1.5.

Table 1.5 : Success Of Major Projects In Achieving Project Objectives

PROJECT	*Time*	*Cost*	*Specification*
Concorde	X	X	✓
Thames Barrier	X	X	✓
UK Advanced Passenger Train	X	✓	X
PAYE Tax System	✓	✓	✓

Source : Adapted From Williams T.M. : The International Journal Of Project Management - February 1993

Many factors may affect the successful execution, or otherwise of a project. External factors such as competition in tendering, market changes in terms of demographic or socio-economic shifts, or government regulation. Internal forces such as over-optimistic scheduling can have severe consequences when the project reaches execution stage in both time and cost terms.

However, most problems encountered in the management of projects stem from small intermittent deviations from intended actions, but which, if left unmanaged can develop into bigger, more deep-rooted problems. A worthwhile description of this is given by Brooks (1975) in his essay *"Hatching A Catastrophe"* where he explains the process of falling behind in this way. [49]

"When one hears of disastrous schedule slippages in a project, he imagines that a series of major calamities have befallen it. Usually, however, the disaster is due to termites, not tornadoes; and the schedule has slipped imperceptibly but inexorably. Indeed, major calamities are easier to handle; one responds with major force, radical reorganisation, the invention of new approaches. The whole team rises to the occasion. But the day-to-day slippage is harder to recognise, harder to prevent, harder to make up. Yesterday a key man was sick, and a meeting couldn't be held. Today the machines are all down, because lightening struck the buildings' power transformer. Tomorrow the disk routines won't start testing because the first disk is a week late from the factory. Snow, jury duties, family problems, emergency meetings with customers, executive audits - the list goes on and on. Each one only postpones some activity by a half-day or a day. And the schedule slips one day at a time."

Stone (1988) also discusses some of the factors that may affect project success in terms of achieving time and cost objectives, during the construction phase. [50] These include a shortage of suitable manpower, failure or non-conformance to specifications, late delivery of materials, and industrial labour disputes.

Examples of the reasons for some of the failures of projects were put forward by Ferns (1991) who divided them into two categories, large and small. [51] His classifications are shown in Table 1.6.

Table 1.6 : Reasons For Failures On Large And Small Projects

REASONS FOR FAILURES ON LARGE PROJECTS	*REASONS FOR FAILURES ON SMALL PROJECTS*
• Lack of objective evaluation • Lack of clear and agreed objectives • Poor leadership and teamwork • Lack of risk management • Contractual disputes • Organisational and political issues	• Lack of objective evaluation • Lack of clear and agreed objectives • Poor leadership and teamwork • Lack of risk management • Contractual disputes • Organisational and political issues • Poor visibility of projects by senior management, owing to weak reporting, lack of prioritisation, both within and between projects • Inefficient use of resources • Project led by technology, rather than user needs • Development of backlogs of work • Lack of recognition and understanding of dependencies, both within and between projects • Rework, owing to lack of attention to interfaces, with other projects, systems, procedures

Source : Adapted From Ferns D.C. - 'Developments In Programme Management' - The International Journal Of Project Management - August 1991

Lessons can always be learned from other projects, although every single project is unique in its own self, and proper methodical management of projects can assist greatly in ensuring the successful outcome of a particular contract.

1.8 PROJECT LIFE CYCLE

Projects normally follow a life cycle comprising a number of distinguished phases. Adams and Barndt (1988) believe that the project life cycle can vary from anything between three to six phases, but typically go through the following four phases : [52]

- phase 1 - conceptual
- phase 2 - planning
- phase 3 - execution
- phase 4 - termination

Nathan (1991) concludes that people perceive the phases making up the project life cycle differently; however, authors generally agree on four main phases, and where there are more than four there is generally an overlap between the principal four phases. [53]

The *conceptual* phase involves ascertaining the need or benefit of a particular scheme to a client. The aims of the project are established and an estimation of the resources necessary to be committed to the project made. The *planning* phase involves determining the project organisational structure and targets for the project. Schedules are prepared for the execution phase and tasks within the project are defined and assigned resources. The project team is built up at this stage. The *execution* phase involves performing the work of the project. This may include aspects of design, production, construction etc depending on the type of the project. The *termination* phase involves the transfer of the project 'end product' and the termination of the project. All the resources require to be redeployed at this stage.

Throughout these four phases of the project cycle many different things get managed simultaneously within a typical project environment. According to the Project Management Institute, the following elements of management can occur at any one time within a project : scope management, time management, human resource management, cost management, quality management and communication management.

Roman (1968) comments that there is general agreement that each project phase involves different management considerations and different tasks to be performed. [54] The peak 'level of effort' required in the life cycle of projects is at the commencement of the execution phase and successful implementation is clearly the key to achieving project success and achievement of objectives. Similarly, Sidwell (1990) comments that in construction projects, a life cycle is followed which is dynamic and goal orientated. [55] They are managed by a project team, each phase of the project life cycle being different in nature demanding different skills, roles and responsibilities for the team.

In the United States, the Department Of Defence (D.O.D) and the National Aeronautics and Space Administration (N.A.S.A) have five extensively defined project life cycle phases. These are the conceptual phase, the definition phase, the production or acquisition phase, the operational phase and the divestment phase.

1.9 THE ROLE OF THE PROJECT MANAGER

The Project Manager, in the context of a Construction firm carrying out a project, organises, plans, schedules and controls all construction work and is responsible for ensuring that the project is completed within time, cost and quality parameters. The Project Manager is the focal point for all facets of a project and brings together the efforts of all the organisations having inputs in to the construction process. In particular, the effective management of human resources is one of the key factors in the determination of project success.

Clough and Sears (1979) indicate that a project manager organises, plans, schedules and controls the site operations and is responsible for getting the project completed within the time and cost limitations. [56] Clearly, the project manager is the link - pin in the project environment and must possess many skills and attributes to carry out his duties effectively. His role, stated concisely by Oberlender, (1993) is [57] :

" to lead the project team to ensure a quality project within time, budget and scope constraints "

In order to meet these wide ranging responsibilities, the project manager must possess a range of managerial and human relations skills to get the best out of all project personnel. Martin (1976), Stuckenbruck (1976), Einsiedel (1987) and Oberlender (1993) all comment on the various attributes, or skills and personal characteristics required of project managers.

Martin (1976) classifies project managers according to their skills and personal characteristics, the latter including leadership, honesty and integrity. [58] Skills include planning, financial control, knowledge of behavioural sciences and supervision.

In a different manner, Stuckenbruck (1976) lists ten attributes required of a 'a proficient project manager', these being [59] :

- Multi-disciplinary orientated
- 'Global problem' orientated
- Effective problem solver and decision maker
- Good manager and administrator
- Good analytical abilities
- Creativity in dealing with information and problems
- Effective communicator (both verbal and written)
- Good motivator
- Be flexible and adapt to change
- Right temperament

Einsiedel (1987) put forward a project manager profile comprising five characteristics. [60] Firstly, the project manager must be taken seriously (both by the customer and his own staff). Secondly, he must be capable and creative in solving problems. Thirdly, he must be able to tolerate ambiguity. Fourthly, he must have a flexible management style to cope with situational changes. Finally he must be an effective communicator. Because projects are unique in nature and project teams are formed for relatively short durations, the tasks undertaken by the project manager are made all that more difficult.

With direct reference to the managerial duties required to be undertaken by a project manager, Oberlender(1993) points out that the five basic functions of management, namely, planning, organising, staffing, directing and controlling must be performed. However, this is not consistent with Kerzner's (1992) viewpoint who believes that the project manager does not have any responsibility for staffing in the project environment with functional managers being responsible at all times for appointing their own staff. [61]

Oberlender(1993) provides useful summaries of the project manager's role in each of the main functions of management, shown in Table 1.7. [62]

Table 1.7 : Project Manager's Role In Planning, Organising, Staffing, Directing And Controlling

	PROJECT MANAGER'S ROLE IN PLANNING, ORGANISING, STAFFING, DIRECTING AND CONTROLLING
	Project manager's role in planning
1.	Develop planning focused on the work to be performed
2.	Establish project objectives and performance requirements early so everyone involved knows what is required
3.	Involve all discipline managers and key staff members in the process of planning and estimating
4.	Establish clear and well-defined milestones in the project so all concerned will know what is to be accomplished, and when it is to be completed
5.	Build contingencies into the plan to provide a reserve in the schedule for unforeseen future problems
6.	Avoid reprogramming or replanning the project unless absolutely necessary
7.	Prepare formal agreements with appropriate parties whenever there is a change in the project and establish methods to control changes
8.	Communicate the project plan to clarify individual responsibilities, schedules and budgets
9.	Remember that the best-prepared plans are worthless unless they are implemented
	Project manager's role in organising
1.	Organise the project around the work to be accomplished
2.	Develop a work breakdown structure that divides the project into definable and measurable units of work
3.	Establish a project organisational chart for each project to show who does what
4.	Define clearly the authority and responsibility for all project team members
	Project manager's role in staffing
1.	Define clearly the work to be performed, and work with appropriate department managers in selecting team members
2.	Provide an effective orientation (project goals and objectives) for team members at the beginning of the project
3.	Explain clearly to team members what is expected of them and how their work fits into the total project
4.	Solicit each team member's input to clearly define and agree upon scope, budget and schedule
	Project manager's role in directing
1.	Serve as an effective leader in coordinating all important aspects of the project
2.	Show interest and enthusiasm in the project with a 'can do' attitude
3.	Be available to the project staff, get problems out in the open, and work out problems in a cooperative manner
4.	Analyse and investigate problems early so solutions can be found at the earliest possible date
5.	Obtain the resources needed by the project team to accomplish their work to complete the project
6.	Recognise the importance of team members, compliment them for good work, guide them in correcting mistakes, and build an effective team
	Project manager's role in controlling
1.	Maintain a record of planned and actual work accomplished to measure project performance
2.	Maintain a current milestone chart that displays planned and achieved milestones
3.	Maintain a monthly project cost chart which displays planned expenditures and actual expenditures
4.	Keep records of meetings, telephone conversations and agreements
5.	Keep everyone informed, ensuring no one gets any 'surprises', and have solutions or proposed solutions to problems

Source : Adapted From Oberlender G.D. : Project Management For Engineering And Construction - 1993

As can be seen from Table 1.7 the project manager's role is extensive in all the general areas of management. A useful definition of the 'complete project manager' is put forward by Graham (1985) [63] :

"The Complete Project Manager understands the transactional and organisational environments as well as the way in which the forces in these environments affect the project team. Such a project manager understands that most organisational policies aim to preserve stability while most projects aim to implement change. If the organisation culture tends towards the bureaucratic while the project culture tends towards a task orientation, this will be a source of constant friction between the organisation team. The complete project manager understands such an organisational interface exists, the complete project manager being basically a team builder. In addition, this manager understands that project must be managed differently depending on the nature of the project, the knowledge of the process and the strength of the project culture. This difference in management involves engaging in various degrees of planning, controlling and managing people. The complete project manager is interested in the long term. As such, this manager will set up project management as part of a learning system so that projects will be better managed in the future. The complete project manager is flexible in management style. This manager understands that people need to be managed differently as the project progresses through different phases. Finally, the complete project manager is a communicator. Much communication in organisations takes place almost automatically. When a new project is beginning, much of this communication is missing, mostly because the project manager and the members of the team are new to each other. If the project manager is not a supreme communicator, he may inadvertently cause upset, as people begin to think he is attempting to benefit from what they believe is poor communication".

1.10 STANDARDS FOR PROJECT MANAGEMENT

In the United States, the Department Of Defence have a formal project management system which contractors undertaking defence projects must adhere to. [64] It comprises six elements of systems and control requirements, namely, organising, planning and budgeting, accounting, variance analysis, revisions, and data access and management.

In the UK, no such standards exist, although there is a British Standard which deals primarily with the use of network techniques in project management. [65, 66, 67 & 68] Pozzi (1979) believes that an attempt should be made to establish standard methods and procedures for working systematically towards given project goals. [69] Reiss (1987) also comments that the lack of available standards and inadequacy of documentation produced by the British Standards Institution are partly attributable to the lack of project management procedures in many organisations. [70]

SECTION TWO : OVERVIEW OF SYSTEMS THEORY

Systems theory can be looked upon as a management approach that attempts to integrate and unify scientific information across many fields of knowledge and solve problems by looking at the total picture rather than through an analysis of individual components. Kerzner (1992) describes project management as an 'outgrowth' of systems management. [71] Similarly, Knoepfel (1983) comments that the most important basis of management is thinking in terms of systems. [72] Furthermore, Somasundaram and Badiru (1992) have stated [73] :

" it is evident that project management uses the systems approach to management and that is the key to its success "

General systems theory has been in existence since the 1950s, for instance, Ludwig von Bertalanffy (1951) when he described 'open systems' in relation to the human anatomy. [74] The human body, skeleton, muscles, and such like were all described as 'sub-systems' of the total system, the human body. He put forward the principle that specialists in each sub-system could be integrated to obtain a better, overall understanding of the knowledge of the operations of the system.

Boulding (1952) identified that communication problems could occur during systems integration. [75] He simply advocated that sub-system specialists must speak in a 'common language' in order for successful integration to take place. Boulding further postulated that all areas of scientific interest could be categorised according to their level of development. He put forward nine categories, or levels of development which are shown in Table 1.8.

Table 1.8 : Boulding's Classification Model For Hierarchy Of System Levels

LEVEL	BOULDING'S CLASSIFICATION MODEL FOR HIERARCHY OF SYSTEM LEVELS
1.	The first level is that of the static structure. It might be called the level of frameworks; for example, the anatomy of the universe.
2.	The next level is that of the simple dynamic system with predetermined, necessary motions. This might be called the level of clockworks.
3.	The third level is the control mechanism, or cybernetic system, which might be nicknamed the level of the thermostat. The system is self-regulating in maintaining equilibrium.
4.	The fourth level is that of the 'open-system' or self-maintaining structure. This is the level at which life begins to differentiate from not-life; it might be called the cell.
5.	The next level might be called the genetic-societal level; it is typified by the plant, and it dominates the life of the botanist.
6.	The animal system level is characterised by mobility, teleological behaviour and self-awareness.
7.	The next level is the 'human' level, that is, of the individual human being considered as a system with self-awareness and the ability to utilise language and symbolism.
8.	The social system or systems of human organisation constitute the next level with the consideration of the content and meaning of messages, the nature and dimensions of value systems, the transcription of images into historical record, the symbolisations of art, music and poetry, and the complex gamut of human emotion.
9.	Transcendental systems complete the classification of levels. These are the ultimates and absolutes and the inescapeables and unknowables, and they also exhibit systematic structure and relationship.

Source : Adapted From Boulding K.E. : 'General Systems Theory - The Skeleton Of Science' : Management Science - April 1956

Kerzner (1992) narrates that that although these nine levels may appear to be somewhat vague, they can be categorised into three groupings as shown in Table 1.9.

Table 1.9 : Kerzner's Reclassification Of Boulding's Hierarchy Levels

BOULDING'S CLASSIFICATION	KERZNER'S CLASSIFICATION
Level Nos 1, 2, & 3	Mechanical or Physical Sciences
Level Nos 4, 5, & 6	Biological Sciences
Level Nos 7, 8, & 9	Arts and Social Sciences

Source : Adapted From Kerzner H. : Project Management - A Systems Approach To Planning, Scheduling And Controlling - Fourth Edition - 1992

Kerzner goes on to state [76] :

"the important usage of these disciplines, specialities and functions is that they must be able to integrate and interrelate all of the activities so that the proper contribution will be made to each higher level in the hierarchy of systems"

It took until the early 1960s before systems theory became more widely accepted at large. Johnson, Kast and Rosenzweig (1967) related the corporate enterprise structure to an open-ended cell. [77]

"An organism is an open system which maintains a constant state while matter and energy, which enter it, keep changing (so-called dynamic equilibrium). The organism is influenced by, and influences, its environment. Such a description adequately fits the typical business organisation. The business organisation is a man-made system which has a dynamic interplay with its environment - customers, competitors, labour organisations, suppliers, government and many other agencies. Furthermore, the business organisation is a system of interrelated parts working in conjunction with each other in order to accomplish a number of goals, both those of the organisation and those of individual participants"

They likened this description of business to the second level of Boulding's classification. This was followed by comparison to the human body. The skeleton and muscle systems represented the operating line elements and the circulatory system as a necessary staff function. The nervous system stood for the communication system. The brain symbolised top-level management. This philosophy led the way for an analysis of an organisation as a group of interrelated functions operating towards a common goal.

This simplistic, but effective, representation of the systems theory concept led to rapid acceptance by businesses. Moore (1964) summed up the general feeling stating that the flow of resources is the basic force that identifies the dynamic nature of a system. [78]

Col. Kayloe (1969) believed that systems theory at this stage had resulted in a management technique that was able to 'cut-across' many organisational disciplines such as finance, engineering, marketing and such like, while still carrying out the functions of management. [79] Kerzner (1992) describes this technique as having come to be known as systems management, project management or matrix management (the terms are used interchangeably).

There are, of course, different types of business systems and sub-systems which may exist in organisations, including, according to Kerzner [80] :

- Organisation systems
- Information systems
  - informal information systems
  - formal information systems
  - management information systems
  - operating information systems
  - decision making information systems
- Financial information systems
- Marketing information systems
- Inventory control systems
- Personnel information system
- Production/operating information systems

Newcombe, Langford and Fellows (1990) state : [81]

"the focus of systems theory is upon sub-systems which are inter-related in the pursuit of goals or objectives"

They also state that before analysis of a system may be undertaken, it is necessary to define the *Primary Task* of such a system. Miller and Rice (1967) describe the primary task of an organisation as the thing it must do to survive. [82] Newcombe, Langford and Fellows (1990) comment on a number of systems concepts which require to be modelled for the achievement of the primary task. [83] These are shown in Table 1.10.

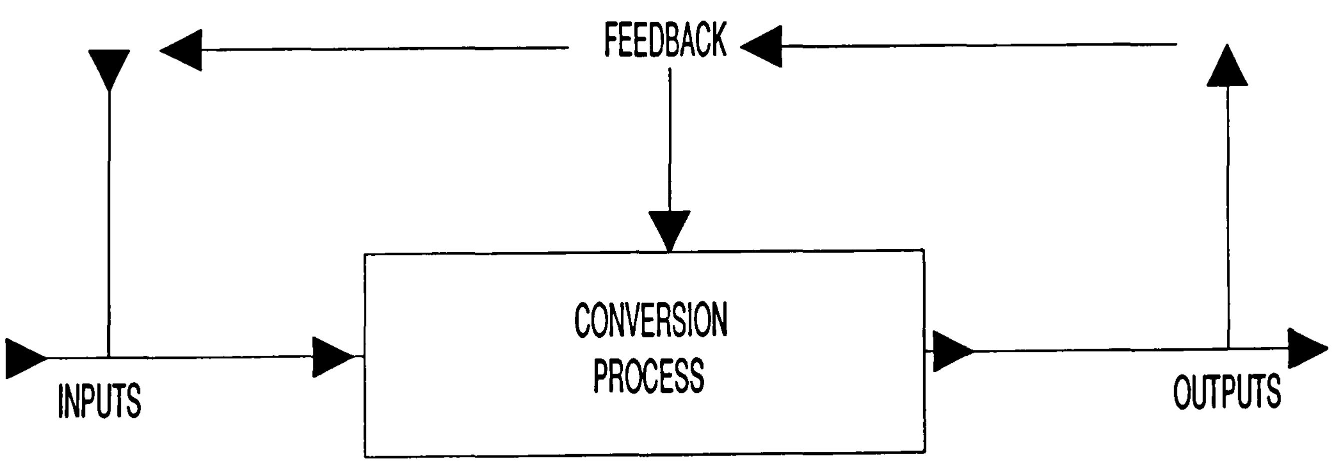
Table 1.10 : Systems Concepts

No	SYSTEMS CONCEPTS PUT FORWARD BY NEWCOMBE, LANGFORD AND FELLOWS (1990)
1.	Large systems comprise smaller sub-systems which work, preferably independently, towards the larger systems goals or Primary Task
2.	Those sub-systems form a hierarchy of systems, and by studying the inter-relationships of the sub-systems, we can understand the larger system
3.	Systems are 'open' because they interact with their environment. The environment affects the system through constraints and imperatives but is not part of the system because it does not share the same goals as the system
4.	The system receives inputs from the environment, applies some sort of conversion process and exports outputs to the environment
5.	There is a permeable boundary between the system and its environment through which inputs and outputs pass. 'Boundary management', or managing the interface between the system and its environment, is a key systems concept. These boundary management positions are usually very stressful. Boundaries also occur between sub-systems within a larger system
6.	There is feedback when part of the output is fed back to become an input; thus a cycle of events is established which enables the system to monitor its own behaviour

Source : Adapted From Newcombe, Langford and Fellows : Construction Management 1 - Organisation Systems - 1990

Katz and Kahn (1966, 1978) suggest that it is necessary to trace the input-conversion-output processes of the organisation, along with feedback mechanisms which, in effect, reactivate the system. [84] Newcombe, Langford and Fellows (1990) depict this simple, but powerful concept in Figure 1.2.

Figure 1.2 : Input, Output and Conversion processes Associated With Systems Theory



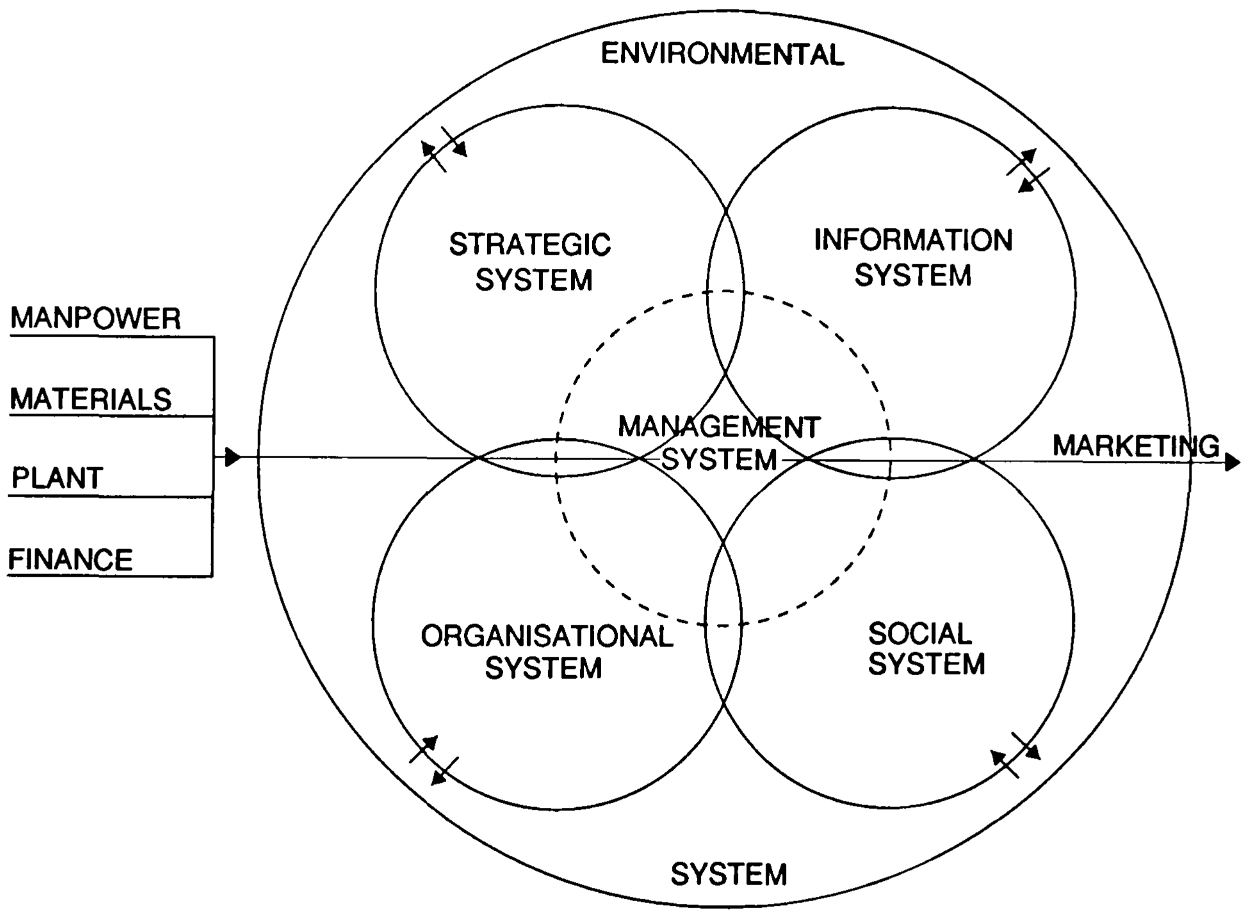
Source : Adapted From Newcombe, Langford and Fellows : Construction Management 1 - Organisation Systems - 1990

They go on to state that [85] :

" the development of open-systems thinking is vital for managers of building companies to ensure the survival of the business "

Perhaps the best way to illustrate the application of systems theory in a construction environment is by means of an example, such as the one shown in Figure 1.3.

Figure 1.3 : A Systems Approach To Construction Management



Source : Newcombe, Langford and Fellows : Construction Management 1 - Organisation Systems - 1990

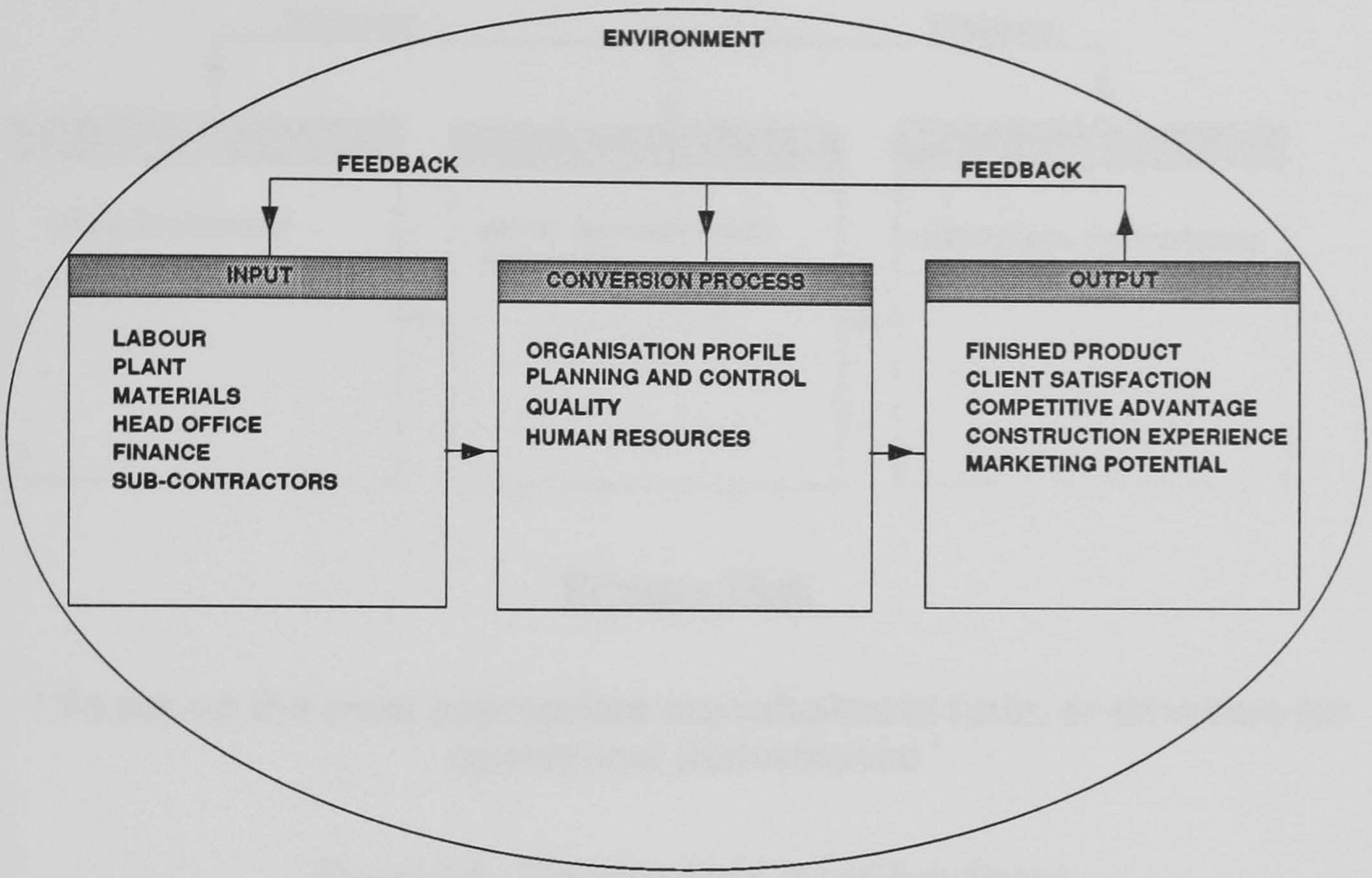
The *strategic* system performs the task of deciding the long-term direction of the organisation. The *organisational* system seeks to divide up, or differentiate the work of the organisation in a rational way and to integrate or co-ordinate the activities involved. The inputs to this are environmental, organisational characteristics and current activities undertaken by the organisation. The outputs to this are a formal organisation structure and an informal structure together with a complimentary culture. The *social* system's input is people of various types and levels. Through the processes of motivation, leadership and communication the system seeks to achieve an output of satisfied, committed and involved personnel. The *information* system provides the lifeblood running through the arteries of the organisation. Information from external sources together with data from inside is collected, sifted, sorted and disseminated to the other systems in the form of time, cost, quality, resource and statutory data. Information may be formally documented or verbally disseminated. The *management* system is central to the whole organisational system. At any level the management role involves making decisions, handling information and interacting with people. The way in which a manager fulfils the role will depend upon the inputs received through the perception of the organisation, the job itself, the team worked with and the task to be undertaken. Perceptions will be influenced by the manager's own personality, preferred management style and the demands, constraints and choices within the job. The outputs of the management system are primarily decisions and actions, but providing a motivating environment to facilitate the implementation of decisions is equally important.

SECTION THREE : SYSTEMS APPROACH TO STUDY

The study set out to adopt a systems approach in the use of project management procedures by private and public sector construction contractors. This short section, which concludes the Chapter, sets out some of the parameters to be considered.

Figure 1.4 shows the main system which will be under consideration, namely, the process of creating a finished civil engineering project via the utilisation of a number of different kinds of resources. The study, in the main, will concentrate on the items listed in the main conversion process, that is, organisation profile, project planning and control, quality management and human resources.

Figure 1.4 : Systems Model For Study

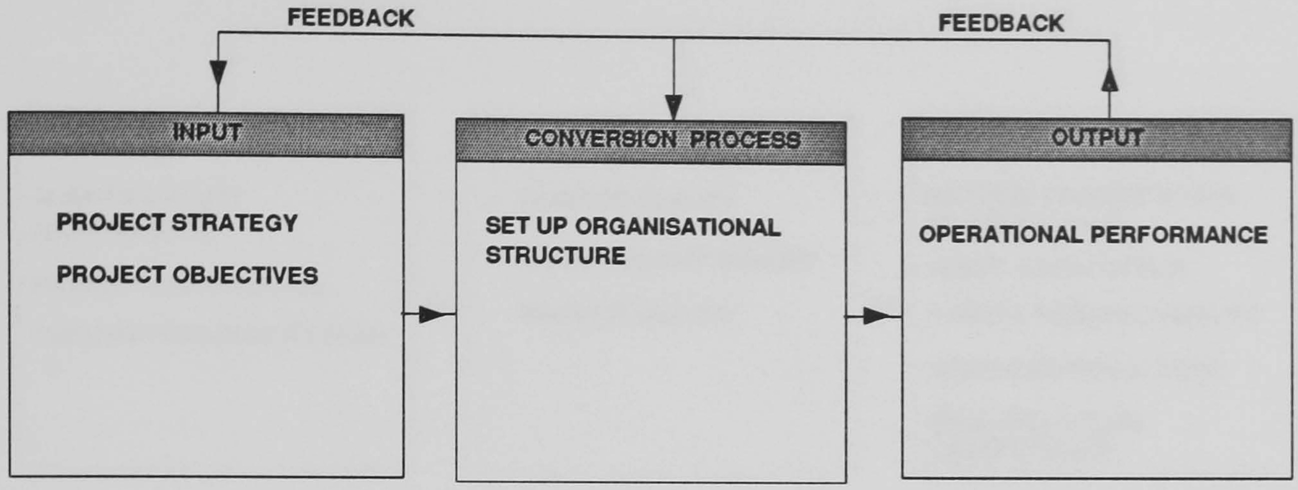


Primary Task

' To make effective use of project management procedures to facilitate the achievement of client satisfaction and competitive advantage in the execution of projects '

Each of the four central areas shall be considered as a separate sub-system of the main system and shall have its own sub-system diagram depicting the input-conversion-output attributable to its function in the process. (Figures 1.5, 1.6, 1.7 & 1.8).

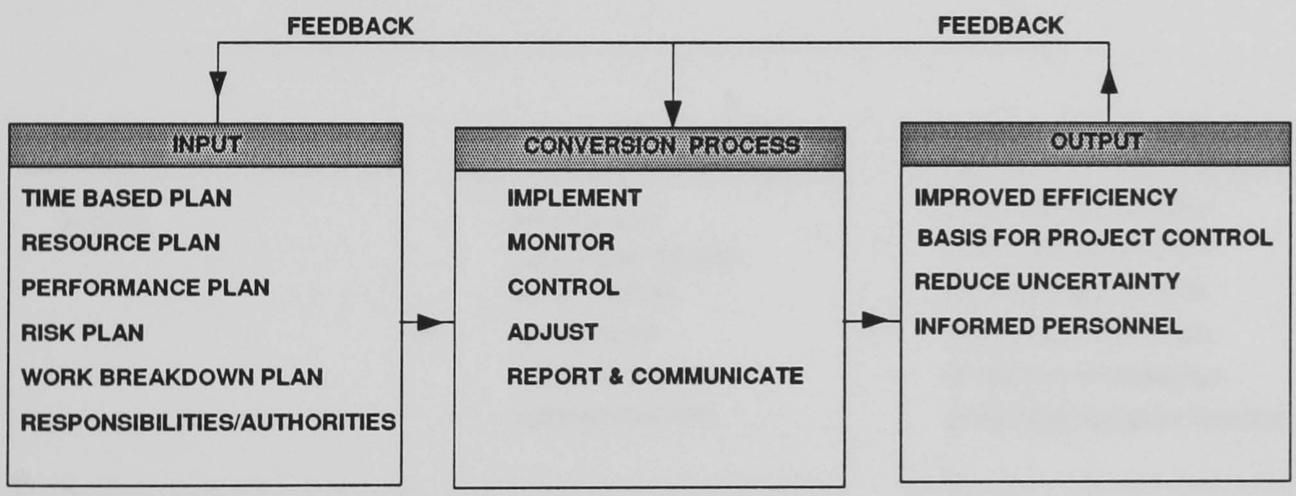
Figure 1.5 : Organisation Profile Sub-System



Primary Task

' To set-up the most appropriate organisational form, or structure for operational performance '

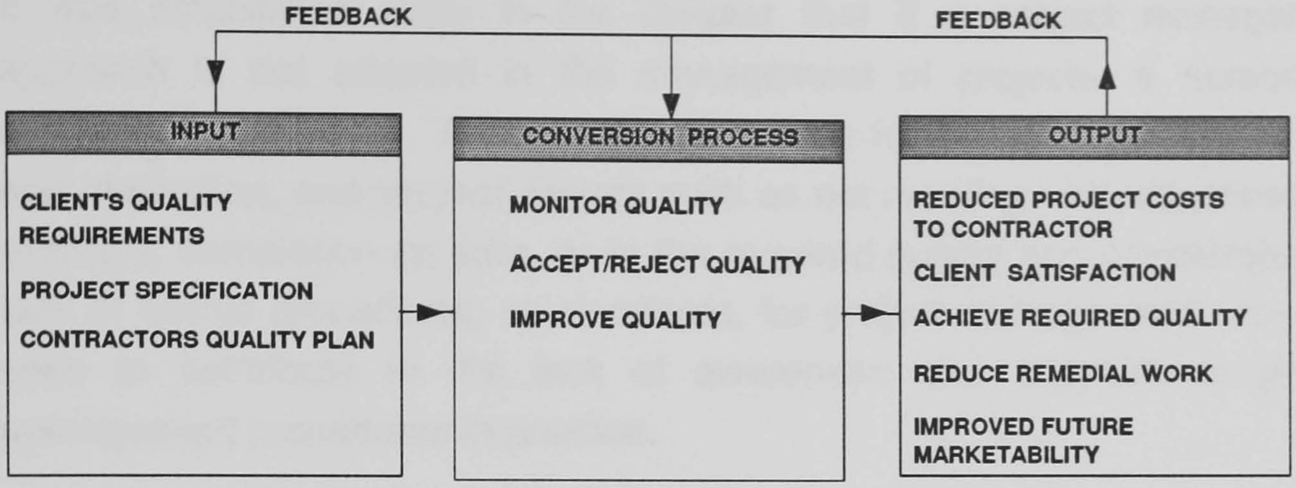
Figure 1.6 : Planning And Control Sub-System



Primary Task

' To operate effective planning and control procedures to manage the project's time, cost and performance parameters '

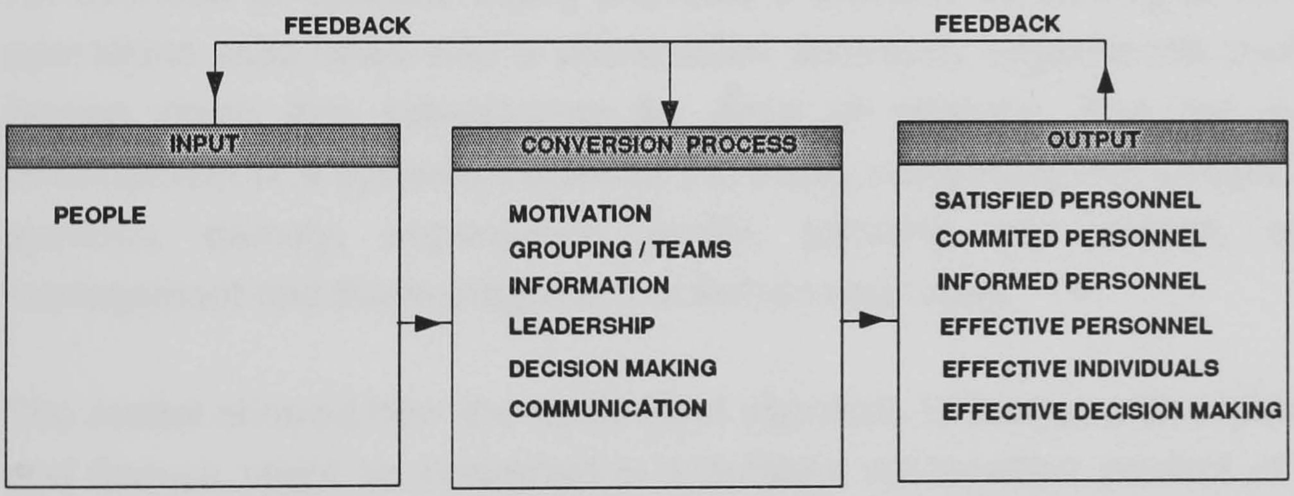
Figure1.7 : Quality Sub-System



Primary Task

' To operate an effective quality management system to facilitate meeting pre-determined project quality objectives '

Figure 1.8 : Human Resource Sub-System



Primary Task

' To create and maintain a culture, where management of human resources are adequately considered and meet employees' aspirations'

1. 11 APPLICATION OF CHAPTER ONE

It was established early in the chapter that if a project management approach is not adopted in the management of projects, a number of problems might occur. These included human factors such as low morale and motivation, and 'project' factors such as not meeting vital objectives, for example, completion on time, or to the required quality and specification. A lack of formal procedures, or standards, for project management was also seen to contribute to the lack of awareness and adoption of project management procedures in practice.

The author considers that where project management procedures are adopted in the management of projects, a project manager will have the potential to better manage the project, than would otherwise be the case. Planning and control of time, resources, costs and quality along with the effective management of people were identified as the basic concepts of project management.

An overview of systems theory provided a platform for looking at how the operations associated with a construction contractor organisation could be broken down into sub-systems for ease of analysis. This led to the development of a systems model for the study, comprising four integral sub-systems, namely, organisation profile, planning and control, quality management and the management of human resources.

The model showed how the basic input elements of labour, plant, materials and finance might be converted to a finished construction product offering client satisfaction, along with future marketing potential and competitive advantage. Essential to making this happen was the effective implementation of project management procedures in the areas of organisation profile, planning and control, quality management and human resource considerations.

Specifically, the overall relevance of this chapter has been to 'set the scene' for the subsequent analysis, in further depth, using the systems approach, of a number of project management procedures which may be used in effectively managing projects. In future chapters, important aspects of organisation profile (chapter three), project planning and control (chapters four and five), quality management (chapter six) and human resource management (chapter seven) will be analysed.

Empirical chapters (chapters ten and eleven) identify the use of particular project management procedures in both private and public sector construction contractors, showing and explaining where similarities, or differences in approach are present. This allows a direct comparison to be made of the degree of utilisation of such procedures across the full spectrum of private and public sector construction contractors currently operating in competition within the construction industry.

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CHAPTER TWO : PRIVATE AND PUBLIC SECTOR CONSTRUCTION OUTPUT

2.1 SUMMARY OF CHAPTER TWO

This Chapter is essentially divided into two sections.

Section One looks at the private and public sector construction output within the UK. The breakdown of construction output between the two sectors, as a result of compulsory competitive tendering (CCT) legislation in the public sector, is analysed to demonstrate in detail the stark changes that have arisen since the initial legislation of 1980.

The functions carried out by Local Authorities and the need for Direct Labour Organisations is discussed prior to looking at some of the legislation which has caused the changes referred to. Comments from both sectors on the 'fairness' of the legislation conclude this section of the chapter.

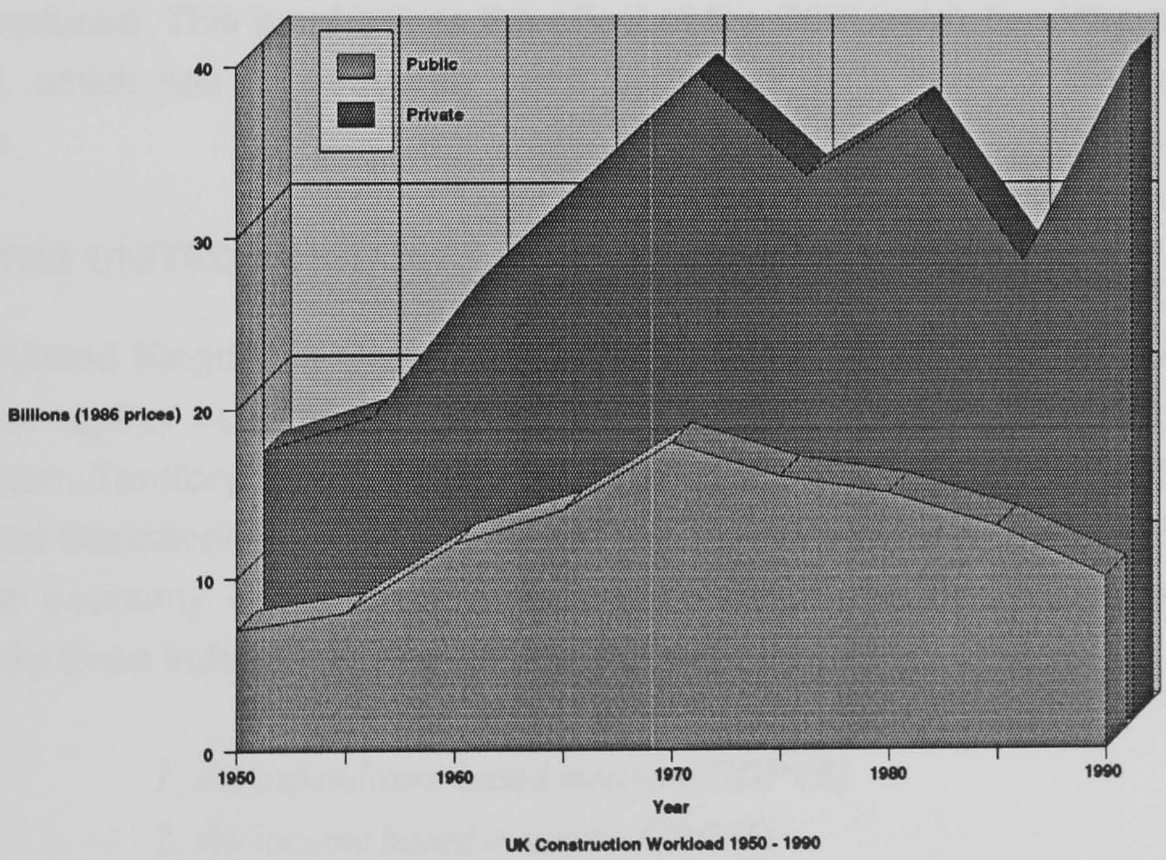
Section Two comprises a case study of the Direct Labour/Direct Service Organisations within Lothian Regional Council. After a brief overview of all the Direct Labour Services provided, an investigation into how the Highways DLO Section addressed the changes imposed by CCT legislation over the period 1981-1991 is undertaken to demonstrate how one such organisation has managed the changes which it sees as necessary to survive in a competitive environment.

SECTION ONE : PRIVATE AND PUBLIC SECTOR CONSTRUCTION OUTPUT

2.2 UK WORKLOAD SINCE SECOND WORLD WAR

A report carried out by the Institution of Civil Engineers (1987) attempted to produce on a constant price basis, figures of Construction Workload in the United Kingdom since the period from the end of the second world war.[1] However, this apparently straightforward exercise proved to be somewhat more complicated seeing that successive Governments had changed the appropriate indices at least five times during a period of virtually continuous inflation. In real terms £1 spent on construction work in 1986 was worth about 6.5p in 1949. Figure 2.1 shows the annual total of all construction work in the United Kingdom for the period 1950 to 1990 (at 1986 prices).

Figure 2.1 : UK Construction Workload 1950 - 1990



Source : Adapted From The Institution of Civil Engineers - Education and Training Standing Committee Report of the Working Party on "Civil Engineering for the 1990's" - 1987

Following the virtual cessation of construction work except for military purposes, during the second world war, there was a consistently steady rise in construction output until the late 1960's. However, during the last three decades there have been major fluctuations in construction output. Notably, in the mid-1970's there was a major down-turn prior to a partial recovery in the early 1980's which did not meet the value of output attained in 1970. From 1980-1985 a rapid decline in construction output was experienced, in real terms, less than the amount spent around 1960. However, a recovery has since been apparent from 1985 onwards.

An interesting point to note is the fluctuation between the private and public sector output. Rougvie (1987) states that the public sector is a source of great interest in the construction industry due to its historical role as a provider of a large proportion of the industry's workload. [2] Langford and Male (1991) describe the decline in public sector work as one of the starkest trends in construction output stemming from the 1970s. [3] Since the mid-1980's, the introduction of compulsory competitive tendering (CCT) has resulted in an increase in private sector output, whereas public sector work has reduced. This emphasises the effect of the CCT legislation introduced in 1980, which has subsequently been 'tightened' on a number of occasions since.

2.3 THE UNITED KINGDOM'S GROSS DOMESTIC PRODUCT

The United Kingdom's Gross Domestic Product (GDP) can be described as the concept of value of the total economic activity taking place within United Kingdom Territory. The definitive estimate of the GDP recommended by the Central Statistical Office (CSO) for assessing levels of medium/long changes in the economy is the average estimate GDP(A). [4] This is derived from broadly three independent measures, namely:-

1. *the expenditure based measure GDP (E)*
2. *the income based measure GDP (I)*
3. *the output based measure GDP (O)*

GDP is defined as being the 'value added' by industry, that is to say, the excess of the value after values of goods/services purchased from outside the industry (used in production) have been deducted. Construction work, if properly planned and executed, can represent a good investment for the benefit of current and future generations because the assets created are not only desirable, but also of continuing usefulness, for example, dams, sewers, roads, railways and the like. It has been said that the proportion of GDP which a nation devotes to construction and repair of infrastructure is related to the stage that development has reached and the extent to which the present generation is willing to renew and improve for the future on assets which have been inherited from previous generations. [5] Knoepfel (1992) comments that a continuous investment of around 10 - 15% of the gross national product is usual in industrialised countries. [6]

Records of the United Kingdom's GDP and the contribution made to it by the Construction industry for the period 1981-1991 are shown in Table 2.1 at both current prices and 1985 values. In order to highlight the changes over the period 1981-1991, the 1985 value, at 1985 prices, has been taken as 100, and the values for other years have been taken as a proportion of this.

Table 2.1 : Gross Domestic Product (GDP) And Construction's Contribution To (GDP) At Current And 1985 Prices

	GDP (Great Britain)			Contribution to GDP from construction			
Year	Current Prices (£M)	1985 Prices (£M)	1985 = 100 (1985 prices)	Current Prices (£M)	1985 Prices (£M)	1985 = 100 (1985 prices)	Percentage (%)
1981	218 755	274 991	89	13 027	16 376	89	5.96
1982	238 231	279 723	91	14 100	16 556	90	5.92
1983	261 083	289 998	94	15 733	17 475	95	6.03
1984	280 758	295 794	96	17 183	18 103	98	6.12
1985	307 901	307 901	100	18 399	18 399	100	5.98
1986	328 130	319 612	104	20 718	20 180	110	6.31
1987	360 599	334 511	109	24 083	22 341	121	6.68
1988	401 127	349 635	114	28 988	25 267	137	7.23
1989	441 136	359 372	117	32 084	26 137	142	7.27
1990	479 452	356 824	116	35 616	26 507	144	7.43
1991	497 001	349 382	113	33 686	23 681	129	6.78

Source : Adapted From Annual Abstract of Statistics: Central Statistical Office - 1993

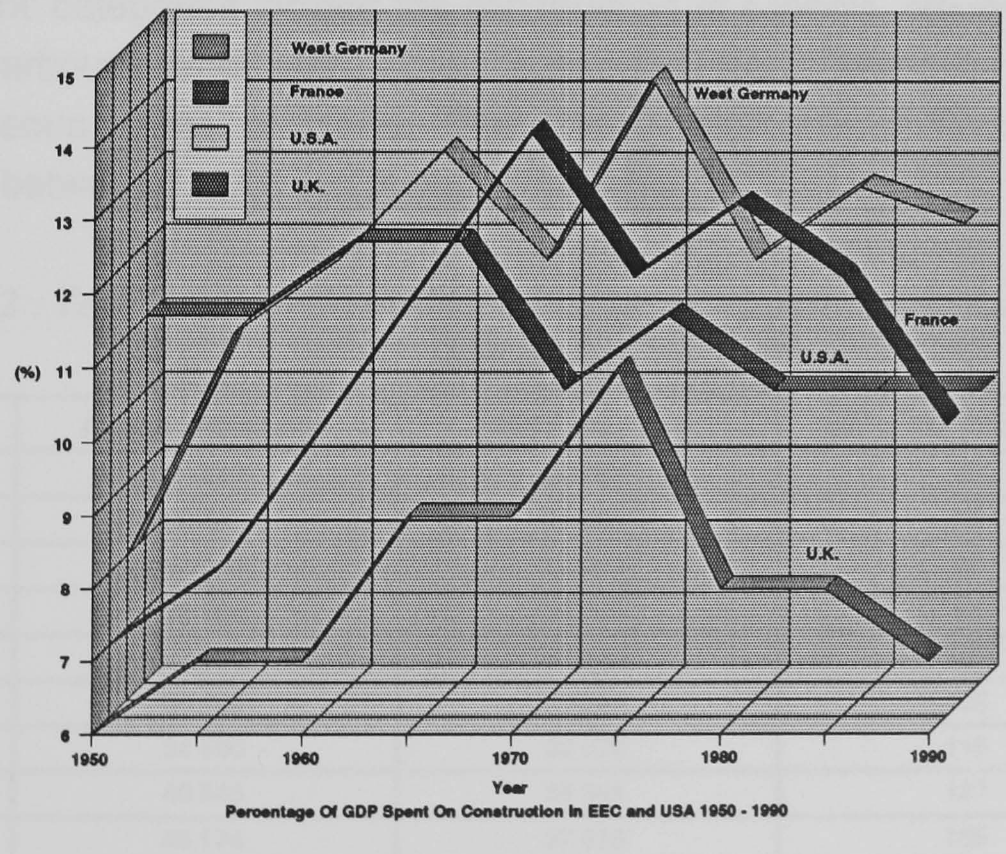
It can be seen that the GDP wavered throughout the period (1981-1991) with the contribution made by construction following a similar trend. Based on the 1985 = 100 figure, the GDP has fluctuated from a low point of 89 in 1981 to a high of 117 in 1989. Similarly, the figures for the construction contribution to GDP has a low of 89 in 1981 and a high of 144 in 1990. In real terms the average increase in GDP annually in the United Kingdom has been approximately 2.2% since 1981.

In contrast, in countries such as America and Japan the annual increase in GDP has been typically around 4.5% (over a 20 year period to 1985). On a European note, France has consistently increased her GDP by approximately 3.5% annually.

The table also shows that the percentage contribution made to GDP by construction ranges from a low of 5.92% in 1982, to a high of 7.43% in 1990, but falling again to around 6.78% in 1991. In real terms, the average annual increase in construction's contribution to GDP is approximately 3.64% (compared with a 2.18% average annual increase in GDP).

The proportion of GDP devoted to Construction in several developed countries for the period 1980-1985 is shown in Figure 2.2.

Figure 2.2 : Percentage of GDP spent on construction in EEC and USA 1950 - 1987



Source : Adapted From The Institution of Civil Engineers - Education Training Standing Committee Report of the Working Party on "Civil Engineers for the 1990's" - 1987.

As can be seen from Figure 2.2 the United Kingdom's contribution to GDP from construction is lower than either that of Germany, France and the United States Of America. It is evident that the construction output in terms of percentage of GDP has risen faster in the USA, Japan, West Germany (now Germany) and France than in the UK over the period. USA is well ahead on its standard of living. Japan, Germany and France are in the next group.

2.4 PUBLIC AND PRIVATE SECTOR CONSTRUCTION WORK IN THE UK

The Central Statistical Offices' Annual Abstract of Statistics provides useful information on the value of construction output in the UK in terms of new work in various categories and also repair and maintenance, from figures provided by the Department of the Environment. [7] For new work the figures are divided into new housing and other new work, for both the private and public sectors. Other new works for the private sector alone, are further split between industrial and commercial categories. Figures for repair and maintenance are divided into housing (not divided between private and public), public other work and private other work. Public works involving 'other work' categories include the construction of schools, offices, factories, roads, harbours and waterways, sewerage and, railways and other miscellaneous areas of works. The Construction output for the United Kingdom between 1981-1991 is shown in Table 2.2.

Table 2.2 : Total Value Of Construction Output In Great Britain At Current And 1985 Prices

Year	Current Prices (£M)	1985 Prices (£M)	1985 = 100 (1985 prices)
1981	21 547	27 087	97
1982	22 540	26 465	95
1983	24 343	27 039	97
1984	26 203	27 606	99
1985	27 850	27 850	100
1986	30 123	29 340	105
1987	34 580	32 078	115
1988	40 546	35 341	127
1989	46 174	37 616	135
1990	48 467	36 071	130
1991	43 709	30 727	110

Source : Adapted from Annual Abstract Of Statistics - 1993

The values shown for construction here are greater than those given for the contribution to GDP arising from construction, since they also include any 'value added' that may have been contributed by an industry other than that of construction.

In real terms the value of construction output remained steady throughout the period 1981-1985, but picked up in 1986 to an amount 8% greater than 1980 in real terms. From 1987, the annual rise for the following three years was 10%, 18% and 8% respectively, although this was met with a 5% decline in 1990 and a further mammoth 20% reduction in 1991. Over the 11 year period the average increase in construction output in real terms has been around only 1.2% per annum.

2.5 BREAKDOWN OF CONSTRUCTION OUTPUT IN THE UK

The value of construction output in the United Kingdom for the period 1981-1991 is shown in more detail in Table 2.3, categorised into various sections of new work and repair and maintenance work, both excluding housing, for both private and public sector works.

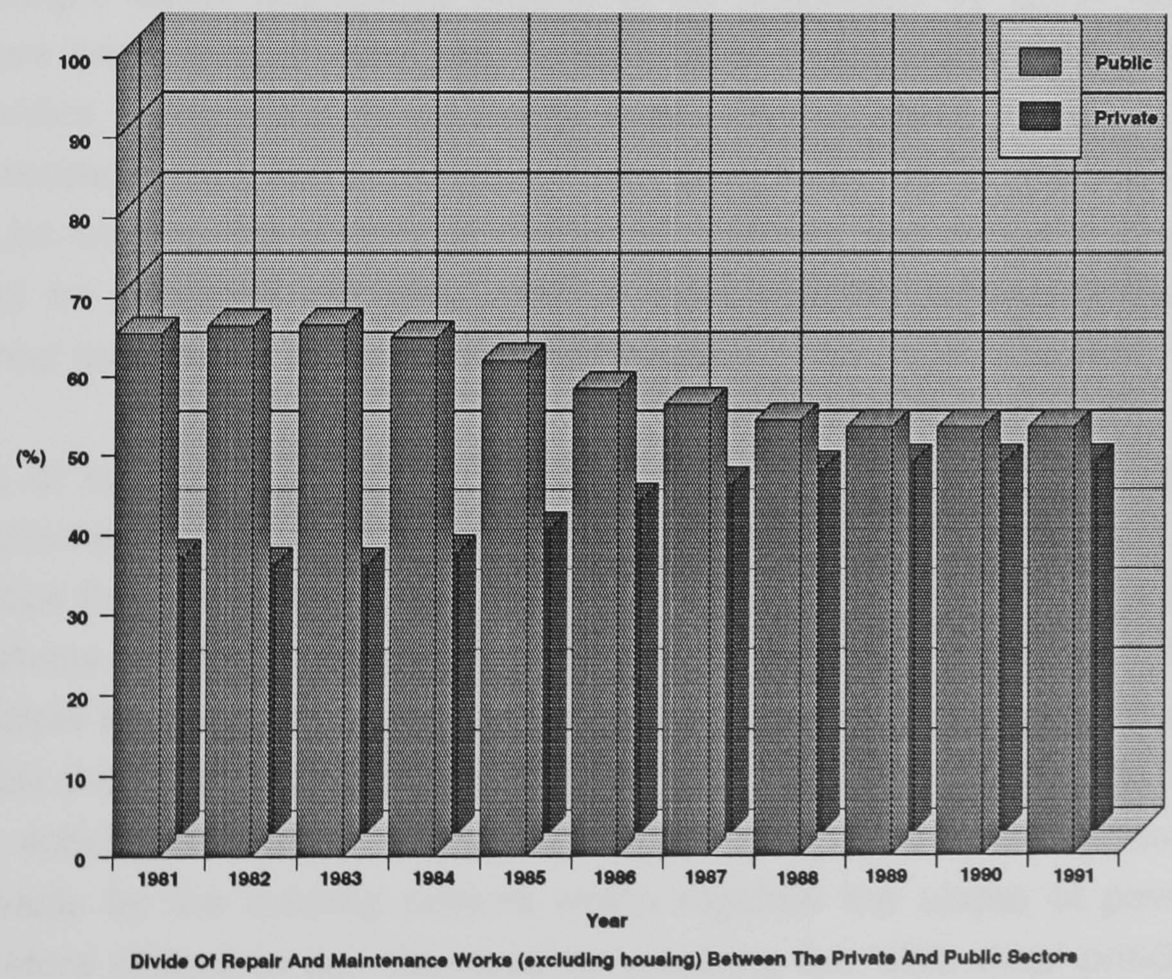
Table 2.3 : Total Value Of Public Construction Output In Great Britain For New Work And Repair And Maintenance 1981-1991 At Current Prices

Year	New work (exc housing) Public Output	New work (exc housing) % of GB	Repair/Maint (exc housing) Public Output	Repair/Maint (exc housing) % of GB	All work (exc housing) Public Output	All work (exc housing) % of GB
1981	£3572 M	41.46%	£3026 M	65.43%	£6598 M	49.83%
1982	£3671 M	42.15%	£3285 M	66.48%	£6956 M	57.44%
1983	£3729 M	43.63%	£3548 M	66.63%	£7277 M	57.59%
1984	£3833 M	41.28%	£3746 M	65.03%	£7579 M	56.89%
1985	£3786 M	37.29%	£3800 M	62.08%	£7586 M	54.98%
1986	£3888 M	36.18%	£3748 M	58.47%	£7636 M	52.80%
1987	£3870 M	31.41%	£4042 M	56.50%	£7912 M	49.75%
1988	£4318 M	28.88%	£4251 M	54.51%	£8659 M	46.41%
1989	£5095 M	26.47%	£4635 M	53.59%	£9730 M	45.30%
1990	£5837 M	27.19%	£5044 M	53.64%	£10 881 M	46.54%
1991	£5772 M	29.89%	£4807 M	53.56%	£10 579 M	37.40%

Source : Adapted from Annual Abstract Of Statistics : Central Statistics Office - 1993

Table 2.3 shows the differences in trends between private and public sector works with the private sector output rising much more markedly in the new work (excluding housing) category than in the public sector. Similarly, in the repair and maintenance (excluding housing) category for public and private other work, in 1982 the public sector (66%) had almost twice the amount of value of such works over the private sector (34%); in 1991 the value of work under this category is split fairly evenly (54% public & 46% private). It should be noted that the repair and maintenance other works category encompasses the majority of works that DLOs carry out in the provision of services, for example, the maintenance of roads. The change in market share of repair and maintenance works (around 25% swing in favour of the private sector), again, show the effects of compulsory competitive tendering legislation introduced in 1980 and significantly tightened since. This change in market share between the two sectors is shown graphically in Figure 2.3.

Figure 2.3 : Divide Of Repair And Maintenance Work (excluding housing) Between The Private And Public Sectors



The construction output in the United Kingdom arises principally from two sources, namely, from Direct Labour Organisations controlled by Local

Authorities and from Private Contractors. Direct Labour Organisations are only engaged in public sector work and have to compete in competition against private contractors. The graph shows the nature of the 'swing' from the public to private sector since the introduction of Compulsory Competitive Tendering Legislation. Public sector output will inevitably fall further still as the legislation is extended into other areas of work and current thresholds are further reduced.

2.6 LOCAL AUTHORITY FUNCTIONS

Local Authorities are creatures of statute. Unlike private sector companies a Local Authority must point to a legal power before it can undertake any activity. Private concerns are, generally, empowered to carry out anything which is not legally prohibited. The failure to act within the powers or abuse of such powers are, according to Bennet and Cirel (1992), "the separate links of ultra vires", the term given to this phenomenon of having to possess express authority to undertake any form of work. [8]

In simple terms two issues require to be addressed by Local Authorities before embarking on any activity by way of municipal trading, without its activities being held to be 'ultra vires'. Firstly, there needs to be an expressed, or implied power to perform an activity, that is, the activity must not be beyond the powers of the Local Authority and secondly, the power must be exercised properly, that is not irrationally without following the correct procedures or for the wrong motives.

It is of interest to note that in times of the single European Market and harmonisation of all different types of legislation and standards across Europe that the system prevalent in continental Europe is the same afforded to private individuals or companies in the UK and the terms of the 'ultra vires' principle do not apply in the strictest sense. Bennet and Cirrel (1992) go on to say that even if the doctrine of 'ultra vires' was abolished in the UK then the activities of Local Authorities would still be adequately controlled, primarily by the existing powers which regulate the abuse of power. It is therefore difficult to see the need for retaining the 'ultra vires' principle and likewise the Local Authorities (Goods and Services) Act 1970 [9], which is discussed later in this Chapter, both of which appear to exercise unnecessary control over the activities of Local Authorities - and to a much greater degree than our neighbours in the rest of Europe.

There are many functions carried out by Local Authorities which can be extremely varied in nature. In Scotland these functions have been split between Regional Councils, Island Councils and District Councils. Similarly, in England functions have been split between Metropolitan County Councils, County Councils and District Councils. The reorganisation of Local Government in Scotland legislated for by the Local Government (Scotland) Act 1973 divided the typical functions provided by Local Authorities in a manner as shown in Table 2.4. [10]

Table 2.4 : Split Of Local Authority Functions In Scotland

REGIONAL COUNCILS	*DISTRICT COUNCILS*
Education	Housing
Social Work	Environmental Health
Water Supply	Refuse Collection And Disposal
Drainage	Street Sweeping
Highways/ Transportation	Leisure & Recreation
Strategic Planning	Parks & Open Spaces
Industrial Development	Libraries
Civil Defence	Museums and Art Galleries
Trading Standards	Burial Ground And Crematoria
Registration Of Births, Deaths, And Marriages	Building Control
Electoral Registration	Local Planning
Valuations	District Courts
Community Charge Registrations And Collection	Licensing
	Tourism

Source : Adapted From Lothian Regional Council Annual Report - 1990

A number of these services previously provided as a matter of right by DLOs are now required to be carried out under compulsory competitive tendering legislation. Prior to looking at details of such legislation, a short history is given in the next section of how one such widely recognised service (the provision of and maintenance of roads) has evolved, to illustrate the development of a typical local authority service through the ages.

2.7 BRIEF HISTORY OF DEVELOPMENT OF ROADS AND MAINTENANCE RESPONSIBILITIES IN THE UK

The Romans are generally given credit for being the first 'real' road builders. The withdrawal of the Roman Legion's from Britain in AD 407 preceded the complete breakdown of the only organised road system in Europe. During the Dark Ages little or no effort was made to preserve the through roads, and these soon fell into disrepair. O'Flaherty (1989) narrates that by the middle of the 16th century road conditions were so bad that in 1555 the Parliament in England was forced to pass an act "for amending the Highways being now very noisome and tedious to travel and dangerous to all passengers and carriages". [11] This was the first Act which provided by Statute for the Maintenance of Highways. The 17th and 18th centuries saw a steady rise in the amount of wheeled vehicular traffic. In the first half of the 18th century formal construction of 250 miles (400Km) of roadway in Scotland by General Wade took place. However, it was not until 1881 that the State accepted financial responsibility for aiding the Highways.

Similarly, after much change in the early 20th century it was not until 1975 when the Local Government (Scotland) Act 1973 [12] came into effect that the platform was provided to implement recommendations, many of which had been made by Lord Wheatley in 1969. [13] One of the most important recommendations made by Lord Wheatley was :

"Effectiveness - Local Government Services should operate on a scale which will allow the provision of high standard services, coherent decision making and adaptable and flexible service provision".

The relationship between Central and Local Government has changed dramatically since the mid 1970's. Acts of Parliament in 1980 and 1988 compelled Local Authorities to invite private companies to tender for works. The service concept has therefore, altered dramatically, in the case of roads and most other direct labour organisation functions and has followed a cycle as follows :

- No provision of a service [up till 1880's]
- Provision of a service [1880's till 1980]
- Provision of a service under competitive conditions [1980 onwards]

2.8 WHY HAVE DIRECT LABOUR ORGANISATIONS ?

In the case of roads, it can be seen that DLOs have existed in some form since 1555 when parishes were required to supply labour and materials for the purposes of maintenance. Other functions within Local Authorities have similarly developed through time as particular service needs have arisen within communities. Other reasons why DLOs have developed are the benefits to the community that can be gained by having the retention of and the ability to train a skilled work force to carry out specific local authority works, the ability to respond rapidly to particular council concerns and emergencies. Also the presence of DLOs serves to provide a marker against which standards of service and costs of contractors in the private sector can be judged.

Public services, however, have often attracted criticism and tend to be vulnerable in view of the fact that all their activities are carried out in the public arena and that in general the public perceives such works as being 'personally' funded through rating or community charge taxation. Such criticism of Local or Central Government is world-wide! For example, Table 2.5 shows details from a report carried out under the sponsorship of the National Aeronautics and Space Association (NASA) in the USA of some of the general public's perceptions of private vs public sector projects : [14]

Table 2.5 : Private vs Public Sector Projects

PRIVATE	*PUBLIC*
Efficient	Inefficient
On Schedule	Behind Schedule
Within Budget	Overrun Of Budget
Well Planned	Poorly Planned
Competitive	Non Competitive
Capable Managers	Non Capable Managers
Good Performance Well Rewarded	Good Performance Not Well Rewarded

Source : Adapted From Murphy D.C., Baker B.N., Fisher D. : Determinants Of Project Success : A Report Carried Out Under The Sponsorship Of NASA - 1988

Despite the comparison made, the successes and achievements of NASA (a public body) are well known. The point to note is, however, that no matter how successful in terms of profitability and meeting legislative requirements a DLO may be, it must also satisfy both the client's and the public's needs to help ensure that the public in general perceive that DLOs offer an effective service.

2.9 EFFECTS OF COMPETITIVE TENDERING LEGISLATION

In 1969, the former Ministry of Housing and Local Government published a manual of principles of financial and management control for Local Authorities for those carrying out work by direct labour. [15] The manual made it clear that the main aim, to which all policy concerned with the operation of a direct labour organisation should be directed, was that on a year by year basis the department should provide a financial saving to the local authority as against having the work carried out by private contractors.

Some 10 years later, the election of the conservative party in 1979 resulted in radical proposals for change in Local Authority systems. Savage and Robins (1990) describe the Government's policy as being one which would implement such legislation in an incremental fashion in order to react to the perception of Local Government as being inefficient, poorly managed, lacking accountability and poor responsiveness to consumer demand. [16]

The aims of the policies, according to Painter (1991), were to cut public expenditure, reduce the size of the public sector and constrain the powers of the trade unions. [17] O'Neill (1991) goes on to state that that the objectives of the policies were to replace the traditional style of the local government system with the lean, hungry, efficient and cost conscious characteristics of the private sector. [18] The core objective of central government in the 1980 Planning And Land Act of Parliament, introducing DLO legislation was to ensure that DLOs were [19] :

" tested in fair and frequent competition with private sector contractors in certain areas of work "

This legislation compelled Local Authorities to undertake a tendering exercise in order to perform construction or maintenance activities with their own workforces and retain the jobs of their own staff. Hence, if DLOs were to win contracts under competitive conditions then public perception of DLOs would be one of a public service, carrying out necessary works whilst providing that service with value for money.

According to Cross (1992), the law relating to Local Authorities has greatly increased in recent years and he cites tendering as being [20] :

" once a simple administrative function which has become the subject of involved legal provisions, set out in statute, statutory instruments, case law and circulars "

The principal legislation upon which the law of compulsory competitive tendering is based is The Local Government Planning And Land Act 1980 [21] for construction and maintenance work and both the Local Government Act 1988 [22] and The Local Government Act 1992 [23] for defined activities. Other legislation which is directly relevant includes The Local Authorities (Goods And Services) Act 1970 [24], Local Government Act 1972 [25], Local Governments Finance Acts 1982 [26] and 1988 [27], The Local Government And Housing Act 1989 [28] and The Environmental Protection Act 1990. [29]

Legislation is, of course, the primary method of statutory authorisation; however, there are also other elements of subordinate legislation which are also applicable. These include Statutory Instruments under both the 1980 and 1988 Acts and circulars from the Department of The Environment. Some 15 Statutory Instruments and 3 circulars from The Department of The Environment are applicable to the 1980 Act and 27 Statutory Instruments and 6 Circulars to the 1988 Act.

The Local Government (Planning and Land Act) 1980 was preceded by a Consultation Paper issued by the Secretary Of State for the Environment in August 1979. The result of the consultation exercise was the passing of the 1980 Act which had the stated objectives of improving the efficiency of Direct Labour Organisations used by Local Authorities to carry out such works and to subject the performance of those Direct Labour Organisations to competition.

Cirel and Bennet (1992) [30] describe the Act as being Central Government's first attempt at competitive tendering legislation and as a result it was never a prime example of good legislative drafting. This is borne out in the judicial disapproval in the Scottish case of *In Re Colas Roads (1991) per Lord Prosser* [31] where the confusing terms contained within the 1980 Act in relation to other CCT legislation were criticised.

The 1980 Act came into effect in England and Wales on 1 April 1981 and Scotland on 1 April 1982 and set out particulars in five main areas which affect the manner in which a DLO can be operated. These are shown in Table 2.6.

Table 2.6 : Five Main Areas Which Affect The Manner In Which A DLO Can Be Operated

	FIVE MAIN AREAS WHICH AFFECT THE MANNER IN WHICH A DLO CAN BE OPERATED
1	Requirements to keep separate accounts for each of the categories of work.
2	Requirements to obtain tenders for work above certain limits in each category.
3	Requirement to obtain tenders for work above certain limits in each category.
4	Requirement on the provision and publication of financial reports.
5	The power of the Secretary Of State to close down DLOs.

Source : Adapted From The Local Government Planning And Land Act - 1980

Before the introduction of the legislation, Local Authorities could carry out any work that they wished to undertake by themselves, without the need for a tendering process to take place. Clearly, the principles of tendering for work and financial accountability were 'new' concepts to the public sector. Financial reports were required to be produced annually along with a prescribed rate of return to be achieved. Furthermore, the Secretary of State was given the power to close down inefficient DLOs.

Table 2.7 shows that the introduction of CCT legislation was directed across a number of traditional Local Authority services including highways, sewerage and other works of new construction.

There have been numerous changes to this legislation since 1980. Table 2.8 indicates the changes in the tender limit threshold values and 'percentage of works less than the threshold value' that can be given to a DLO in Scotland without the need for competitive tendering.

Table 2.7 : Categories Of Work Affected By CCT Legislation

	CATEGORIES OF WORK AFFECTED BY THE LEGISLATION
1	General Highway Works
2	General Water And Sewerage Works
3	Works Of New Construction, other than general highway works or general water and sewerage works, the cost of which is estimated to exceed the prescribed limit.
4	Works of new construction, other than general highway work or general water and sewerage works, the cost of which is estimated at below the prescribed limit required to be subject to 33.33% tendering based on the previous year's turnover.

Source : Adapted From The Local Government Planning And Land Act - 1980

Table 2.8 : Present DLO Thresholds In Scotland (As Of 1/1/94)

PRESENT DLO THRESHOLDS	*1982*	*1984*	*1988*	*1990*
General Highways	£ 100 000	£ 50 000	£ 25 000	£ 25 000
General Water And Sewerage	£ 50 000	£ 50 000	£ 50 000	£ 50 000
Other New Construction	£ 50 000	£ 50 000	£ 50 000	0
Maintenance Work	£ 10 000	£ 10 000	£ 10 000	0

Source : Adapted From The Local Government Planning And Land Act - 1980 and The Local Government(Scotland) Act - 1988

All contracts with an estimated value higher than the threshold figure must be put out to tender. It can be seen how the value of the threshold has been eroded by successive sets of regulations and by inflation. Local Authorities may award a proportion of contracts falling below the threshold value to the in-house DLO.

As the threshold has been reduced so has the proportion of work which may be awarded in-house without competition below the threshold value. Table 2.9 shows the changes which have occurred in this respect. It should be noted that for the small value of projects commonly undertaken by DLOs this part of the legislation has had an extremely significant effect on the operation of many DLOs.

Table 2.9 : Percentage Of Contracts Below Threshold Value Which May Be Awarded Inhouse - Scotland (As Of 1/1/94)

WORK CATEGORY	1982	1984	1988	1990	1991
General Highways	100 %	70 %	70 %	70 %	40 %
General Water & Sewerage	100 %	100 %	100 %	100 %	0
Other New Construction	62 %	40 %	40 %	0	0
Maintenance Work	100 %	40 %*	40 %*	0	0

* OR £ 300 000 (whichever was greater)

Source : Adapted From The Planning And Land Act - 1980 And The Local Government (Scotland) Act - 1988.

The changes in thresholds for Scotland, to complicate issues further, have in general tended to follow and mirror legislation which had been introduced in England and Wales previously. For general highways work the timescales for the changes to the legislation in England are shown in Table 2.10 to illustrate the differences between the implementation of the legislation in England and Wales compared to Scotland.

Table 2.10 : Present Thresholds Of General Highways Work And Percentage Of Contracts Below Threshold Value Which May Be Awarded Inhouse - England (As Of 1/1/94)

GENERAL HIGHWAYS	1981	1982	1983	1987	1988
Present Threshold	£ 100 000	£ 50 000	£ 50 000	£ 25 000	£ 25 000
% Below Threshold Which May Be Awarded Inhouse	100 %	100 %	70 %	70 %	40 %

Source : Adapted From The Planning And Land Act 1980 And The Local Government Act 1988.

Much comment has been written about municipal trading by Bennet and Cirel (1992) and others and whether Local Authorities are able to engage in it, or not. [32] The Local Authorities (Goods and Services) Act 1970 affects DLOs in so much that it dictates the choice of client that a DLO may carry out work for. In the main, it restricts DLOs to operate within their own authority and to work for other public bodies. The other public bodies are in fact very limited markets for DLOs and include such organisations as New Towns and Health Boards.

The Local Government Act 1988 and The Local Government (Scotland) Act 1988 introduced further changes in relation to works which were to be subject to competitive tendering and listed 'defined activities'. Any such activity whose annual expenditure exceeded £100 000 would be subject to the legislation. Defined activities included the collection of refuse, cleaning of buildings, other cleaning, catering for purposes of schools and welfare, other catering maintenance of ground and repair and maintenance of vehicles.

The legislation has changed dramatically since 1980 and clearly DLOs have had to and will continue to have to alter their working practices in order to survive in a competitive environment. Figure 2.4 shows the effect that CCT legislation has had on the amount of work that a DLO can reasonably expect to secure over the period 1982-1993 taking into account the continual changes that have taken place in the legislation over this period. In order to derive this representation a number of straightforward and realistic assumptions have been made as follows :

- That prior to 1982, DLOs had a 100% monopoly of their market area
- That 10 % of projects undertaken are over £100 000
- That 10 % of projects undertaken are between £50 000 and £100 000
- That 20 % of projects undertaken are between £25 000 and £50 000
- That 60 % of projects undertaken are less than £25 000
- That for work subject to competition, a 1 in 3 tender success rate is assumed

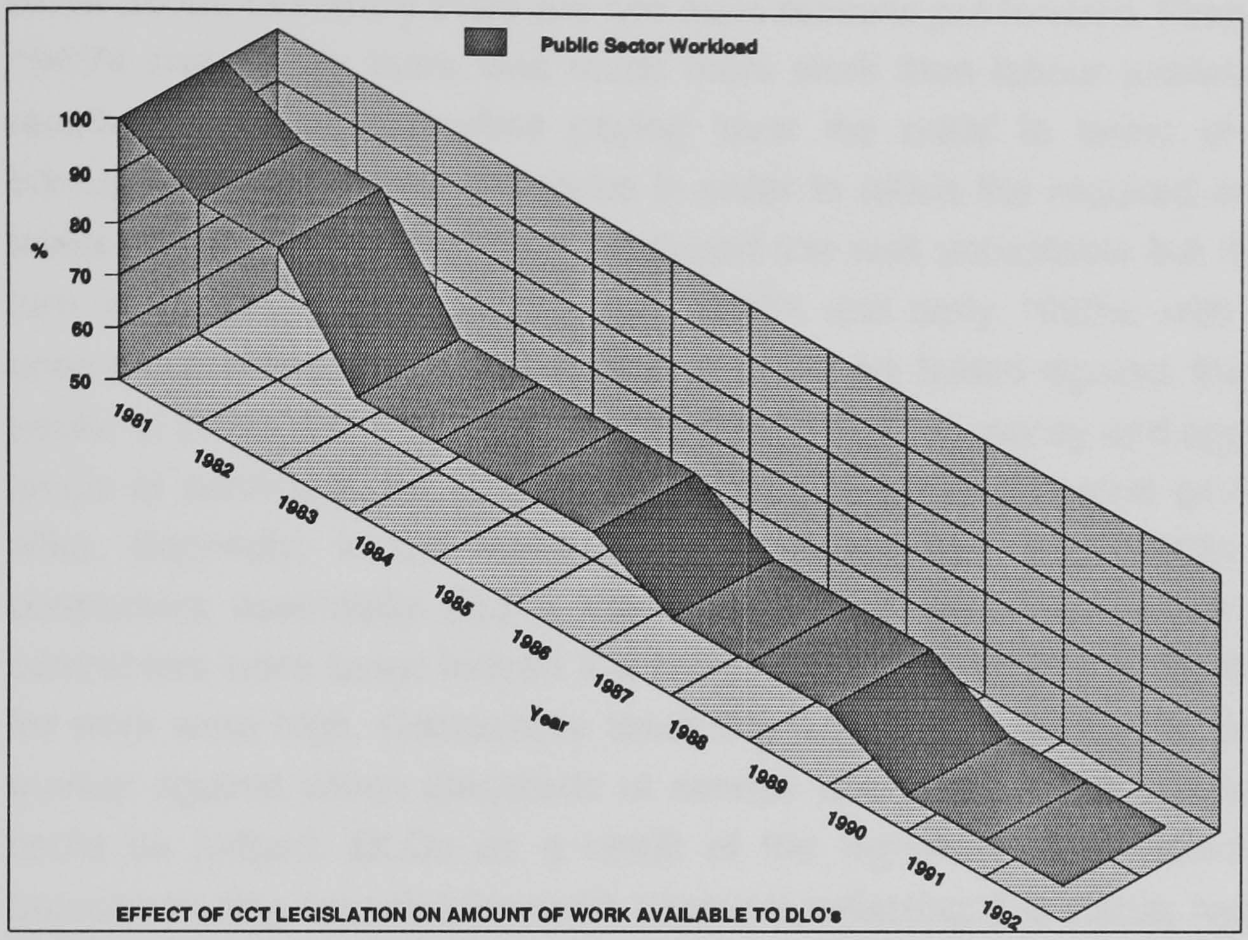
The changes arising from the legislation have clearly had a dramatic effect on the amount of work available to DLOs. Table 2.11 shows these effects, based on the previous assumptions.

Table 2.11 : Effects Of CCT Legislation On Work Available To DLOs

Year	Amount Of Work 'Available'	Amount Of Work 'Lost'
pre 1982	100 %	0%
1982	93 %	7 %
1984	73 %	27 %
1988	65 %	35 %
1991	57 %	43 %

Source : McLellan R. - 'CCT - Roads Maintenance' - ICE Seminar - Feb 1993

Figure 2.4 : Effects Of CCT Legislation On Amount Of Work That A DLO Can Reasonably Expect To Obtain



In 1993, a typical DLO, based on the assumptions made above, would only be able to obtain 57% of its pre-CCT workload. Clearly, with very limited 'outside' markets available to DLOs the majority have had to shed a large proportion of their staff and manual workforces and many have 'externalised' (become privatised), or gone out of existence altogether. This reduction of available work by some 43% can be compared with the apparent 25% swing of work from the public sector to the private sector in the repair and maintenance section of the UK's construction output.

The difference, 43% vs 25% can really only be explained by two factors, namely :

• DLOs are achieving a higher tender success rate than would normally be commercially viable by a private sector enterprise

• DLOs are undertaking extensive work in other market areas, probably contravening the terms of the Goods And Services Act 1970, in order to supplement previously reduced market share.

2.10 DLOs VIEWPOINT ON COMPETITIVE TENDERING LEGISLATION

In the first instance it is worthwhile looking further into why the legislation came about. Generally there are two main reasons put forward. Firstly, in the 1960's and 1970's there was much more work than labour available. This resulted in Local Authorities paying 'over the odds' in terms of wages, bonuses and conditions of service in order to retain the required employee levels. While high employment continued this was acceptable but the down turn in the UK economy in the late 1970's and early 1980's, with rises in unemployment, made it important that DLOs be tested against the private sector to prove that they were still providing value for money and appropriate levels of service to the benefit of the rate payers, and central government alike. Secondly, in the same period in the 1960's and 1970's private contractors essentially had a free hand in the tendering market and all contractors were busy; indeed if a contractor was available at all, the rates for work were high. Competitive tendering was thus necessary to provide a marker against which standards of service and costs in the private sector could be judged. DLOs as a result of the legislation were effectively to become trading organisations with accounts reflecting that status, required to tender for the majority of major work contacts and manage their service accounts based on valuation of the work done rather than actual cost.

However, over and above the need to operate as a trading body in competition with private contractors, DLOs were required to achieve a rate of return on capital employed. The rate of return on capital employed was a requirement for each of the categories of work discussed previously, the actual rate being prescribed by regulations by the Secretary of State based on the rate of return on capital in British Industry as a whole and not just the Construction Industry. Furthermore, if the target rate of return has not been made by the Local Authority, the Secretary of State must be informed within 6 months. Should any DLO fail to meet the target rate of return in any given area of work for three consecutive years the Secretary of State has the power to order that this area of work should be closed down.

DLOs, apart from the trading account legislation imposed by competitive tendering, are also subject to two other areas of control, namely pay and conditions of service and Local Authority standing orders.

The pay and conditions of service for workers employed in DLOs are negotiated and laid down by the National Joint Council for Local Authority Services (manual workers), whereas the pay and conditions of operatives in the private sector are determined by different bodies, for example, the National Joint Council for the Building Industry for builders. The Local Authority negotiating bodies lay down fixed rates of pay and conditions of service and local authorities cannot vary these although they do have powers to negotiate bonus schemes at local level.

In broad terms the conditions of service of DLOs are better and hence more expensive than those of comparable operatives in the private sector. Table 2.12 shows an example of this at 1984 prices. [33]

Table 2.12 : Comparison Of Pay And Conditions Of Service In The Public And Private Sectors

PAY AND CONDITIONS OF SERVICE	PUBLIC SECTOR	PRIVATE SECTOR
Equivalent hourly rate of pay for a mason at standard performance	£ 3.18	£ 3.03
Holiday entitlement after 5 years service (including public holidays)	35 days	29 days
Superannuation contributions by employer (per month)	16.8 %	Not applicable
Sick leave entitlement after 6 years service	6 months full pay + 6 months half pay	£ 294
Overall equivalent cost per productive hour	£ 4.88	£ 3.83
Difference In Unit Cost	*+ 27 %*	

Source : Adapted From State Of The Art Report - Direct Labour : Municipal Engineer, February 1985

It can be seen clearly that the overall difference in employment costs for a typical local authority craftsman was approximately 27% higher than in the private sector. Most DLO operations are highly labour intensive and therefore to 'be competitive' with private sector companies DLOs need to close this differential by better management, higher productivity and by increased motivation of the workforce.

Before the introduction of the trading account legislation most Local Authorities had Standing Orders which were designed to protect them as employers of outside contractors. For example, rules governing the letting of tenders or the acquisition of goods or provision of services were normally contained within the standing orders. Most traditional standing orders were negative in nature in so much that they served to prevent something happening - however, DLOs in many instances required positive standing orders to enable them to do or direct something. Standing orders had to be changed to reflect the trading account rules in so far as they require committees to follow the trading requirements.

Local Authorities are further restricted by the Goods and Services Act 1970 which imposes limitations on DLOs with respect to who they can actually work for; their counterparts in the private sector are not subject to the same. Aspects of the legislation impose rules on Local Authorities on what factors are considered to be acceptable or unacceptable with regard to possible anti-competitive behaviour which may cause distorted competition. Such regulations are quite specific and include rules for such items as making available council depots, packaging of contracts, specifications and the rules relating to the fact that there can be no requirement on contractors to break even or make a profit within individual contracts.

Certain categories of cost may also be taken into account when evaluating tenders. These include potential redundancy costs; additional costs as a result of employing disabled people, apprentices etc; net costs as a result of the cancellation of leasing, maintenance, service or supply contracts; the cost of any losses which would be incurred if a successful contractor did not make use of vehicles available, and costs arising from the immediate payment of frozen holiday pay when staff are made redundant. The regulations state how and to what extent each of these categories may be applied and in general terms they are far from a 'lifeline' to DLOs who may not have submitted the lowest tender for a particular contract.

2.11 PRIVATE CONTRACTOR'S VIEWPOINT ON COMPETITIVE TENDERING LEGISLATION

The Federation of Civil Engineering Contractors stated one year after the introduction of competitive tendering legislation [34] :

" that while a few Counties have made strenuous efforts to increase the efficiency of their DLO's, none sought to test that efficiency through adequate competition with contractors and that even where competition has taken place, it has not always been fair "

In a survey carried out at this time the Federation questioned the profitability, in terms of rate of return on capital employed (ROCE), quoted by many Local Authorities as having been achieved. For example, West Glamorgan cited a ROCE of some 49.5% - this was, however achieved against no competition whatsoever to check costs against the private sector. Furthermore, private contractors expressed concern about the wide variation of interpretation of the term 'capital employed'. Essentially capital employed consists of three elements, namely, land and building, plant and stock. The calculation of ROCE is shown in Figure 2.5. [35]

Figure 2.5 : Calculation of Rate of Return on Capital Employed (ROCE)

RATE OF RETURN ON CAPITAL EMPLOYED (R.O.C.E.)	=	GROSS TRADING INCOME	MINUS	COST OF WAGES MATERIALS OVERHEADS EXPENSES	MINUS	ALLOWANCE FOR ANNUAL DEPRECIATION OF CAPITAL ASSETS AT REPLACEMENT COST	MINUS	ALLOWANCE FOR STOCK DEPRECIATION
		TOTAL CAPITAL EMPLOYED, INCLUDING WORKING CAPITAL, WITH LAND AND OTHER ASSETS VALUED AT CURRENT MARKET VALUE AFTER BEING WRITTEN DOWN TO REFLECT PHYSICAL DEPRECIATION						

Source : Direct Labour Organisations: Implementing the New Legislation - The Institute of Local Government Studies - University of Birmingham

Depending on how Local Authorities interpret the three elements there can be fluctuations in the value of ROCE calculated. Wearne (1989) comments that return on capital employed measures the percentage profit (after depreciation) of a project against its capital cost. [36]

The Federation of Civil Engineering Contractors have also expressed concern at many of the practices being adopted by Local Authorities which they deemed were leading to unfair competition giving advantages to DLOs. Some of the practices considered unfair were in relation to the use of certain contract clauses with respect to apprenticeship levels, health and safety policies, policy approval, performance bonds, union only contract clauses which created 'unfair' competition and occasions where tenders were awarded to DLOs where they were not the lowest tenderer.

Central Government have since tightened up on these aspects through revised legislation and these practices are much less likely to be found.

Section Two of this Chapter, which follows, discusses a case study of a Direct Labour Organisation, namely, Lothian Regional Council's Department Of Highways DLO. This analysis serves to demonstrate how one such public sector organisation has addressed the changes occasioned by the introduction of compulsory competitive tendering legislation in its approach to business in competition with contractors in the private sector.

SECTION TWO : CASE STUDY

WORK OF LOTHIAN REGIONAL COUNCIL'S HIGHWAYS DEPARTMENT DIRECT LABOUR ORGANISATION AND OTHER DIRECT SERVICE ORGANISATIONS

In accordance with legislative requirements Lothian Regional Council operates five DLOs/DSOs. These are the Highways DLO, Water/Drainage DLO, Building Maintenance DLO, Cleaning and Catering DSO and Lothian Fleet Services (Plant and Vehicles Maintenance). In the financial year 1989/90 the work carried out by each of these groups was as shown in Table 2.13. [37]

The Council operates *three* Direct Labour Organisations under the provisions of the Local Government Planning and Land Act, namely the Highways DLO, the Water and Drainage DLO and the Building and Maintenance DLO. Highways and Water DLOs commenced operations under the Act on 1 April 1982 and the Building and Maintenance DLO on 1 April 1989.

Table 2.13 : Work Carried Out By Lothian Region's DLOs/DSOs - 1989/90

DLO CATEGORY	INCOME	EXPENDITURE	PROFIT/LOSS
Highways DLO	£ 18.839 M	£ 17.990 M	£ 849 000
Water And Drainage DLO	£ 2.426 M	£ 2.327 M	£ 99 000
Building Maintenance DLO	£ 1.266 M	£ 1.297 M	- £ 31 000
Catering DSO	£ 512 000	£ 517 000	- £ 5000
Lothian Fleet Services	£ 543 000	£ 563 000	- £ 20 000

Source : Adapted From Lothian Regional Council : Direct Labour Organisation - Annual Report And Accounts : 1989/90

Under the Local Government (Scotland) Act 1988 the council operate *two* DSOs namely the catering and cleansing DLO and Lothian Fleet Services. These and other defined activities in the Act are subject to competition in a phased manner with different pre-determined starting dates for each function for each authority. The catering and cleansing DSO commenced operations on 1 April 1989 and Lothian Fleet Services on 1 January 1990.

The Highways DLO (INROADS) is by far the largest of the Council's DLOs/ DSOs. Table 2.14 shows the output of the Highways DLO over the period 1982- 1992. [38, 39, 40, 41, 42, 43, 44, 45, 46 & 47]

Table 2.14 : Details Of Lothian Region Highways DLO (INROADS) Output 1982 - 1992

YEAR	TURNOVER	SURPLUS	CAPITAL EMPLOYED	R.O.C.E	STAFF manual	STAFF salaried
1982/83	£ 14.426 M	£ 306 213	£ 3.984 M	7.69 %	686	118
1983/84	£ 13.588 M	£ 445 337	£ 4.043 M	11.02 %	644	107
1984/85	£ 13.833 M	£ 341 178	£4.644 M	7.00 %	619	108
1985/86	£ 14.789 M	£ 296 535	£ 5.802 M	5.1 %	586	106
1986/87	£ 15.593 M	£ 706 573	£ 5.611 M	12.6 %	579	105
1987/88	£ 18.062 M	£ 586 589	£ 5.906 M	9.9 %	584	97
1988/89	£ 18.417 M	£ 860 313	£ 5.591 M	15.4 %	527	99
1989/90	£ 18.839 M	£ 1 026 644	£ 5.544 M	18.5 %	492	97
1990/91	£ 20.331 M	£ - 117 169	£ 5.403 M	8.8 %	473	96
1991/92	£ 19.984 M	£ 122 808	£ 5.035 M	10.0 %	463	86

Source : Adapted From Lothian Regional Council : Direct Labour Organisation - Annual Reports And Accounts : 1982 - 1992

The accounts for the Regional Council's Direct Labour/Service organisations are prepared in accordance with the 1980/1988 Acts.

As can be seen from Table 2.14 INROADS have had to adapt to the competitive tendering legislation imposed between 1982-90. In this period a rationalisation of both salaried and manual staff has resulted in a *decrease* in numbers of both by 18% and 28% respectively. This has been achieved in contrast to an *increase* in turnover of some 31% during the same period. Capital employed has also risen by some 39% between 1982-90, reflecting in the case of the INROADS, a large investment in new plant and new technology, keeping stock levels at a minimum and reducing land/buildings/ depots throughout the period. The Return on Capital Employed (ROCE) has been in excess of that required by the legislation throughout.

Pre-Thatcher, INROADS, (or as it was known at that time, the Direct Labour Organisation of the Lothian Regional Council Highways Department) has been described by the present managers in retrospect, in a manner similar to Bichard (1990), as a stereotypical local government department, in that it was inflexible, status ridden, bureaucratic, monopolistic, defensive and wasteful. [48] There was also the attitude from all levels of the organisation that the future would always be there, since it was never considered that the organisation would be exposed to competition. There were little formal objectives other than to provide a pool of labour for weather emergency purposes and to provide a range of other services to the public at large. There were few incentives to be profitable or to do the job as quickly or efficiently as possible. In fact, the organisation was paid on a cost plus basis, whereby, the longer it took to complete a piece of work, the more revenue they received. This is still true to this day in some areas of work undertaken by DLOs which are exempt from CCT legislation - however, the attitude to undertaking this type of work is now similar to that for contract works.

The initial piece of legislation affecting INROADS position in the market was the Local Government Planning and Land Act 1980. From 1 April 1992 INROADS were required to achieve a rate of return on capital employed and the 1980 Act also gave the Secretary of State the power to close down any DLOs which do not achieve this rate. More significantly, however, was that highway maintenance and construction contracts with an estimated value above £100,000 were to be put out to tender, effectively breaking the monopoly of work previously given to DLOs 'as a matter of right'.

To remain static was not an option for any DLO faced with competition from the private sector. As Belasco (1990) states, it was a case of [49] :

" change or die "

The required change was not simply an improvement on current methods, but a transformational and revolutionary change.

In the early days, the management team saw the 1980 Act as a threat to their security, and had proposed to simply reduce future investment in the already antiquated and dilapidated plant and machinery, in order to attain the required rate of return laid down by the secretary of state. During this time and until 1984, the effects of the legislation had been relatively limited with no real need for action. That year, however, saw the appointment of a new Assistant Director and the lowering of the threshold limit at which contracts were required to be put out to tender (from £100,000 to £50,000). He dismissed the fears of the old management, and perceived the Act as an opportunity which Inroads could capitalise upon.

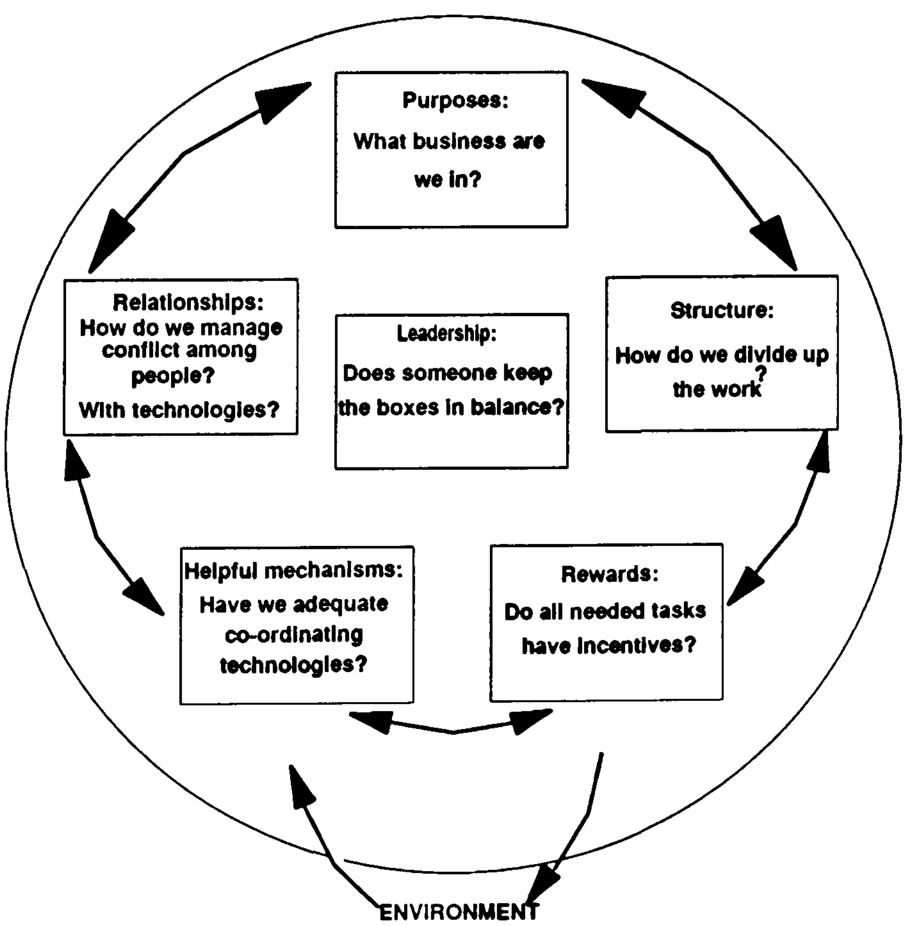
The management team identified that the organisation's present approach to the business could not continue in the increasingly competitive market, and estimated the closure of Inroads in 3 years should the system persist. The previous management team was changed by replacing some of the more entrenched managers with younger and fresher minds. A new post was also created in the Commercial Manager with responsibility to install commercial awareness into the operations of INROADS and monitor cash flows and contract costs. It was this new management team of 15 managers, which prepared to transform the old DLO into what they now perceive as a highly competitive, civil engineering contracting firm.

The initial problem facing the management team was the way in which to tackle the necessity of change. The first stage of the analysis took the form of a series of detailed questionnaires which sought to identify problems and hindrances in the workplace. These were completed simultaneously by teams of 2-3 people of management status. The total number of people who were involved at this stage was approximately 40, of which all were of supervisory or management status. Manual employee participation was never considered; however, the management team recognised in hindsight that such participation could have improved the quality of the action plans and the implementation could have been smoother, quicker and more deep rooted. The responses of the questionnaires were analyzed and the results fed back to the senior management team.

Taking these on board, the management team participated in intense, offsite workshop sessions, chaired by an industrial psychologist. The purpose of these sessions was to diagnose further problems and create action plans for the change. Techniques such as brainstorming were used to identify further problems, solutions, and objectives.

The management team used Weisbord's six box model as a framework for analysing the organisation (Figure 2.6). [50]

Figure 2.6 : Weisbord's six-box model



Weisbord's Six-Box Organisational Model

This required diagnosing the formal and informal aspects of the organisation taking the following into account : purpose, structure, rewards, helpful mechanisms, relationships and leadership.

Weisbord argued that the larger the gap between the formal and informal aspects of an organisation, the more inefficiently it was operating. INROADS found the gap to be substantially large. One of the aims of the change therefore was to reduce the 'grapevine' and maintain more formal communication wherever possible.

Due to the nature of the change which was required by INROADS, they specifically attempted not to limit the analysis to a few 'familiar alternatives' as Lindblom suggests. [51] The analysis was limited in that the cognitive limits of the managers prevented all possible courses of action and their outcomes from being identified. It may also be argued that the managers were restricted by time (both to get the plans into practice as quickly as possible and to maintain present operations of the organisation), thus preventing the manager devoting all his time towards the change process and costs.

The end result was a 2 year programme of 70 action plans, each with individual deadlines. In selecting the use of action plans to bring about the change, it may be argued, that the managers, to some extent, sought to enforce a structure on the implementation phase. This, they felt, would give them some form of control over implementation. The method may be described as being structured in that each action plan detailed what was to be implemented, when it was to be completed, and who was responsible for its implementation. The action plans could be categorised into four broad areas. However, due to the nature of the change, they tended to be inter-related :

- Marketing
- Human Resources
- Communication
- Commercial Awareness

Of the 70 action plans which were set out, most were completed to a satisfactory level; however some were never achieved. The progress of change was reviewed by regular management meetings where each manager was required to present a report on the progress of each of the action plans he was responsible for. Beer (1980) suggests that for an action plan to achieve success, an enormous amount of activity must follow, requiring much of managers time and energy [52]. This however was almost impossible for INROADS management team who were required to maintain their usual duties and responsibilities as their priority, with the change duties coming a poor second.

The progress made by the action plans was evaluated in the next major development encountered by INROADS. Having adopted a business philosophy in their operations, INROADS felt the need to give impetus to their future direction in the form of a strategic plan. The business plan was compiled by the management team in a number of intensive offsite workshop sessions. The management team participated in what could be described as 'vociferous yet fruitful discussions' regarding a number of issues.

Their first concern was to conduct a SWOT Analysis of INROADS. The SWOT analysis enabled the management team to define their situation and identify strategic business units which existed. They also tried to propose possible courses of action for Inroads as a whole and for the strategic business units individually.

As a result of the business plan exercise, INROADS underwent a facelift. Until 1989, the organisation had remained under the DLO name. However, there had been a number of articles in the local newspapers claiming that many of the DLOs were losing money and some may be forced to reduce their workforce. Anxiety and fear grew within the workforce of INROADS, despite the fact that the organisation was remaining profitable. The tension within the workforce prompted the management to create a new name and corporate identify. Thus the name INROADS was adopted, and a new corporate logo was designed, which is now used on all correspondence and emblazoned on most plant and machinery. By doing so, the management team were attempting to move away from the image of a bureaucratic and inefficient DLO, to that of an efficient and complete contracting firm. It may be argued that in changing the corporate image (due to the pressures of the external environment), demonstrates that the organisation existed in an open environment and changes or developments in the environment would thus cause repercussions in the organisation.

The business plan put forward a five year strategy for INROADS. However, the management team were fully aware that annual updates would be necessary in order to maintain its applicability.

Peters and Waterman's (1982) 'In Search of Excellence' [53] was a key piece of literature which influenced the manner adopted by INROADS throughout the 'change' process. The eight characteristics of excellence put forward provided the managers with frames of reference which could then be built on. These were :

- A bias for action
- Close to the customer
- Autonomy and entrepreneurship
- Productivity through people
- Hands on, value driven
- Stick to the knitting
- Simple form, lean staff
- Simultaneous loose - tight properties

It was found however that, due to the time and cost pressures enforced on the managers, the search for possible courses of action and the formulation of the action plans tended to merge in with the analysis stage.

The Case Study has shown that in order to survive and succeed in the competitive environment INROADS had to make significant changes to their organisational set-up since 1982. INROADS has examined its operations through Action Plans and the formulation of a Business Plan which have provided the platform to help build commercial awareness and to help motivate staff and manual workers. The broad strategy which emerged comprised of the establishment of a Mission Statement for the DLO, revised approaches to improve communications, working relationships and commercial, business financial control and image consciousness.

Some of the key factors that INROADS adopted in managing the change process are shown in Table 2.15.

Table 2.15 : INROADS Approach To 'Change'

DESCRIPTION	*DETAILS*
MISSION STATEMENT	We are a civil engineering contractor committed to quality products and services, customer satisfaction, value for money and progressive employee practices
CUSTOMER PHILOSOPHY	• provide customers with a high standard of service through the integrity of relationships and quality of product • enhancement and maintenance of customer satisfaction and trust
MANAGEMENT PHILOSOPHY	• effective leadership, motivation and communication • setting standards and objectives • achieve and reward efficient and effective resource utilisation • achieve good relations between all employees, customers and the community • inform people and train them in their role in the process • promotion of principles of commercial awareness • importance of good client relationships
FINANCIAL PHILOSOPHY	• to achieve and maintain the required rate of return on capital employed
IMAGE PHILOSOPHY	• intentionally maintain a high profile supported by clean, tidy sites • quality products and services delivered timeously
OPERATIONAL PHILOSOPHY	• to adopt a project management approach to the management of projects to provide the best foundation to survive and flourish in the CCT environment

The work subsequently led to investigating the implementation of project management planning and control procedures, the formulation of a quality management system within INROADS, investigating the possibilities of organisational restructuring to improve the efficiency and effectiveness, along with the assessment of training requirements of manual and supervisory staff.

2.12 APPLICATION OF CHAPTER TWO

The main theme of this chapter has been to review the changes in private and public sector construction output, arising from the introduction of compulsory competitive tendering (CCT) legislation. Essentially, this has resulted in public sector construction contractors, who previously carried out the majority of their works 'as a matter of right', now having to compete with the private sector. Both sectors of the industry (private and public) are considered in the light that they form the later study sample. (see chapter nine).

A main objective of the chapter has been to consider the relative 'operating' environments in which private and public sector construction contractors compete with each other. This helps understanding how both the private and public sectors go about their business.

Future chapters will build upon the framework of this overview of the private and public sector construction industry by looking at a variety of project management procedures which might be utilised to help project managers 'bring in' their projects to the required standards.

A case study of how Lothian Regional Council's Highways Department Direct Labour Organisation (INROADS) has managed change since CCT was introduced and served to illustrate how one public sector construction contractor has adapted since the early 1980s. In essence, A belief put forward by Nackasha (1990) concisely describes the aims of how Direct Labour Organisations must view the provision of their services [54] :

" the key to success in a global and turbulent environment business environment is to perform locally with a global vision "

The main application of this chapter has been to explain from a broad viewpoint how both the private and public sectors consider construction projects, so that in future empirical chapters, an understanding of the use of various project management procedures can be related to the particular type of organisation under consideration, namely private or public. This is particularly relevant, bearing in mind that a major element of the empirical chapters (chapters ten and eleven), is to compare and contrast the extent of use and application of a number of project management procedures between private and public sector construction contractors.

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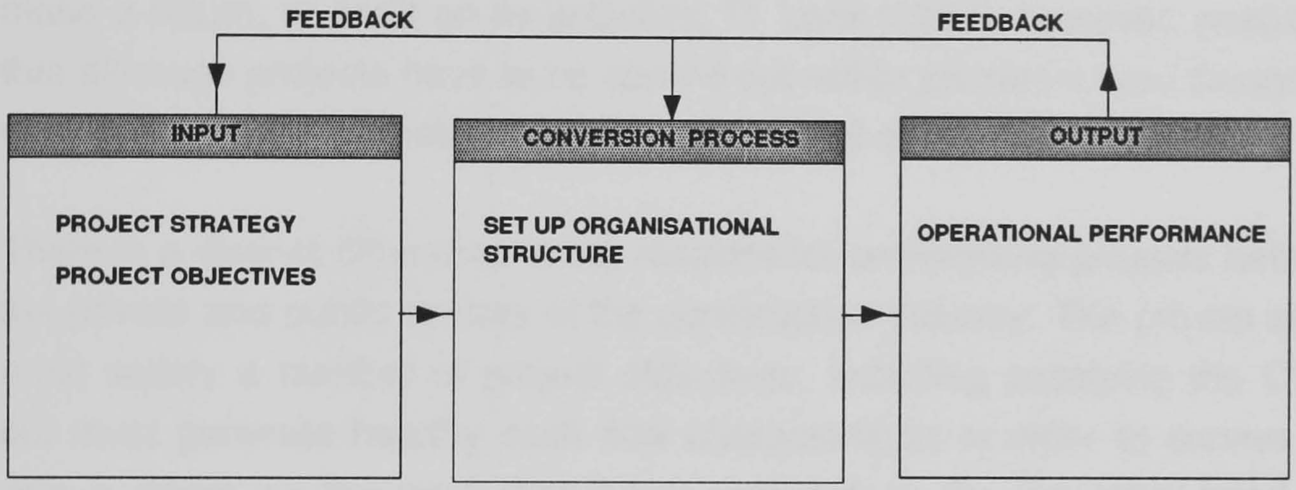
CHAPTER THREE : ORGANISATION PROFILE

3.1 SUMMARY OF CHAPTER THREE

The sub-system model for organisation profile, previously put forward in Chapter One (Figure 1.5), along with its defined 'primary task' is shown again for reasons of clarity.

Organisation Profile Sub-System



Primary Task

' To set-up the most appropriate organisational form, or structure, for operational performance '

The Chapter begins by looking into the reasons why construction contractor organisations undertake projects. This is followed by a brief analysis of the strategic considerations, including looking at different approaches to strategy and strategic behavioural types, that have to be taken into account in the overall management approach to projects.

Various types of cultures which may exist within organisations, including task and role cultures are also looked at in an attempt to identify typical classes of culture akin to private and public sector construction contractors.

The chapter concludes by looking at the organisational environment of projects and several of the more common types of organisational structures including functional, project and matrix forms.

3.2 REASONS FOR UNDERTAKING PROJECTS

Barrett (1993) states that the principal reason for private practice firms being in existence is to generate a profit. [1] Likewise, Wearne (1989) comments that the major consideration in a commercial environment for a construction contractor is the resultant profitability. [2] A different consideration put forward by Newcombe, Langford and Fellows (1990) describes the primary task, or objective, of a construction organisation as being able to obtain and execute construction projects to the client's satisfaction whilst meeting stakeholder's objectives, which also emphasises the overall need for an organisation to make a return, or profit on its activities. [3] Lock (1987), however, postulates that although projects have to be carried out within predetermined timescales with defined performance criteria they are not all carried out for profit. [4]

There is a distinct difference in the reasons for undertaking projects between the private and public sectors of the construction industry. The private sector must satisfy a number of project objectives, including satisfying the Client, but must generate healthy cash flow characteristics in order to survive and give a return on the work that it has undertaken. On the other hand, the public sector are still looked upon by the general public as providing some kind of service, be it the provision of new drainage facilities, maintenance of roads or other activities. Local Authorities are required to make a rate of return on a large percentage of the works that they undertake. However, they do not, as a rule have to worry about maintaining a healthy cash flow and any profits, or surplus generated is normally 'fed' into the Council's overall financial accounts and redistributed as best needed and not reinvested in either the people, equipment or buildings of the service sector which may have generated the profit.

3.3 STRATEGIC MANAGEMENT

Newcombe, Langford and Fellows (1990) describe the strategic element within an overall construction organisation system as being that which determines the long term direction of the organisation. [5] Barrett (1993), in a similar fashion comments that the key facet of strategic management is the quest for major decisions that affect the whole of the organisation and its long term relationship with the business environment. [6] Perhaps, more concisely, Langford and Male (1991) describe strategy as being the *means* to meet *ends*, that is concerned with achieving objectives. [7]

Strategic management is therefore concerned with managers making decisions about a company's future direction. There are, of course, a number of levels within an organisation where decisions made will affect company strategy. For example, Newcombe, Langford and Fellows (1990) classify three levels, namely, corporate, business and operational or project strategies. [8] At the corporate level decisions about the organisation as a whole will be made. Business strategy will involve looking into how an organisation should operate in a particular market and operational or project strategies will be concerned with aspects of individual projects which may have an effect on the organisation as a whole.

Clearly, strategic decisions are made by many people within organisations and not just necessarily by the Board Of Directors, as is commonly misconceived in the industry. The strategist(s) role within an organisation, as put forward by Langford and Male (1991) is shown in Table 3.1.

Table 3.1 : The Role Of The Strategist

	ROLE OF STRATEGIST
1.	Monitor, analyse and diagnose the environment in order to anticipate opportunities and threats
2.	Assess the degree of risk associated with any opportunities in the environment
3.	Assess the firm's strengths and weaknesses
4.	Match the opportunities available in the environment with the firm's strengths whilst minimising the weaknesses against possible threats
5.	Develop strategies, decide amongst alternatives and allocate resources to enable selected strategies to be undertaken
6.	Monitor results and take corrective action via feedback

Source : Adapted From Langford D. And Male S. : Strategic Management In Construction - 1991

Strategic management is one of the most important considerations for the effective initiation of plans in order to subsequently seek to attain determined objectives. Cleland and King (1988) have stated [9] :

" strategic management is concerned with the design of the organisational mission, objectives and goals and the implementation strategy whereby enterprise purposes are attained "

This quotation shows the importance of strategic management in relation to an organisation's mission statement, which is always the pinnacle of a company's business planning strategy and normally contained within the company business plan.

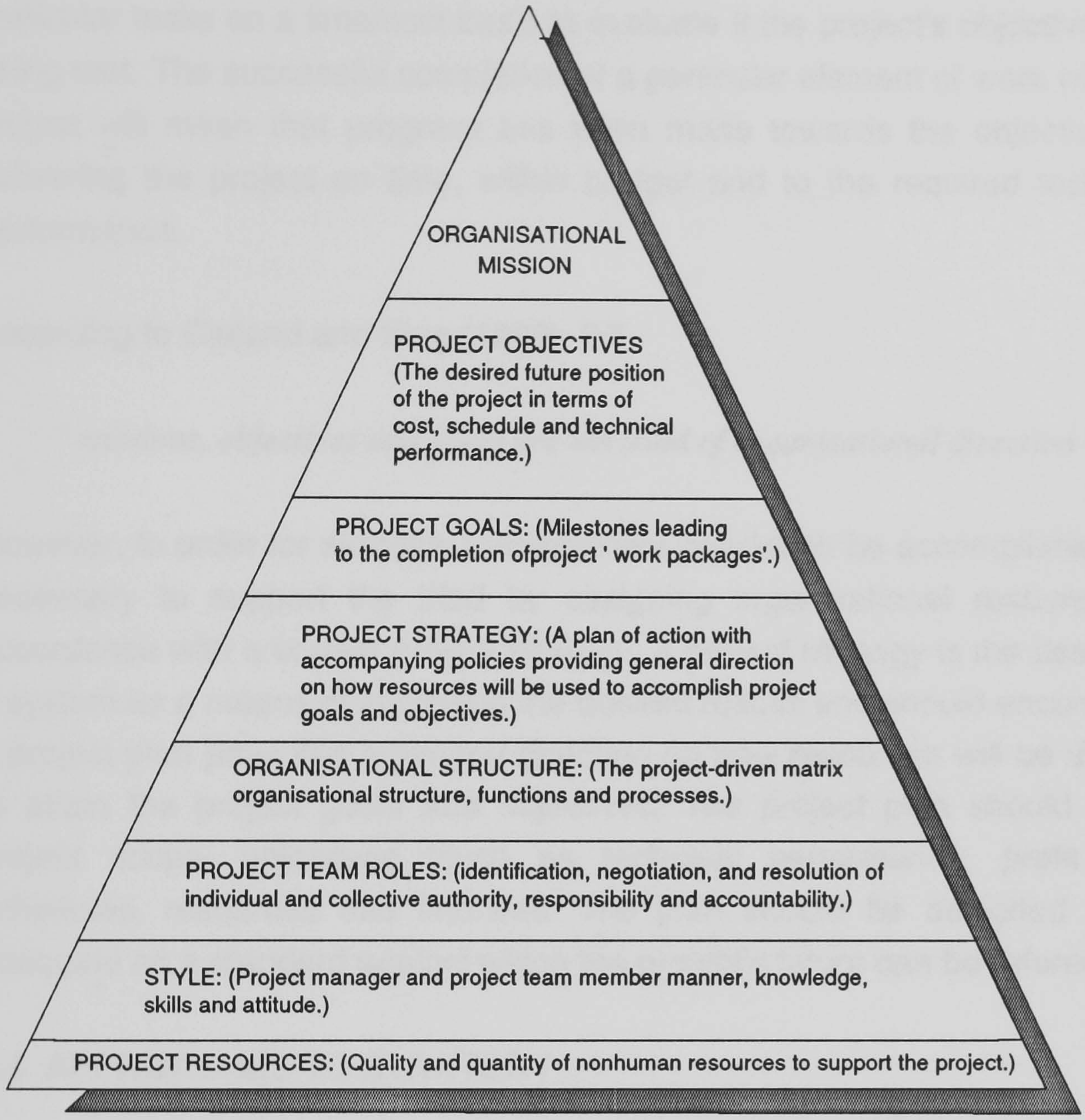
The nature of strategy integrates organisational policies, procedures, programmes and projects in to a balanced view of the short and long term purposes of an organisation. It also relates the organisation's sense of direction in terms of identity, character and purpose expounded in mission, objectives and goals. Tripp (1987) discusses the combined activities of the strategic planning, finance and project management functions in evaluating and developing project plans. [10]

Projects play an important role as the foundation of attaining organisational purposes. A project is usually a group of inter-related tasks to be performed and should have well defined objectives and goals. If a project fails to meet its time and cost schedules or its performance criteria then the implementation of an organisational strategy will have been impaired. Kerzner and Cleland (1985) have stated that [11] :

> *" effective strategic management means that organisational missions, objectives, goals and strategies have been defined; an organisational design has been selected; and functional supporting plans, policies, systems and procedures have been developed in response to changing environmental conditions and enterprise resources "*

and they depict a model of an effective approach to strategic management which is shown in Figure 3.1. Each of the layers in the triangle can be described in the following manner.

Figure 3.1 : An approach to strategic management



Source : Kerzner H. And Cleland D.I. : Project/Matrix Management Policy And Strategy - 1985

The organisation's *mission* is basically a statement which describes the businesses that the organisation is involved with. The mission of an organisation should provide the impetus to design suitable implementation strategies. Furthermore, the mission should be clearly articulated and allow action to be taken based on it.

Project *objectives* are the end result of managing the financial, schedule and technical performance of each task within a project in accordance with the project plan. The accomplishment of the project objectives contributes directly to the mission of the organisation.

Project *goals* have to be established in order that during the management of a project the measurement of specific elements of work carried out on particular tasks on a time/cost basis to evaluate if the project's objectives are being met. The successful completion of a particular element of work within a project will mean that progress has been made towards the objectives of delivering the project on time, within budget and to the required technical performance.

According to Cleland and King (1988) [12]

" missions, objectives and goals are the triad of organisational direction "

However, in order for strategic management policies to be accomplished it is necessary to support the triad by assigning organisational resources in accordance with a correct project strategy. A project strategy is the design of a system as a means of achieving the desired results and should encompass a project plan providing a general direction on how resources will be utilised to attain the project goals and objectives. The project plan should cover project scope, objectives (such as technical performance, profit etc), schedules, resources and finances. The plan should be designed to be adequate as a standard against which the project's future can be referenced.

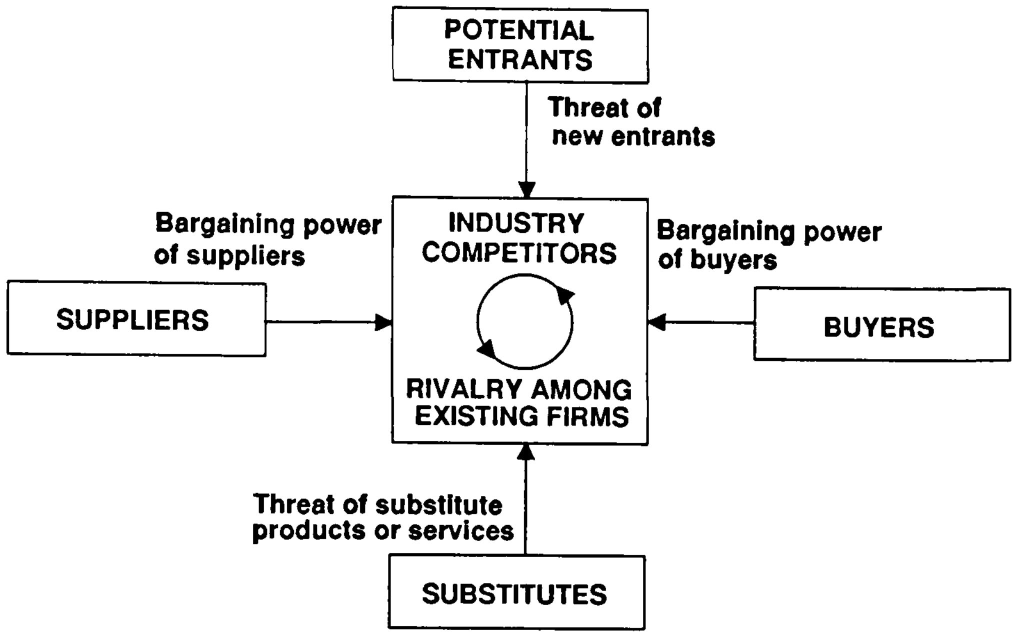
3.4 APPROACHES TO STRATEGY

Porter (1980) put forward a model which could be used to examine the competitive environment of an organisation. [13] His belief was that the primary purpose of a firm being in business is to obtain and sustain a *competitive advantage* over other firms in the industry. Porter's model is shown in Figure 3.2.

The basis of competition within the model is by means of three generic strategies, namely, cost leadership, differentiation and focus.

The *cost leadership* style places emphasis on the cost control processes within the organisation. The *differentiation* style is appropriate where firms can offer uniqueness from its potential competitors. The *focus* style is where an organisation concentrates on a particular niche market, in many instances, a smaller specialist group of its overall workload.

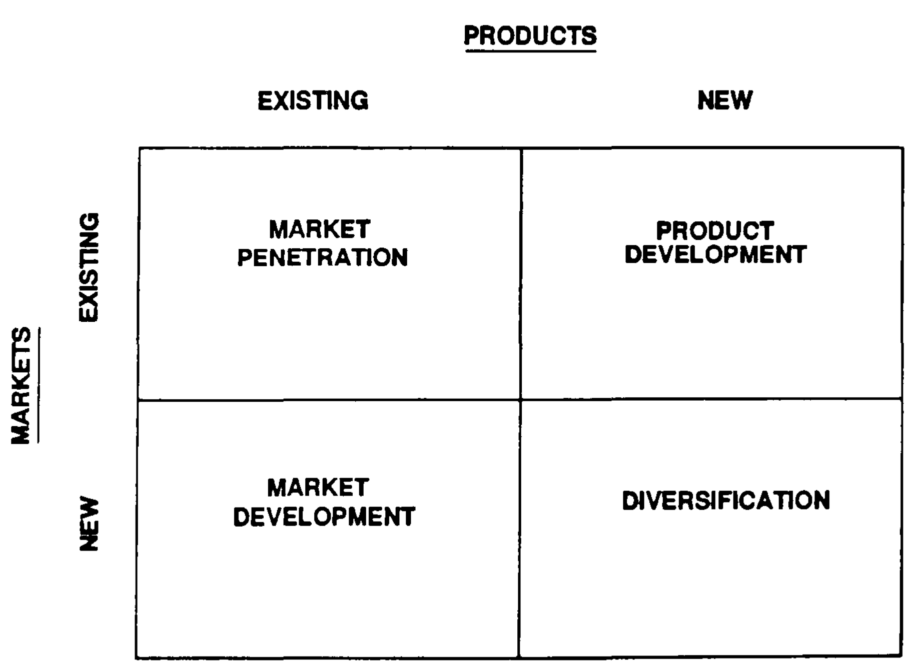
Figure 3.2 : Porter's Model For Structural Analysis Of An Organisation



Source : Adapted From Porter M.E. : Competitive Strategy - 1980

Porter's approach to strategy is only one of the schools of thought available. Ansoff (1965) put forward four '*growth vectors*', namely market penetration, market development, product(or service) development and diversification as a strategic model for organisations. [14] These four vectors deal with a firm's existing markets and give a means of assessing direction into new market areas. Ansoff's model is depicted in Figure 3.3.

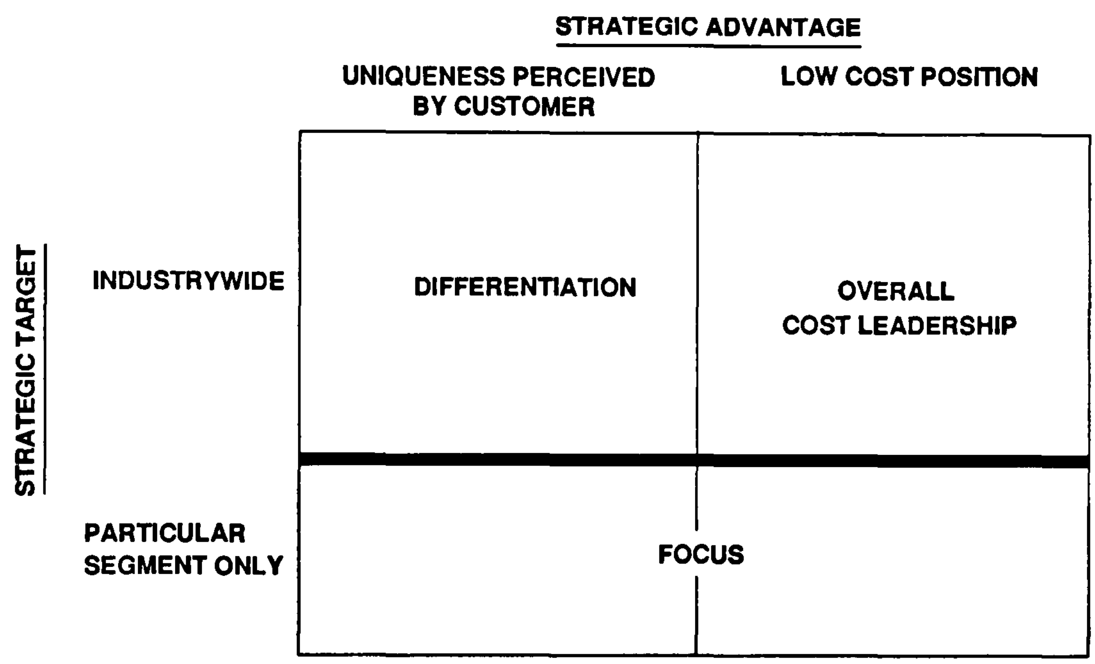
Figure 3.3 : Ansoff's 'Growth Vector' Strategy



Source : Adapted From Ansoff I. : Corporate Strategy - 1965

A third different approach to strategy is the *strategy-structure* concept as originated by Chandler (1966). [15] He defined strategy in terms of the degree of diversification and geographic expansion adopted by the business. Channon (1978) built upon and refined Chandler's work and classified an organisation's strategy into three major dimensions, namely, diversification, international activity and acquisition. [16]

Figure 3.4 : Channon's Classification Of Organisational Strategy



Source : Adapted From Channon D.F. : The Service Industries - Strategy, Structure And Financial Performance - 1978

Diversification strategy can be sub-divided into two - the dominant business strategy and the alternative, related business strategy. As the names would suggest, the former involves an organisation staying predominantly within a single market, but perhaps adding a few additional activities. The latter is where an organisation's workload consists of a number of activities which give a balanced overall business perspective.

International business is normally undertaken for one of two reasons, or a combination of both, these being to increase growth or to offset fluctuations within the organisation's home market.

Acquisition, as a means of growth is strongly related to the type and rate of acquisitions undertaken by an organisation. It may be 'aggressive' in the open market or simply a strategy of internal development by expansion and diversification.

3.4.1 Strategic Behaviour

Langford and Male (1991) discuss three varying typologies of strategic behaviour put forward by Miles and Snow (1978) [17], Mintzberg (1979) [18] and Ansoff (1987) [19] which they believe are of use in describing the strategic behaviour of the variety of organisations prevalent in the construction industry. These are shown in Table 3.2.

Table 3.2 : Strategic Behaviour Typologies

	STRATEGIC BEHAVIOUR TYPOLOGIES (Newcombe, Langford and Fellows, 1991)
Miles & Snow (1978)	*Defenders* : concerned with stability and efficiency *Prospectors* : flexibility and exploitation of new market and product opportunities *Analysers* : combines aspects of defenders/prospectors seeking to minimise risk while attempting to maximise the opportunity for profit *Reactors* : inconsistent and unstable behavioural strategy
Mintzberg (1979)	*Simple structure* : direct supervision is its prime coordinating mechanism *Machine bureaucracy* : standardisation of work processes is the prime coordinating mechanism *Adhocracy* : mutual adjustment through interpersonal interaction is the prime coordinating mechanism *Divisional structure* : standardisation of outputs is the prime coordinating mechanism
Ansoff (1987)	*Proactive systematic mode* : strategic thinking and decision making is explicit *Proactive ad hoc mode* : strategic thinking and decision making is implicit *Reactive mode* : Emphasis is on minimisation of strategic changes

Source : Adapted From Langford D. And Male S. : Strategic Management In Construction - 1991

Local Authority organisations can, in the main, be linked in terms of strategic behaviour as being defenders, machine bureaucracy and reactive as per Miles and Snow's, Mintzberg's and Ansoff's categories. Similarly, private sector construction contractors can be likened to prospectors, analysers, ad-hocracy and proactive.

3.5 ORGANISATIONAL ENVIRONMENT OF A PROJECT

The structure of an organisation is involved in determining how the resources for a project are applied. Ruskin and Estes (1986) comment that organisational factors greatly influence a project's success. [20] Despite this, Melchers (1977) has commented that little attention appears to be given with respect to proper organisational structures and procedures in the successful implementation of projects by the civil engineering profession. [21]

Before discussing organisational structures appropriate to a project environment a definition of the term 'organisation' in the project sense is put forward. According to Young (1981) the term has four different, but related meanings. [22] Firstly, it may refer to the systematic arrangement or division of work between individuals or groups with the necessary allocation of duties and responsibilities to allow common objectives to be achieved. Secondly, it may relate to a cohesive social group with formal relations between them who combine together to achieve common goals. Thirdly, it may relate to the aggregation of human and material resources that can be distinguished as a separate entity purposely combined together to achieve specific objectives. Finally, Young states that the term may be referenced to the structure of authority and responsibility relationships in a cohesive social system that is a separate entity set up to achieve specific objectives.

The traditional model of an organisational structure is based upon three organisational concepts, namely, the functional division of management, the hierarchical concept of superior/sub-ordinate relationships and a number of principles of management. In the project environment these basis concepts are violated in the management of projects.

There have been significant advances in the introduction and development of new organisational structures. Wallace (1963) identified four factors which caused the onset of the organisational revolution [23] :

- the technology revolution
- competition and the profit squeeze
- the high cost of marketing
- the unpredictability of consumer demands

Grinnel and Apple (1975) put forward five conditions which would indicate that the traditional form of organisational structure may not be the best for managing projects. [24] Firstly, management may be satisfied with its technical skills, but projects are not meeting time, cost and other project requirements. Secondly, there may be a high commitment to getting project work done, but great fluctuations in how well performance specifications are met. Thirdly, highly talented specialists involved in the project may come to feel exploited and misused. Fourthly, particular technical groups or individuals may start to blame each other for failure to meet specification or scheduled dates. Finally, projects may be on time and to specification but the groups and individuals are not satisfied with their achievement.

Sadler (1971) put forward a 'checklist' addressing the questions that an organisation should consider prior to formulating any form of organisational structure. [25] His checklist explored a company's tasks, social climate and relationship to the environment. Table 3.3 shows his questions.

Table 3.3 : Assessment Of Organisation Profile Requirements

	SADLER'S SIX QUESTION CHECKLIST ON ORGANISATION PROFILE
1.	To what extent does the task of the organisation call for close control if it is to be performed efficiently?
2.	What are the needs and attitudes of the people performing the tasks? What are the likely effects of control mechanisms on their motivation and performance?
3.	What are the natural social groupings with which people identify themselves? To what extent are satisfying social relationships important in relation to motivation and performance?
4.	What aspect of the organisation's activities needs to be closely integrated if the overall task is to achieved?
5.	What organisational measures can be developed which will provide an appropriate measure of control and integration of work activities, while at the same time meeting the needs of the people and providing adequate motivation?
6.	What environmental changes are likely to affect the future trend of company operations? What organisational measures can be taken to ensure that the enterprise responds to these effectively?

Source : Adapted From Sadler P. : "Designing An Organisational Structure" : Management International Review Volume 11, Number 6 - 1971

Kerzner (1992) describes organisations as groups of people who must coordinate their activities in order to meet organisational objectives and comments that organisational restructuring is a compromise between the traditional (classical) and the behavioural schools of thought. [26]

Before looking at the various forms of organisational structure, and in particular the advantages and disadvantages of the project, functional and matrix types, it is useful to analyse what different authors believe are the most appropriate organisational forms for organisations carrying out projects.

The Association Of Project Managers (1984) believe that no one form of organisation structure is applicable to all projects and that the three most appropriate forms, namely, functional, project and matrix all have advantages and disadvantages. [27] Quite simply they advocate that the simplest organisational structure that 'will meet the job' is the best choice.

Kerzner (1992) comments that project management utilises the systems approach to management by having the functional personnel (the vertical hierarchy) assigned to a specific project (the horizontal hierarchy). However, he states that there is no such thing as a good, or a bad organisational structure - only appropriate or inappropriate ones. [28] Peters and Waterman (1982) further believe that the adoption of project management allows the classical organisational model to be relaxed and therefore is an important attribute of successful firms that are well adapted to today's turbulent end-of-century environment. [29]

Reiss (1992) comments that the matrix form is a clever method of getting people to start to think about projects as entities in their own right. [30] The responsibility of these people is to 'push' the project across the matrix, headed by the functional heads of each department. Hajek (1984) describes that the matrix method has resulted in the reduction, or elimination of the resource problems that are inherent in 'line' organisations. [31] Baker, Murphy and Fisher (1988) and Menard (1981) succinctly describe project management as a means of adopting a projectised, or matrix structure, both of which are described as being more flexible and effective for achieving a specific output while respecting limitations on cost, time and technical specifications. [32, 33] Robbins (1993) further comments on the advantages of the matrix form of structure. [34] Firstly, if matrix management is adopted in a company it is likely to extend continually its technical excellence through the efforts of functional heads. Secondly, it makes room for individuals (project managers) who have a brief which is totally in line with the customers' needs and interests, that is, in terms of finished project, schedule and cost. Tatum (1981) believes that matrix management results in effective management of construction projects and improved performance. [35] The key improvement is identified as being the assignment of single responsibility.

Drucker (1973) puts forward a sensible reminder to all those who are involved in looking into the appropriateness of organisational structures [36] :

" the test of a healthy business is not the beauty, clarity or perfection of its organisation structure, but the performance of the people "

Therefore, when symptoms such as friction, frustration and attention occur, these are clear indicators that the wrong kind of organisational structure has been adopted.

3.6 CULTURE OF ORGANISATIONS

There are a number of different cultures and structural forms which can exist in organisations. Graham (1985) [37], Galbraith (1971) [38] and Handy (1985) [39] write of task and role cultures, a continuum of structural forms ranging from classical to project and role, task, power and person cultures respectively.

Graham (1985) typifies the organisational environment of a project into two cultures, that of a 'role' culture and that of a 'task' culture. [40] He likens the role culture to that of a bureaucratic organisation and the task culture to organisations who operate on an ad hoc basis. Table 3.4 shows Graham's summary of the differences between role and task cultures.

Table 3.4: Summary of differences in Role v's Task Cultures

CATEGORY	ROLE CULTURE	TASK CULTURE
General management ethos	Logic and rationality	Get the job done
Work norms	Job description important	job stresses individual sensitivity to people and self-control over work
Source of power	Position power due to job title	Expert power due to knowledge
Pro and con	Good for routine Bad for innovation	Good for innovation Bad for routine
Chief Problem	Change	Control

Source : Adapted From Graham R.J. - Project Management Combining Technical And Behavioural Approaches For Effective Implementation - 1985

Handy (1985), however, discusses four types of organisation culture. In addition to the two types previously discussed, that is, the role and task cultures, Handy identified a power form of culture within organisations and also a person type culture. [41]

In power type cultures the central person's role is critical to the organisation's success and therefore control is centralised. Where an organisation may be operating in an environment which may pose significant threats this can be a useful cultural form.

In a person type culture, the structure of the organisation, unusually, is focused around the individual. Emphasis is placed on the people within the organisation and the management revolves around the knowledge and expertise of a number of members of staff.

Schon (1971) considered that organisations are moving from a state of 'bureaucracy' to a state of 'adhocracy', that is to say, organisations are moving from the state of the well known, predictable and orderly to a state of the less known, less predictable and less orderly. [42]

The management form most associated with stability is the classical bureaucracy, whose working environment gives rise to the functional form of management in which people are grouped into departments by functional speciality. Graham (1985) states that there are three hallmarks of a bureaucratic organisation which are in direct opposition to the principles behind an ad hoc organisation. [43] These are shown in Table 3.5.

Table 3.5 : Hallmarks Of Bureaucratic And Adhocracy Organisational Structures

TYPE	HALLMARKS OF BUREAUCRATIC AND AD HOCRACY STRUCTURES
BUREAUCRATIC	*Repeatability* : same or very similar processes to produce same or similar products *Predictability* : products and processes are known in advance *Boundedness* : Each department has specific bounds for its part in the overall process
AD HOCRACY	*Non-Repeatibility* : new products dictate new processes and vice versa *Non-Predictability* : Totally different products may be discovered by experimentation *Non-Boundedness* : Departments may not exist - people will perform variety of different tasks

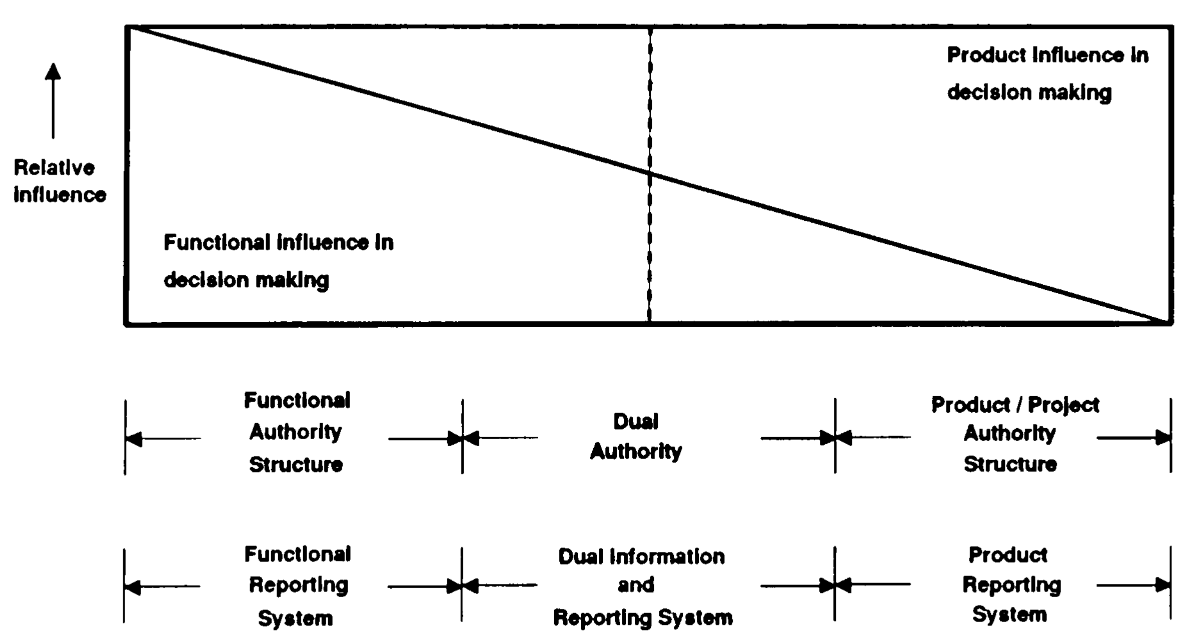
Source : Adapted From Graham R.J. - Project Management Combining Technical And Behavioural Approaches For Effective Implementation - 1985

In a bureaucratic environment, the organisational culture is therefore itself repeatable, predictable and bounded. In an ad hocracy environment the environment is not stable and a different organisational form is required to manage the change which is constantly taking place.

Handy (1980), advocated, that to support this adhocracy, a culture will be developed which is flexible and task orientated. [44] People will possess many skills and move freely from one task to another rather than stay in just one role. They will learn how to function in multi-disciplinary teams that are formed for 'nonrepeatable' tasks, such as individual construction projects, for a specified period of time and then are disbanded. The reward system for employees in such an environment must be linked to performance and flexibility - unlike the bureaucratic case, where reward is normally based on conformity.

Galbraith (1971) also identified and attempted to classify the continuum of structural forms adopted by organisations. [45] He classified the various of organisational structures as ranging from a functional organisation, to a matrix organisation through to a project organisation. He cross-referenced these forms of organisation to the authority and responsibility functions contained within them. Figure 3.5 shows Galbraith's model.

Figure 3.5 : Galbraith's Hypotheses of Organisational Forms



Source : Adapted From Stone R - Management of Engineering Projects - 1988

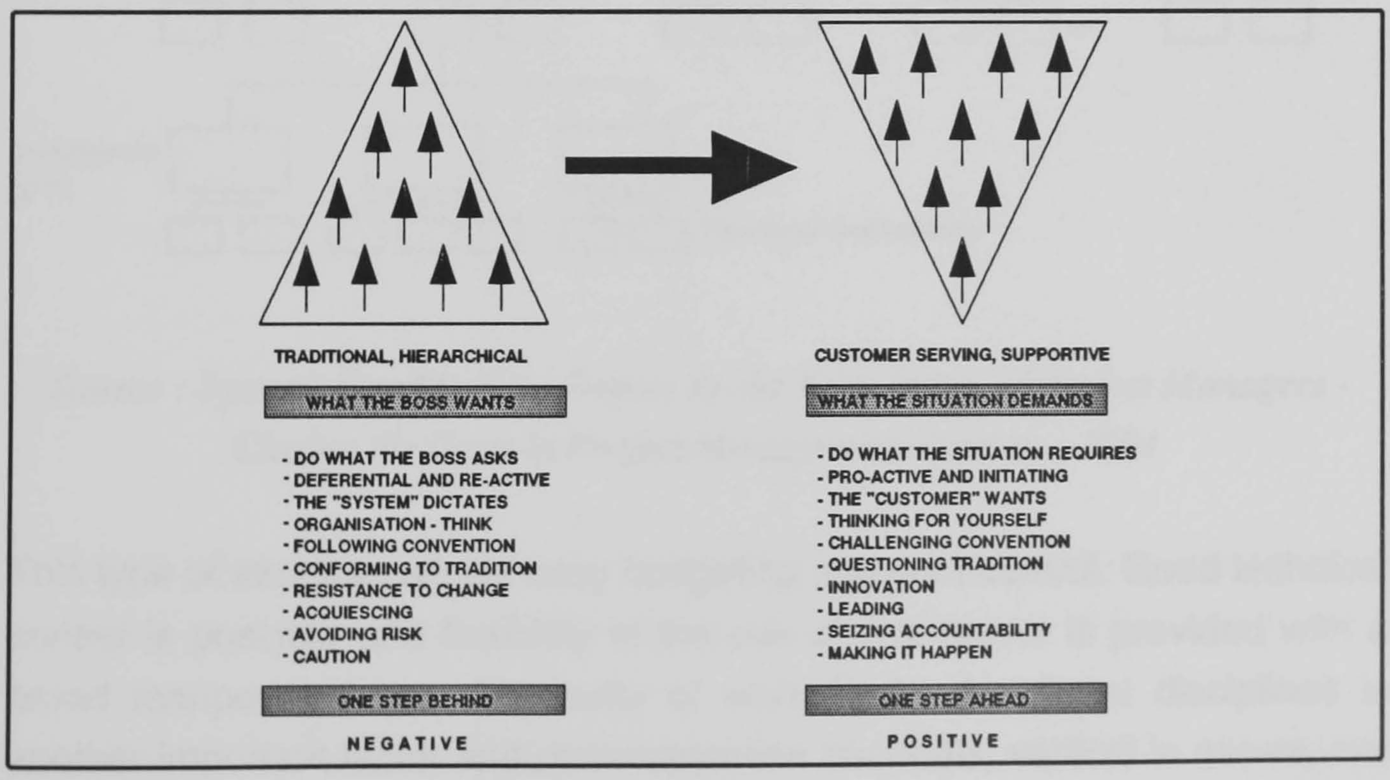
The functional organisation is based on a sub-division of tasks, by function, for example planning and estimating. Each of these specialist functional departments contributes to the product/project or service. It is recognised as being suitable for organisations carrying out projects in a limited number of markets.

At the opposite end of Galbraith's continuum is the product, or project form which is suitable for organisations carrying out a range of products/projects or services, for several markets. The product/project form is similar to the bureaucratic form in the sense that its structure is hierarchical in nature, but with focus on the product or project.

Graham (1985) describes both functional and product/project types of organisational structure as being in a 'steady state', and not necessarily the best form for managing projects where, much communication, flexibility and responsiveness, rapid decision making and such like will frequently be required. [46] He comments that the matrix form of organisational structure is often advocated for such tasks.

Freemantle (1993) also puts forward a traditional versus task, or customer oriented culture for organisations, which is shown in Figure 3.6. [47]

Figure 3.6 : Traditional vs Customer Serving Organisation Culture



Source : Adapted From Freemantle D. - 'Business Planning Handbook' - 1993

Freemantle emphasises the need for having a positive approach to the business with employees being encouraged to carry out their duties with the maximum amount of freedom, which in most instances will result in properly motivated people within the organisation.

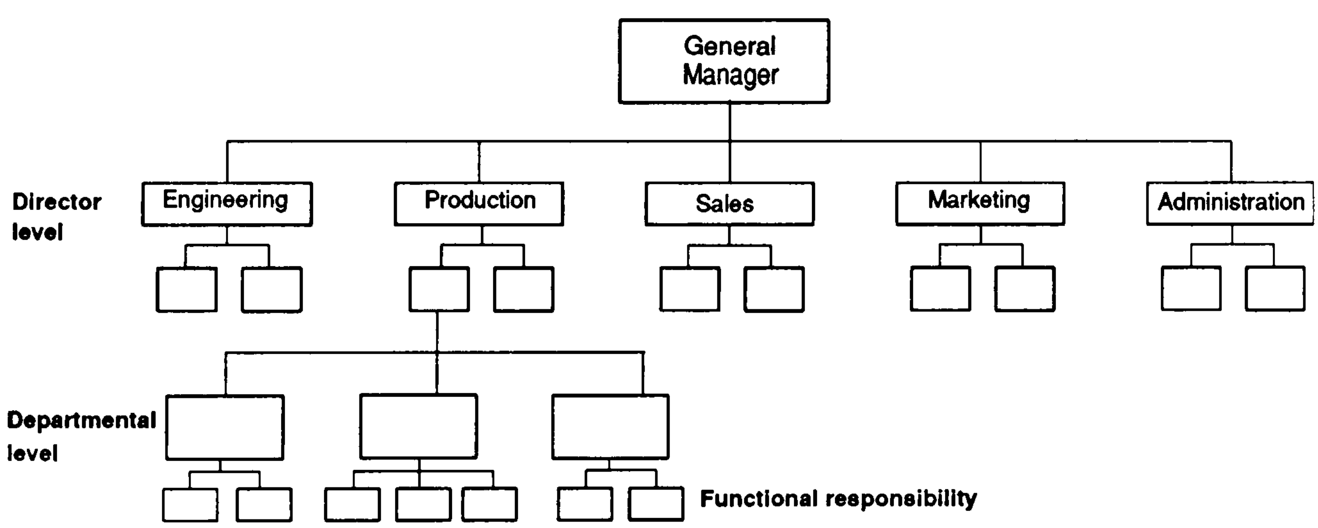
3.7 TYPES OF ORGANISATIONAL STRUCTURES

Thomas, Keating and Bluedorn (1983) and Roseneau (1992) describe that there are generally three forms of organisational structure which are commonly prevalent, known as, the functional, project and matrix forms. [48, 49]

A brief diagrammatic representation and discussion on the advantages of the functional, project and matrix types of organisation structure are now considered. [50]

3.7.1 The Functional Organisational Structure (Figure 3.7)

Figure 3.7 : Functional Organisation



Source : Systems Gap Working Report by the Association of Project Managers - Closing the Gaps in Project Management Systems - 1984

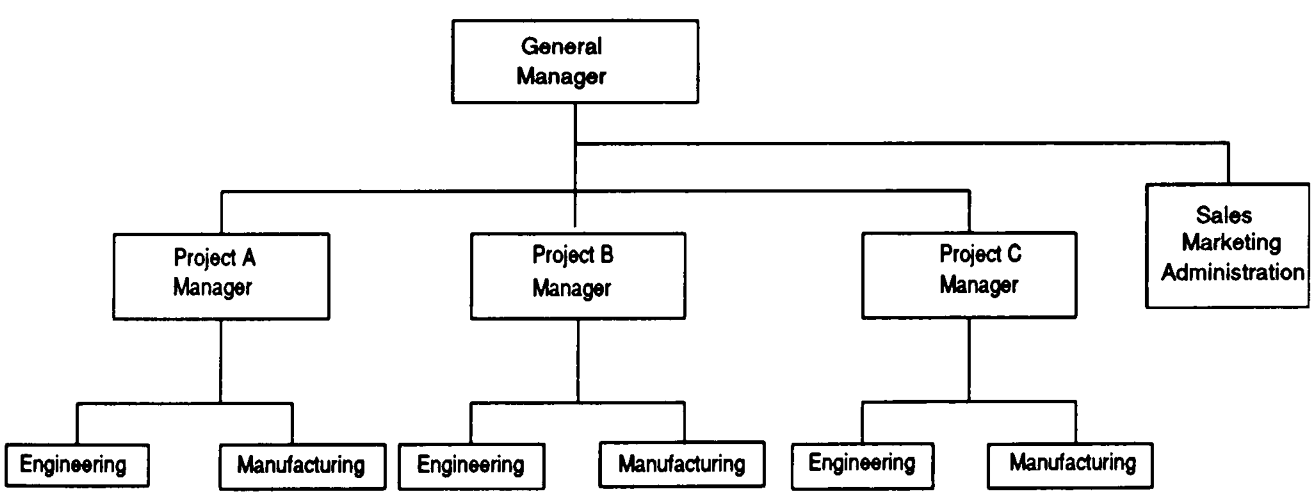
This type of structure allows easy budgeting and cost control. Good technical control is possible and flexibility in the use of manpower is provided with a broad manpower base. Continuity of work in the functional disciplines is another important factor and communication channels, vertical in nature, are distinct in that each employee has only one person to report to. Quick reaction capability does exist, but this may be dependant upon the priorities of the functional managers.

A disadvantage of this type of structure is that no one individual is responsible for the total project and it does not provide the project orientated emphasis necessary to achieve the project tasks. There is no customer focal point which may lead to problems in the project environment. Ideas within the organisation will tend to be functionally orientated with little regard for on-going projects and project reporting will have difficulty in pin-pointing responsibility. Decisions will normally favour the strongest functional groups which can also lead to a decrease in motivation and innovation within the structure.

3.7.2 Project Organisational structure (Figure 3.8)

In a project organisational structure the system provides complete line authority over projects, that is to say strong control is present through a single project authority.

Figure 3.8 : Project Organisation



Source : Systems Gap Working Report by the Association of Project Managers - Closing the Gaps in Project Management Systems - 1984

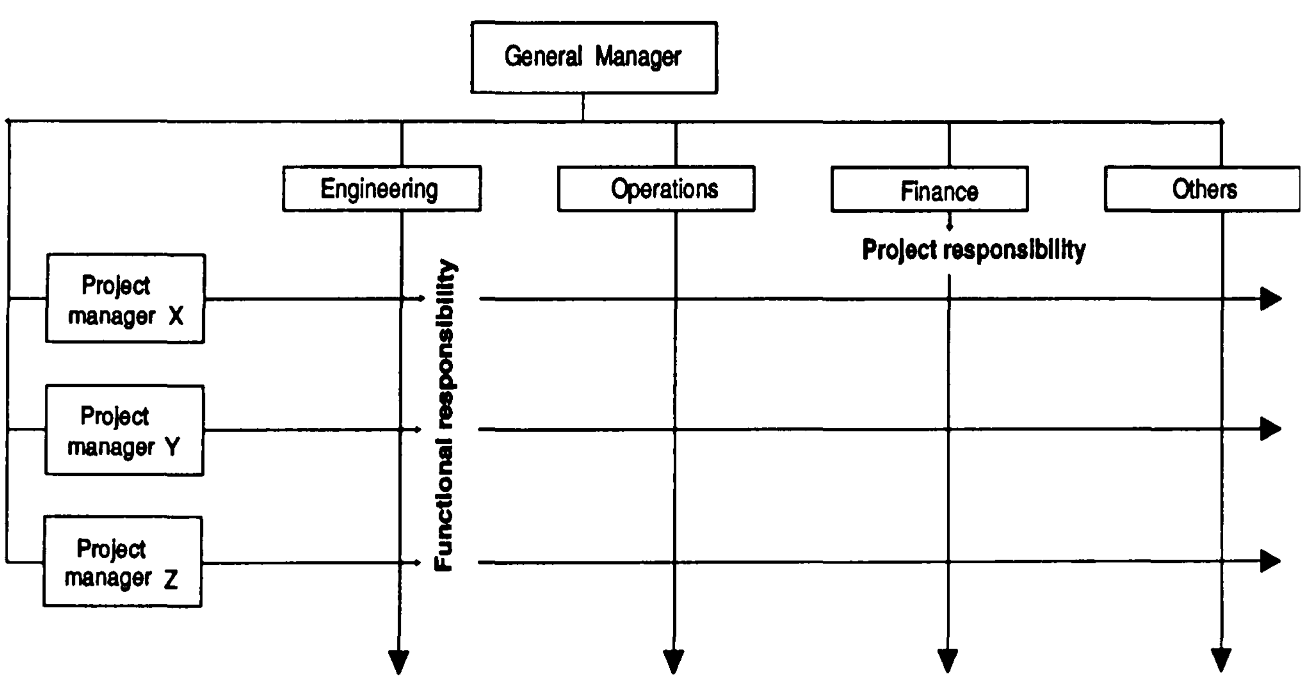
The project participants work directly for the project manager inducing a more profit-conscious arrangement. Communication channels are strong with reaction time very short and expertise can be maintained on a given project without sharing key personnel. Personnel will tend to be loyal to the project resulting in better morale with product identification. A focal point is also provided for external customer relations.

Disadvantages include the cost necessary to maintain this form of organisation, especially where numerous projects are handled simultaneously. Technology will tend to suffer in view of the fact that no strong functional groups are present and project personnel may suffer a possible lack of career continuity and opportunities.

3.7.3 Matrix Organisational Structure (Figure 3.9)

The matrix organisational form attempts to cross the project/product and the functional approaches to departmentalism in order to get the best of each and to allow the project manager to maintain maximum control over all resources including cost and personnel.

Figure 3.9 : Matrix Organisation



Source : Systems Gap Working Report by the Association of Project Managers - Closing the Gaps in Project Management Systems - 1984

For each project, policies and procedures can be set up and tied into the overall company policies and procedures. Rapid responses to changes, conflict resolutions and project needs are possible. The functional organisations exist in their own right but have a primary responsibility to support the project. Job continuity should be good and, because key people can be shared, this also aids motivation. A strong technical base can be developed and in general there is a very good balance between time, cost and performance in such an organisational structure. Disadvantages include the fact that possibly more administrative people are required in such a structure, care must be taken to ensure that duplication of effort does not occur as each project organisation operates independently and more initial effort is needed to define policies and procedures. Functional managers may be biased to their own set of priorities and the balance of power between functional and project organisations must be controlled carefully as the structure allows conflicting loyalties to be present. Rapid response time is possible for individual problems, but overall matrix response time is quite slow. The balance of time, cost and performance must be achieved across a number of projects and this can create co-ordination difficulties.

3.7.4 Types Of Matrix Organisational Structure

The first application of the matrix structure was in the late 1950's in the aerospace industry in the United States as a result of government requirements for single point responsibility among and within contracting organisations. There are a number of different forms of matrix organisational structure. Knight (1977) identified three types of matrix organisation. [51] These were the co-ordination model, the overlay model and the secondment model.

In the *co-ordination* model all staff remain in their normal departments, but organisational arrangements are introduced to enable cross-department communications to take place, for the purposes of the project. A project team is normally formed with representatives from each of the department involved in the project reporting back to this project team. The project leader in such a structure often appears to be in a co-ordinating role rather than managing. Those people being co-ordinated have the right of direct access through their line management to higher levels of the organisation who are setting or co-ordinating the tasks to be performed. This, clearly, may lead to problems.

In the *overlay* model, staff members become members of two organisational groupings, namely, members of functional departments within an organisation providing specialist services for one, or a number of projects, or as project managers with responsibility for the successful completion of the project within time and budget constraints.

Finally, in the *secondment* model staff move from a functional department to a project team for the completion of elements of the project requiring their particular expertise. This may involve such specialist functional staff in moving from one project to another on completion.

Lock (1987) in a similar approach to the classification of matrix organisational structures advocated that there were two forms, these being shifting or fixed. [52] In a *shifting* matrix personnel in the function departments were shifted between projects depending on workload of projects. In the *fixed* matrix form personnel in functional departments were always assigned to the same project manager, whatever the project.

As has already been apparent, matrix structures are not without problems. Davis and Lawrence (1977) reckoned that the matrix form is only appropriate in extreme circumstances, in particular [53] :

- when two, or more sectors are critical for the organisation's success (functions, products, services, markets, areas)
- where there is a need to carry out uncertain, complex and interdependent tasks
- when there is a need to secure economics in the use of scarce human resources, such that their use is shared and flexible

Handy (1981) reported that project teams can be a waste of resources when a task can be handled effectively through the existing organisational structure. [54]

A number of types of organisational structures have been considered and the project manager must make a decision, based on the needs of a particular project, which will be the most appropriate.

3.8 APPLICATION OF CHAPTER THREE

The sub-system for organisation profile was portrayed as being the mechanism for translating previously defined project strategies and objectives into operational performance. The theme of the chapter was to look at these factors with respect to organisation structures and the like which might be involved in this conversion process in order to facilitate improved efficiency.

The chapter consisted of two distinct parts. Firstly, the input to the sub-system required a review to be undertaken of strategic management, approaches to strategy and an investigation into the reasons why organisations undertake projects. This allowed the 'thinking' behind private and public sector construction contractors' approaches to projects to be assessed. Secondly, the culture of construction contractor organisations and the types of organisational structures that may be utilised in the setting up of a project team were analysed to elicit the organisational alternatives to best meet project objectives and strategies for a particular project.

In subsequent empirical chapters (chapters ten and eleven), an analysis into the approaches adopted towards construction projects, along with the factors considered most important in terms of project objectives, is carried out for both private and public sector construction contractors. This will be compared at a later stage, to the review given in this chapter, to assess the current state of play within the industry with respect to how both private and public sector construction contractors view issues related to organisation profile.

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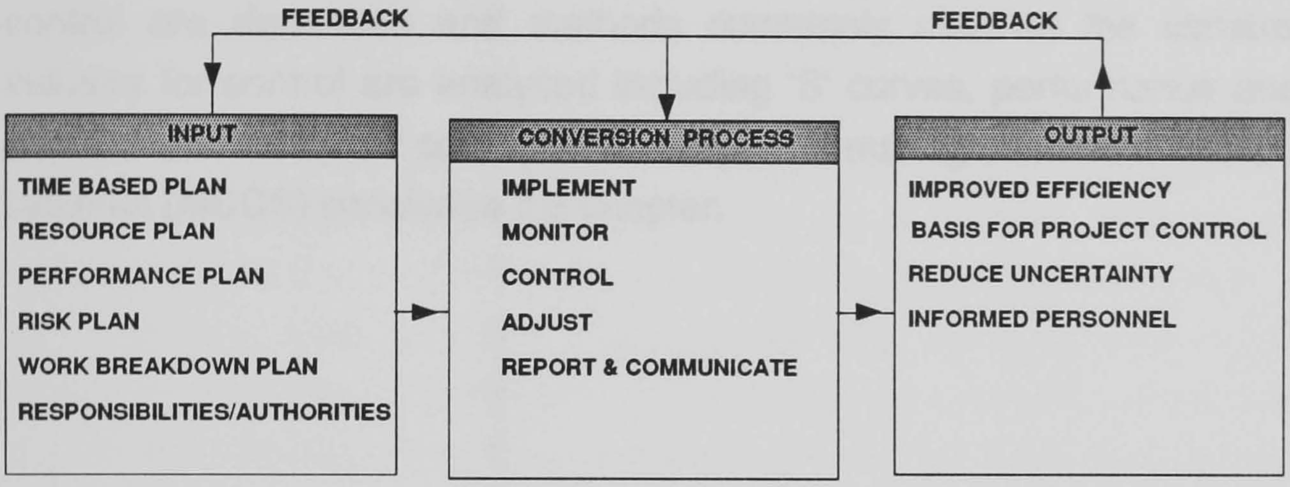
CHAPTER FOUR : PROJECT PLANNING AND CONTROL

4.1 SUMMARY OF CHAPTER FOUR

The sub-system model for planning and control, previously put forward in Chapter One (Figure 1.6), along with its defined 'primary task' is shown here.

Planning And Control Sub-System



Primary Task

' To operate effective planning and control procedures to manage the project's time, cost and performance parameters '

This chapter is essentially divided into three sections, namely, section one dealing with project planning, section two with work breakdown structures and linear responsibility charts and section three with project control.

Section One begins by looking at the purpose of planning and how projects can be represented in plan form after a modelling process has been carried out. Planning techniques currently in use are briefly identified followed by a description, in some detail, of the bar chart and network planning techniques.

The project network is considered extensively with respect to logic constraints, time parameters and resource/cost parameters. The simple computations involved in the various processes are referred to throughout. Project schedules, which are the end result of the 'baseline' planning process conclude this section of the chapter.

Section Two looks at work breakdown structures and linear responsibility charts. The development of a work breakdown structure (WBS) and the establishment of costs for each WBS element are discussed prior to outlining the subsequent pricing out procedure. The use of linear responsibility charts, or matrices. This facilitates a depiction in greater detail than a mere organisational structure diagram, the responsibilities, authorities and reporting structures in the project environment.

Section Three looks at project control. The principles of effective project control are discussed and methods commonly used in the construction industry for control are analysed including 'S' curves, performance analysis and the 'earned value' concept. An analysis of management and cost control systems (MCCS) concludes the chapter.

SECTION ONE : PROJECT PLANNING

4.2 PURPOSE OF PLANNING

The purpose of utilising planning techniques is to express the work to be done in a project against a time-scale and may include resources and costs. Shapira and Laufer (1993) comment that planning in a construction company is an ongoing process that is conducted through all stages of a project, from inception to completion. [1] This emphasises the point that planning also comprises a monitoring and control function after initial 'baseline' plans have been formulated.

Kerzner (1992) describes that without proper planning, a number of typical consequences can arise in the execution of a project. [2] After project initiation a period of wild enthusiasm will be experienced as the project 'takes off'. However, with improper planning this will probably lead quickly to disillusionment resulting in chaos on the project as work does not proceed in a coherent manner and a search is made for the 'guilty parties'. More often than not it will be the innocent who are punished (ie those not responsible for correct 'planning') and at this stage all concerned will probably be hastily seeking a definition of requirements for the project, which should have been the first step in the planning process.

Kerzner goes on to state that there are four basic reasons for project planning. Firstly, planning will help to eliminate or reduce any uncertainty that may be involved in the project. Secondly, the efficiency of the operations involved should be improved by proper planning. Thirdly, a better understanding of project objectives will be experienced by going through the formal planning process. Finally, and perhaps the most significant reason for planning at all is that it provides a basis for monitoring and controlling of the work to be undertaken.

Planning enables the subsequent control of time, resources and costs in a project. The major components of the planning techniques involved are activities, activity durations, project timescale, work method, resources, costs and values. The activities represent elements of work to be undertaken which take time and consume resources. Activity durations are the times required for the completion of particular activities in relation to the overall structure of the timescale of a project. Work methods employed in a project must be expressed in some logical way in a project indicating the sequence of operations and the inter-relationships of them. Resources utilised in a project may be labour, machines, materials or money and project overheads will also have to be allowed for at the planning stage. Costs and value are closely related, with costs representing the amount of money expended on a particular project and value the amount of money earned.

Harrison (1985) describes planning as being an essential element of managing a project and serves many functions within the project environment. [3] It is a means of organising the work of a project; deciding who does what, when how and why; determining and allocating the resources required; defining and allocating responsibilities co-ordinating all the activities and the people involved; estimating time to completion and controlling progress through the execution phase of a project. Planning provides a basis for the budgeting and financial control of a project and a means of imposing a sense of time consciousness on those involved and the activities undertaken within a project.

Clough and Sears (1979) believe that the construction planning process can be said to consist of three steps, namely, the determination of the jobs, or activities to be undertaken, ascertaining the sequential relationships among these activities and the presentation of planning information in the form of a network. [4] Furthermore, they state that :

> *" project managers work within an extremely complex and shifting time frame, and they need a management tool that will enable them to manipulate large numbers of job activities and complicated sequential relationships in a simple and understandable fashion - critical methods are just such expedients and constitute the basis for the ensuing treatment of project time control. This method applies equally well to all construction work, large and small, intricate and straightforward "*

Reiss (1992) puts forward three simple objectives in project planning [5] :

- 50% Thinking ahead
- 25% Communication
- 25% Yardstick

The value of planning is described as providing the opportunity and motivation to think ahead about the project that they are undertaking. The ability must be present to produce and communicate reports to project personnel about proposed timing of activities and status. The plan also provides a yardstick against which progress on a project may be monitored.

Harrison (1985) comments that planning, if carried out effectively, should above all, help to complete a project is less time and money than would otherwise be the case. [6] Kirschenman (1986) has stated that innovative planning will be required for survival and growth in the construction industry for the next decade. [7] As projects become more complex, planning concepts and methodologies need to be implemented that will require more effective resource management at the project level.

Dinsmure and Burgoine (1981) describe that the planning stage of a project has six principal steps, these being [8] :

- Definition of the work
- Identification of responsibilities
- Preparation of project plan
- Development of project organisation
- Determination of manpower requirements and project costs
- Establishment of project administrative functions

Planning can therefore be summarised as comprising of two principal phases, that is, the 'front end' planning and the subsequent 'control' phase. Initially it serves to set out a project in terms of time, resources and budget parameters. Thereafter, project control may be exercised against the original plan (or subsequently updated plan) and communicated to all relevant project personnel to keep them informed of project status and allow corrective action to be taken as necessary.

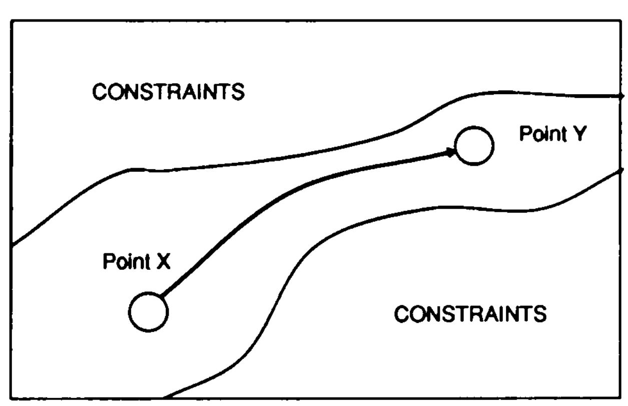
Laufer and Tucker (1987) comment that there is growing concern over the failure of construction planning to achieve its goals even though considerable resources are often allocated to it. [9] Despite the obvious benefits that can be obtained from effective planning and control in the management of projects, Rougvie (1987) describes the United Kingdom as having consistently shown a rather 'schizophrenic attitude' towards the planners and the concept of planning itself. [10]

4.3 REPRESENTATION OF A PROJECT

In order that the thinking necessary to make decisions about the proper planning of a project may be made confidently, a mental representation of the project must be formed. The particular features of an individual project must be modelled, the usual means of carrying out this process being to utilise some form of planning technique. A project exists in time and is effectively a sequence of events to be achieved. The project is said to be complete when all these events have been successfully completed.

In 1947, Norbert Weiner was looking for a name for the emerging science of control and decided on 'cybernetics', a word derived from the Greek meaning steersman. Weiner suggested a useful picture of the planning and control of projects, that of a journey between two points. [11] Figure 4.1 illustrates this analogy.

Figure 4.1 - Project Represented As A Journey Analogy



Source : Adapted From Jackson M.J. : Computers in Construction Planning and Control - 1986

The project is considered as a journey between the two points (x and y), the method of work is the route to be taken, the route map is the project plan and the project manager is the navigator who will steer the ship. The Project Manager is responsible for completing the journey successfully using the resources available to him. The manager's success will depend upon the completion of the journey and the costs involved. The analogy helps to identify and emphasise several important planning features of project management. These are the interdependence of planning and control, the required detail of plans, the need for forward vision, the need for rapid reporting and the fact that plans are dynamic in nature.

Control of a project is impossible without a plan to check against. Planning should therefore be considered as a process which extends into the control phase. Effective control of a project consists of checking actual progress and actual expenditures against envisaged values and taking the necessary action to ensure that they actually mirror, or better the planned values. The manager of a project will wish to be aware, but not in great detail, of the strategy of the future of a project but will require a far greater detail of planning to enable him to make decisions on matters immediately ahead on the project schedule. Information from the past is usually necessary for prediction of information into the future and also for corrective action to be taken in the control phase. The classic approach to project control has always relied on the principle of feedback. However, this is not in accordance with the 'journey analogy'.

The journey analogy can be linked to the use of network analysis. Pilcher (1992) looks upon a critical path network as being able to represent the logic of a project as follows [12] :

" the network is really a project graph - a means of representing a plan so that it displays clearly the series of operations that must follow in order to complete the project "

The main purpose of a control system is to provide a manager with information on which he may make decisions relating to the future. It is therefore appropriate that decisions are made on information which concerns the future. In Project Management Information Systems, the feedback cycle consists of observing data and comparing and acting upon the differences between the actual and envisaged data. The time required for the feedback process must not be such that the information is received too late for corrective action to be taken, if necessary. It is imperative that plans are changed and expanded during the currency of a project. If this process is not carried out the plans will soon become obsolete and unacceptable for use on the project. It is clear from the above 'journey analogy' principle, that for a planning technique to be of use it must take into account all of the factors outlined above.

Wearne (1989) describes alternative methods of organising the responsibility for planning a project, as follows [13] :

- A central planning function, not directly responsible to the project manager can plan it
- One or more members of the staff from a planning section can be temporarily allocated to a project manager
- The planning can be left to the project manager
- The planning can be left to the groups or individuals contributing work to the project

In all instances, it will be the responsibility of the project manager to decide upon which method will best serve the nature of the project to be undertaken.

4.4 PLANNING TECHNIQUES CURRENTLY IN USE

Neale and Neale (1989) narrate that the main techniques currently in use for planning or control purposes are bar charts, the line of balance principle, linear programming methods and network analysis. [14] Each of the techniques are now outlined briefly before looking further at bar charts and network analysis methods.

Bar charts are best suited for projects which are straightforward in nature with simple relationships between the activities. A bar chart also has the advantage of being a relatively easy technique to understand.

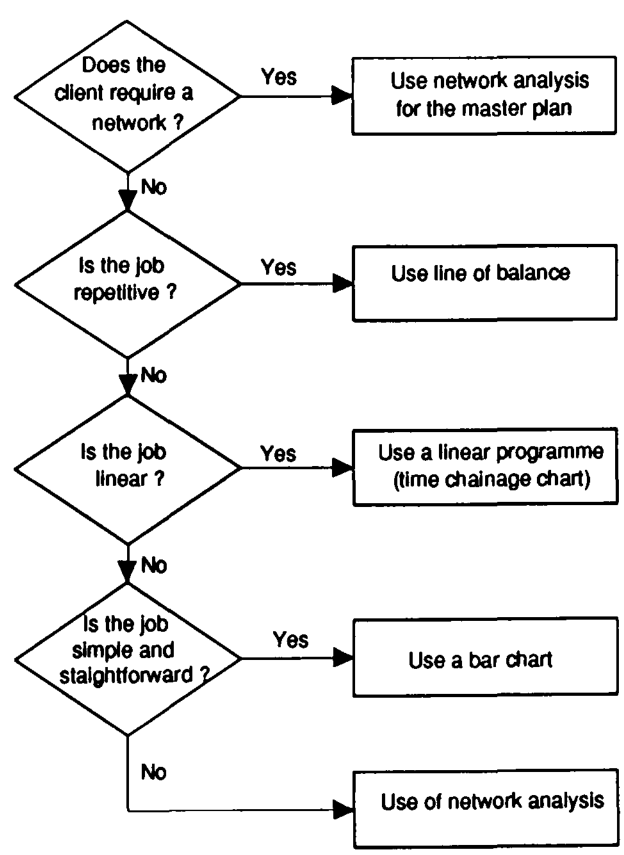
Line Of Balance is a specialised planning technique for use in projects where repetitive work is carried out such as the construction of identical floors in high rise construction, or a large development of identical houses. This method is an excellent one for relating resources, activity durations and work progress on these types of projects.

Linear Programming is a specialised technique applicable for projects of a linear nature.eg-motorway construction and is in effect a time-chainage chart of a project.

Network Analysis is a technique which can be used most effectively in complicated projects where there are complex activity inter-relationships and possibly external constraints. It is based on the drawing of the logical relationships between the activities followed by the application of durations to activities. Thereafter, simple computational processes determine those activities which have the most critical effect on the overall project duration to be determined.

A flow chart to assist in the selection of the planning technique for a particular project, or part of a project, is depicted in Figure 4.2 and Table 4.1 summarises the main characteristics of the planning techniques.

Figure 4.2 - Flowchart For Selection Of Planning Technique



Source : Adapted From Neale R.H. & Neale D.E. - Construction Planning - 1989

This diagram, however, oversimplifies the factors involved in the choice of planning technique. Project personnel experience of particular techniques, personal preferences and company policy all have a part to play.

Table 4.1 : The Planner's Tool-Kit

Technique	Planning uses	Programme uses	Progress control use
Bar chart	Simple projects	Good communicating tool Universally understood In common use Good basis for resource scheduling Most computer systems give bar chart from network	Absence of explicit logic relationships limits usefulness Tedious to update manually
Line Of Balance	Repetitive work	Good communicating tool Demonstrates trade interference	Useful planning tool Difficult to show a lot of detail clearly Illustrates general pace of work and trade interference
Linear Programme	Linear products	Good communicating tool of sequential operations	Useful planning tool Progress shown easily if plan kept simple
Network Analysis	Complex projects Management projects Design management	Poor communicating tool in network form Usually converted to bar chart for general use	Powerful control tool especially for large numbers of contractors Forms basis of most computerised systems

Source : Neale R.H. & Neale D.E. - Construction Planning - 1989

4.5 BAR CHARTS

The Bar chart, or more correctly the Gantt chart, was first utilised by Henry Gantt in the early 1900's and has been the traditional management device for planning and scheduling of many kinds of projects, notably in construction. Bar charts are useful as a means of displaying simple activities plotted against time (or money). A barline in a bar chart represents the amount of work required to be carried out within a particular time period on a particular activity. Project progress and definition of specific work to be carried out to achieve an objective can be clearly depicted on bar charts. The basic form of bar chart is an excellent means of relating activities in a project to time, but it does have a number of shortcomings as a planning technique.

Bar charts do not show the inter-dependence of activities or relate them to a location. The rate of progress within each time bar cannot be ascertained and the results of a late or early start of an activity cannot be shown. The technique also does not provide a basis for the determination of activities which have no flexibility in their durations and those which have float. True project progress is not portrayed as individual activities, behind schedule, may not mean that the overall project schedule is behind.

Simms (1987) indicates several limitations in the use of barcharts. [15] Apart from the main problem in not showing directly how different activities are connected he states that barcharts were not designed to have links shown between activities; here diagrams are better to show the overall inter-relationships.

According to Clough and Sears (1979), the basic bar chart is not an adequate planning and scheduling tool in that : [16]

" it does not portray a detailed, integrated and complete plan of operations "

A development of the bar chart to take account of the inter-relationships of the activities was put forward by Karol Adamiecki in 1931 and termed the Harmony Graph. [17] This was effectively a bar chart rotated by ninety degrees with a vertical time-scale, a column (movable strip) for each activity in the project and was an effective means of showing the activity inter-relationships. This development was completely overlooked, it seems, and it was not until the late 1950's that further advances were made with regard to procedures relative to planning and control disciplines.

Further alterations to the basic bar chart can be made to overcome its inherent deficiencies. For example, the bar chart can be used to show the slack, or float time associated with a particular activity by extending the bar with an 'empty' portion. Normally the activities which depict the critical path for a project (and have no float) would be placed at the top of the bar chart. All other activities with float would be placed below in ascending order of total float. However, although total float can be indicated for each individual activity it is important to realise that the total float is actually shared between activities and utilising some of the float in one activity will affect the float available in others.

Another form of bar chart termed the 'hybrid' bar chart depicts the critical activities at the top of the chart as per the float-linked chart, but with the other activities constructed below in consecutive-job order. Empty bars can be added to show either total float (same problem as above) or free float.

A method of adapting bar charts to show the interdependence of activities called the 'stage-chart' was put forward by Oddey (1981). [18] This involved the linkage of related activities by vertical lines within the bar chart. This method although satisfactory for very simple bar charts can easily become very complicated and is ineffective where numerous inter-relationships are present between multiple activities.

Lockyer (1984) [19], Battersby (1970) [20] , Baboulene (1970) [21] and others have identified at length the advantages and disadvantages of the use of barcharts as opposed to network diagrams. In particular, Baboulene lists a direct comparison of a number of important characteristics of barcharts and networks which are shown in Table 4.2

Table 4.2 : Comparison Of Barcharts And Networks

NETWORK	***BARCHART***
Logical planning of activities is separated from time scheduling	Planning cannot be separated from scheduling
Inter-relationships of activities throughout the project (including those of outsiders such as sub-contractors) can be clearly seen	Very few relationships shown
All the effects of any delay, change or emergency can be quickly traced	A few of the more immediate effects traceable
May have to be re-timed from any point, but rarely re-drawn	Frequently becomes completely out of touch with reality
Total resource requirements, and when particular resources required, known in advance	Very limited in this respect
Available spare time systematically calculated and allocated	No planning of spare time
Critical activities and bottlenecks highlighted	No identification of these - 'crash' resources may be wasted on non-critical jobs
Problems are foreseen, decisions taken in good time, promises kept	Last-minute or late owing to limited view ahead
Overall costs minimised subject to policy	No counterpart

Source : Adapted From Baboulene B. - Critical Path Made Easy - 1970

Reiss (1992), in a different approach, expresses the differences between barcharts and network diagrams by considering their characteristics in relationship to timing, logic, familiarity and presentation, four of the most important functions of any form of planning technique. [22] His representation is shown in Table 4.3.

Table 4.3 : Characteristics Of Barcharts And Networks

CHARACTERISTIC	BARCHART	NETWORK
Timing	Shows timing clearly	Does not show timing clearly
Logic	Does not show logic	Shows clearly which tasks depend on others
Familiarity	Most people are used to Barcharts	Most people are not used to Network diagrams
Presentation	Can be scaled down to A4 size	Plans are hard to read and quite large

Source : Adapted From Reiss G. - Project Management Demystified - 1992

4.6 HISTORY OF DEVELOPMENT OF NETWORK PLANNING TECHNIQUES

In the late 1950's three independent developments were taking place in the network analysis field.

In 1955, in the UK, Andrew of ICI was using 'a controlling sequence duration' for scheduling maintenance and the Central Electricity Generating Board (CEGB) devised its 'minimum irreducible sequence' in 1957. Both these operations involved techniques similar to the Critical Path Method, using the activity on the arrow method.

In 1956, the American chemical firm E I Dupont de Nemours and Company started to look at new ways of scheduling projects. Walker, of this company and Kelley, of Remington Rand produced the Critical Path Method (CPM) in 1957. The first test was made in 1958 when network analysis was compared with previous means of scheduling in the construction of a chemical plant. In March 1959 the new method was applied to a shut-down at the Du Pont works in Louisville, Kentucky, USA and the non-productive time was reduced from 125 hours to 93 hours. The technique focused on the activities in to which the work of a project could be categorised and was referred to as 'activity-on-the-arrow'. The method featured a single time estimate for each activity and also allowed a cost to be associated with that duration. A second set of duration/cost data called the 'crash' time and cost could be defined for situations which required expediting. Therefore, the most economical means to shorten project durations could be determined.

Levine (1986) narrates how these initial systems were developed through time, to meet the needs of specific organisations. [23]

In 1958, The Programme Evaluation Review technique (PERT) was devised for the Polaris military project by the Program Evaluation Branch of the Special Projects Office of the US Navy, helped by the Lockheed Missile System Division and the consultants Booz-Allan and Hamilton.

This method was 'event-orientated' with events being represented as milestone points and connected with arrows to show the relationships, the arrow depicting the duration between each event.

The time durations in this method were expressed as three estimates per arrow, namely, the pessimistic duration (10% likelihood), the most likely duration and the optimistic duration (10% likelihood). The calculated duration was evaluated by the following formula :

$$\textbf{Calculated Duration} = \frac{\textbf{Pessimistic + (4x most likely) + Optimistic}}{\textbf{6}}$$

Graham (1985) gives advice on the facts to be taken into account in the calculation of the three time estimates. [24] Statistical evaluation of these durations allow the determination of the probability of meeting any scheduled completion date for a project.

Following the development of these techniques Professor John Fondahl of Stanford University, in 1958 developed an alternative 'activity-orientated' approach called activity-on-the-node (AON). This was similar to AOA, except for the graphic representation where activities are referenced by their own node identification rather than by their preceding and succeeding activities as in AOA. This method was somewhat forgotten about until 1973, when, in its original form it proved to be the technique used in most microcomputer programs. The AON method has gained favour because it allows activity relationships to be shown without the need for use of 'dummy' activities as in AOA.

In the USA the Department Of Defence (DOD) [25] and Department Of

Energy (DOE) [26] issued guidelines for a PERT/COST technique. This in reality was a CPM/COST technique based on the AOA method and established certain cost-tracking parameters as required for certain of their contracts.

A further development in network planning techniques occurred in 1973 with the creation of the Precedence Diagram Method (PDM).This method allowed more complex modelling of the relationships between the activities than in AOA or AON which only allowed start-finish relationship to be modelled pre-supposing that the predecessor activity would have to be completely finished before the successor activity could commence and also that the successor activity started at exactly the same time as the predecessor ended. The AOA and AON methods did not therefore depict reality and would have to be manipulated to model the project properly. The PDM technique allows start-finish, start-start, finish-finish conditions to be modelled which can be applied with, or without lead/lag times between activities thus giving the planner a much more powerful tool in relation to real-life modelling of projects.

Kharbanda and Stallworthy (1983) set the scene in the year 1974 [27] :

> *" the project network method is the most powerful technique yet developed for planning and scheduling a project, but ... it has not yet been proved as useful for monitoring and controlling a project "*

Furthermore, they state, :

> *" whilst remarkable advancement has been achieved in the area of networking techniques and sophisticated reporting, the rate of successful utilisation of such systems has not attained a comparable growth "*

In 1975, in the USA, the Department Of Defence issued Specification 7000.2 called the 'cost schedule control system criteria' (c/scsc). The DOE also introduced a system called 'performance measurement system'. These systems were effectively developments from the PERT criteria which fell into disuse in the 1960's. The nature of these 'new' systems was that cost planning and tracking would be based on the 'earned value' of the work planned or performed to ensure integration between the amount of work completed and the cost to complete that amount of work within a particular time. The introduction of the 'earned value' technique requires that the measurement and reporting of cost progress be integrated with that of schedule progress.

Lockyer (1984) states that despite the difficulties associated with Gantt charts, the ability to translate a network into a Gantt or barchart valuable for four reasons. [28] Firstly, it allows the plan to be more readily understood by 'unskilled' persons at all levels. Secondly, progress can easily be displayed on it. Thirdly, the meaning of float and activity times can be understood by examining a barchart. Fourthly, it allows simple resource allocation and subsequent more detailed resource allocations to be carried out.

Simms (1987) narrates that at one time planning project activities was limited by the notation available. [29] Visual representation in the form of barcharts afforded a useful scheduling and control tool but (with the exception of the very simplest cases) it was never possible to indicate all the complex relationships and sequence dependencies between activities. He states that the introduction of network diagrams overcame this problem.

The use of network techniques is not without problems. Stone (1988) comments that a network analysis might look more impressive than a barchart, but it might end up confusing the originator as well as the project team! [30] Furthermore, Barrett (1987) states that [31] :

" A critical path network is not an accurate representation of reality "

It predicts the start times of activities from estimates of the time necessary to carry out preceding tasks; a schedule derived from such predictions might be quite unrealistic in view of perhaps parallel activities which cannot run simultaneously in view of resource limitations.

Pinnell (1980) comments that network based scheduling is seldom used or understood in spite of over twenty years availability. [32] He states that the most effective way to increase the use of such methods is for everyone to understand the basics, before attempting sophisticated computer technology. Schlomo (1974) describes the inadequacy of network analysis and resource allocation techniques in producing a workable schedule for site management. [33]

Tavakoli and Riachi (1990) carried out a survey of the use of network techniques in 400 companies. [34] The results were compared to a similar survey which had been carried out 15 years earlier. Their use had increased and was also found to be more effective. The increase in use had been assisted by the availability of good project management planning and control software and better educated personnel. Where network analysis techniques were not used, the main reason appeared to be the lack of support from employees. Jaafari (1984) comments that despite criticism concerning the inadequacy of the critical path method as a project planning tool, his research found it to be equally useful as a planning tool for all kinds of projects, including linear or repetitive ones. [35]

Espedal, Hetland and Jordanger (1992) comment that the traditional methods for modelling projects, including network analysis, invariably perform rather badly. [36] They put forward a model called TOPP (Total Project Planning) as a platform for the next generation of planning models and tools. The main areas of the TOPP concept include :

- Development of realistic project models
- Optimisation of project profitability given a set of restrictions
- Project life cycle scheduling
- Risk levelling

The optimal project schedule is defined as a function of the project execution time, in view of the fact that the availability of relevant project schedule information increases as a function of time.

4.7 PRINCIPLES OF NETWORK ANALYSIS

Network analysis is now considered in some detail in view of its importance with respect to project planning and control in the construction industry today. This method of planning, despite being in existence for many years, is still the *most* widely utilised planning technique which allows effective modelling of activities within projects.

Other planning procedures, such as 'knowledge based' systems, based on pre-programmed 'intelligent' information, although researched, are still unavailable for common use within the construction industry.

Neale and Neale (1989) describe network analysis as [37] :

" a general term for a graphical planning technique which shows the project as a network of its activities linked together to show their inter-relationships and sequence of execution. With the addition of activity durations, the diagram can be analysed numerically to determine the estimated project duration "

This analysis also distinguishes between those activities whose timely execution is vital to the earliest completion of the project and those which may be delayed for a specific time without causing delay in the project completion.

They go on to state :

" that the evaluation of how much non-critical activities may be delayed without causing a delay in project completion allows an objective means of scheduling project activities to make best use of available resources "

In a more simplistic form Battersby (1970) described network analysis as breaking the project into a set of individual jobs or events and arranging them into a logical network, estimating the duration and resource requirements of each job and deducing a schedule in order to ascertain which jobs control the completion of the project; thereafter the re-allocation of resources as necessary to improve the schedule would be carried out. [38]

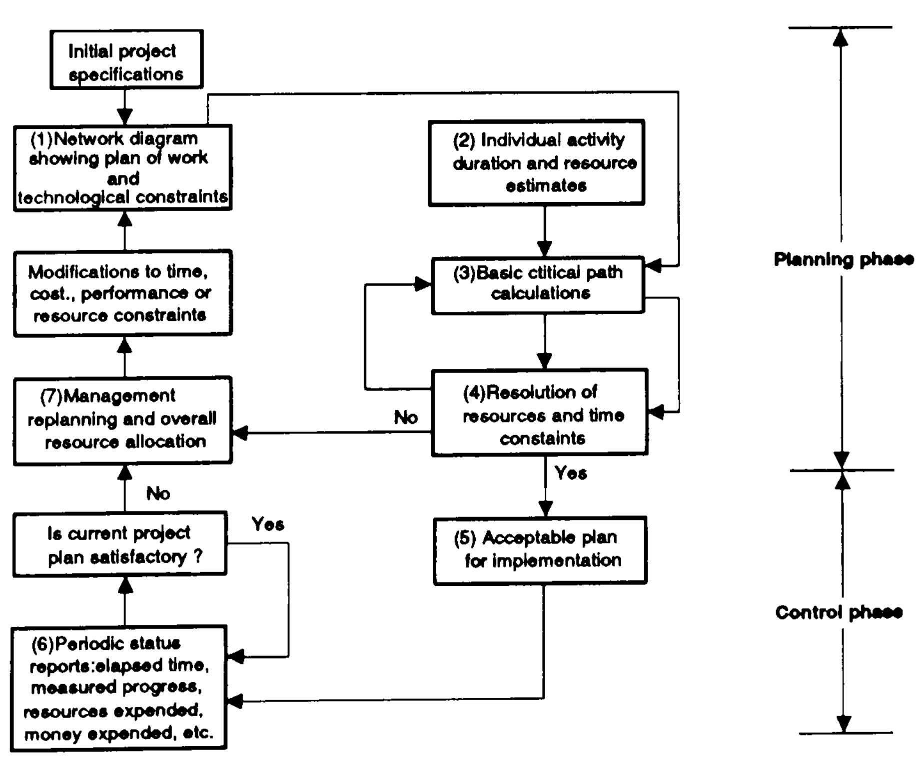
The technique forces a thorough pre-planning of the activities to be undertaken within a project and this logical planning is separate from time scheduling of the activities. The inter-relationships between activities can be clearly depicted with a resultant improvement in co-ordination. The effects of any delay, change or problem areas can quickly be identified, often in advance, and the responsibility for such effects determined. The technique compels the project planner to identify total resource requirements for the project and to re-allocate these resources as necessary within the 'spare' time that has been systematically calculated. Critical activities are easily identified and managers can therefore concentrate closely on them and ensure time is not concentrated on non-critical events. Optimum start and finish times are identified before the project begins and can be used as a baseline target schedule for each individual activity. It allows project reporting to be made and facilitates the process of communicating information to the correct project personnel at the correct time.

Lockyer (1984) [39] notes the most important findings of the 1984 NEDO report (always to be borne in mind in the planning of projects) were that the importance of planning is generally accepted, but that the success of the planning effort is enhanced by the speed of response and ease of comprehension, rather than the size or sophistication of the network.

4.8 NETWORKS AS MODELS FOR PROJECTS

Pelikan (1990) comments that the modelling of networks has shown itself to be very efficient in project management. [40] Moder (1988) put forward a model of the scope of critical path methods as the basis of a dynamic network-based planning, scheduling and control procedure. [41] (Figure 4.3)

Figure 4.3 : Dynamic Network-Based Planning And Control Procedure



Source : Moder J.J. - Adapted From Project Management Handbook Edited by D.I. Cleland And W.R. King - 1988

It clearly distinguishes the two phases involved in planning, namely, the initial planning definition requirements and the subsequent control in the project execution phase.

Step 1 is the representation of the project plan in the form of a network. Steps 2 & 3 involve the estimation of individual activity times and hence overall project duration and the determination of its critical path. Steps 4 & 5 involve the modification of the original project baseline plan to satisfy time and resource constraints placed on the project. Steps 6 & 7 involve monitoring and controlling the project through to its completion.

With respect to the control phase, Reiss (1992) raises two important points as follows [42] :

- It is not necessarily a crime to be running late......but it is a crime not to know that you are running late
- You can only manage the work that remains to be done

4.8.1 Drawing of network plans

Initially, it is necessary to make a list of all activities associated with a particular project. Prior to translating this list into a network plan there are a number of questions which have to be addressed for each activity. Firstly, it must be established which activity (or activities) must precede the activity under question. Secondly an activity (or activities) which follow the current activity must be identified. Thirdly, it is necessary to determine which activity (or activities) can take place concurrently with the activity in question.

Pilcher (1992) describes that the very process of drawing a network diagram can itself be a profitable procedure for the site manager. [43]

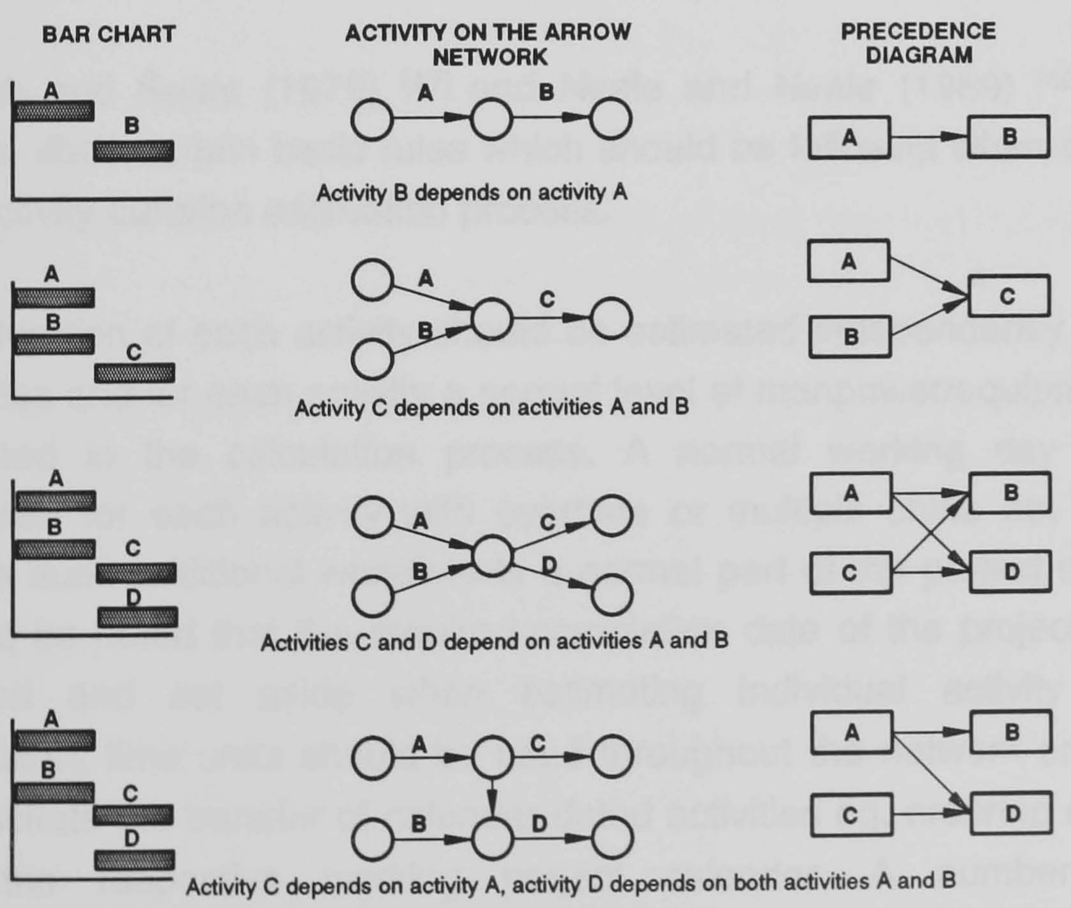
The drawing of the network plan will vary dependent upon the method of critical path analysis adopted, that is, activity-on-the-arrow, activity-on-the-node, programme evaluation review technique or the precedence method.

Clough and Sears (1979) state that even though the job logic is portrayed exactly the same, the diagrams are different in appearance. [44] They cite several advantages of Precedence over Activity-on-the-Arrow. Firstly Precedence notation is considerably easier to learn and to comprehend, particularly in view of the fact that there is no need for dummy activities to maintain logic. Secondly, It is much easier to update Precedence diagrams and to add or delete other activities which makes it much more suitable for control purposes.

Likewise, Simms (1987) describes the Precedence form as being a more elaborate form of the Activity-on-the-node network in that it allows greater complexity of modelling in terms of finish-start, start-start, finish-finish and start-finish relationships. [45]

Typical commonly occurring conventions put forward by Pilcher (1992) which depict AOA, Barchart and Precedence Diagram notations for simple activity relationships are shown in Fig 4.4 [46].

Figure 4.4 : Comparison of Bar Chart, Activity on the arrow and Precedence Diagram Notations



Source : Pilcher R - Principles of Construction Management - 3rd Edition - 1992

These advantages have led to the Precedence method of network analysis becoming the most popular one in use currently. This kind of diagram is easier to follow by people familiar with flow charts; activities are represented by one number only and hence it is much easier to insert additional activities without changing existing activity numbering. Also, multiple dependency relationships can be modelled. The method can be understood much more easily and diagrams constructed more quickly than the AOA method, for example. The Precedence Method is catered for in almost all computer software packages for network analysis and for this reason, and the advantages previously stated, this particular technique will be utilised to demonstrate the formulation and applications of network analysis in the following text.

4.8.2 Estimation Of Activity Durations

Up to now the formulation of a Precedence Diagram as a network planning technique has been considered up to the logical planning stage. Prior to carrying out time scheduling on a network it is necessary to estimate activity durations for each activity in the network. In Precedence Diagrams it is necessary to consider only a single time estimate for each activity.

Clough and Sears (1979) [47] and Neale and Neale (1989) [48], amongst others, state certain basic rules which should be followed when carrying out this activity duration estimation process.

The duration of each activity should be estimated independently of all other activities and for each activity a normal level of manpower/equipment should be used in the calculation process. A normal working day should be assumed for each activity with overtime or multiple shifts not considered unless such additional worktime is a normal part of the project operation. It should be noted that the required completion date of the project should be ignored and set aside when estimating individual activity durations. Consistent time units should be used throughout the network and this may necessitate the transfer of calendar dated activities eg. ordering of materials into the respective working project calendar. A number of other considerations which may or may not be imposed upon the contract by the contract conditions, can also affect the duration estimates of activities. These might include such items as timing of road and service diversions, stages of construction, limited working hours and public and industry holidays.

Output rates to establish individual activity durations should be related to overall average performance and therefore should make some allowance for items, for example, plant breakdowns, absenteeism and sickness, weather and low temperatures.

In all cases of estimation of activity durations the best estimates will usually be obtained from the people who will actually supervise the work (normally the functional managers in a matrix organisational structure - see Chapter Three) or from people who have had the necessary relevant experience.

4.8.3 Network Computations

Once the process of estimating individual activity durations has been completed basic network scheduling computations may be carried out. The purpose of these simple step-by-step calculations is to determine the overall project completion time and the time periods (early start to latest finish) that each activity must be carried out within to ensure completion within the overall project completion time. This also establishes the 'spare' time capacity, or float, for each activity.

The British Standard for the terms used in project network techniques is BS 4335 : 1987 and many useful definitions are contained in it. [49]

Table 4.4 : Definitions Of Early Start/Finish And Late Start/Finish Times

Term	***Definition Given In BS 4335 : 1987 - Terms Used In Project Network Techniques***
Earliest Start	The earliest start of an activity is the earliest possible time which an activity can start within the logical and imposed constraints of the network
Earliest Finish	The earliest finish of an activity is the earliest possible time by which an activity can finish within the logical and imposed constraints of the network. The earliest finish time is determined by adding the activity duration to the earliest start time.
Latest Start	The latest start of an activity is the latest possible time which an activity can start within the logical and imposed constraints of the network without affecting the overall project duration
Latest Finish	The latest finish of an activity is the latest possible time which an activity can finish within the logical and imposed constraints of the network without affecting the overall project duration

Source : Adapted From BS 4335 : Terms Used In Project Network Techniques - 1987

The *latest start* of an activity is obtained by subtracting the activity's duration from its latest finish time. The calculation of *early start and finish* times proceed from the project start to the project finish and is commonly known as the 'forward pass'. The basic assumptions in this process is that every activity will start as early as possible, that is, immediately on the completion of a predecessor activity. If two, or more predecessors link to one particular activity its earliest start time will be the highest value of early start obtained because the early start of an activity is dependent on the completion of all predecessor activities. The overall minimum project duration is calculated by adding the last activity's duration to its predecessor's earliest finish time.

The calculation of the *latest start and finish* times for each activity is commonly known as the 'backward pass'. This process is essentially the reverse of the afore-mentioned 'forward pass'.

Clough and Sears (1979) describe the calculations involved as [50] :

> *" elementary and with practice, can be performed rapidly. Even so when several hundred activities are involved, the manual development of activity times can be tedious, time-consuming and subject to errors "*

From the simple computations carried out to determine early/late start times and early/late finish times a number of important characteristics of both the overall project and of individual activities can be identified. These include overall project duration, identification of activities with no flexibility with regard to time (critical activities) and identification of activities which have a degree of flexibility with regard to time (non-critical activities). The overall project duration is identified after the 'forward pass' of the network has been carried out and is verified at the start of the network after the 'backward pass' has been carried out to ensure that no simple arithmetical errors have been made in either process. The overall project duration has been calculated from the longest path through the network, namely the critical path. Activities which after the forward and backward passes have resulted in *identical* early and late start times and early and late finish times can be described as critical. Any such activity will lie on the critical path for the project.

After the forward and backward passes, some activities have variances between early and late start times and early and late finish times; these are described as having float. Float can be seen as the time available for the activity or path in the network in addition to its duration. A number of different types of float can exist including total float, free float, independent float and negative total float. The following definitions again stem from BS 4335 : 1987. [51]

Table 4.5 : Definitions Of Various Types Of 'Float'

Term	*Definitions Given In BS 4335 : 1987 - Terms Used In Project Network Techniques*
Total Float	The time by which an activity may be delayed or extended without affecting the total project duration
Free Float	The time by which an activity may be delayed or extended without delaying the start of any succeeding activity
Independent Float	The time by which an activity may be delayed or extended without affecting preceding or succeeding activities in any way
Negative Total Float	The time by which the duration of an activity or path has to be reduced in order to permit a limiting imposed date to be achieved

Source : Adapted From BS 4335 : Terms Used In Project Network Techniques - 1987

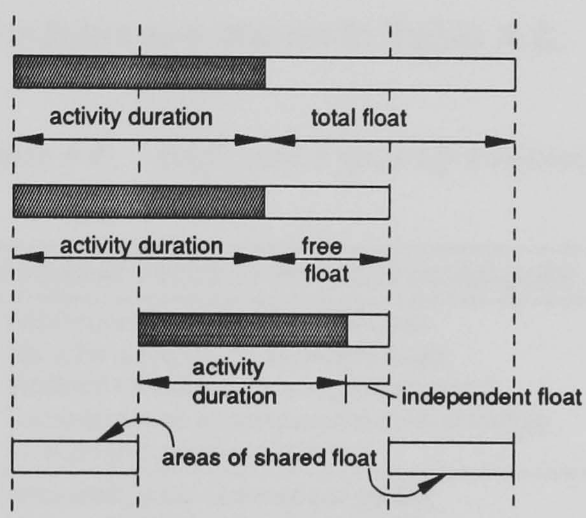
The *total* float of an activity can simply be calculated by subtracting its early start time from its latest start time or similarly subtracting its early finish time from its latest finish time. The same value will be obtained in both cases. An activity with a total float of zero has no flexibility with regard to the time available to carry it out and is thus a critical activity and as such has a direct control on the overall project completion time. In typical networks total float is usually *shared through a path of activities in the network* and this must be borne in mind when prioritising scheduling of activities with respect to total float.

The *free* float of an activity can simply be calculated by subtracting its earliest finish time from the earliest start time of any activities directly following. Free float is the amount of time by which the completion of an activity can be delayed without delaying the early start of any succeeding activities or affecting any other activity in the network. Free float, therefore, becomes significant if the activity commences at its early start time since it gives an indication of the float which is not shared by any of its succeeding activities.

The *independent* float of an activity can simply be calculated by evaluating the difference between the early start time of the activity and the latest finish time of its predecessor and subtracting this value from the free float time within the activity. Independent float is found only infrequently in networks and therefore does not provide much further benefit over free float with regard to activity or overall project scheduling.

Figure 4.5 shows diagrammatically the most frequently encountered types of float in the project environment.

Figure 4.5 : Diagrammatic Representation of Types of Float



Source : Adapted From Pilcher R - Principles of Construction Management - 3rd Edition - 1992

4.9 PROJECT SCHEDULES

After the network has been formulated and the critical path, critical activities and non-critical activities with their various elements of float determined, it is necessary to prepare schedules for use in the time management of the project. These schedules can take various forms such as an 'early start schedule' which lists all activities in a project at their earliest start and finish times. This serves to illustrate to the person responsible for a project as a daily reminder of the necessity of meeting these dates in the case of critical activities and also identifies activities where float is being used, that is, activities which have not started on their earliest start dates. A 'late finish schedule' occurs where all activities are listed in order of their latest finish dates. If an activity is not completed by its latest finished date the overall project duration is behind schedule according to the original project baseline plan. A 'total float schedule' lists the total float in ascending order for activities associated with a project and indicates those activities which should have top priority with regard to timeous completion.

Ottobrunn (1986) describes standard schedules that are commonly used in practice. [52] He divides the schedules into three categories, namely :

- Time Schedules
- Resource Schedules
- Cost Schedules

These types of schedules are shown in Table 4.6.

Table 4.6. : Different Types Of Project Schedules

	DIFFERENT TYPES OF PROJECT SCHEDULES
Time Schedules	1. Initial schedules with dependencies 2. Baseline schedule as of project begin 3. Updated schedules showing actual status 4. Trend-analyses accompanying each schedule 5. Total project overview schedule
Resource Schedules	1. Total manpower required per period 2. Manpower required by department 3. Manpower required by department and type 4. Manpower required versus available per period 5. Manpower loading per period 6. Several other charts as required
Cost Schedules	1. Cumulative total cost 2. Cumulative total cost by department 3. Total labour cost 4. Total direct cost 5. Cost variance from plan 6. Several other charts as required by project management

Source : Adapted From Ottobrunn H.H.D. - The International GPM/INTERNET Symposium - Project Management Software Application-Implementation-Trends - 1986

Project time schedules allow identification of time slippages in activities to be readily detected and appropriate action to be taken to get the project back on schedule. The schedules should be updated regularly and it should be noted that such updates may result in the shifts of critical paths and substantial changes in the float of activities and it is essential that the latest project schedule is communicated to all those concerned to give a true picture of the current stage of a project. Other points to be noted in the communication of project schedules to various project personnel are as follows.

It is acceptable to supply information of early-start schedules, critical activities and values of free float to persons immediately supervising certain project activities. This provides the supervisor with detailed information to allow time schedules to be met with the flexibility in activities with free float to utilise this 'extra' time to meet unexpected job conditions. However, any information supplied with regard to total float should be done so with caution, because as stated previously, total float is usually shared between a number of activities and the use of total float on one activity will affect the float available on others. If managers are only responsible for certain elements of projects there could be problems from 'misleading' information being provided in the form of total float values.

Graham (1985) suggests that the information from network charts, barcharts and the like should be sorted out into a three tier framework for management attention to activities. [53] These are shown in Table 4.7.

Table 4.7. : Schedules - Framework For Management Attention

	SCHEDULES - FRAMEWORK FOR MANAGEMENT ATTENTION
Level 1	Are activities which require maximum management attention during both the planning and execution of the project (critical activities or nearly critical activities)
Level 2	These activities require less management attention (near critical activities or activities with high variance)
Level 3	These activities require very little management attention (activities of low or medium variance and some amount of free slack, or float)

Source - Adapted From Graham R.J. - Project Management Combining Technical And Behavioural Approaches For Effective Implementation - 1985

4.10 RESOURCES AND THE PROJECT

Karaa and Nasr (1986) state that resource management is one of the most important ingredients for competitiveness and profitability. [54] Ballard (1972) acknowledges that many resources are limited in extent and advocates that procedures for establishing resource planning and consumption along with monitoring of performance should be set up. [55]

To date networks have only been considered in relation to time constraints. It is self evident that all projects consume resources in the process of achieving their objectives and the availability of these resources normally has an important effect upon the project scheduling process. The processes previously described have in essence considered resources to be unlimited in supply with regard to project activities.

Prior to looking at incorporating resources into the network scheduling process a number of terms as referred to in BS 4335 are listed in view of their relevance in Table 4.8. [56]

Table 4.8 : Definitions Of Resource Terms Used In Projects

Term	***Definitions Given In BS 4335 : 1987 - Terms Used In Project Network Techniques***
Scheduling	A list of activity start and finish times subject to the constraints of logic, time and/or resources
Resource Aggregation *	The summation of the requirements of each resource, and for each time period
Resource Limited Scheduling **	The scheduling of activities, so that predetermined resource levels are never exceeded
Time Limited Scheduling ***	The scheduling of activities, so that the specified project duration, or any imposed dates are not exceeded
Resource Smoothing	The scheduling of activities, within the limits of their float, so that fluctuations in individual resource requirements are minimised
Resource Levelling	The process of producing a schedule that reduces the variation between the maximum and minimum values of resource requirements

Source : Adapted From BS 4335 : Terms Used In Project Network Techniques - 1987

** It should be noted that the aggregation process can be based on early start or late start times for activities and will give different results in both cases.*
*** This process may cause the minimum overall or specified project duration to be exceeded.*
**** This process may result in envisaged resource levels being exceeded.*

The first step in applying resource management is to identify all the resources to be used in a project. This essentially involves tabulating for each activity the labour required by craft and the major items of plant/ equipment necessary for its execution. This process is carried out for each activity and a cumulative labour, plant/equipment resource aggregation against the timescale of the project will be achieved. This process will normally be carried out on an 'early start' basis which will exacerbate any peaks in the demand for a particular resource. At this stage of resource management certain peaks of resource demand will normally be encountered.

Resource management, in general, can be considered to be the process associated with the determination of scheduled times for project activities by levelling the resource requirements in time subject to the project duration not being exceeded, minimising the project duration subject to the constraints of limited resources and minimising the total cost of the resources and the penalties due to project delay. The three factors just mentioned make the process of resource optimisation a far from easy one and does not lend itself to solution by mathematical programming. This has led to heuristic procedures being developed to produce 'good' feasible solutions to the optimisation process. Generally, priorities are assigned to activities which are used in making activity sequencing decisions required for the resolution of resource conflicts. A common priority used is that of least value of latest start followed by least value of total float. Clough and Sears (1989) state that [57] :

" resources must often be allocated on a project-wide or company-wide basis, with some system of priority being established among the separate sources of demand "

There are basically two scheduling methods which help to identify the optimal resource allocation for a project, namely parallel or serial scheduling. [58, 59]

In *parallel* scheduling, activities are scheduled one day at a time working from the first to the last day of the project. Each day, the activities which are ready to start are listed in their priority order and as many as possible are scheduled taking the availability of resources into account. At the end of each day the resources available are updated and the overall process repeated until all activities within the project are scheduled.

In *serial* scheduling the priority applied to each task is only applied once at the start. The activities are then scheduled one day at a time as soon as all their predecessors are scheduled (not necessarily completed) and they are considered for scheduling in the order in which they appear on the original list.

The serial method tends to schedule activities serially along the network, whereas, the parallel method tends to schedule activities in parallel along different paths.

In practice resource peaks can be levelled off by using the technique of resource smoothing which effectively utilises the available float in non-critical activities, that is free float and total float. Absolute resource smoothing may not free the possibility that certain resources may still be over-committed at certain times to keep the project within the original envisaged timescale. A resource limited analysis by defining the actual availability of specific resources can then be applied to the network to evaluate the effect of these resources on the delay of the completion of the project timescale.

The process of achieving the best project baseline schedule taking resources into account is an iterative one and lends itself to the 'what-if' analyses that can be carried out on the majority of project management computer software packages that are currently available. The computer analyses will produce a schedule that will keep resource levels within their defined limits and still maintain project logic at a minimum extension of project duration by rescheduling activities with float in an optimum manner, if a schedule within the original time constraints cannot be modelled in view of the limited resources available. Once an optimum baseline schedule has been ascertained with respect to time and resources it will be saved as the 'revised baseline schedule' for the project. It will, thereafter, be necessary to update this schedule at regular intervals as the work progresses after project execution begins. This involves monitoring actual activity start and finish times, duration completed on activities, percentage of duration completed and duration remaining at a particular project update time.

Soft Decision Inc (1990) reported on variances that may be experienced in using planning software for resource optimisation. [60] The aim of the survey was threefold :

- How different and how significant is the improvement of the results achieved by one program versus others ?
- How consistent are the allocation results and is there clear evidence that one levelling procedure is better than others ?
- How do the leading Project Management software programs on the market compare in this regard ?

The summary of conclusions of the survey are shown in Table 4.9.

Table 4.9 : Survey Results On Use Of Resource Optimisation Techniques

	SURVEY RESULTS ON USE OF RESOURCE OPTIMISATION TECHNIQUES
1.	Resource allocation results may differ by more than 50% among different programs
2.	Results of resource levelling should not be accepted without some form of checking. Otherwise, there may be considerable damage in predicting the project end date, and the way resources should be allocated
3.	Project management software is inconsistent in its ability to produce efficient resource levelling results
4.	There is no specific resource levelling rule that produces better results in every case. The levelling procedures must be run using all options and pick the best solution.

Source : Adapted From Soft Decision Inc (1990)

Barrett (1987) narrates that most organisations work on several projects simultaneously and frequently require some of their resources to be provided from a common pool. [61] Clearly, when several projects are being scheduled against resources which are common, priorities need to be established. Initially, the total float of activities for different projects may be used to prioritise and allocate resources between the projects.

SECTION TWO : WORK BREAKDOWN STRUCTURES AND LINEAR RESPONSIBILITY CHARTS

4.11 DEVELOPMENT OF THE WORK BREAKDOWN STRUCTURE(WBS)

The principles of work breakdown structures have been developed over the past 40 years from the United States Department of Defence. Scasso and Larenas (1991) explain it as : [62]

" the representation, or modelling of a project requires an instrument for breaking it down into sub-systems, and these sub-systems into units, with clear identification of each one, the relationships between each also being shown "

The use of a work breakdown structure (WBS) serves such a purpose. Turner and Cochrane (1993) describe the WBS at any level of breakdown as the two dimensional matrix of products and activities showing the relationship between them. [63] Hribar and Asbury (1985) comment that in the project environment, administration, engineering and cost/schedule control should be separated into individual units via means of a work breakdown structure. [64]

Kerzner (1992) describes a number of logical steps which should be followed in order to determine detailed estimates for elements of and overall project costs. [65] A complete definition of the work requirements must be formulated and should include a Statement Of Work (SOW) describing all the work to be performed in the project with goals and objectives to be achieved, specifications which dictate the standards for pricing of the work and project schedules which identify such criteria as start/finish dates for items of work and other important project dates as well as providing a basis for data reports once the project is underway.

Once the work requirements have been outlined, a logic network should be constructed, as detailed in Section One, which normally serves as the basis for the framework of the Work Breakdown Structure (WBS). This network shows the logical sequence of events in the project and at this stage of the pricing process initial assumptions are made that there are no limitations on resource availability and that no calendar restraints should be made.

The Work Breakdown Structure is an important project management tool and is used to define the work to be done, identify who is responsible for this work and most importantly forms the basis for the integration of the work to be done, the organisation of, and the planning and control systems within a project environment.

Oberlender (1993) states [66] :

" that for any size project, large or small it is necessary to develop a well defined work breakdown structure (WBS) that divides the project into identifiable parts that can be managed "

The concept of the WBS is simple. In order to manage a whole project, a project manager must control each of its parts. Oberlender describes the WBS as the cornerstone of the project work plan.

The development of the WBS is normally carried out by assessment of individual activities in the logic network into groups of activities or an individual activity in order that costs may be controlled at a specific level and detail. The elements of the WBS must be manageable in as much that specific authority and responsibility can be assigned; it must be able to be integrated into the total project package, but still be independent with regard to other elements of the project; it should also be of use in terms of measuring project progress.

The WBS provides a common framework for the project from which planning can be performed, costs and budgets can be established, with time, cost and performance being tracked. Furthermore, company objectives can be linked in a logical manner with respect to resources, schedules and status reporting procedures so that they can be established and controlled. A variety of formats can exist for WBS's, but one of the most common is the six-level indented structure as shown below in Table 4.10. [67]

Table 4.10 : Six Level Indented Work Breakdown Structure

1	TOTAL PROGRAMME
2	PROJECT
3	TASK
4	SUB-TASK
5	WORK PACKAGE
6	LEVEL OF EFFORT

Source : Adapted From Kerzner H. - Project Management - A Systems Approach To Planning, Scheduling And Controlling Projects - 1992

Kerzner (1992) describes the top three levels as being associated with the managerial and levels 4 to 6 associated more with the technical.

Level 1 comprises a number of projects and equates to the summation of the activities and costs associated with singular projects. *Level 2* is the level at which project budgets are evaluated from schedules prepared for elements of work at *Level 3*. (Levels 1-3 are normally the levels utilised for summarising for reporting purposes and reflect integrated efforts and do not relate to one specific department or section). *Level 4* is the level at which work is detailed in a particular task and at *Level 5* any specific element of work should be identifiable and homogeneous for the same categories of work in different projects.

The WBS requires to be 'priced out' and the project manager(s) and functional manager(s) have different inputs at this stage. The project manager's responsibilities include establishing the 'what', 'when' and 'why' requirements of the project whereas the functional manager is responsible for 'how', 'who' and 'where' aspects of their particular elements of the WBS This process in reality is the most important element of the pricing function and it is probable that the project manager will require various meetings with functional managers at this stage. Initially the project manager should have a meeting, where all functional units should provide details of costs/budgets and resource requirements for the project. Thereafter, further meetings, if necessary, should be held with appropriate functional managers to finalise the cost elements of that functional unit in relation to the project as a whole.

Once cost and resource information has been received from each functional manager, the project manager (or project team) is responsible for the integration of all the costs to ensure that all the work involved in a particular project is accounted for. At this stage it is possible that any problems concerned with limitations of resources will be discussed between the project manager and the functional managers in depth to try and achieve an optimum solution in relation to the problem. During this review period the project manager must also consider the following :

- Was sufficient time allowed for estimating purposes ?
- Were the estimates based on past similar work or simply 'guesstimates' ?
- Will the estimates require a continuous shifting of personnel in and out of the project ?
- Will the necessary personnel be available with the necessary skills ?

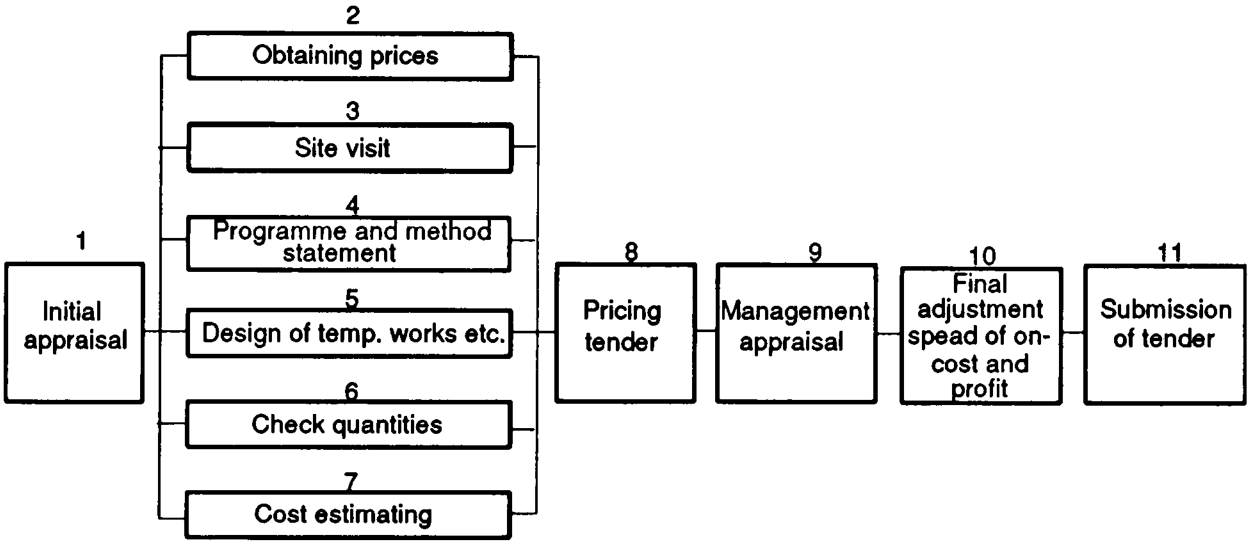
Depending on the answers to the above points it may be necessary to re-evaluate costs for certain items of work and overall project costs accordingly. At this stage the project manager is in a position to decide upon the optimum baseline schedule for the project taking into account time, cost and performance rationalisations which may have had to be made in the pricing process to date. Communication at this stage should be made with the customer and/or senior level management prior to developing the final detailed critical path network time and resource schedules for the project. Ultimately, the project will be controlled through the WBS and the project manager must define with confidence the baseline costs for each WBS element. This is usually carried out at level 3, the task/activity structure level of the WBS.

4.12 PRICING OUT THE WORK BREAKDOWN STRUCTURE (WBS)

In order to price out the WBS in a project relating to construction each WBS element must be evaluated at net price prior to adjustment for spread of overheads and profit.

Figure 4.6 depicts a typical outline, put forward by Landon and Everest (1990) on the estimating and tendering process in the Construction Industry. [68]

Figure 4.6 : Typical Outline Of Estimating And Tendering Process



Source : Adapted from Spon E & FN - Spon Civil Engineering and Highway Works Price Book - 1990

An important point to note is that estimating can be considered to be the *technical* process of predicting the costs of construction, whereas tendering is a separate and subsequent *commercial* function based upon the estimate. The final tender submission is based on the following elements in Table 4.11.

Table 4.11 : Elements Making Up Final Tender Submission

	ELEMENTS MAKING UP FINAL TENDER SUBMISSION
1.	Preliminaries
2.	Main contractor labour
3.	Main contractor materials
4.	Main contractor plant
5.	Domestic sub-contractors
6.	Prime cost sums
7.	Nominated sub-contractors
8.	Provisional sums
9.	Contingencies
10.	Programme
11.	Method statement
12.	Temporary works
13.	Overheads and profit

Source : Adapted From Spon E & F.N. - Spon's Civil Engineering And Highway Works Price Book - 1990

A contractor normally makes a decision to tender on a project on the basis of evaluating the present construction workload, the nature and conditions applied to the project, the estimating workload and the location of the project. Items 1, 10, 11 and 12, as outlined in the previous section relating to the formulation of the WBS would be discussed between the project manager/ functional managers based on a logic network for the project. Items 2, 3 and 4 are normally there which comprise the main input by the estimator during the tender period. The estimator is also responsible for the issue and receipt of sub-contractors prices as Item 5. Items 6 - 9 are normally stated in the tender document for a project. The determination of apportioning overheads and profit is almost always a management decision by Directors as in Item 13. Each of the items to which the contractor has an input are now discussed briefly to illustrate the process of pricing out the various functions within an individual WBS element.

Preliminary items generally occur over the whole duration of a project as in the case of site accommodation but may be over a specific period of time. Where a particular element of work can be apportioned to an individuals activity of the WBS this should be carried out. However, where costs cannot readily be identified against an activity the costs should be allowed for in the preliminaries. A Contractor in the UK has to allow for the payment of Main

Contractor's Labour as per the current Working Rule Agreement. In the case of DLOs, labour rates are based on the current National Joint Council's rates. If a project is to be carried out over a period when a wage increase is anticipated (eg annual increase) then this will have to be allowed for in the estimating process. A contractor normally has to estimate an 'all-in' hourly rate for tradesmen and labourers which incorporates the basic hourly rate plus bonus, holiday pay, travel, employees liability insurance, national health insurance, sickness benefit, subsistence allowance and Construction Industry Training Board levy. The process of calculating the 'all-in' labour rate is shown in Table 4.12 and (if adjusting it for a wage increase) in Table 4.13. [69]

Table 4.12 : Make Up Of 'All-in' Labour Rate (Based on current rate for period July 1988 - June 1989)

Make Up Of 'All-In' Labour Rate	***Tradesmen (£)***	***Labourers (£)***
Basic Hourly Rate	2.52	2.15
Paid Hours, say 51	128.52	109.65
Guaranteed Bonus	15.21	12.87
Holidays With Pay - Annual	14.45	14.45
Public Holidays	3.36	2.87
Daily Travel	7.56	6.45
Periodic travel	-	-
Employer's Liability Insurance 1.5%	3.00	2.70
National Health Insurance 10.45%	20.9	18.9
Sickness Benefit	2.00	2.00
Weekly Fares	10.00	10.00
Subsistence Allowance	-	-
Construction Industry Training Board Levy	1.70	1.00
	206.70	**180.89**
Guaranteed Time 3%	6.20	5.43
	212.90	186.32
Hours Worked	4.53	3.96
Plus Rate	0.25	0.25
	4.78	**4.21**

Source : Adapted From Fairclough Civil Engineering Contractors - 1988

Table 4.13 : Adjustment Of "All-In" Labour Rate For Annual Pay Increase

TRADESMEN	
April 1989 - June 1989 : 3months @ £2.52	£7.56
July 1989 - March 1990 : 9 months @ £2.77	£24.93
	£32.49
Divided By 12	***£2.70***

LABOURERS	
April 1989 - June 1989 : 3months @ £2.15	£6.45
July 1989 - March 1990 : 9 months @ £2.36	£21.24
	£27.69
Divided By 12	***£2.31***

Source : Adapted From Fairclough Civil Engineering Contractors : 1988

Main Contractor's Materials will normally be priced after specific material quotations from suppliers have been sought and received. It is of the utmost importance that the correct specification of each material along with the approximate quantities and time period for delivery are issued with each enquiry in relation to a material supply contract.

For tendering purposes main contractor's plant is normally estimated at plant hire rates appropriate to specific items of plant. Rates must include an allowance for fuel and attendance costs. Plant, normally, falls into two categories, namely operated and non-operated. In operated items rates must include for the labour accordingly.

For those parts of the work that a contractor does not wish to undertake directly, quotations will be sought from domestic sub contractors. It is essential that all such quotations are based on the same contract conditions as the main contract. The main contractor is at all time responsible for the acts, defaults or neglects of any sub-contractors which may be used in a project.

Tender finalisation and submission is the stage where a management decision is made on the allocation of overheads and profits. Consideration can be given to the workload of the company and the availability of staff and plant. The recent award, or loss, of other projects can evidently influence decisions at this stage.

The percentages for overheads and profit are added to the net prime cost for the project, excluding any provisional sums or dayworks which may not form part of the project, and normally will be inserted as a lump sum in the preliminaries section of a bill of quantities.

4.13 LINEAR RESPONSIBILITY CHARTS

Section One of the Chapter has detailed some of the current planning techniques in use within the construction industry which enable 'baseline' schedules to be prepared. Section Two, taking this a step further, looked at the important role played by work breakdown structures in dividing work into manageable units for both planning and control purposes. It is now considered worthwhile to analyse a further project management procedure (the use of linear responsibility charts) which may be used to communicate responsibilities, authorities and the like to project personnel, with a view to further improving project communications.

Cyert and March (1963) comment on some of the benefits of the traditional organisational chart [70] :

" Traditionally, organisations are described by organisation charts. An organisation chart specifies the authority or reportial structure of the system "

However, Jasinski (1959) is critical of the pyramidal organisational chart in view of its failure to display the 'non-vertical' relationships between the various parts of the organisation. [71] He further states :

" necessary as these horizontal and diagonal relations may be to the smooth functioning of the technology, or work flow, they are seldom defined or charted formally. Nonetheless, wherever, or whenever modern technology does operate effectively, these relations do exist, if only on a non-formal basis "

Graham (1985) likens responsibility charting as a simplistic method of clarifying relationships and involves decisions, actors and types of participation of each actor in each decision. [72]

Cleland and King (1983) comment that the organisational chart is much derided amongst organisational participants. [73] However, organisational charts can be of great help in both the planning and implementation phases of project management. Such charts go beyond the simple display of formal lines of communication, grades, departmental functions and line-staff relationships.

Relating to job position and inter-relationships with other job positions, the linear responsibility chart also includes advisory, informational, technical and speciality aspects. They go on to state that linear responsibility charts normally show the following characteristics which are shown in Table 4.14.

Table 4.14 : Characteristics Of Linear Responsibility Charts

	CHARACTERISTICS OF LINEAR RESPONSIBILITY CHARTS
1.	Core information from conventional organisational charts and associated manuals displayed in a matrix format
2.	A series of position titles along the top of the chart (columns)
3.	A listing of responsibilities, authorities, activities, functions and projects down the side of the chart (rows)
4.	An array of symbols indicating degree or extent of authority and explaining the relationship between the columns and the lines

Source : Adapted From Cleland D.I. And King W.R. - Project Management Handbook - 'Linear Responsibility Charts In Project Management' - 1988

There are, however, several limitations inherent in linear responsibility charts. Cleland and King (1988) state [74] :

" that the linear responsibility chart does reveal the functional break down of the work to be done and the inter-relationships between the functions and job positions.......however, it does not show how people act and interact "

Kanger and Murdick (1963) also express some caution in the use of linear responsibility charts, but overall consider them to be of considerable use. [75]

" Obviously the linear responsibility chart has weaknesses, of which one of the lesser ones is that it is not a mechanical aid. Just because it says something is a fact does not make it true. It is very difficult to discover, except generally, exactly what occurs in a company - and with whom. The chart tries to express in specific terms

relationships that cannot always be delineated so clearly; moreover, the degree to which it can be done depends on the specific situation. This is the difference between the formal and informal organisations mentioned. Despite this, the linear responsibility chart is one of the best devices for organisational analysis "

The next Section moves to consider how 'baseline' project plans are monitored and controlled in the execution phase of construction projects.

SECTION THREE : PROJECT CONTROL

4.14 INTRODUCTION

Sections One and Two of this chapter have analysed how in planning terms a project may be broken down onto sub-sections via the use of a work breakdown structure, or similar, and how time durations and resource estimations can be applied to each sub-element to formulate a 'baseline' schedule in terms of time and cost for a particular contract. This process is fundamental to the subsequent successful monitoring and control a project. Furthermore, some problems will inevitably arise as the project develops because of external disturbances which are usually random and unpredictable and are not possible to build into the original 'baseline' schedule; however, these can be incorporated into future updates of the plan to demonstrate the effect of these unplanned events.

The techniques that apply to control and communications are grouped together as cybernetics. (management cybernetics being the application of such principles to the control of complex and probabilistic systems which occur in government and industry). This section of the chapter considers then how effective project control may be achieved and looks at project cash flow, cost control and performance monitoring techniques in this process.

4.15 EFFECTIVE PROJECT CONTROL

Pinto (1990) describes the process of project monitoring and control as [76] :

" a different and often inexact process "

However, effective control of a project is fundamental to its successful completion. Without effective control the people within the organisation carrying out the project may become 'slack' in their work attitudes with a probable increase in cost and time to project completion. In construction projects work rarely ever goes exactly according to plan or budget and proper management of a project requires that there must be some form of determining how the project is progressing in terms of time and cost in order that any action necessary to minimise delays and cost over-runs may be taken before they become 'real' problems. An effective control system should readily bring to the attention of the project manager deviations from plan and budget, as soon as possible after they occur and thus allow the proper management of a project.

Lockyer (1984) discusses six essential features of an industrial control system which can equally well be applied to a construction environment. [77] These are shown in Table 4.15.

Table 4.15 : Essential Features Of A Control System

	ESSENTIAL FEATURES OF A CONTROL SYSTEM
1.	A plan must be made
2.	The plan must be published and communicated
3.	Once working, the activity being controlled must be measured
4.	The measurement must then be compared with the plan
5.	Any deviations must be reported to the appropriate person
6.	A forecast of the results of any deviations must then be made, and corrective actions taken to cause the activity to continue in a way that will produce the originally desired result, or if this is not possible, a new plan must be made

Source : Adapted From Lockyer K. - Critical Path Analysis And Other Network Techniques - 1984

Harrison (1985) states that an effective control system has essentially two important functions. [78] Firstly, it serves to monitor progress and cost parameters and secondly, it allows the project manager to 'be in the picture' and hence aids management of the project.

Responsibility for overall cost and time in the project environment lies solely with the project manager. The project manager has to accumulate cost and progress information for all elements of the project in order that managerial analysis may be carried out globally and control action taken, if necessary. A large proportion of a project manager's time will be spent on the aspects of control of a particular project(s).

Harrison (1985) goes on to list three major factors associated with an organisation's project and control systems which may lead to *poor* overall control of projects :

- The firm's control systems are cost accounting oriented
- The traditional variance approach to 'analysis' is inadequate
- The 'quality' of some control and information systems is low

Cost control systems, in themselves, are *not* sufficient to adequately control project work. However, quite often the only control system lies with the project accountant and in this respect many people believe that project control and cost control should be considered together. However, cost control should be viewed as being a sub-system of the overall project control system and will become ineffective if separated from control of other factors. The project manager is required to control much more than just costs and generally is concerned with minimising both time and cost, whilst maintaining an appropriate quality standard of performance.

In essence, there must be a combination of technical, accountancy and managerial factors, together with the integration of progress and cost in the management/control of projects. Effective control of a project requires the integration of all the sub-systems for control. It has been found essential that the sub-systems for planning, budgeting, information and control of both progress and cost must be integrated with the work to be done, and the people and organisational structure involved. This integration is the basis of any effective project management system. Project managers need to be backed by such effective systems; otherwise, there will not be effective project management and there will almost inevitably be increases in the time and costs to carry out the project greater than is necessary.

Variance analysis essentially measures the difference between two factors, normally planned and actual values for a particular element. The technique can be applied to time, cost or manhours and such like. Harrison describes variance analysis as an inadequate method of project control because :

- It is a historic, backward looking method of analysis
- It does not lend itself to an integrated approach with progress and cost
- It does not clearly indicate performance

He goes on to state that there are three sets of data (not two as in variance analysis) which need to be analysed together to give information for control. These are :

- The planned, or budgeted expenditure of resources
- The actual expenditure of resources
- The value earned, or more commonly the 'earned value' by this actual expenditure of resources

A good control and information system must make good use of the three sets of data, that is baseline level of performance (ie : plan and budget), the actual performance (ie : progress, costs or resources used) and the earned value obtained by the use of these resources. Furthermore, such a system must bring to a management's attention and also those responsible, any deviations from planned performance so that corrective action may be taken as required. Essentially, it should serve to demonstrate positively to people what their performance has been and what is required to keep a high performance, or what is required to bring up performance to the planned, anticipated values.

The effective control of a project cannot therefore be achieved without the integration of all the sub-systems for control. Harrison (1985) goes on to state that previous experience has shown it is essential that :

" planning, budgeting, information and control of both progress and cost must be integrated with the work to be done, who is to do it, organisation structure, and that this integration is the basis of an effective project management system "

Kerzner (1992), in a similar fashion to Harrison states [79] :

" that management must compare the time, cost and performance of a project to the budget time, cost and performance, not independently but in an integrated manner "

Above all, Oberlender (1993) comments that experienced project managers are familiar with the problems of using only partial information such as time or costs only to track the status of a project. [80]

It is therefore necessary to take cognisance of Kerzner's and Harrison's belief regarding proper integration of time, cost and performance. Kerzner (1992) concisely describes the two main purposes of exercising control. [81] Firstly, it serves as a verification process by comparing actual to planned performance. Secondly, control requires a communication process to take place and allow decisions to be made effectively and timeously by management.

4.16 PRINCIPLES OF EFFECTIVE CONTROL METHODS

Neale and Neale (1989) have described monitoring and control as the core activity of site management consisting of essentially three components. [82] Firstly, information requires to be *collected* about the actual achievements on the project. Secondly, this information has to be *processed* into simple reports which compare planned and actual progress to aid project communications. Thirdly, any *controlling* action or replanning should be taken as may be necessary. Wearne (1989) tabulates important factors as put forward by Noon with regard to over or under planning and control of projects, and these are shown in Table 4.16. [83]

The lists are not intended to be extensive but if a predominance of the points are present in any one quadrant of the table, then some action on a particular project will be necessary to achieve a correct balance of planning/ controlling and cost.

Table 4.16 : Indicators Of Over Or Under Planning And Control

	UNDERPLANNED	OVERPLANNED
Undercontrolled	Plans and budgets are not available Few routine reports Meetings only in crisis Cash flow problems Staff complain of lack of direction, or erratic work loads Management dominated by personalities Many projects have priority High proportion of tenders lead to orders Poor relations with customers, particularly because of poor deliveries Poor, erratic profits No enthusiasm present	Plans out of date or "the project runs the planning" Few progress reports, all unrelated to the plan Meetings triggered by crisis Staff complain of lack of direction Management involved in details High proportion of tenders lead to orders Many projects have priority
Overcontrolled	Violent changes of direction Plans and budgets not available Extensive formal processing activity not related to plans Frequent detailed meetings Cash flow problems Staff complain of frequent job changes Staff of low calibre "Low-level" personalities dominant No top management support for systems Customers exert pressures History of delivery crisis	Many forms of report in evidence Frequent formal meetings Little cash flow difficulty Staff tend to be low calibre, leave work on time Top management enthusiasm for systems Programme and progress reporting at high level Poor tendering success rate Good relations with customers History of recent crisis and/or management changes

Source : Adapted From Wearne S. : Engineering Management - Control Of Engineering Projects - 1989

Neale and Neale (1989) tabulate items which require to be monitored and controlled and these are shown in Table 4.17.

In the project environment the contractor has to monitor and control direct costs such as labour, plant, materials and sub-contractors; on-site overheads such as site staff, offices and equipment; and off-site overheads such as HQ costs, insurance and finance costs. The indicators of over or under planning and control and the ways of monitoring construction resources and costs make constant reference to terms such as project budgets, cash flow and S-curves. The use of this terminology will be explained in succeeding paragraphs of this section of the chapter.

In all cases, for effective project control, information requires to be collated, analysed and acted upon timeously to allow management to correct deviations where possible.

Table 4.17 : Methods Of Monitoring Construction Resources and Costs

	Principal resources and costs	What can go wrong?	How can resource use be monitored?	Some possible control measures
Direct Costs	Labour	Low output Industrial action Sickness and Absenteeism	Regular cost/income comparisons "s" - curves	Replanning Bonus systems Enlightened management and welfare
	Plant	Low output/misuse Breakdowns Theft	Regular cost/income comparisons "s" - curves	Operator training Preventative maintenance
	Materials	Waste Overuse/misuse Short measure Theft	Regular reconciliation of delivery and use "s" - curves	Delivery checks Setting-out checks Good housekeeping Secure
	Sub-contractors	Insolvency Inefficiency Incompetence	Progress monitoring Firm negotiating	Financial and technical vetting before contract
On-site Overheads	Site staff	Too many/few Inexperienced Lack of skill and understanding	Compare actual costs with forecast staff costs and other project staff costs	Issue written job descriptions Control staffing Practical training Provide motivation
	Site offices/equipment transport etc	Full establishment remains on site after reduction of level of activity	Compare time-related establishment cost with turnover	Adjust establishment to suit turnover
Off-site	HQ office costs	Plenty !		
	Insurance	Poor damage and accident records Pushes up premium	Accident reporting system	Disciplinary measures for carelessness Training
	Finance costs	Heavy start-up costs not matched by early income Client slow to pay	Value-income monitoring	Quicker certification Rigorous credit control Good client relations

Source : Neale R.H. and Neale D.E. : Engineering Management : Construction Planning : 1989

4.17 PROJECT BASELINE PLANNING

The baselines for any project control system (as discussed in Section One of this chapter) are the finalised optimum baseline schedule and a time phased budget of costs based on it. The cost estimate for a project and the project baseline schedule must be integrated into a time phased budget with cost centres based on planned activities, each of which, will have a budgeted expenditure for each time period involved. If this is not done, the project manager will lose financial control, and hence overall management control of a project. Many project management planning software packages (discussed in chapter 5) automatically prepare a project budget from the baseline plan.

The two critical performance baselines, that is, the plan and time-phased budget are not static baselines. Projects by the uniqueness of their nature tend to deviate from original plans in many instances. It can be argued that the original baseline plan and budget should always remain the baseline and should not be altered to take account of changes that may have occurred. The reasoning behind this view is that if the original plan and budget are frequently changing then they are merely being adjusted for inefficiency, and change would therefore not provide a valid baseline. The counter argument is that many changes do occur in project work and if the plan and budget are not changed to take account of the major changes then they will quickly lose credibility as a control baseline.

More important than these two views is that the plan in addition to being a control baseline should be considered as an important management tool to assist the project manager in making decisions in relation to the project. The baseline plan and budget must, therefore, be maintained as a real time aid to the management of a project. However, budgets should not just be changed because costs to date are higher than budgeted or if progress is less than planned. That is, to say, budgets and plans should not be changed to compensate for variances already experienced. The principal factors which should be considered in determining whether a baseline budget or plan should be updated are changes to the project, variations in the plan or inflation.

When work on a project commences, changes to the time phasing of the work will probably occur and when this has happened the time-phased budget will also be affected. If an activity is re-planned to start later or take longer than was originally planned then the time phased budget should be changed. If the original plan and estimate have been inaccurate then it may be necessary to re-plan, re-estimate and re-budget the complete project in order that the project manager can make the best decisions in the light of the changed circumstances. This kind of major revision should not be undertaken lightly.

4.18 PROJECT BUDGET

The budget is a financial plan for the contract as a whole and is normally used in construction work for two main purposes. Firstly, it may be used as a yardstick against which to compare actual progress; secondly, it allows the amount of liquid cash that will be required over the various periods of the contract to be determined. Pilcher (1992) in a simple but effective manner describes the budget as being a financial version of the programme, or a financial forecast. [84] The use of budgets are important to companies with regard to establishing their trading position when taking all project budgets into account. Much money is normally involved in construction work and the process of formulating accurate budgets and cash flow forecasting (now to be discussed) is fundamental to the successful management of an organisation.

Budgeting allows, in addition to being a performance baseline, a facility for cash flow forecasting. Cash flow forecasting is important to a contractor as the process establishes the difference in funding that a contractor requires to support on-going projects as opposed to the money that is being obtained in terms of payments to the contractor. The budget, in the initial stages of a project is used to forecast cash flow; thereafter, as work commences, the budget forecasts of cash flow must be modified by an analysis of performance on the project. The traditional method of graphically depicting project cash flows is by the use of 'S'-curve analysis. Here, Baumgaertner (1986) comments that project budgeting is one of the most important aspects of project management. [85]

4.19 METHODS OF PROJECT CONTROL

The traditional form of budgetary control is by means of variance analysis, that is to say, the comparison of budget costs with actual costs. This form of accounting oriented analysis has previously been described as *inadequate* for the control of project work, since it informs only whether more or less has been spent than was budgeted for in the time periods concerned. It does not indicate whether the work expected for the money spent is being achieved. Variance analysis of cost *must* be integrated with progress, through some form of measurement of progress, such as the percentage complete on an activity. This idea of integrating costs with progress and time is sometimes referred to as the 'earned value' concept.

Overheads within a project environment have to be accounted for and controlled and are more difficult to allocate than labour, plant, material or sub-contract costs which can easily be allocated to work packages. Overheads can be divided into two classifications, namely direct overheads or indirect overheads. Direct overheads can usually be allocated to a work package, but indirect overheads which cannot be apportioned to such packages must be allocated to a project as a whole. For example, central company overheads would come into this category. An overhead rate for the organisation may be calculated in any annual period on the basis of a percentage of total annual turnover. This application rate can thereafter be applied to individual projects.

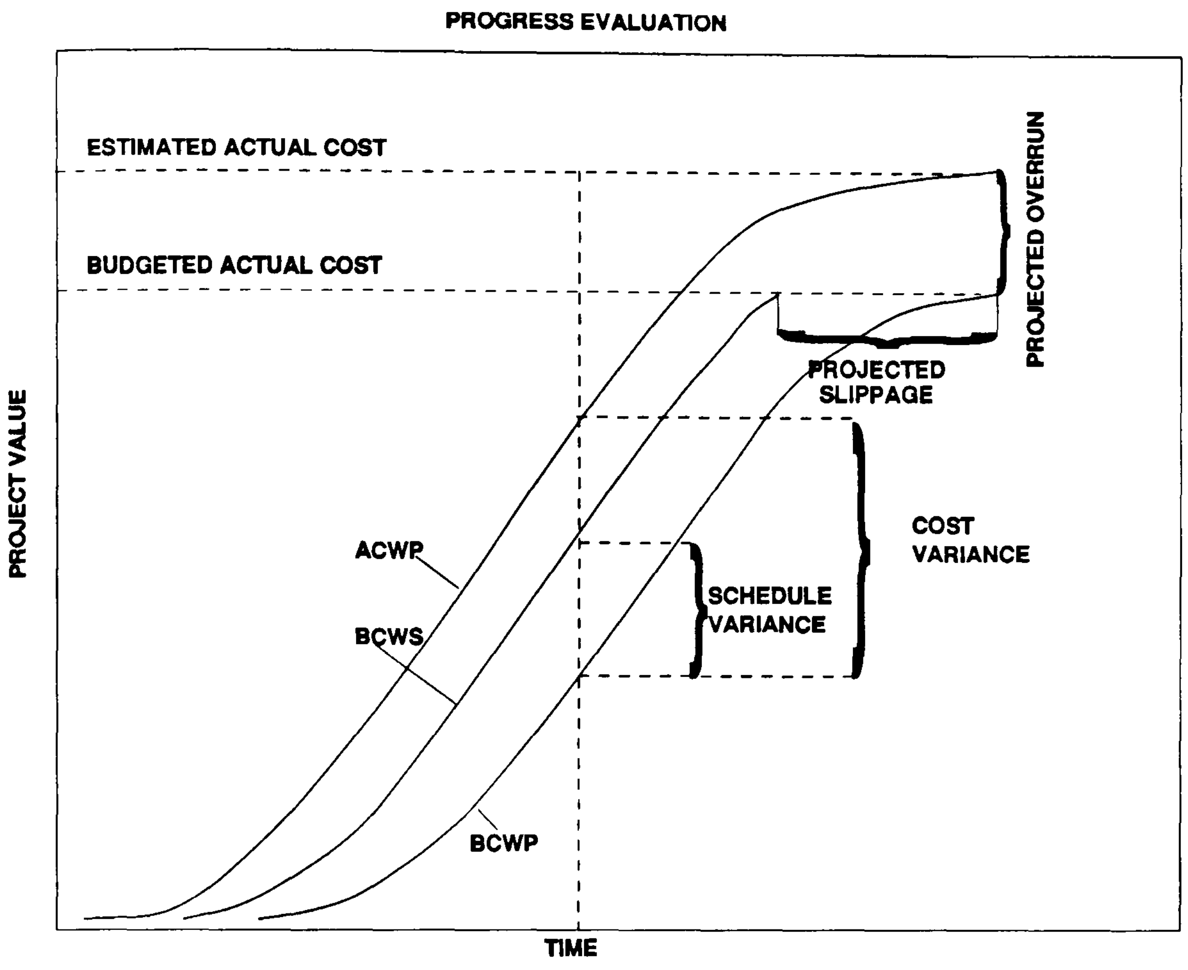
4.19.1 'S' Curve Analysis

Neale and Neale (1989) describe 'S' Curves as being the basic tool for the subsequent monitoring and control phase of a project. [86] Stevens (1986) states that an integrated cost/schedule performance curve provides a visual summation of a project's cost, time and performance status. [87] Hajarat and Smith (1993) further comment that [88] :

> *" the relationship between time and cost in construction is often represented by means of time/cost curves "*

'S' Curves can be used to show the amount of planned resources against time in the pre-execution phase and thereafter allow control of actual resources consumed against time. 'S' Curves may be drawn to represent money, people, materials and even overheads. The typical shape of an 'S' Curve is shown in Figure 4.7.

Figure 4.7 : Example Of 'S-Curve' (Earned Value Analysis Curves)



Source : Adapted From Association Of Project Managers : Closing The Gaps In Project Management Systems - Systems Gap Working Party Report - 1984

'S' Curves are prepared from the project programme and are used to show the anticipated expenditure and income for a particular project. They can be prepared by assigning each Bill of Quantity Item within a project to a specific activity on the contractor's programme of works. The total sum of money expended to complete each activity requires to be calculated and recorded on the programme against the relevant activity. Normally, this sum of money is apportioned evenly over the duration of the particular activity.

The total sum of money expended for each successive time period is obtained by adding together the sums of money for each activity taking place during that same given period of time. The cumulative sum of money expended each time period can then be obtained and a graph drawn. This graph will normally take the form of a smooth curve linking the points in the shape of an extended 'S', hence the term 'S' curve. The process should be repeated for income with due allowance being made for retention money.

Both expenditure and income should be plotted together against time. It must be noted that the income will be in the shape of a 'ladder' as payments are only made at stipulated regular intervals, normally monthly, after certain values of work have been carried out. The shape of an 'S' Curve normally indicates the time on a project before maximum intensity of work is undertaken. As a project nears completion the level of activity is much reduced prior to final completion. These same control curves can be used for progress and cost/value comparisons on projects.

A number of advantages of the 'S' curve method are that it enables a contractor to determine the maximum sum of money that will have to be provided to finance the contract and when profit is expected to be made, allowing individual contract cash flows and hence total company cash flows to be determined.

4.19.2 Performance Analysis

For effective project control there must be a reliable estimate of progress carried out on a project up to the time of the assessment process. This may consider progress simply in terms of 'percentage complete', or may take a form such as the 'earned value' method which attempts to measure progress against value of work achieved.

It is the case on many projects that an over-optimistic estimate of percentage completion is made with the result that these projects tend to be on schedule and budget up to 80-90% of their total value. Thereafter, they stay at this level until the project 'catches up' with previously reported estimates with a resultant increase in project completion date and overrun of budget. Reiss (1987) refers to this type of over-optimistic reporting as [89] :

" the 99% complete syndrome "

Harrison (1985) further states that modern project control methods attempt to limit this sort of subjectivity in assessing progress so as to allow control action, if necessary, to be taken at the earliest possible opportunity. [90] In his view a project manager needs the following information (shown in Table 4.18) in order to control a project effectively.

Table 4.18 : Information That A Project Manager Needs For Effective Project Control

	INFORMATION THAT A PROJECT MANAGER NEEDS FOR EFFECTIVE CONTROL
	What Has Happened In The Past With Respect To Time ?
1.	Are we on schedule, ahead of schedule or behind schedule ?
2.	If we have a variation from schedule, where did it occur ?
3.	If we have a variation from schedule, who was responsible for it ?
4.	What effect will a variation have on other parts of the project and what will we do about it ?
	What Has Happened In The Past With Respect To Budget ?
1.	Is the work being completed to the budget estimate, or less than the budget estimate, or is it costing more ?
2.	If we have a variation from budget, where did it occur, why did it occur, or what caused it, who was responsible for it and what can we do about it ?
	What Is Going To Happen In The Future ?
1.	Are we going to be on schedule, on budget, or over schedule and over budget ?
2.	What is the trend of progress and cost ?
3.	What is the forecast of the final cost ?
4.	What is the final forecast of completion date ?
5.	Is the rate of work accelerating or decelerating as it should ?

Source : Adapted From Harrison F.L - Advanced Project Management - Second Edition - 1985

4.19.3 Earned Value Concept

McConnell (1985) describes the use of the earned value concept as [91] :

" a technique which is a proven method to evaluate work progress in order to identify potential schedule slippage and areas of budget overruns "

As described previously a project manager could measure progress against a pre-determined schedule and measure the actual cost of work performed against the project budget. However, it was not possible to determine whether, or not, for the money spent, the appropriate progress was being achieved or, conversely, how much should have been spent on the progress achieved compared to the actual costs incurred.

Oberlender (1993) states [92] :

"for example half of a project may be expended by the midpoint of the scheduled duration, but only 20% of the work may have been accomplished "

The earned value concept integrates cost, time and progress elements within a project to alleviate this problem. The concept essentially consists of comparing the budgeted cost for work performed on a simple rates basis to calculate project variances with respect to cost and time.

Barnes (1988) amplifies the need for an integrated control system in terms of time and cost [93]:

"earned values are needed for economic measurement of output and as a basis for the controlling process (considering both the whole company as well as the project)"

However, Oberlender (1993) stresses that [94]:

" to be effective a project control system must be simple to administer and easily understood by all participants in a project "

Furthermore,

" control systems tend to fall into two categories; they are either so complex that no one can interpret the results that are obtained, or they are limited because they apply to only costs or schedules rather than integrating cost, schedules, and work accomplished "

The *Budgeted Cost for Work Scheduled (BCWS)* is effectively the time based schedule against which performance is measured for the project, and for individual cost accounts. For any given time period the BCWS is determined by cumulating all the budgets for all work packages (activities) scheduled to be completed, plus the budget for all work packages in progress scheduled to be accomplished, plus the budgets for the overheads for that period.

The *Budgeted Cost For Work Performed (BCWP)* is effectively the budgeted cost of all work completed during any given time period. The BCWP is determined by accumulating the budgets for work packages actually completed, plus the budget applicable to the completed-in-progress work, plus the overhead budget. The evaluation of the work in progress element of the BCWP necessitates in an assessment of how much of the proportion of individual work packages have actually been completed.

The *Actual Cost of Work Performed (ACWP)* is simply the costs that have actually been incurred and recorded in accomplishing specific items of work within a particular period.

These three elements of data, that is, the BCWS, BCWP and ACWP can be used to calculate cost and schedule variances. Time and cost estimates to completion can thereafter be produced by this method. Figure 4.8 shows the terminology commonly used in earned value analysis. Care must be taken when using the 'earned value' technique that people are aware of the principles of the method and that they have been adequately trained.

Figure 4.8 : Earned Value Analysis Terminology

EARNED VALUE ANALYSIS TERMINOLOGY

Cost Variance = BCWP - ACWP
Schedule Variance = BCWP - BCWS
Cost Performance Index (CPI) = BCWP / ACWP
Schedule Performance Index (SPI) = BCWP / BCWS
Estimate To Complete The Project (ETC) = (BAC - BCWP) / CPI
Estimate At Completion = ACWP + ETC

Kerzner (1992) puts forward a number of different project scenarios which when analysed using the 'earned value' technique can give interesting information on the true status of a project. [95] Each gives an analysis of the 'true' interpretation of the current project status in terms of both time, and cost. These are shown in Table 4.19.

Table 4.19 : What Can Be Established About A Project's Status By Earned Value Analysis ?

Case	Planned Earned Value (BCWS)	Actual Costs (ACWP)	Actual Earned Value (BCWP)	Description
1.	800	800	800	This is the ideal planning situation where everything goes according to schedule.
2.	800	600	400	Costs are behind schedule, and the project appears to be under-running. Work is being accomplished at less than 100%, since actuals exceed BCWP. This indicates that a cost overrun can be anticipated. This situation grows even worse when we see that we are 50% behind schedule also. This is one of the worst possible cases.
3.	800	400	600	In this case there exists good news and bad news. The good news is that we are performing work efficiently (efficiency exceeds 100%). The bad news is that we are behind schedule.
4.	800	600	600	The work is not being accomplished according to schedule. However, the costs are being maintained for what has been accomplished.
5.	800	800	600	The costs are on target with the schedule, but the work is 25% behind schedule because the work is being performed at 75% efficiency.
6.	800	800	1000	Because we are operating at 125% efficiency, work is ahead of schedule by 25% but within scheduled costs. We are performing at a more favourable position on the learning curve.
7.	800	1000	1000	We are operating at 100% efficiency and work is being accomplished ahead of schedule. Costs are being maintained according to budget.
8.	800	600	800	Work is being accomplished properly, and costs are being underrun.
9.	800	1000	800	Work is being accomplished properly, but costs are being overrun.
10.	800	1000	600	Costs are being overrun while underaccomplishing the plan. Work is being accomplished inefficiently. This situation is very bad.
11.	800	600	1000	Performance is ahead of schedule, and the costs are lower than planned. This situation results in a big Christmas bonus.
12.	800	1200	1000	Work is being done inefficiently, and a possible cost overrun can occur. However, performance is ahead of schedule. The overall result may be either an overrun in cost or an underrun in schedule.
13.	800	1000	1200	Although costs are greater than those budgeted, performance is ahead of schedule, and work is being accomplished very efficiently. This is also a good situation.

Source : Adapted From Kerzner H. - Project Management - A Systems Approach To Planning, Scheduling And Controlling - Fourth Edition - 1992

4.20 MANAGEMENT COST AND CONTROL SYSTEMS (MCCS)

The work breakdown structure (WBS), as discussed in section two of this chapter is an essential component of a project management system. Personal responsibility for progress and cost can be identified at the appropriate level of the WBS. The requirements for control in the project environment are generally completely different to those of a traditional accounting system and therefore necessitate a separate management information system to the normal accounting system of a firm. Such a system must integrate progress and cost and be quicker from an 'update' point of view than a traditional accounting system.

The term normally given to the overall planning, cost and control system in organisations which practise project management is the Management Cost and Control System (MCCS).

Kouskoulas and Grazioli (1977) state that the integration of project operations into a single process is very difficult and practically impossible without the introduction of computer methods. [96] They describe the mechanism as comprising of two steps. Firstly, the development of a project management system which contains in their natural sequence all the algorithmic operations necessary for project management. Secondly, the developed system should be computerised.

Turner and Speiser (1992) relate that over the last three decades, project management information systems have gone through three stages of development [97] :

- early systems - essentially just critical path networking packages
- followed by - PERT systems with additional functionality
- current day - computerised planning and control information systems

However, they state that :

" existing project management information systems are unable to meet all the needs of programme management "

Kerzner (1992) describes the phases of a Management Cost and Control System as being represented by a two-cycle process: a planning cycle (discussed in Section One of this chapter) and an operating cycle. [98] He goes on to state that the purpose of any management cost and control system (MCCS) as being the process of establishing policies, procedures and techniques that can be used in the day-to-day management of projects. The information elements that Kerzner believes are essential requirements of a planning and control system are depicted in Table 4.20.

Table 4.20 : Information To Be Provided From A Typical Project Planning And Control System

	Information To Be Provided From A Typical Project Planning And Control System
1.	Indicate a true picture of work in progress
2.	Indicate the relation between cost and schedule performance
3.	Identify potential problems and their sources
4.	Provide summarised information to project managers
5.	Demonstrate that important scheduled events are able to be obtained

Source : Adapted From Kerzner H. - Project Management - A Systems Approach To Planning, Scheduling And Controlling - Fourth Edition - 1992

In addition the planning control system may be utilised to develop planning, measure progress and control change. In this context, the Association of Project Managers (1984) state that a Project Management Information System has the following functions as depicted in Table 4.21. [99]

Table 4.21 : Functions Of Project Management Information Systems

	Functions Of Project management Information Systems
1.	To develop plans, schedules and budgets and corresponding standards of performance
2.	To provide all participants with information to permit timely control action to be taken
3.	To generate and transmit progress information
4.	To analyse progress information for control purposes
5.	To present summarised information to management
6.	To revise or redevelop plans
7.	To pass on revised information
8.	To simulate and analyse alternatives open to decision

Source : Adapted From Association Of Project Managers : Closing The Gaps In Project Management Systems - Systems Gap Working Party Report - 1984

Essentially these functions can be seen to relate to the concepts of planning, information dissemination by management and information retrieval relevant to progress and current status. Management must compare the time, cost and performance in an integrated manner.

Otter (1985) comments that [100] :

> *" all too often project control systems are sluggish and cumbersome to operate, error prone and do not link in automatically with other systems "*

He goes on to describe opportunities for creating responsive computer based project management tools and techniques which can overcome these problems. It is evident that if such problems can be readily overcome then project control systems can be of great assistance to the project manager.

4.21 APPLICATION OF CHAPTER FOUR

The sub-system for planning and control was initially presented to show the input-conversion-output processes associated with the aim of achieving improved efficiency and control in the execution phase of projects.

Input elements of the planning process included details of time, resources (including costs) and the division and allocation of work through the utilisation of work breakdown structures and linear responsibility charts. The conversion processes were seen to involve implementing, monitoring, controlling, adjusting, reporting, and communicating project plans to allow up to date information and meaningful decisions to be made on projects.

The chapter looked at the overall purpose of planning and the various methods of representing projects in plan form. Planning techniques, widely used within the construction industry, were considered along with a detailed analysis of the computations and information that can be derived thereafter by adopting network analysis procedures. The review has also considered the important techniques of work breakdown structures and linear responsibility charts to illustrate how work may be sub-divided and communicated to project personnel. Methods of project control to monitor, track and update 'baseline' plans were studied to emphasise the dynamic nature of planning in the control phase.

There are two main areas of the literature review where particular further investigation is carried out in the later empirical chapters (chapters ten and eleven). Firstly, the general approaches to planning and control by both private and public sector construction contractors are investigated. This is to assess the extent of use of planning 'tools' and will allow similarities and differences between the two sectors to be established. Secondly, and more specifically, an analysis of the methods in use for project costing is looked into. This is to determine whether costing is considered in an integrated manner with planning and control processes, or otherwise.

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CHAPTER FIVE : PROJECT MANAGEMENT SOFTWARE

5.1 SUMMARY OF CHAPTER FIVE

Initially the various types of applications of software relative to Project Management are discussed from their evolution to their current state of development. During this process the development of computer hardware is also considered to illustrate its impact on software development.

The complete planning process is analysed from the point of view of implementation using a microcomputer, including the formulation of 'baseline' schedules and subsequent monitoring and control.

A basis for the evaluation of the many available project management planning and control software packages is put forward prior to looking at various surveys on software analysis, already carried out.

A brief look into recent research on how microcomputers have influenced the planning process in the construction industry concludes the chapter.

5.2 TYPES OF PROJECT MANAGEMENT SOFTWARE

Nathan (1991) has stated [1]:

" research on information technology, compared to other areas has been fragmented and limited in scope. One reason for this is the recentness of the new technology, in particular microtechnology, and the ubiquitous microcomputer "

However, there are many software applications available which may aid a project manager in the management of projects. Maxwell (1985) comments that microcomputers can greatly influence the cost effectiveness of civil engineering resources to ensure optimum performance. [2] Dworatschek (1986) lists four types of project management applications software used in practice that can be identified. [3] These are, network technology software, specific functional software, workplace software and computer-based training (CBT) teachware.

Network technology software provides the basis for the formulation of the standard planning elements of a project, namely, the work breakdown structure, time schedules, cost schedules, resources schedules, comparison of 'actual versus planned reporting' along with the capability to output reports in varying formats.

Specific functional software includes such needs to meet increasing demands in areas including risk analyses, configuration management, cost controlling, cost estimation and expert or knowledge based systems.

Workplace software consists of a number of diverse software packages to cater for requirements relative to word processing, spreadsheet calculation, business graphics and databases; all these functions make it possible for the project manager to augment his productivity.

An increasing number of project managers, in order to meet rising demands for training of new project staff have discovered the importance of *computer-based-training (CBT) teachware.*

Badiru and Whitehouse (1989) describe how project management applications software has developed by two main sources, namely users themselves, or by professional programmers.[4] They list various advantages and disadvantages of either method and these are shown in Table 5.1.

Table 5.1 : Advantages And Disadvantages Of Commercial Versus User Written Software Packages

TYPE OF PACKAGE	*ADVANTAGES*	*DISADVANTAGES*
Programs Written By Users	• can be written to meet exact needs of user • if successful they can be sold to other interested parties	• a high level of programming expertise is needed • they require much development time • there is lack of formal testing
Commercial Programs	• can be produced for immediate use • they are relatively inexpensive • they are available for many applications • May be customised to fit user's needs	• may be too general to meet user requirements • may not be computer compatible • frequent updates may cause disruption to operations

Source : Adapted From Badiru A.B And Whitehouse G.E. : Computer Tools, Models And Techniques For Project Management - 1989

Atkin (1985) [5], Fisher and Atkin (1985) [6], Barnes (1987) [7] and Otter (1987) [8] all refer to the need to integrate such elements as estimating, bidding and job costing into the project management information system. However, Aish (1989) [9] describes this possibility as being a future one, rather than the present, despite taking account of the recent tremendous developments in computer technology. His reasons are primarily the fragmented nature of the construction industry and the fact that many people are actually against such developments.

Arditi and Rackas (1986) [10] and Norman (1987) [11] contend further that computerised systems in the industry have been used only for functional purposes such as business administration and not pure project management. The scope of this study will concentrate on project planning and control software in view of its importance in the planning and control aspects of project management which have been previously discussed in Chapter 4.

A survey carried out by the UK Construction Industry Computing Association (CICA), showed that less than a third of 800 contractors contacted were using computer based project management. [12] Artemis (1993), a leading software vendor for project management planning and control software provide a useful description of what a good package should be able to achieve [13] :

" Excellence in project management means being able to keep your fingers on the pulse of progress, to know what has been achieved, what's to come, and what's going on right now "

According to Atkin (1983), a report of the Alvey Committee called for, [14]

" a massive input of research and development on information technology. In particular, it places great emphasis on the efficient and productive use of existing information technology in order to pave the way to the subsequent use of the more advanced technology. At the same time it stresses the need to improve the capability and understanding of users of current information technology, which is considered to be particular poor "

The above paragraph is particularly relevant to the area of project management planning in view of the major advances in computer hardware and planning software over the last 10 years, or so. The development of such software planning packages is now discussed further to indicate the speed with which technology has changed over this short period of time.

5.3 DEVELOPMENT OF PROJECT MANAGEMENT PLANNING SOFTWARE

Meredith and Mantel (1985) [15] acknowledge the benefits that can be obtained by using manual project management information systems. However, they comment :

" there is a definite need for computerised systems because of the nature and size and complexity of most projects "

Badiru (1988) describes how the present stage of project management planning computer software has been achieved through five distinct generations of software evaluation. [16]

The *first-generation* (Pre-world War II) was the era of the unstructured project when managers executed the project plan (if indeed there was one) by 'gut-feeling' rules. The *second-generation* (from Mid 1950's) was the era marked by the emergence of critical path analysis. However, project analysis was carried out manually at this time. The *third-generation* (from the early 1970's) was the era when mainframe computer applications of PERT/CPM became prevalent. Access to the programs was restricted to only those with the necessary hardware, mainly in the form of mainframe computers. The *fourth-generation* (from the early 1980's) marked the period when more accessible project management planning programs became available on mini and micro-computers. This accessibility gave managers a readily available tool for timely project monitoring and control. The *fifth-generation* (from the mid 1980's) marked the introduction of integrated project management packages. These particular programs combined the traditional network type analysis with project graphics, report generations, spreadsheet, and cost analysis. The sixth generation is developing from packages already available.

Project Management applications have exploited the developments in computer technology; the availability of powerful, reliable and inexpensive personal computers has contributed widely to the use of project management software. A useful comparison of the hardware developments facilitating the use of project management software is put forward by Grove (1986) [17] in Table 5.2. (it should be noted here that these specifications relate to average hardware characteristics)

Table 5.2 : Comparison Of Hardware Specifications For Supporting Project Management Software Between 1979 And 1986

1979 MINI COMPUTER	***1986 PERSONAL COMPUTER (PC)***
20 Mb hard disk	30 Mb hard disk
10 Mb removable disk storage	20 Mb removable disk storage
64 k memory	640 k memory
Mono graphics	Colour graphics screen
Plotter (4-pen slave to terminal)	Plotter (8-pen)
Printer (low quality - 180 cps)	Printer (near letter quality - 200 cps)

Source : Adapted From Grove T. - Integrated Project Management On The Personal Computer - GMP/INTERNET Symposium 1986

In 1993 the average specification of a PC being used as a stand-alone computer running project management software and other applications software would be of the following order :

- Laptop, or notebook portable colour computer
- 120 Mb Hard Disk
- 8 Mb RAM
- Colour graphics
- Printer (Laser, 600 dpi)

New computer technology has also led to much faster operating systems resulting in increased processing times of the large amounts of data inherent in many projects associated with the use of project management planning techniques. Over and above the advancement in computer hardware and software with respect to the development of project management planning packages, there are other issues which make computers desirable, if not absolutely fundamental, to the successful planning and control of projects. Among other factors, projects are being carried out with an increasing complexity of tasks and there is also the need for a greater knowledge base from which to work in the project environment. However, according to Wall (1988), [18]

" practice lags behind technical possibility "

That is to say, that a consequence of technological change can lead to opportunities not being exploited expeditiously. Yeo (1991) further comments that the failure to fully exploit the potential of information technology is largely due to a lack of experience and inhouse expertise, problems in training and generally a less than enthusiastic attitude towards computers mirroring a resistance to change. [19]

5.4 PROJECT MANAGEMENT PLANNING USING MICRO-COMPUTERS

Abang and Beasley (1986) [20] and Naylor (1987) [21] comment on some of the advantages that microcomputer based planning and control systems can give to the project manager. Abang and Beasley also list some disadvantages. All are shown in Table 5.3.

Table 5.3 : Advantages And Disadvantages Of Planning/Control Software

ADVANTAGES OF PLANNING/CONTROL SOFTWARE	DISADVANTAGES OF PLANNING/CONTROL SOFTWARE
1. Reduced dependence on data processing dept. 2. Absence of mainframe queues 3. No necessity for the specialist facilities required for a mainframe computer - a desktop will do 4. The interactive capability can speed up work and response 5. Simplified control because of micro constraints 6. An ability to formulate an 'ideal' plan which can be adjusted as necessary to reflect reality, through a process of adding constraints and performing 'what ifs' quickly, a daunting process to go through manually 7. Increased data security, as disk access is relatively easy to control 8. Generally greater autonomy for the user	1. A DIY tendency which can be detrimental if the micro user lacks expertise in the area and is inexperienced in the project management function, not realising the limitations of the package used 2. The development of a situation where a user is regarded as the 'micro expert' in the department/comp with a consequent increase in demand for his/her time in non-project related areas 3. Micros can be very seductive, and in fact addictive, which can lead to more time than is necessary being spent with the machine rather than on the specific requirements of the project (eg meeting people, talking over problems etc) 4. A tendency to become distracted from the real issues and a concentration on what may be termed the 'process' of the project rather than the progress

Source : Adapted From Wall A.J. - Project Planning And Control Using Micros - 1988

Levine (1986) discusses how the role of the computer fits into the process of project management planning. [22] He goes through the complete planning process from setting initial objectives, through to formulating 'baseline' planning of time and costs before examining how the microcomputer can be effectively used in the project control phase once the project has reached execution phase. He concentrates on the following five areas :

- Establishing project objectives and definition of work
- Formulating logic and time network
- Resource modelling
- 'Baseline' time and resource plans
- Project monitoring and control

5.5 CLASSIFICATION OF PROJECT MANAGEMENT PLANNING SOFTWARE

Levine (1986) [23], Riis & Thorsteinsson (1986) [24] and Kerzner & Thamhain (1986) [25] have all attempted to classify project management planning packages.

Levine (1986) splits the types of project management computer software into 4 categories, namely the bare bones level, the mass market level, the advance moderate level and the advance sophisticated level.

The *bare bones level* entered the market circa 1984/85 and can be described as programs that have many useful features to the project manager, but which also operate within severe limitations with regard to modelling the project. This level cannot facilitate project control. The *mass market level* extends from the bare bones level offering more features with respect to modelling of the project and also allows project tracking. The *advance moderate level,* according to Levine, attempts to bridge the gap between the mass-market level and the advanced-sophisticated level. More features are available and project control, cost monitoring and improved program functionality. The *advance sophisticated level* programs normally operate on the principles of a database system allowing greater functionality and reporting characteristics - however, with the need for a more complex program the ease of use and learning are greater than for lower level programs.

Riis and Thornsteinsson (1986) also split the types of project management planning software into 4 categories, but in a slightly different manner. These are simple, programs, medium developed programs, advanced project management programs and programs for solving specific tasks.

Simple programs offer some scheduling and simple resource planning facilities. Project Tracking facilities, if any, will normally be poor. *Medium developed programs* offer a combination of time scheduling and resource planning facilities. These will be suitable for use in combinations with well designed administrative systems. *Advanced project management programs* offer facilities for time scheduling, resource planning and cost control, along with good tracking, capabilities. These programs normally have database or file handling facilities. *Programs for solving specific tasks* include ones used for estimating purposes, risk management or other similar independent tasks.

Kerzner and Thamhain (1986) classified project management planning products in three levels.

Level 1 software is described as of use for single project planning only and any deviations from the original plan requires the complete replanning of the project. No project tracking is possible. *Level 2* software is described as of use for a single project and allow planning, tracking and reporting of projects. Projects may be managed beyond the planning stage and such software facilitates semi-automatic project control. *Level 3* software is described as packages featuring multi-project planning, monitoring and control by utilising a common database and allowing extensive cross-project monitoring and reporting.

Developments in project management software over the last 4/5 years have effectively led to all project management software packages being grouped into two categories. In an article in Project Management Today Magazine these were conveniently classified by Dooley (1989) as stand alone project management packages or development system project management packages. [26]

Stand-alone packages can be described as packages which contain certain fields of information relating to activities within a project with respect to resources, costs and such like. The range of information, which may be entered into the project database, is pre-designed and rarely open to alteration or extension. Some stand-alone packages allow multi-project facilities. In *development systems*, the range, quantity and type of information that may be stored in relation to a particular project is not pre-set. Generally speaking, before project activities are entered, it is necessary to define the database which will hold the items of activity, resource and cost information; only certain pre-defined fields necessary for network analysis techniques are pre-designed.

Development systems are more flexible in terms of the information that may be stored or reported from the system, but generally tend to be more difficult to use. Stand-alone systems are rather inflexible in nature, but it should be noted that many stand-alone systems now provide a facility to sort/select previously set data in formats required by the user.

5.6 CHARACTERISTICS OF PROJECT MANAGEMENT PLANNING SOFTWARE

Kerzner (1992) states that [27] :

" efficient project management requires more than good planning, it requires that relevant information be obtained, analysed and reviewed in a timely manner "

and

" whilst even the most sophisticated software package is not a substitute for competent project leadership - and by itself does not identify or correct any task related problems - it can be a terrific aid to the project manager on tracking the many inter-related variables and tasks that come into play with a modern project "

He lists a number of specific examples of the information that may be obtained from project management information systems. (Table 5.4)

Table 5.4 : Capabilities Of Project Management Information Systems

	CAPABILITIES OF PROJECT MANAGEMENT INFORMATION SYSTEMS
1.	Project data summary : expenditure, timing and activity data
2.	Project management and business graphics capabilities
3.	Data management and reporting capabilities
4.	Critical path analysis
5.	Customised, as well as standard, reporting formats
6.	Multiproject tracking
7.	Subnetworking
8.	Impact analysis (what - if ..)
9.	Early warning systems
10.	On-line analysis of recovering alternatives
11.	Graphical presentation of cost, time, and activity data
12.	Resource planning and analysis
13.	Cost analysis, variance analysis
14.	Multiple calendars
15.	Resource levelling

Source : Adapted From Kerzner H. - Project Management - A Systems Approach To Planning, Scheduling And Controlling - Fourth Edition - 1992

In a logical sequence project management planning packages are used to develop a baseline schedule for a project, develop resource plans and budgets and track the project schedule, resources and costs during the running of the project. The results will require to be displayed in a variety of formats throughout these various phases of the project.

Kerzner and Thamhain (1986) describe the extensive capabilities for project planning, monitoring and controlling present in all but the most simple project management software packages. [28]

Most packages allow networking in either activity-on-the-arrow or precedence diagram format. Calendars may be developed both for the overall project and individually for availability of resources. Graphic displays of output in network/WBS/Gantt form can be produced and preferably can be output via a plotter output. The output of reports should be flexible via the presence of a report generator within the program.

The program should allow resource allocation to be optimised by the use of algorithms. Updating should be able to be carried out and the input of revised time estimates and completion dates possible to re-compute revised schedules as necessary. The program should facilitate budget costs and actual costs for each activity in a network which will allow control of project expenditures as the project progresses.

Levine (1986), in his excellent publication 'Project Management Using Microcomputers', describes in greater detail extensive capabilities of most project management software packages. A summary now follows. [29]

5.6.1 General

In all computer-based project management systems, it is necessary to establish a specific named project file. Within this file all the data relevant to the project will be stored. Initially the project title and description will normally be input to the program so that all generated reports/graphics will have the same titles. A start date for the project is normally entered so that a reference point for activity date schedules is present. A variety of calendar formats exist within most programs. Varying work weeks can be depicted and holidays inserted. It may be possible to allocate different calendars to different activities or to stipulate different working schedules for different resources. Greater flexibility in defining calendars allows the actual project situation to be more closely modelled.

5.6.2 Scheduling

Programs should allow project schedules to be calculated from activity durations and the relationships between activities. Most programs allow either arrow or precedence networks to be formulated - however, the precedence method allows more complex inter-relationships to be modelled. It is preferable within projects to be able to break down work into various categories either on a responsibility basis, budget basis or more simply just particular sections of work. The use of a work breakdown structure (WBS) present in many programs facilitates this requirement and portrays the work within a project like an organisational chart. If data that has been stored within a project is needed to be retrieved by sorting and selecting from a WBS, a proper coding structure within the WBS will be necessary. This coding will allow only part of the project data-base to be looked at, if required, and hence will assist in the production of meaningful reports in relation to the project.

Each activity will either be given a number or some other form of identification and will be allocated a duration. An activity description is also input against each activity. Relationships between activities will also be entered into the program (varying depending on type of network adopted) to allow schedule times to be established. More precise modelling is possible by adopting precedence network procedures. Finish to start, start to start and finish to finish relationships can be depicted along with the introduction of lead and lag times to model closely the project involved. Most programs allow imposed start and finish times to be input for particular activities to again facilitate the modelling process.

The project schedule can now be processed which will produce a list of activity start and completion dates and the float of each activity. This schedule can be optimised in terms of time prior to assessing the impact of resource planning and budgets to the baseline schedule.

5.6.3 Resources

Within project management programs it is possible to manage the use of labour, materials and costs within a project. This involves determining what level of resources are required to carry out the work as planned in the baseline schedule, and also determining the optimum resource profile for a project taking into account time, scope and quality objectives. Project planning software will be able to computate resource usage against time for each resource. If the maximum level of a resource is known the software can also compute when additional resources are required.

Resource aggregation will normally result in a curve/histogram showing significant variations in requirements over the project period. Optimisation of this aggregation of resources can be achieved by allowing non-critical activities to be re-scheduled into time periods when demand is lower. This facility can normally be carried out with the program. Many programs allow resource limited scheduling, time-limited scheduling and a combination of time/resource limited scheduling. In resource limited scheduling, activities are scheduled when resources are available, but resource availability is not exceeded. The resources are assigned on a priority basis, normally those most critical first and others thereafter. The overall project durations may be exceeded using this method. In time-limited scheduling, activities are again scheduled according to the availability of resources and normally also in priority using total float values. However, to ensure project completion as in the baseline plan, resource limits can be exceeded. In time/resource-limited scheduling a secondary resource level can be invoked when the target completion date cannot be met with the base resource availability or the user may specify a date that the schedule can be allowed to slip to if target completion with base available resources cannot again be met. The computer can carry out these optimisation procedures readily with only minimal manual input required.

5.6.4 Costing

Management Software should allow the definition of a variety of cost types to be accommodated including fixed costs, resource driven costs and should allow certain costs to be apportioned in different manners across the duration of an activity. Programs should incorporate individual activity cost analysis and also provide a cash flow plan or project expenditure for the project. The production of a project cost plan establishes a baseline for measuring cost progress.

5.6.5 Optimisation of Baseline Plan and Tracking of a Project

The time/resource scheduling operations necessary to optimise a baseline plan for a particular project can make great use of computers with regard to 'what if ?' scenarios. This baseline plan is the tool used for computer tracking of progress.

Progress of activities once a project has commenced require to be input into the project management program. This can be carried out by inputting expected completion dates, remaining durations or by percentage complete. Out of sequence activity progress is handled differently by various programs and care must be exercised in this respect. Schedule progress can be depicted either in a tabular format with actual versus planned dates or graphically in Gantt Bar Graph type format. Resource tracking involves the input of actual resources utilised against particular activities compared with those anticipated. Resource performance can be monitored. A cost tracking framework must be set-up to match the tracking and analysis needs for the project, that is to say, the method of tracking costs must be able to compare with the original baseline cost. Where use of resources have been input, costing will have been calculated on a resource-driven basis. Fixed costs can normally be input independently to an activity.

Most programs can calculate the forecast of costs to completion by adding the actual costs to date with the estimated costs to completion. Areas where work has been carried out ahead or behind budget costs can be identified and reported upon with a view to taking remedial action as necessary.

5.6.6 Performance Monitoring

A technique available in many packages which assesses cost performance in terms of earned value is called earned value analysis. This technique is very powerful and relates time to cost and vice versa to generate accurate reporting of costs for work that is in progress. Earned value is the budget value for a particular item of work that should have been expended over a certain time period. If actual progress is maintained in terms of time and costs performance reporting of both the schedule and budget can be expressed in comparable units. The program's performance reporting should allow variances in current or projected status of the project to be compared against the original planned values and should also allow forecasting of the results at the completion of the project. The normal parameters which are either input or output from a computerised performance reporting system include budget at completion, budgeted cost of work scheduled, actual cost of work performed, estimate to complete, estimate at completion, forecast to complete, forecast at completion, cost variance and schedule variance. These terms have previously been discussed in detail in chapter four.

5.7 EVALUATION OF PROJECT MANAGEMENT PLANNING SOFTWARE

Arditi and Singh (1991) comment that the market has been flooded with sophisticated and versatile computer packages dealing with various elements of the construction process. [30] In many instances, existing and potential users of project management planning and control software will require some assistance, or guide, to the facilities offered by the many packages available.

Kerzner (1992) [31], Badiru and Whitehouse (1989) [32] and Stone (1988) [33] have all put forward 'checklists' for potential purchasers of project management planning and control software with respect to important factors which packages should possess.

Kerzner's evaluation parameters are shown in Table 5.5.

Table 5.5 : Evaluation Of Project Management Software Packages

	EVALUATION OF PROJECT MANAGEMENT SOFTWARE PACKAGES
Performance	Print Gantt to Laserjet/Print PERT to Laserjet Print Gantt to Paintjet/Print PERT to Paintjet Change views Recalculate schedule Level resources
Quality	Gantt chart on Laserjet/PERT chart on Laserjet Gantt chart on Paintjet/PERT chart on paintjet Resource levelling
Versatility	Project calendar Scheduling constraints Task durations Precedence relationships Other scheduling features Outlining Resource information Resource/cost allocations Levelling Task tracking Resource allocation tracking Gantt charts PERT charts Schedule reporting Resource scheduling reporting Resource profile reporting Cost reporting Cash flow reporting Earned value analysis Sorting Selecting Output Import/Export Networking Multiple project support Miscellaneous
Ease of learning/ Ease of use	Manuals and learning aids General program interface Project set-up Editing a project Tracking progress Preparing reports File management and printing General ease of learning General ease of use

Source : Adapted From Kerzner H. - Project Management - A Systems Approach To Planning, Scheduling And Controlling - Fourth Edition - 1992

In a similar fashion, Badiru and Whitehouse (1989) list a number of factors to be considered in the evaluation of software. These are shown in Table 5.6.

Table 5.6 : Evaluation Of Project Management Software

	EVALUATION OF PROJECT MANAGEMENT SOFTWARE
Project Plan	Ease of entering and storing the project plan Full precedence capability Limitations on number of activities (network size) Work breakdown structure capability Work splitting
Resource Management	Capability of assigning partial resources Resource levelling Assignment of costs What resource allocation heuristics are available ?
Progress Tracking	Display of time-based project schedule Project replanning (network editing)
Report Generation	Network diagram (limitation on size, ease of understanding) Gantt chart Milestone schedule Resource reports Cost reports Performance variance analysis
Ease of use	On-line training and help Input format Output format and contents Quality of documentation
General	Software version. Compactness (eg 3 discs versus 10 discs) File import/export capability Availability of trial package Copy protection and back-up procedures. Does the program permit limited or unlimited hard disk installations ? Speed of execution Compatibility with the computer hardware and other software used in the project environment
Software Capabilities	Analytical methodology (eg CPM,PERT) Number of tasks that can be handled (at least 50) Number of resource types that can be accommodated (at least 10) Help and error handling abilities Milestone identification Resource profiling and levelling
Hardware	Disk drive (single, dual, or fixed) RAM requirement Coprocessor or hardware board requirements Input devices (mouse, joystick, keyboard etc) Output devices (types of printers supported) Display unit/adapter WYSIWYG (What you see is what you get) screen capabilities
Vendor	Reputation Sales volume Replacement support Product support Toll-free telephone lines (for customer support) Cost of programme updates Other supporting products

Source : Adapted From Badiru A.B. and Whitehouse G.E - Computer Tools, Models And Techniques For Project Management - 1989

Stone (1988) in a slightly more restricted, but also useful, fashion gives a checklist for selecting network analysis software which is shown in Table 5.7.

Table 5.7 : Checklist For Selecting Network Analysis Software

	CHECKLIST FOR SELECTING NETWORK ANALYSIS SOFTWARE
1.	Can it be used for monitoring and control, or just planning ?
2.	Is it menu driven ?
3.	What format does the output have (barcharts and/or networks) and how is the critical path identified ?
4.	What output hardware is required - a printer and a plotter ?
5.	How easy is it to make changes ?
6.	Can the software optimise resource allocations ?
7.	Can the software manage a multi-project scenario ?
8.	Does the software adopt a hierarchal structure ?
9.	Is there an integral finance package ?
10.	Who else with similar requirements uses it ?
11.	How good is the documentation ?
12.	Is a benchmark test needed ?
13.	Will there be continuing support for the hardware and software ?

Source : Adapted From Stone R. : Management Of Engineering Projects - 1988

Badiru and Whitehouse (1989) state that [34] :

" a close examination of any modern project environment will reveal that it fits the criteria for using project management software "

They list a series of ten questions shown in Table 5.8 which can be used as a guide in determining whether project management software is required.

Table 5.8 : Is Project Management Planning And Control Software Required ?

No	IS PROJECT MANAGEMENT PLANNING AND CONTROL SOFTWARE REQUIRED ?
1.	Do you manage more than one project at a time ?
2.	Do your projects typically contain more than 20 tasks ?
3.	Is your project scheduling environment very complex ?
4.	Are more than five resource types involved in each project ?
5.	Do you perform other numerical analysis in your project management functions ?
6.	Is the generation of graphics output such as GANTT or PERT charts important ?
7.	Do you need to perform cost analysis on a frequent basis ?
8.	Is it necessary to generate forecasts from historical project data ?
9.	Is automated reporting important in your organisation ?
10.	Is computerisation one of the goals of your organisation ?

Source : Adapted From Badiru A.B. and Whitehouse G.E - Computer Tools, Models And Techniques For Project Management - 1989

If more than five of the questions can be answered in the affirmative, they advocate the use of project management software.

5.8 SURVEYS OF USE OF PROJECT MANAGEMENT PLANNING SOFTWARE PACKAGES

The basic characteristics of project management planning software packages have been discussed.

Surveys on the availability and use of project management planning software packages have been carried out by a number of sources, including the Project Management Institute in the USA (1982 onwards) [35], the Project Management Today Magazine in the UK (1989 onwards) [36], Wall (1988) [37] in an excellent publication via the National Computing Centre Limited and by Nathan (1991). [38]

The Project Management Institute's and Project Management Today's surveys concentrate wholly on project management planning software packages available, whereas Wall and Nathan also consider the more wider view of how the project planning fits into the overall picture of an organisation's activities. Each are now considered briefly.

5.8.1 Project Management Institute (PMI) Survey of Project Management Software Packages

The American Project Management Institute periodically carry out surveys of software in use in industry with the objective of assisting bodies considering the purchase of such a package. A subsidiary objective of the provision of the information is that it may result in project manager's being made more aware of the possibility of enhancing their abilities with respect to the planning and execution of projects.

The Initial survey took place in 1982, but a modified questionnaire form was circulated in 1986 to glean additional information on items such as user-friendliness, to eliminate less necessary information obtained in 1982 and also to adapt the survey results to the changes in computer software/ hardware which had taken place since 1982.

A wealth of information is provided for each individual project management software package. Webster (1987) states that [39] :

> *" Assuming that a potential purchaser has a good technical concept, or access to such advice, of the theoretical aspects of project management planning and therefore a good idea of his/her specific needs required in such a package then this survey can certainly provide an invaluable reference guide to potential buyers "*

A range of products to meet particular requirements can easily be identified by summary tables at the rear of the survey results, before as in-depth analysis and comparison of 'suitable similar' packages is made in the decision making progress.

5.8.2 Project Management Today Magazine - Guide to Project Management Software

Project Management Today Magazine, published monthly, was first introduced in October 1989. From this date, a regular feature of the magazine has been to assess monthly, a project management software package(s) on a benchmark testing basis. The 'ground-rules' for this benchmark testing were included in the inaugural issue (October 1989). The aim of the survey was to ask the question :

> *" What is the best project management package on the market for me ? "*
> *rather than the normal*
> *" What is the best project management package on the market ? "*

Each package is described as being a classic of the 80/20 rule. To find 80% of the facilities that one needs is not difficult but it is the remaining 20% that is the hard part. The choice of a particular package is almost inevitably going to be a compromise of some description. The project management software in the surveys was assessed by practising project managers and each package was reviewed within the framework of a consistent set of parameters including tests performed on a set of benchmark projects. The main categories, under which each package was considered, were an introductory section, modelling and scheduling, highlights and low points, support and a summary.

Each project management planning software package analysed in the survey was summarised in terms of flexibility, power and value for money. A 'scoresheet' for each package giving points out of a possible twenty for the following characteristics was also included in each survey. The idea behind this method was for the reader to personally 'weight' the factors which he/she most wanted from the package so that an overall weighted score could be ascertained and 'compared' with other package reviews. The characteristics of a package with points awarded were installation, documentation, environment, project structure, timing, resources, cost control, reporting, communication, support, ease of use, price, performance and any individually named highlights or low points

The Project Management Institute Survey and the Project Management Today Survey have concentrated wholly on Project Management Planning Packages and provide very useful and helpful information to potential purchasers of such products - as long as the prospective purchaser has a good technical knowledge of project management planning procedures.

Other surveys and directories providing information on project management software include Arditi and Riad (1988) [40], Arditi and Rackas (1986) [41] and Kerzner and Thamhain (1986). [42]

5.8.3 Study By Wall (1988)

A study was carried out by Wall (1988) under the auspices of the operations Management Division of the Management Centre, Slough College and the information collated, analysed and published in a book by the National Computing Centre named 'Project Planning and Control Using Microcomputers'. [43] The study concentrated on investigating the planning and control methods available to project managers, including those involving computers in conjunction with the examination of the types of project management software available on the market. One interesting aspect of the study indicated that :

> *" It is not common practice for a company to examine a large number of project management planning packages before deciding on purchasing such a product "*

Most organisations, in fact, appear to restrict themselves to a limited choice. One of the reasons put forward by Wall, was that those responsible for selection had little experience of where to look for information on packages. This may be so, but as discussed earlier in this Chapter a number of readily available sources exist in this respect. Another reason put forward by Wall is the sheer number of packages on the market with few people being aware exactly how many there are.(again access to a survey such as the PMI's which is updated regularly would alleviate this potential problem). Wall states that less than one quarter of users had used a package and had subsequently abandoned using it. However, only a very small number of such cases stated that they would not consider using such a package at a future date.

The questionnaire revealed that respondents had a good knowledge of the common terms and techniques of network analysis; however, the same was not true of planning, structuring and control techniques.

Respondents indicated that cost monitoring on half of all projects was applied to all activities in the project and on a third of projects a sample of activities was used for this purpose.

" None of the respondents, according to the survey, completed their projects ahead of schedule and some often were behind schedule "

Wall concluded that this was probably one of the prime reasons why project managers are looking for technological solutions to project problems. The time period for reviewing or reporting progress on projects was predominantly once a month, or once a week, with some companies carrying out bi-weekly assessments. Wall considered that one quarter of companies were using this 'update' project information within 1 day and three quarters within a week of the update to base future decisions on projects.

Wall (1988) summarised the functions of the 'ideal' package for project planning and control. His results are shown in Table 5.9.

Table 5.9 : Ideal Functions Of Project Management Planning And Control Software

	IDEAL FUNCTIONS OF PROJECT MANAGEMENT PLANNING AND CONTROL SOFTWARE
1.	Choice of activity-on-arrow or precedence networks
2.	Password security system
3.	Capacity of around 4000 to 5000 activities
4.	Around 200 resource capability would be sufficient
5.	Cost measurement and reporting facility
6.	Variable project start date
7.	Variable time unit measurement, from hours to months
8.	Ability to impose time restraints on activities and to schedule delays
9.	Progress marking - actual vs plan on the same report output for ease of comparison
10.	Several calendars, but one per activity or resource not necessary
11.	Resource smoothing - not essential, bit useful as an add-on module for those who want it
12.	Able to prioritise activities for resource allocation
13.	User-defined report generator
14.	Variance reports, preferably including graphical, clearly showing schedule and cost variances
15.	Network diagram and resource histogram printing
16.	If no presentation quality graphics, then data transfer ability to a popular package that can enable this
17.	Handle sub-networks and multi-projects
18.	Training in project planning and use of the software - needs to be effective and time-efficient

Source : Adapted From Wall A. - Project Planning And Control Using Micros - 1988

" Of those actually using project management planning packages 100% considered that they contributed significantly to improved planning of a project and almost 90% of users thought that the packages contributed to improved project control once they were implemented "

Further 'plus' factors in the use of planning software were that eight out of ten of respondents stated that such packages helped to improve data manipulation, three quarters seemed to think that savings in time and faster response to management crisis could be made, and two thirds stated that the software package used, aided the process of forecasting resource usage.

Wall further stated that six out of ten of respondents had concluded that :

" cost savings may also possibly result from the use of a software package in view of an improved plan for managers to manage, better project control and data manipulation "

Walls's study was taken over a range of 56 project managers responsible for planning and control aspects of their projects. The summary results outlined above show clearly the positive results that can be achieved in the planning and control aspects of projects by adopting the use of appropriate computer software. This study is of great value to potential purchasers of such software as equal importance is given to both the 'ideal' features that a package should possess and to the results of their actual use, by practising project management.

5.8.4 Study By Nathan (1991)

Nathan carried out research into the application and implications of usage of project planning and control systems.(Table 5.10) [44]

Table 5.10 : Results From Research On Planning And Control Systems

QUALITATIVE FINDINGS	***QUANTITATIVE FINDINGS***
1. Improved planning and monitoring of projects through the imposition of standards and discipline, ability to cope with voluminous data, considerable speed and accuracy, reduction of tediousness of planning/control process.	1. Improved planning through the imposition of disciplines and standards for defining projects. Easier monitoring of projects.
2. Demand for more computer literate staff applying project planning and control systems. Immediate remedy to recruit computer literate staff (without necessarily project experience or qualifications)	2. Growing requirement for project personnel to acquire computer based skills.
3. Over reliance on planner(or equivalent staff) familiar with project planning and control systems. Growing gap between younger generation of computer literate staff (or advocates) and older professionals.	3. Too heavy reliance on competent user who is regarded as expert.
	4. Improved planning
	5. Improved updating and monitoring
	6. Over reliance on planning/computing staff
	7. Need for more computer literate personnel
	8. Emphasis on computing process
	9. Improved bidding performance/contract awards
	10. Excessive or too detailed information
	11. Data security problems
	12. Improved decision making
	13. Reduction in middle-management levels

Source : Adapted From Nathan P. - 'Project Planning And Control Systems : An Investigation Into Their Application And Implications Of Their Usage' - Phd Thesis Brunel University -1991

Nathan adopted both a quantitative (through a mail questionnaire) and a qualitative (through face-to-face interviews) approach to the research.

It is commonly believed that the imposition of standards for defining, planning and monitoring projects can generate improvements over current practices. However, this maybe offset to a limited extent in the initial stages, by the requirement for more computer literate staff who have been trained, or are conversant with computerised planning/control techniques. Care must be taken not to allow the computer to 'take over' the role of the project manager in the management of projects. In other words, it is much more preferable to have a project manager trained in the use of computerised methods, rather than bring in an expert in the software who know little about the management of the global project environment.

5.9 APPLICATION OF CHAPTER FIVE

The use of project management planning and control software has proliferated since the mid 1980s with the increased availability and reduced costs of both hardware and software relative to planning and control. Such software can greatly aid the project manager in effectively planning, monitoring and controlling time, resources and costs associated with projects in the construction industry.

The chapter has considered the development of project management planning and control software from its evolution to the present day. 'Ideal' features desired by project managers have been put forward along with detailed 'checklists' that may be used in the assessment process to decide upon a particular package. Previous research into the use of computerised methods for project planning and control have identified improved planning, updating and control and decision making; however, the extent of use of such methods appears to be limited and many projects are still completed behind schedule or overrun their budgeted costs.

The later empirical chapters (chapters ten and eleven) seek to investigate the use of computerised methods with respect to planning and control, in both private and public sector construction contractor organisations. Specifically, the extent of use and the benefits, or otherwise, of adopting such an approach are assessed.

The findings from future empirical chapters are later cross-referenced to the review given in this chapter to ascertain how the current use of project management software within the construction industry compares to the literature.

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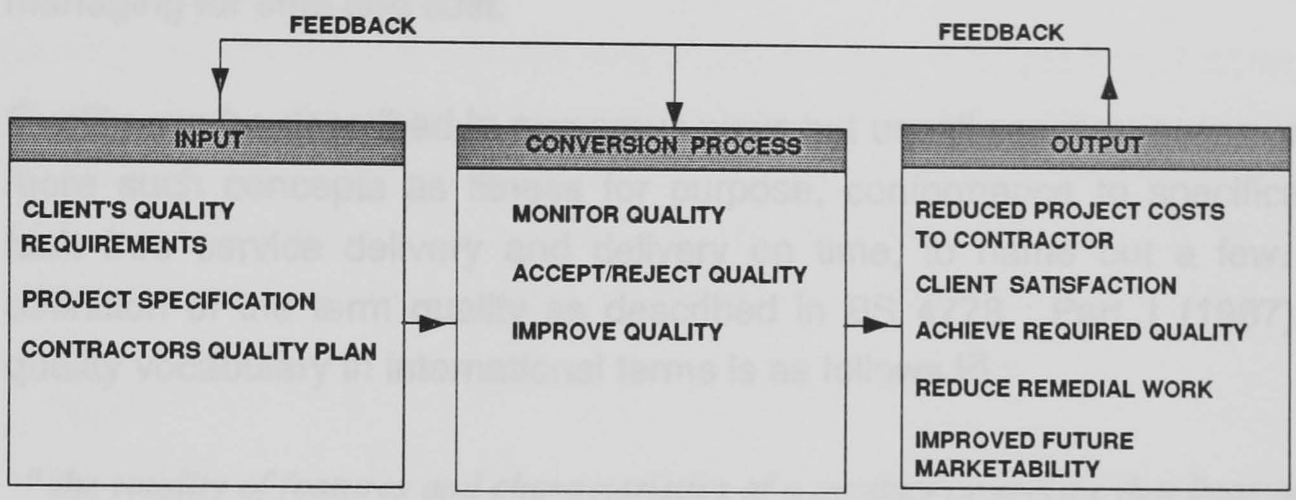
CHAPTER SIX : QUALITY MANAGEMENT

6.1 SUMMARY OF CHAPTER SIX

The sub-system model for quality, previously put forward in Chapter One (Figure 1.7), along with its defined 'primary task' is shown again for reasons of clarity.

Quality Sub-System



Primary Task

' To operate an effective quality management system to facilitate meeting pre-determined project quality objectives '

This Chapter is essentially divided into two sections.

Section One stresses the need for satisfying quality requirements within a project as well as satisfying time and cost objectives. The balance between schedule, cost and quality is discussed and the history and development of quality standards along with an in depth look at the quality standard BS 5750 concludes this section of the chapter.

Section Two looks at planning and implementing a Quality System within an organisation. The planning aspects consider Quality System Documentation with the implementation phase looking at how assessment is carried out to assess an organisation in terms of quality. A brief look into Total Quality Management (TQM) concludes the chapter.

SECTION ONE : INTRODUCTION TO QUALITY CONCEPTS AND DEVELOPMENTS OF QUALITY STANDARDS

6.2 WHY HAVE QUALITY ?

An observation put forward by Heidereich (1988) [1], but one sometimes not in the forefront of the minds of project managers is that to complete a project satisfactorily in terms of time and cost objectives, but without achieving the quality required, can hardly be described a success! Project Management, therefore, is a process which includes managing for quality as well as managing for time and cost.

Quality can be described in numerous ways but usually encompasses one or more such concepts as fitness for purpose, conformance to specification, fault free service delivery and delivery on time, to name but a few. The definition of the term quality as described in BS 4778 : Part 1 (1987), the quality vocabulary in international terms is as follows [2] :

" the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs "

A number of important writers on quality view its meaning differently. Juran and Gryna (1980) [3], the Department Of Trade And Industry (1985) [4], Crosby (1986) [5] and Peters and Austin (1985) [6] have put forward the following definitions of the meaning of quality in Table 6.1.

Table 6.1 : Definitions Of The Term 'Quality'

'Quality'	***Definition Put Forward***
Juran and Gryna (1980)	" quality means fitness for use "
DTI (1985)	" Quality is fitness for purpose, value for money, as perceived by the customer "
Crosby (1986)	" Quality has to be defined as conformance to requirements, not as goodness "
Peters and Austin (1985)	" Quality, above all, is about care, people, passion, eyeball and gut reaction. Quality is not a technique, no matter how good "

The construction industry has to adopt practical approaches to address the most appropriate method of carrying out complex projects. One such practical example of the meaning of quality was put forward by Taguchi (1986). [7] He referred to the large number of homes in San Francisco using wind-powered generators, but for 15% of the year there was not enough wind to generate the power required! He simply stated that in *quality* terms, the general public would be outraged if a commercial power company decided to shut down without warning for 15% the days in a year!

Perhaps, one of the most simple, but idealistic definitions of quality, is referred to by Antilla (1992) [8] and Ireland (1992) [9] :

" Quality means customer satisfaction "

Quality Management is the process where the aim is to get things done right the first time. This aim can be accomplished by utilising the basic elements of management, namely, planning, organisation, implementation, feedback and corrective action. Deming (1986) has described the process of quality improvement as a never ending management cycle consisting of [10] :

- Plan
- Do
- Check
- Action

In Japan, this process is known as 'kaizen', the search for a better way.

Management responsibilities and actions in quality management include understanding quality, quality planning, balancing schedule, cost and quality, quality implementation, feedback of quality related information and taking corrective action as may be required.

Sherwood (1986) comments that [11] :

" The entire operation, whether for manufacture or for a service, must be committed to meeting the prescribed quality needs. Inspection of finished goods is not enough. Employees have to be trained and motivated to see that quality cannot be 'inspected in' but has to be 'built in' "

He also goes on to describe that there must be a total, organised and long term commitment to quality from the highest level of management in the particular organisation. This is related to the factors outlined in Table 6.2.

Table 6.2 : Factors Involved In Long Term commitment To Quality

	FACTORS INVOLVED IN LONG TERM COMMITMENT TO QUALITY
Attitudes	Understanding, Consensus, Teamwork
Abilities	Aptitudes, Training, Techniques
Determination	Motivation, Participation
Structure	Standards, Certification Schemes, Procedures, Organisation

Source : Adapted From Sherwood K.F. - A Guide To Quality Management - 1986

Heisler (1990) comments that [12] :

" quality programmes are instituted to assure predictability of results and ultimately to provide a basis for management control "

Benefits that should be apparent include the reduction of variability in project work operations, identification of whether work is conforming and within acceptable limits, cost reductions due to reduced scrap, waste and rework, and the ability to readily produce documents showing that the project has been prudently managed.

Clearly, effective human resource management is critical to create the correct organisational profile for a quality system to be successful. Once such a culture has been achieved it must be maintained and if possible improved, to enable the continuous process of quality improvement to be practised.

In the Construction Industry quality has generally become accepted to mean fitness for use or compliance with specification requirements. Quality does not happen automatically. In order to achieve quality, a clear definition of what is required within a project along with performance objectives must be translated into working documents such as specifications, drawings, procedures and instructions. During the execution of the project it must be verified that all activities within the project are carried out in accordance with the working documents to ensure that quality requirements have been met. Everybody involved in a project must accept their part in ensuring quality objectives are met. This ties in closely with Crosby's (1986) definition of quality, that is, conformance to requirements. Crosby (1979) further states [13] :

" we must define quality as conformance to requirements if we are to manage it "

A number of factors exist in organisations which can affect the achievement of quality. The standard and type of materials selected, the manufacturing process, the service process and the delivery process are all important aspects which require close attention with regard to quality. Human factors such as carelessness, incompetence, poor judgement, poor attitudes and poor communication skills are more difficult to quantify objectively, but are of utmost importance with respect to quality. Poor procedures, poor equipment and incorrect training of personnel again, clearly, have an important influence on the attainment of quality.

It is of interest to look at Crosby's (1979) approach to quality against another differing perspective, that of Juran (1988). [14] Table 6.3 identifies the approach to quality definition, degree of senior management responsibility, performance standard, general approach, structure, improvement basis, teamwork and costs of quality of these two quality 'gurus'.

Table 6.3 : Crosby Versus Juran - Approaches To Quality

	CROSBY (1979)	*JURAN (1988)*
Definition Of Quality	Conformance to requirements	Fitness for use
Degree of senior Management responsibility	Responsible for quality	Less than 20% of quality problems are due to workers
Performance standard	Zero defects	Avoid campaigns to 'do perfect work'
General approach	Prevention, not inspection	General management approach to quality, especially 'human' elements
Structure	14 steps to quality improvement	10 steps to quality improvement
Improvement basis	A 'process' not a programme - improvement goals	Project-by-project team approach - set goals
Teamwork	Quality improvement teams - quality councils	Team and quality circle approach
Costs of quality	Cost of nonconformance - quality is free	Quality is not free - there is an optimum

Two points put forward by Juran are applicable to the construction industry, these being, fitness for use and a project-by-project improvement basis. However, Crosby's approach is more typical of the approach to quality in modern day construction projects, where,

- Quality is about conforming to a pre-determined specification
- The performance standard is zero defects against the pre-stated specification
- Quality is free if compliance with the specification is achieved first time

Crosby advocates total quality improvement not just product/service quality. He believes that everyone involved should participate in the quality process, focus on prevention by doing things right the first time, and focus on supplier/ customer arrangements within the process. He put forward four absolutes of quality management and fourteen steps which should be implemented by a company to achieve these absolutes. [15] These are shown in Tables 6.4.

Table 6.4 : Crosby's Approach To Quality Management

DEFINITION OF QUALITY	***CONFORMANCE TO REQUIREMENTS***
Quality problems	There is no such thing as a quality problem!
Quality economics	There is no such thing as the economics of quality! It is always cheaper to do the job right the first time
Performance standard	The only performance standard is zero defects
Performance measurement	The only performance measurement is the cost of quality

	CROSBY'S 14 STEPS FOR QUALITY MANAGEMENT
1.	Management commitment
2.	Quality improvement team
3.	Quality measurement
4.	Cost of quality evaluation
5.	Quality awareness
6.	Corrective action
7.	Zero defect planning
8.	Employee education
9.	Zero defects day
10.	Goal setting
11.	Error cause removal
12.	Recognition
13.	Quality councils
14.	Do it all over again

Source : Adapted From Crosby P.B. - Quality Is Free - The Art Of Making Quality Certain - 1979

Crosby in a similar manner to Juran and Gryna defined that the cost of quality could be considered to be split up into two elements, namely, the price of conformance and the price of non-conformance. He described the price of conformance as being the price that should be paid to ensure that the things that are carried out by a company are carried out correctly the first time. Crosby defined the price of non-conformance as being the converse of this theory, namely, the price that is paid when things are not carried out correctly the first time.

6.3 THE BALANCE BETWEEN QUALITY, SCHEDULE AND COST

Top level management within an organisation are responsible for establishing policies to ensure that clear appreciation of the objectives and philosophy of the organisation is held by all managers. Reference to quality should be made within these objectives, philosophy and policies to demonstrate top management's commitment to quality. This is important, because if quality is not emphasised as an important goal to be achieved, then other members of the organisation may not perceive it as important as other goals, such as schedule and cost.

In order to establish the balance between quality, schedule and cost objectives it is necessary to consider, at an early stage in the planning of a project, the quality function in tandem with other organisational functions. Project Management integration of costs, schedule and quality planning, control and performance aspects should be carried out through all phases of the project.

The cost of the quality concept dates back to the 1950's when a number of forces urged companies to evaluate costs associated with the quality function. Juran and Gryna (1980) described four such forces. [16] *Firstly,* quality costs were increasing due to growth in volume of complex products which demanded higher precision, reliability and such like. *Secondly,* the influence of the increase of long life products with resulting high costs due to long term maintenance costs forced management to look at quality and cost closely together. *Thirdly,* they believed that modern products and services offered great benefits to society, but also demanded protective measures in the form of adequate quality controls. *Fourthly,* they considered that at this time quality specialists required to express their findings and recommendations in financial terms to satisfy upper management and to promote the ideals of quality management.

Juran and Gryna state :

" that the cost of attaining fitness for use has become huge - of the order of 10% - hence the opportunity for cost reduction is also huge "

Juran and Gryna (1980) [17], Crosby (1979) [18], and Oliver (1992) [19] have all attempted to classify the various quality cost categories which are associated with the making, finding, repairing or avoiding defects. These include internal failure costs, external failure costs, appraisal costs and prevention costs. Oliver's findings in this respect are shown in Table 6.5.

Table 6.5 : Prevention, Appraisal And Failure Costs With Respect To Quality

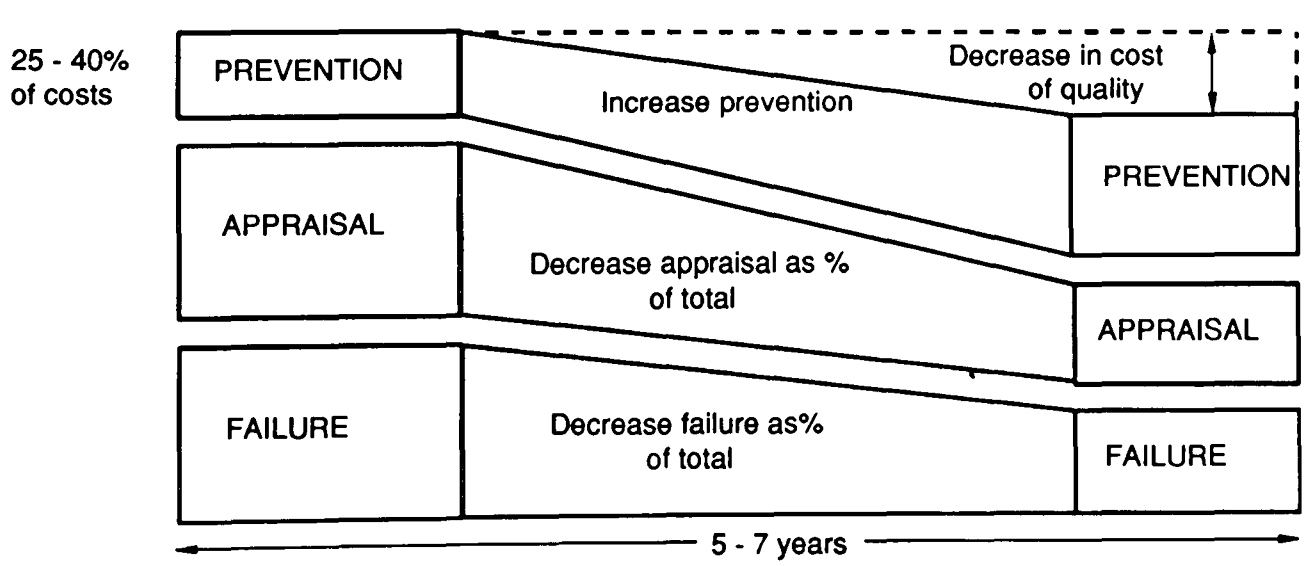
COST CATEGORY	*QUALITY COST CATEGORIES ASSOCIATED WITH THE MAKING, FINDING, REPAIRING OR AVOIDING DEFECTS*
Prevention	**The costs of any action taken to investigate, prevent or reduce defects and failures** • establishing and maintaining a quality system • quality training • preparation of quality plans • analysis of performance data for quality improvement purposes • calibration and maintenance of equipment or instrumentation used to set quality standards or evaluate quality • pre-qualification of external technical services organisations
Appraisal	**The costs of assessing whether work has been carried out to the required standard** • the verification, checking or testing of goods or services supplied by others • the verification, checking or testing of the organisation's own work while it is in progress • the verification, checking or testing of the organisation's final output immediately before delivery to the purchaser • reviewing the results of such verification, checking or test data
Failure	**The costs incurred through failure to achieve the specified quality first time** • rejected work (one's own or an outside supplier's) • repeated or modified work (one's own or an outside supplier's) • trouble shooting • analysis of defects or failures • re-verification, checking or testing • downgrading of any form • dealing with purchaser complaints • claims and litigation

Source : Adapted From Oliver G.B.M. - Quality Management In Construction - Implementation In Design Services Organisations - 1992

There are a number of *internal failure* costs relating to items such as unacceptable work, work which has to be rectified, reinspection of work which has been rectified and idle work time resulting from defects to name but some. *External failure* costs are those which have been discovered after a customer has received the product or service and may include such items as returning and replacing defect product or service, any warranty charges applicable or may be accepted by client as a concession at a reduced cost. *Appraisal* costs incurred by a supplier include incoming material inspection, inspection and test status, maintaining accuracy of test equipment and cost of the consumption of products via destructive tests (eg concrete). *Prevention* costs are those incurred to keep failure (both internal and external) and appraisal costs down to a minimum and include quality planning, training, process control, quality data acquisition, analysis and reporting and quality improvement practices.

Elliot (1991) puts forward a simple, but extremely effective, diagrammatic representation of the typical inter-relationships between the costs associated with quality of conformance, costs of appraisal plus prevention, failure costs and total quality costs. [20] These are depicted in Figure 6.1. [20]

Figure 6.1 : Costs of Appraisal, Prevention And Failure Versus Costs Associated With Quality Conformance



Source : Adapted From Elliot G. - 'Quality First' - Quality Improvement With Ethicon Limited - 1991

Juran and Gryna comment that the ratios of quality category costs vary widely from industry to industry and even between companies operating in the same industry. [21] They do, however, offer a 'general' view of the relative properties and these are shown in Table 6.6.

Table 6.6 : Comparison of Quality cost categories

QUALITY COST CATEGORY	% OF TOTAL QUALITY COST
Internal failures	25 - 40
External failures	20 - 40
Appraisal costs	10 - 50
Prevention costs	0.5 - 5.0

Source : Juran J.M. and Gryna F.M. : Quality Planning And Analysis - 1980

It can be seen in 'general' terms that appraisal costs can be much less than possible failure costs and similarly that prevention costs are extremely low in comparison to the total cost of quality.

Crosby (1979) is considered to be the pioneer of the concept known as the 'cost of quality'. He demonstrated that the cost of traditional approaches to quality could cost as much as 20% of the company's sales. [22] By doing things right the first time this could be reduced below 5%. He also defined quality as being 'conformance to requirements' and linked it in a practical way to a concept known as 'zero defects'.

Mikkelsen (1990) comments that [23] :

" It is considered by some that it costs more to create quality, and it has been said that 'we can afford to correct errors, but can apparently not afford to avoid them' "

BS 6143 deals extensively with the economic aspects of quality. [24] In this standard 'quality related cost' is simply defined as :

" cost in such categories as : prevention cost, appraisal cost, internal failure cost and external failure cost "

6.4 QUALITY CONTROL, QUALITY IMPROVEMENT AND QUALITY ASSURANCE

Quality Control can be described as the process of the measurement of the characteristics of an item to determine its conformance to specification and the taking of remedial action where non-conformance exist. Quality control, therefore, consists of such procedures as inspection, examination and testing. The use of quality control is important in the verification of quality and is used to check that satisfactory results are being achieved in the initial stages of a particular item of work and that this continues to be the case until final acceptance of that particular work. However, it must be noted that these inspections, examinations and tests are conducted *after* work has been performed so as to identify problems *after* they have occurred.

Therefore, in view of the fact that quality cannot be obtained solely by quality control it would not be wise for an organisation to adopt a quality system based solely on quality control.

Quality Improvement can be described as any action or actions which result in an improved standard of quality being achieved. The process involves the collection of measurement data, the identification of problems or potential improvement areas and the taking of action to improve performance. The cost of errors and remedial work can frequently exceed one quarter of the actual cost of a particular item of work. The aim of quality improvement is to reduce this figure to a minimum with workers working together through employee participation schemes, or similar, to solve potential problems at the lowest possible level, which can be a continuous process through all phases of a project.

Quality Assurance can be described as the process where planned systematic actions are carried out to provide confidence that specified requirements are met and that, likewise, items of work carried out under quality assurance will perform satisfactorily in service. Quality Assurance procedures assist in preventing problems, but, where they do occur, it identifies them and corrects them accordingly. The functions of attaining quality and of verifying quality are both catered for in quality assurance. However, it cannot be over emphasised that Quality Assurance will not improve quality where inadequate detail is specified.

Quality Assurance, the assurance of quality is defined in BS 4778 as [25] :

" all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality "

Quality Assurance means the proper arrangement of an organisation's activities in order that clients or customers receive the service that they require and expect every time and that the service is fit for its stated purpose.

Essentially, this necessitates a quality management system requiring a logical and documentary control over all procedures, materials and resources used throughout the organisation, in conjunction with verification that the client's/customer's needs have been met and will continue to be met. Furthermore, the quality management system will provide procedures for dealing with problems and changing the system, as necessary, as a result of this. The quality of the final service will only be as good as the weakest link in the chain of activities necessary to be carried out to achieve that service. The quality management system should be designed to give the maximum confidence that a given acceptable level of quality is being achieved with a minimum total expenditure. To successfully manage a quality management system it is necessary to plan what you do, do what you plan and document what you did.

Stebbing (1987) offers concern where an independent quality department exists in an organisation, believing that a 'them and us' situation can easily prevail. [26] He states :

" Quality is the responsibility of everyone, and every member of the project task force should understand this "

Furthermore, it is important to recognise that Quality Assurance does not define the desired level of quality. Levels of quality are established in specifications, policies or design. A quality management system ensures that the defined quality level is either met or exceeded.

6.5 HISTORY AND DEVELOPMENT OF QUALITY STANDARDS

Product quality and its control, according to Jennings (1993), are shrouded in the mists of time. However, he relates how historians have traced its existence as far back as 3000 BC in Babylonia where it was practised to impose uniformity of units for weights and measures. [27]

There have been a number of initiatives with respect to quality which have preceded the modern British, European and International Quality Standard, BS 5750/EN 29000/ISO 9000. In 1967 the Government produced a white paper entitled 'Public Purchasing And Industrial Efficiency' which stated [28] :

" It is the Government's policy to help make British Industry more efficient and competitive "

The manner which the improvement was to take place was predominantly through quality. Friend (1990) describes a further report in 1977 entitled 'International Price Competitiveness, Non-Price Factors And Export Performance' which highlighted the decline in world exports from 26% in 1950 to 9% in 1976. [29] One of the main reasons for this, put forward in the report, was [30] :

" The UK may be trying to produce the same products as other advanced countries but are failing in certain respects, for example, because of poor delivery dates, or low quality "

This led to Frederick Warner (1976) being invited to put forward recommendations to the National and Economic Development Office (NEDO) which were subsequently published in 1977. [31] One of the main recommendations of the 'Warner Report' was :

" Major public purchasing Government departments should relate their requirements to standards and overseas requirements; and reports should be produced regarding the feasibility of registration by a central body of all quality assurance schemes "

The Government produced a consultative document 'A National Strategy For Quality' (1978) which indicated that the quality of goods and services was the responsibility of industry and commerce, with the Government acting in a supportive role by providing motivation, training and education. [32] Industry, commerce, consumers and Government, through voluntary cooperation were to promote a greater awareness of the importance of quality in meeting market needs, to facilitate the implementation and assessment of modern quality management systems and to ensure that national arrangements for specifications, testing and certification of goods meet overseas market needs were implemented.

These reports and recommendations were the precursor to the publication of the first version of BS 5750 in 1979. Before this, however, the use of quality standards introduced into defence contracts had prompted the British Standards Institution (B.S.I) to take action with respect to making available such guidance and information on the subject to other industrial concerns. This had led, in 1971, to the publication of BS 4778 : Glossary of Terms Used In Quality Assurance [33] followed by, in 1972, BS 4891 : A Guide to Quality Assurance. [34] These documents were only advisory, but were instrumental in bringing out the requirement of defence standards into general terms for the benefit of all industries.

As described previously, in 1979 BSI published the first version by BS 5750 : Quality Systems which served as the definitive quality standard in the UK until 1987 when it was used as a basis by the International Organisation for Standardisation's ISO 9000 series of quality standards. BS 5750 was re-issued in 1987 in a form identical with the corresponding ISO standards. According to Ashford (1990), these standards introduced the words 'quality system" into management terminology and he defined the two objectives of such systems. [35] *Firstly*, the system has to control what is produced to make sure it meets the requirement of the purchaser and *secondly*, the system has to provide confidence or assurance that compliance has been achieved.

The internationally recognised quality standard BS 5750 is now discussed in detail.

6.6 BS 5750 - QUALITY STANDARD

As previous discussed in 1987 a new international quality standard called the ISO 9000 series was published. The same year, this was adopted as a British Standard, retaining the number BS 5750, and replacing the 1979 version. This has also now been accepted as a European Standard called the EN 2900 series.

BS 5750 is therefore the UK, European and International standard for quality management systems. It sets out how to establish, document, and maintain an effective and economic quality system which will demonstrate a commitment to quality and ability to satisfy a client's quality needs.

The standard can be used in either of two ways. *Firstly,* it may be used to set up internal quality systems or *secondly,* it may be used by an outside body coming in to assess a company's quality system against the standard's requirements.

The Standard consists of seven parts as described in Table 6.7.

Table 6.7 : Seven Parts Of BS 5750

PART	*BRIEF DESCRIPTION OF THE SEVEN PARTS OF BS 5750*
0.	**BS 5750 : Part 0 : Section 0.1 / ISO 9000 / EN 29000** [36] is a brief guide to the concepts of quality and serves as a guide to the selection and use of the appropriate parts of the BS 5750 / ISO 9000 / EN 29000 series.
0.	**BS 5750 : Part 0 : Section 0.2 / ISO 9004 / EN 29004** [37] is a guide to overall quality management and the quality elements within the BS 5759 / ISO 9000 series and provides guidance on how to set up your own voluntary quality management system.
1.	**BS 5750 : Part 1 / ISO 9001 / EN 29001** [38] relates to quality specifications for the design/ development, production, installation and servicing when the requirements of goods and services are specified by the customer in terms of how they must perform and which are then provided by the supplier. That is, to say, what must be done in various contractual situations.
2.	**BS 5750 : Part 2 / ISO 9002 / EN 29002** [39] sets out requirements where a firm is manufacturing goods or offering a service, except design, to a published specification or to the customer's specification.
3.	**BS 5750 : Part 3 / ISO 9003 / EN 29003** [40] specifies the requirements for a quality system to be used in final inspection and test procedures.
4.	**BS 5750 : Part 4** [41] (not part of International or European standard) provides notes for guidance on Parts 1, 2, and 3 of the standard.
8.	**BS 5750 : Part 8** [42] provides notes for guidance on Parts 1, 2 and 3 of the standard to services, including Direct Service Organisations. (DSOs)
13.	**BS 5750 : Part 13** [43] provides notes for guidance on Part 1 of the standard for the development, supply and maintenance of software

Source : Adapted From British Standards Institution (various dates)

Part 0 of the standard is essentially a guidance document and is split into two sections 0.1 and 0.2.

Section 0.1 outlines the principal concepts of quality systems and offers guidelines for the selection and use of the appropriate Part of BS 5750 for different applications.

Section 0.2 describes the basic elements of a quality system including all the technical, administrative and human factors affecting the quality of products/ services and is an excellent introduction to QA. This section also provides organisations with guidance on how to set up a voluntary quality management system on a non-contractual basis.

Parts 1, 2 and 3 of BS 5750 are those used in contractual situations when a purchaser (or client) requires the supplier (or contractor) to operate a quality system which will demonstrate, or give assurance, that he is capable of controlling the work which is to be undertaken.

Part 1 is for use when detailed specifications are not available and when the purchaser's requirements have yet to be established or may only be stated in terms of performance to be achieved.

In this instance the supplier undertakes to develop the design and control of quality throughout all stages of the work to final construction completion of a project. *Part 1* is therefore normally applicable for an organisation carrying out the design and monitoring the construction process.

Part 2 of the standard is applicable when the requirements of the purchaser can be stated in terms of an established design and specification, but where conformance to these requirements can only be adequately established by inspections and tests performed during the construction of the works. In relation to construction, this is normally the part of a standard that a contractor would wish to apply to his organisation when carrying out typical construction contracts let against drawings and technical specifications supplied by or on behalf of the purchaser.

Part 3 of the standard is applicable to a product of established design where conformance with specification can be established by inspection or testing in their finished state. Such examples in the construction industry include the testing of aggregates, concrete and such like.

BS 5750 : Part 1 deals with 20 important areas for the effective operation of a formal quality system. Part 2 deals with 18 areas and Part 3 with 12 areas respectively, highlighting the decreasing order of complexity through the various parts of the BS 5750 Standards.

Table 6.8 shows the cross-referencing of the quality system elements of Parts 1 and 2 of BS 5750.

Table 6.8 : Comparison of Part 1 and Part 2 of BS 5750 : 1987

BS 5750 : Part 1 : 1987	***BS 5750 : Part 2 : 1987***
4.1 Management responsibility	4.1 Management responsibility
4.2 quality system	4.2 Quality system
4.3 Contract review	4.3 Contract review
4.4 Design control	4.4 Document control
4.5 Document control	4.5 Purchasing
4.6 Purchasing	4.6 Purchaser supplied product
4.7 Purchaser supplied product	4.7 Product identification and traceability
4.8 Product identification and traceability	4.8 Process control
4.9 Process control	4.9 Inspection and testing
4.10 Inspection and testing	4.10 Inspection, measuring and test equipment
4.11 Inspection, measuring and test equipment	4.11 Inspection and test status
4.12 Inspection and test status	4.12 Control of nonconforming product
4.13 Control of nonconforming product	4.13 Corrective action
4.14 Corrective action	4.14 Handling, storage, packaging and delivery
4.15 Handling, storage, packaging and delivery	4.15 Quality records
4.16 Quality records	4.16 Internal quality audits
4.17 Internal quality records	4.17 Training
4.18 Training	4.18 Statistical techniques
4.19 Servicing	
4.20 Statistical techniques	

Source : Adapted From British Standards Institution : BS 5750 - 1987

6.7 APPLICATION OF BS 5750 TO CONSTRUCTION

BS 5750 is applicable to all areas of work in all industries. However, it employs terminology which the construction industry does not use and by and large, does not understand. Furthermore, Parts 1, 2 and 3 of BS 5750 are structured in a manner which does not adequately reflect the way in which the construction industry works. There is no part of the standard which is appropriate to businesses carrying out design work only, or design and construction monitoring only, whereas, in reality, there are a great number of businesses carrying out only these activities.

Essentially this means businesses having to work out which parts of a more wide-ranging standard are relevant to their activities and those which are not. A useful guide produced by CIRIA prepares an interpretation of the various Clauses of BS 5750 for three areas of work generally categorised in the construction industry. [44] These are design or design related work, construction/installation work and monitoring of construction/installation work. This guide translates the 'manufacturing' type jargon predominantly in use in BS 5750 into a format that should be easily understood by managers concerned with quality in the construction industry. Two other useful guides produced by CIRIA, in relation to construction, deal with contractual aspects [45] and implementation in design service organisations. [46]

6.8 ISO 9000 SERIES

Although it would be reasonable to expect an International standard to be a single referenced document, there are in fact a number of different terms given to the standard globally. [47] These are shown in Table 6.9.

Table 6.9 : Comparison of Standards used in countries for quality system model for quality assurance in production and installation

COUNTRY	QUALITY SYSTEM MODEL FOR QUALITY ASSURANCE IN PRODUCTION AND INSTALLATION	COUNTRY	QUALITY SYSTEM MODEL FOR QUALITY ASSURANCE IN PRODUCTION AND INSTALLATION
ISO (base standard)	ISO 9002 : 1987		
Australia	AS 3902	Austria	OE NORM-PREN 29002
Belgium	NBN X 50-004	Canada	-
China	GB/T 10300.3-88	Denmark	DS/EN 29002
Finland	SFS-ISO 9002	France	NFX 50-132
Germany	DIN SIO 9002	Hungary	MI 18992-1988
India	IS : 10201 Part 5	Ireland	IS 300 Part 2/ISO 9002
Italy	UNI/EN 29002-1987	Malaysia	MS985/ISO 9002-1987
Netherlands	NEN-ISO 9002	New Zealand	NZS 5602-1987
Norway	NS-ISO 9002	South Africa	SABS 0157 : Part2
Spain	UNE 66 902	Sweden	SS-ISO 9002 :1988
Switzerland	SN-SIO 9002	Tunisia	NT 110.20 : 1987
United Kingdom	BS5750:1987:Part2 ISO 9002/EN 29002	USA	NSI/ASQC Q92
USSR	40.9002-88	Yugoslavia	JUS A.K. 1.013
European Community	EN 29 002		

Source : Adapted From Institute Of Quality Assurance News - 1991

Antilla (1992) comments that ISO 9000 standards have already been adopted by the majority of industrialised countries and many different branches in industry. [48] Graham (1990), on the other hand, comments that there are an increasing number of national and international standards on the subject of quality assurance or quality management. [49]

Many of these standards are comparable to BS 5750, especially in the United States and Australia. Within Europe, Barber (1992) states [50] :

" that the UK appears to be leading the way, but various European Directives have given additional significance to quality management in some sectors "

CIRIA analyse these issues in 'SP 89 - Quality Management In Construction - The Impact Of European Legislation (1992) ' [51]

Section One has given an account of the need for the adequate consideration and management of quality in construction projects. This has been reinforced by the adoption of a British, European and International Standard for quality, namely, BS 5750, EN 29000, and ISO 9000 series.

The following section of the Chapter will look at the procedures and practical issues relative to the implementation of a quality management system into an organisation.

SECTION 2 : PLANNING AND IMPLEMENTING A QUALITY SYSTEM

6.9 INTRODUCTION

In planning a quality management system it is necessary at a very early stage to establish the objectives of such a system. Generally these will encompass the concepts of satisfying client/customer requirements by getting it right first time, every time; implementing methods to maintain a system which all managers and employees will relate to in terms of quality.

At the planning stage, an assessment of what parts of BS 5750 are relevant to the parts of the organisation that are to be assessed, will have to be carried out. Planning activities in the initial stages of a Quality Management system include the formulation of a Quality Policy, the setting-up of the necessary staff to plan and implement the quality system, involvement of people at all levels to initiate the commitment to quality, an awareness of the identification of the procedures affecting quality and any new quality procedures that will be necessary. A clear understanding of both current and anticipated contracts with respect to what is involved in compliance.

An important point to realise is raised by Ashford (1990) when he describes the companies who benefit mostly from the introduction-of quality management system as being [52] :

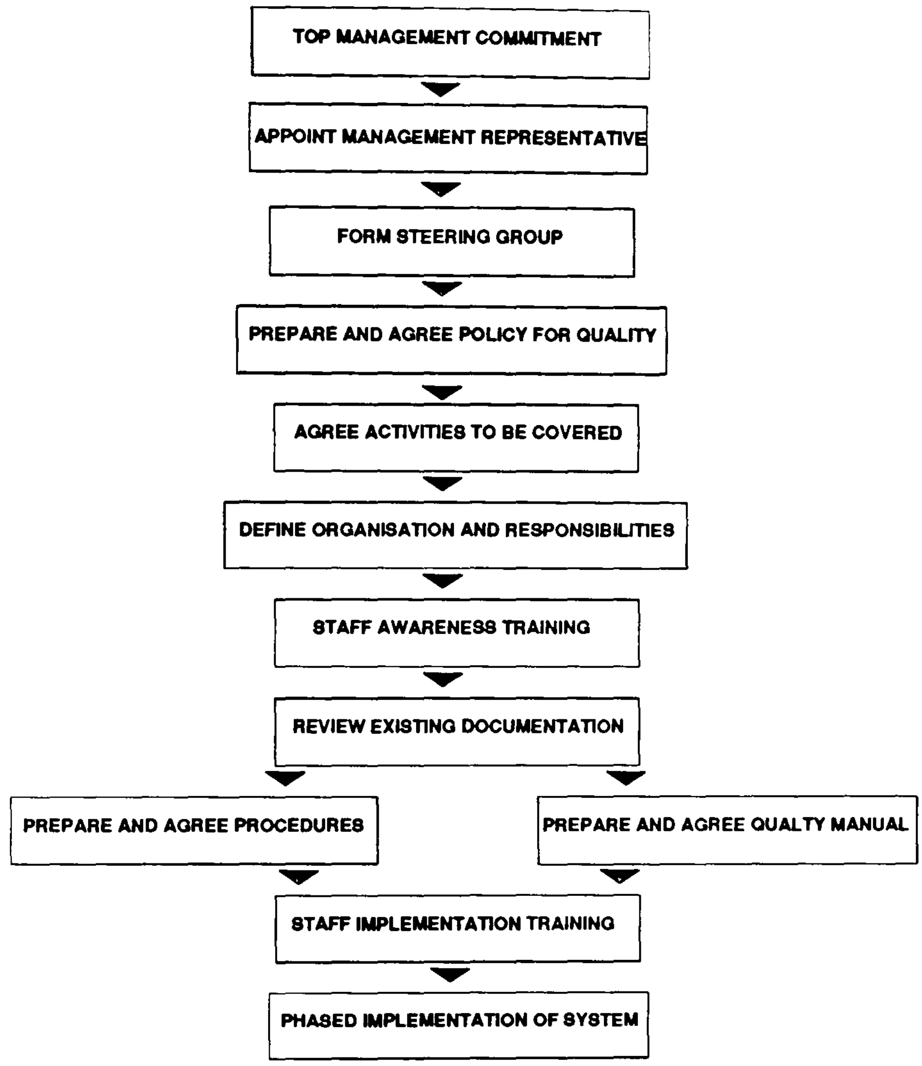
> *" those who do so for the purpose of improving their own efficiency by eliminating the cost, delays, waste, aggravation and disruption brought about by failure to do things properly first time "*

rather than those companies who implement a quality management system merely to be able to make a satisfactory response to clients who make such implementations a condition of a particular contract.

This is an important factor and emphasises the commitment that management must have in establishing quality as an integral function of an organisation's activities. Figure 6.2 shows the typical processes involved in the design and implementation of a quality system.

It is quite apparent that commitment from top management is the key to success in the design and implementation of a quality system. It must be initiated 'top down', but thereafter, all staff should be involved as much as possible in order to gain acceptance of the quality system philosophy to the whole organisation, prior to formal implementation.

Figure 6.2 : Typical Processes Involved In The Design And Implementation Of A Quality System



Source : Adapted From Oliver G.B.M. - Quality Management in Construction - Implementation In Design Services Organisations - 1992

6.10 QUALITY SYSTEM DOCUMENTATION

A Quality System within an organisation is part of that organisation's total management system and should, according to BS 5750, satisfy, the supplier's needs and interests and also, the customer's needs and expectations. The definition of the term 'quality system' in BS 4778 is [53] :

" the organisational structure, responsibilities, procedures, processes and resources for implementing quality management "

A quality system consists of a number of elements (for example, 20 areas in BS 5750 : Part 1) and some of these elements will provide for quality control by eliminating non-conformance and others will supply assurance that the standards have been met.

BS 5750 Part 0.2 identifies three policy objectives which any organisation should seek to fulfil with respect to quality.

Firstly, the organisation should achieve and sustain the quality of the product/service produced in order that the purchaser's stated or implied needs are met as frequently as possible. *Secondly,* the organisation should provide confidence to its own management that the intended quality is being achieved and sustained. *Finally,* the organisation should provide confidence to the purchaser that the intended quality is being, or will be, achieved in the delivered product/service provided. Quality systems consist of a number of different kinds of documentation and before looking at these in detail it is considered appropriate to categorise these in the same manner as in BS 5750 as shown in Table 6.10.

Table 6.10 : Types Of Quality System Documentation

TYPE	*QUALITY SYSTEM DOCUMENTATION*	*ABBREVIATED DESCRIPTION*
1.	A document which states the quality policy of an organisation as a whole and describes the system established for its implementation.	**Quality Manual**
2.	A document which gives corporate instructions on the operational procedures to be followed to ensure product quality.	**Quality Procedures**
3.	A document which describes how a quality system will be applied to a particular project or process and gives details of the specific practices, resources and activities which either have been or will be developed for this purpose.	**Quality Plan**
4.	A document which lists or tabulates all the actions to be taken to ensure that a particular item or element of work will comply with specified requirements.	**Works Instructions**

Source : Adapted From BS 5750 : Quality Systems : Part 0 : Principal Concepts And Applications : Section 0.2 : Guide To Quality Management And Quality System Elements - 1987

Each of these categories of documentation are now discussed.

6.10.1 Quality Manual

The quality manual is the main document used in drawing up and implementing a quality system. The purpose of the quality manual is to provide a description of the quality system, while serving as a permanent reference document on the implementation and maintenance of the system.

The manual must be a reference base for policies and procedures with adequate explanations and justifications to ensure that everyone using the system has a complete understanding of it. It should also demonstrate that the policies and procedures within it have been carefully thought out, incorporating any existing, undocumented policies or procedures. Furthermore it must provide a basis for auditing to ensure proper maintenance of quality procedures and should be written with the view that it will probably become a 'training' document for members of staff.

A company's *quality manual* should according to a definition put forward in BS 5750 : Part 0.2 [54] :

> *" provide an adequate description of the quality management system while serving as a permanent reference in the implementation and maintenance of that system "*

An example of a quality policy (contained in quality manual) is now shown. [55] This is derived from INROADS, the Direct Labour Organisation of Lothian Regional Council's Highways Department. (referred to in Chapter Two).

As a point of interest, Lothian Region were the first Local Authority in the UK to achieve third party accreditation for the laying of hot bituminous materials, which are extensively used in the road construction industry.

INROADS - Quality Policy

INROADS specialises in all aspects of work associated with the construction and maintenance of footways and all classes of highway from motorways to minor roads. Execution of such works involve a combination of labour, plant and materials. INROADS will continue to train all staff to a high degree of expertise and seek to engender continued self-motivation of its workforce. This philosophy is underpinned by the provision, maintenance and phased renewal of its plant and transport and the use of materials which comply with the specified requirements of its customers. The organisation is supervised by a team of managers, committed to Quality and trained to apply appropriate contemporary management techniques.

INROADS has three aims in the execution of works. These are to complete the work to specification, within the period required by the documents and at a cost which permits INROADS to comply with the legislative requirements related to the rate of return. INROADS sees the implementation and maintenance of an effective and efficient Quality System as the foundation of its survival.

INROADS' Quality System is based on BS 5750 : Part 2 : 1987.

Each member of the Quality Management Team shall ensure that this policy is understood, implemented and maintained at all levels in INROADS. A copy of this quality policy has been given to each member of staff. A further copy has been posted in all Depots.

Signed - ________________

Date - ________________

Assistant Director
Lothian Highways ***INROADS***

ROAD DEFECTS 0800 23 23 23

INROADS

BSI REGISTERED FIRM

6.10.2 Operational Procedures

It is one of the most essential of management tasks to ensure that those responsible for executing work should know what they have to do and how they should go about doing it. With respect to quality system documentation this should be achieved by the establishment, maintenance and implementation of documented procedures and instructions. Operational Procedures (or also sometimes referred to as Company Standing Instructions or Quality Procedures) should be written for each operation that a company undertakes and where according to BS 5750 : Part 1 [56] :

" the absence of such procedures would adversely affect quality "

Therefore, the operational procedures should be a series of individually controlled documents containing operational policies and directions relating to the management, execution and checking of work. Procedures will also exist for the activities likely to affect the quality of the work such as the provision of a controlled reference library or information system and formalised staff training.

Stebbing (1987) comments that every procedure must detail clearly the requirements or what has to be controlled, the persons responsible for ensuring that the requirements are met or the control carried out and how, when and where (and possibly why) it is to be controlled. [57]

6.10.3 Quality Plan

The purpose of a quality plan is to specify how the operation of the quality system described in the quality manual will be applied to a particular project and to give details of any specific practices, resources and activities which may have been, or will be developed for this purpose. The quality plan, therefore, identifies those key elements in the product/service necessary to provide fitness for purpose and also the means by which they are to be measured and provided. These elements include the specific allocation of responsibilities, procedures, works instructions to be applied along with suitable testing and conformance requirements.

The term quality plan, as defined in BS 4778, can be described as [58] :

" a document setting out the specific quality practices, resources and sequence of activities related to a particular product, service, contract or project "

6.10.4 Control Of Quality System Documentation

BS 5750 requires that all documents that are relative to quality which have been issued and may be liable to revision be subject to 'control'. That is, to say, that they must be suitably approved before issue, that up-to-date issues are available to all who need them and that obsolete issues are removed from use. A system must therefore be developed to identify, collect, index, file, store, maintain, retrieve and dispose of all quality system documentation, including quality manual, operational procedures and quality plans.

6.11 OPERATION OF A QUALITY SYSTEM

This Chapter so far has looked at some of the requirements of a quality system and of the associated necessary documentation. The author believes that there are three principal factors which are important to the successful operation of quality system, namely, proper implementation, effective quality system reviews and monitoring of quality improvement.

6.11.1 Proper Implementation

Senior management must ensure that the correct culture within an organisation is present and provide clear leadership in stating what needs to be achieved and why. All senior managers must understand the concepts of quality as related to their own organisation's objectives. This understanding must be communicated to all staff and shown to be in operation at all times. The staff of an organisation are its greatest asset and in view of the fact that they provide the service to the organisation's clients, it is clear that they have the ultimate influence on the quality of the service given. Regular training is therefore needed in the meaning and importance of the quality system.

As will be discussed in Chapter Seven, motivation of all staff concerned is vital to the successful implementation of a quality system. Staff must understand what tasks they are expected to perform and be aware of the effects of poor job performance on other employees, the image of the organisation and the cost of the service provided. The need for quality must be continually emphasised and all concerned should know what satisfactory level of quality is required by communicating required standards of performance. Management should, where possible, encourage and provide recognition of performance when satisfactory levels of quality are obtained. This may be achieved by relating bonus payments and such like to quality, and not just purely productivity output.

6.11.2 Effective Quality System Reviews

BS 4778 describes the term quality system review as [59] :

" a formal evaluation by top management of the status and adequacy of the quality policy and new objectives resulting from changing circumstances "

The purpose of a quality system review is to carry out an examination to determine whether a quality system is succeeding in achieving its objectives with a view to implementing changes if this is not occurring. They require to be undertaken at regular intervals (probably twice a year) and should be structured to investigate, reveal and correct defects or irregularities before they may lead to a fundamental breakdown of the quality system. A typical checklist for a quality system review is shown in Table 6.11.

Table 6.11 : Checklist for quality system review

	Checklist For Quality System Review
1.	Are the objectives and policies stated in the quality manual still valid, or have they become obsolete due to changes in the business environment?
2.	Is the organisation structure for quality management functioning satisfactorily and is there proper delegation of responsibilities to nominated personnel?
3.	Are the procedures identified and described in the operational procedures manual appropriate to achieve the current objective and policies?
4.	Are the procedures being adhered to?
5.	If procedures are being ignored or changed without authority, why is this so and what action should be taken?
6.	If procedures are being adhered to, are they achieving the desired effects?
7.	What changes in the quality system, if any, are required to make it more effective?

Source : Adapted From Ashford J.L. : The Management Of Quality In Construction - 1990

Quality system reviews, therefore, are the means by which management assesses the performance of the quality system in operation and such reviews will consider the results of corrective actions and quality system audits (both discussed below) which have occurred between such review meetings.

6.11.3 Quality Improvement

BS 5750 appreciates the fact that no quality assurance management system is perfect and inevitably there will be times when things go wrong. Three separate parts of the standard are designed to ensure that the implemented quality management system is both maintained and progressively updated. One of these, quality system review has been discussed. Corrective action will now be briefly dealt with, before looking at the process of quality audits separately.

6.11.4 Corrective Action

Procedures for taking corrective action must be written and the cause of the problem must be identified, the non-conformances dealt with and the changing of the quality system, as necessary, properly carried out.

The following points, or questions, may help in addressing what should be achieved from the corrective action process. Can we learn from this, can we improve our system and ensure that it does not happen again, does this problem indicate that there is a wider, more serious problem behind it and can we demonstrate to a client that we have taken the right corrective action and improve our quality system audits ?

6.12 QUALITY AUDITS

BS 4778 defines the terms quality audit as [60] :

" a systematic and independent examination to determine whether quality activities and results comply with planned arrangement and whether these arrangements are implemented effectively and are suitable to achieve objectives "

In order to ensure that a quality system is working correctly and efficiently it is necessary to carry out planned and documented checks on the implementation and operation of the system. These checks are carried out to ensure that the quality system documentation adequately defines the needs of the business, that the documented procedures are practical, understood and followed and that training provided by the organisation is adequate.

The timing and frequency of audits will vary depending on the importance of a particular part of the system but will normally be pre-determined and recorded. The results of audits should be documented and the records should indicate the deficiencies found, the corrective action required, the time agreed for the corrective action to be carried out and the person responsible for carrying out the corrective action. BS 7229 (1991) provides guidance for the auditing of quality systems. [61, 62 & 63]

The quality audit need not necessarily be restricted to the quality system of an organisation but may be applied to other areas such as processes, products or services. All audits should be carried out by persons *not* having a direct responsibility in the areas being audited, but preferably in conjunction with the relevant staff personnel. The reason for the design and initiation of quality audits may be any of those shown in Table 6.12.

Table 6.12 : Design And Initiation Of Quality Audits

	Design Of Quality Audits
1.	To determine the conformity or non-conformity of the quality system element
2.	To determine the effectiveness of the implemented quality system in meeting specified quality objectives
3.	To provide the auditee with an opportunity to improve the system
4.	To meet regulatory requirements
5.	To permit the listing of the organisation's quality system in a register
	Initiation Of Quality Audits
1.	To evaluate initially a supplier where there is a desire to establish a contractual relationship
2.	To verify that an organisation's own quality system continues to meet specified requirements and is being implemented
3.	To verify that a "suppliers" quality system continues to meet specified requirements and is being implemented
4.	To evaluate an organisation's own quality system against a quality system standard

Source : Adapted from BS 7229 : Quality Systems Auditing : Part 1 : 1990

The auditor, who carries out quality audits, is responsible for complying with any applicable audit requirements and must plan and carry out assigned responsibilities both effectively and efficiently. Fundamental to the auditor's responsibilities is the need for observations to be documented, the reporting of the audit results and the verification of the effectiveness of corrective actions taken as a result of the audit. The auditor must also safeguard documents relating to an audit and should ensure that they are submitted as required and that they remain confidential.

Clearly, an auditor must be free from bias or any other influences which may affect objectivity. With respect to the auditing of a quality system an auditor should be able to assess and answer the two following points.

- Are the procedures, documents and other information describing or supporting the required element of the quality system known, available, understood and used by the auditor's personnel ?

- Are all the documents and other information used to describe the quality system adequate to achieve the required quality objectives ?

It is evident that a quality auditor has an extremely important role to play in the successful implementation and operation of a quality system within an organisation. He must be given the support of all members of staff and senior management to ensure that his role remains independent of the day to day functions of the organisation to ensure maximum effectiveness.

6.13 METHODS OF PROVIDING QUALITY ASSURANCE

There are essentially three methods by which a company may assess itself, or be assessed in terms of quality assurance. These are commonly known as 1st party quality assurance, 2nd party quality assurance and 3rd party quality assurance. Oliver (1992) describes the three alternatives. [64]

6.13.1 1st Party Quality Assurance

Many companies operate quality control procedures which may consist of a system whereby a particular product or service is checked for compliance with a client's brief or standard specification. For example, in a manufacturing industry such a system may be a feedback system whereby recorded defects found may be traced back to a mechanical fault, or such like. If such system is run by the company themselves and many such as Ford and JCB do then the system is called a first party quality assurance system. Such a system will inevitably be completely confidential as no-one else will know whether it is worthwhile or not - that is, to say, the quality history of the product is unavailable to the client.

The restrictions and limited benefits of such a quality control rather than quality assurance system are plain to see and has led to the setting up of other forms of assessment of quality systems to establish how good the system actually is and whether it is being followed is a manner that people will recognise the system to be of a certain standard.

6.13.2 2nd Party Quality Assurance

This is the term given to the kind of quality system whereby a major client determines the type of quality assurance that is required of suppliers and monitors and audits it himself. This type of quality assurance is prevalent in major construction projects such as the Channel Tunnel Project or nuclear power installations. Such a scheme is normally in addition to BS 5750 and complements it.

6.13.3 3rd Party Quality Assurance

Essentially, a company who operates a 3rd party quality assurance scheme has subjected its quality system to an outside, or third party body for assessment and future auditing. Such an outside body will have no existing or intended contractual relationship with either the purchaser or the supplier.

For many years companies carried out assessments of their suppliers' quality systems to satisfy themselves that the product/service was of the right quality. This led to a proliferation of such schemes which became time consuming, expensive and inefficient with no guarantee of a quality of assessment.

Oliver (1992) relates that the need was apparent for the setting up of a single method of independent, external assessment of quality systems to a known standard, to establish how good a system was and whether it was being followed. [65] Two steps in this regard were made. Firstly, an internationally recognised standard for quality systems (BS 5750) was provided and secondly, the establishment of a system for the assessment of these same quality systems, which would be recognised everywhere as being of equal validity, was necessary. In the UK, a body was set up called the National Accreditation Council for Certification Bodies (NACCB) which checks out the organisation who carry out assessments of quality systems to ensure that a common standard is maintained.

6.14 THIRD PARTY ASSESSMENT FOR REGISTRATION TO BS 5750

Generally, an assessment, or desk study, will be made of the organisations documented quality system. This will identify omissions and deviations from the requirements in order that amendments may be made prior to an assessment visit to a particular organisation's working environment. This visit involves a thorough appraisal of the procedures carried out to ensure compliance with the relevant part of BS 5750 and any relevant quality schedules. The organisation is required to demonstrate the practical application of its documented procedures. McLellan and Hunter (1991) describe three possible outcomes may arise from such an assessment as detailed in Table 6.13. [66]

Table 6.13 : Possible Outcomes Of A Third Party Assessment Of A Quality System

	POSSIBLE OUTCOMES OF A THIRD PARTY ASSESSMENT OF A QUALITY SYSTEM
1.	Unqualified registration : where no discrepancies have been detected
2.	Qualified registration : where minor discrepancies have been discovered and can be corrected prior to first surveillance visit
3.	Non-registration : where there was a fundamental lack, or a total breakdown of a procedure

Source : McLellan R. And Hunter R.N. - 'Competing For Quality' - 1991

In most instances a company will inevitably have a number of minor discrepancies or observations which have been reported from the assessor's audit. A brief description of the meaning or major and minor discrepancies and observations is now given.

If a *major discrepancy* is found this means that there has been a major shortcoming in the system or that there is wholesale non-implementation in some part; such a discrepancy would prevent the assessors in recommending registration. Clearly, failure is to be avoided if at all possible, but it has been commented 'off the record' by two assessment bodies that 40% or so of all initial assessments result in one or more major discrepancies being discovered with the resultant non-registration being subsequently inevitable. On discovering a major discrepancy the assessors must immediately advise the company and offer to terminate the assessment. However, it is probably wise to continue to ensure that any further discrepancies are spotted and corrected. Non-Registration initially will normally result in the Accreditation Body recommending a re-assessment at a later date depending on their findings. A minimum time for correction of such discrepancies would normally be around 3 months.

Minor discrepancies will not, normally, prevent a recommendation for registration, but require a formal response within a fixed period of time (up to 3 months) detailing corrective actions undertaken. However, if a large number of minor discrepancies, which McLellan and Hunter (1991) estimate may be around 20-30, then that might result in the assessors refusing to recommend registration.

Observations are simply points which have been raised by the assessors and may warrant implementation, but do not require a formal response by the company.

It is worth noting that all discrepancies must be agreed between the assessors and the company. It is not accepted that a genuine discrepancy is present, it may be worthwhile arguing the point with the assessors.

6.15 RESEARCH INTO QUALITY MANAGEMENT IN CONSTRUCTION

Friend (1990) carried out research into quality management in the construction industry. [67] The study looked at a number of different areas of quality within a sample of 79 contractors and 69 consultants. The results obtained are shown in Table 6.14.

Table 6.14 : Summary Of Conclusions Of Friend's Research Into Quality Assurance In The Construction Industry

	SUMMARY OF CONCLUSIONS FROM FRIEND's RESEARCH INTO QUALITY ASSURANCE IN THE CONSTRUCTION INDUSTRY
1.	The majority of contractors are either planning to operate or are currently operating a quality system
2.	Multi-disciplinary contractors are more reluctant to adopt quality systems than the more specialist contractors. Consultants are less affected by the work type and in general more advanced in quality system adoption
3.	Turnover significantly affects the likelihood of contractor quality system adoption producing a relationship of : the greater the turnover, the greater the likelihood of a quality system. Consultants are less prone to this variation, adopting systems at all levels of turnover
4.	Full time quality assurance managers are most likely in companies with more than 200 employees. The amount of time spent on quality assurance is linked with the number of employees in the organisation, with less time being spent for a fewer number of employees. Contractors are almost twice as likely to employ a full time quality assurance manager in an organisation of more than 200 employees than a consultant.
5.	The greatest difficulties in the application of a quality system are with human resources and the variability of the workplace. However, no difficulties were considered insurmountable.
6.	The general consensus from consultants and contractors alike is that any cost saving arising from the application of quality assurance will ultimately be passed to the client.
7.	Awareness of quality assurance in the construction industry is quite high although knowledge of application is limited.

Source : Adapted From Friend D. : Construction Quality Assurance - M Phil Thesis University Of Strathclyde - 1990

Quality management has been and will continue to be on the ascendancy in the construction environment, and although human and site factors will inevitably change from project to project, it is fundamental to an organisation to assure quality in a consistent manner across a range of projects.

6.16 TOTAL QUALITY MANAGEMENT

Oberlender (1992) comments that much attention has been given to Total Quality Management (TQM) in recent years. [68] It is perhaps worthwhile to recall the definition of Quality Assurance previously given and compare it with the definition of Total Quality Management to ascertain the differences.

Quality Assurance, the assurance of quality is defined in BS 4778 as [69] :

" All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality "

Total Quality Management is defined in BS 7850 as [70, 71] :

" Management philosophy and company practices that aim to harness the human and material resources of an organisation in the most effective way to achieve the objectives of the organisation "

The TQM philosophy is essentially a natural extension of an organisation's activities who are already operating a quality management system. It concentrates on process improvement, customer satisfaction, cost effectiveness, and defect free quality work. BS 7850 : Part 1 gives fundamental concepts and methods of implementing total quality management. These are shown in Table 6.15.

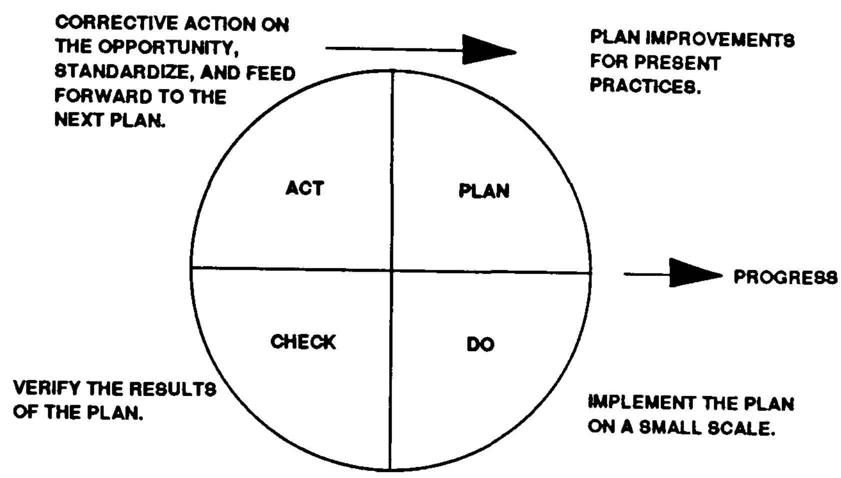
Table 6.15 : Fundamental Concepts And Implementation Of TQM

FUNDAMENTAL CONCEPTS	IMPLEMENTING TOTAL QUALITY MANAGEMENT
• Commitment • Customer satisfaction • Quality losses • Participation by all • Process measurements • Continuous improvement • Problem identification • Alignment of corporate objectives and individual attitudes • Personal accountability • Personal development	• Creating appropriate organisational structures • Implementing process management concepts • Measurement of performance • Introducing improvement planning techniques • Training

Source : Adapted From BS 7850 : Total Quality Management : Part 1 : Guide To Management Principles - 1992

The TQM concept stems from the work of Juran J.M. and Deming W.E. Deming was responsible for the development of the Plan - Do - Check - Act (PDCA) cycle shown in Figure 6.3. [72]

Figure 6.3 : Plan - Do - Check - Act Quality Loop



Source : Deming W.E. - Out Of Crisis - 1986

This cycle is a systematic procedure for incrementally improving methods and procedures by focusing on the correction and prevention of defects. Deming (1986) also defined fourteen points to achieve quality which are shown in Table 6.16.

Table 6.16 : Deming's 14 Points For Achieving Quality

	DEMING'S 14 POINTS FOR ACHIEVING QUALITY
1.	Create constancy of purpose for improvement of product and service
2.	Adopt the new philosophy
3.	Cease dependence on mass inspection to achieve quality
4.	End the practice of awarding business on the basis of the price tag alone
5.	Improve constantly and forever the system of production and service
6.	Institute training on the job
7.	Adopt and institute leadership
8.	Drive out fear
9.	Break down barriers between staff areas
10.	Eliminate slogans, exhortations, and targets for the work force
11.	Eliminate numerical quotas for the work force and numerical goals for the management
12.	Remove barriers that rob people of pride of workmanship
13.	Institute a vigorous program of education and self-improvement for everyone
14.	Take action to accomplish the transformation

Source : Adapted From Deming W.E. - Out Of Crisis - 1986

An example of a typical process of Total Quality Management is given in Annex A of BS 7850 : Part 1 and is shown in Table 6.17. [73]

Table 6.17. : Example Of A Typical Process Of Total Quality Management

	EXAMPLE OF A TYPICAL PROCESS OF TOTAL QUALITY MANAGEMENT
Policy And Strategy Of The Organisation	The mission of the organisation, its leadership and strategies should be developed by management as follows : (a) *Mission* - Establish a mission statement, corporate objectives, strategy for achieving objectives and a business plan (b) *Leadership and commitment* - Have visible, sustained commitment starting from Chief Executive and extending to every member of the business through personal leadership and example (c) *Divisional objectives* - Establish and maintain the roles, responsibilities and objectives for each level of the organisation to support the mission and corporate objectives
Management Of The Organisation	Management planning should include the following : (a) *Organisational structure* - Establish an effective organisational structure (b) *Management system* - Establish, audit and keep under review, an effective management system (c) *Information system* - Establish an effective planned information system throughout the organisation (d) *Communications* - Establish good communications internally and externally with suppliers and customers Communication should be planned both vertically, between manager and staff, through all levels and horizontally between the processes and between the process owners and their suppliers and customers whether internal or external to the organisation
Improvement Of The Organisation	The following should be considered : (a) *Working environment* - In addition to the physical environment of the work place the relationship between the individual and the organisation and other employees should be structured so that each individual, team, department of a process or sub-process is aware of its contribution to the mission statement and the planned methods by which it can effect improvements (b) *Measurement of performance* - Establish measures of performance of individuals or teams involved in each process related, where possible, to internal or external customer satisfaction (c) *Improvement objectives* - Improvement goals should be closely integrated with the corporate objectives, and should be differentiated from implementations of capital intensive projects (d) *Improvement plans* - Establish plans for improvement of product service or process quality, safety, environmental impact, dependability and customer satisfaction to all levels (e) *Monitor and review* - Ensure that all plans, targets and measures throughout the organisation complement each other and reflect the overall objectives of individual process targets and overall objectives of the mission statement, review the results of improvement plans to obtain a measure of their effectiveness

Source : Adapted From BS 7850 : Total Quality Management : Part 1 : Guide To Management Principles - 1992

BS 7850 is not prescriptive in the way that BS 5750 is. It is intended to be a guide to management to suit prevailing objectives and methodology.

Table 6.18 depicts how a systematic approach to improving quality can be applied to the operations of a business.

Table 6.18. : Example Of A Systematic Quality Improvement Process

	EXAMPLE OF A SYSTEMATICS IMPROVEMENT PROCESS
Identify	• Identify any situation where there is an opportunity for improvement
Evaluate	• Define the opportunity for improvement • Define the process involved • Gather and analyse the facts • Define objectives for improvement
Plan	• Identify the cause(s) of the situation requiring improvement • Devise possible solutions • Select preferred solution • Plan the implementation
Execute	• Implement the plan
Check	• Monitor, review and appraise results
Amend	• Repeat the process if planned solution is not achieving its objectives

Source : BS 7850 : Total Quality Management : Part 1 : Guide To Management Principles - 1992

The elements included in the systematic improvement process closely follow the principles put forward by Deming. Such a process should be applied to all operations within an organisation.

6.17 APPLICATION OF CHAPTER SIX

Quality management, including quality assurance (QA) and total quality management (TQM) are topics which have received significant attention since the mid 1980s. The management of time and cost are often considered by project managers to a greater degree than the management of quality, despite the clear need to meet at all times a given specification for a project.

The sub-system for quality management detailed how the input elements such as a client's requirement for quality, a project's specification and contractor's approach to quality might be translated through a conversion process to reducing overall project costs, less remedial work and improved marketability. The conversion process was seen to involve the monitoring, accepting or rejecting of quality and the continual effort to improve all processes affecting it.

Throughout the chapter the need for quality and the balance between time, cost and quality were analysed. The design, implementation and assessment of an organisation's quality management system to BS 5750 was discussed thoroughly in light of the apparent trend of an increase in the number of third party, or independently assessed quality management systems.

The chapter has given food for thought on a number of important issues in relation to quality management which are studied in future empirical chapters.(chapters ten and eleven). It is later investigated why private and public sector construction contractors implement quality management systems and what, if any, associated benefits might be derived from their use. Furthermore, the use of various forms of quality assurance and the differences between them are investigated to ascertain the reasons for implementing a particular type, for example, third party quality assurance. Another interesting facet of the quality theme is to identify specifically the areas of business in which private and public sector construction contractors are 'quality assured'.

The information from these empirical chapters is, at a later stage, compared with the literature review given in this chapter to establish the current situation in the construction industry with respect to quality management.

Chapter Six : References

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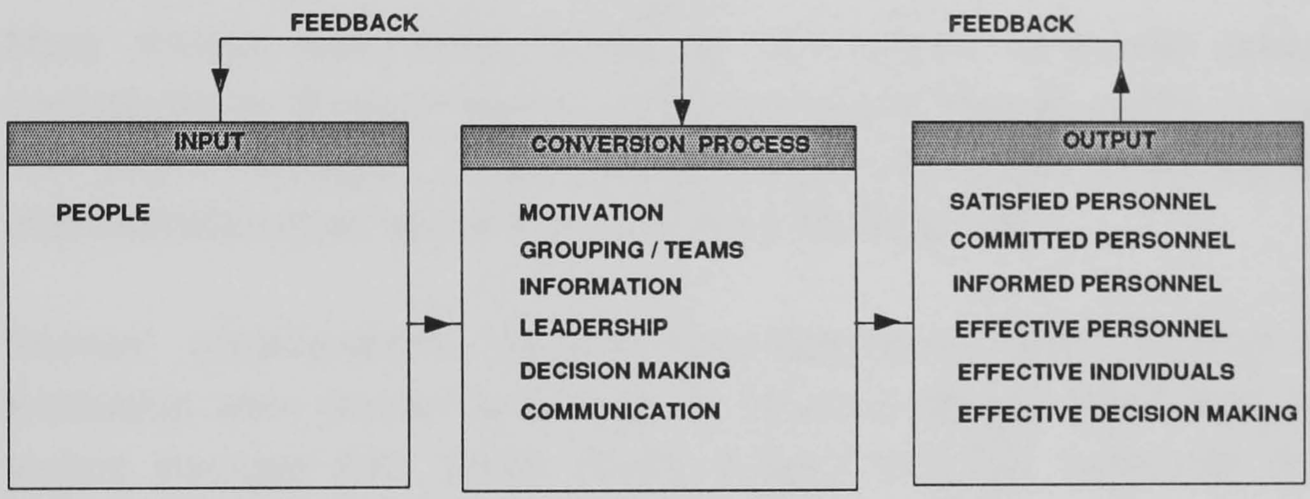
CHAPTER SEVEN : MANAGEMENT OF HUMAN RESOURCES IN THE PROJECT ENVIRONMENT

7.1 SUMMARY OF CHAPTER SEVEN

The sub-system model for human resources, previously put forward in Chapter One (Figure 1.8), along with its defined 'primary task' is shown again for reasons of emphasis.

Human Resource Sub-System



<u>**Primary Task**</u>

' To create and maintain a culture, where management of human resources are adequately considered and meet employees' aspirations'

This Chapter covers some aspects of human resource management, with selection made on the topics of management theories, motivation, teams and leadership as relevant to construction projects.

The Chapter begins by looking at various approaches to management introducing general management theories and principles. Since motivation can have an important effect on the performance of individuals associated with any project, this subject area is considered in detail by looking at the work of various motivation theorists and some notable research carried out in the construction industry. The role of teams and leadership in the project environment complete the chapter.

7.2 INTRODUCTION

Dinsmore (1984) has described human resource management to be the most important supporting management function within project management. [1] A project manager must create and maintain a harmonious atmosphere in the project environment to achieve the maximisation of the human contribution in the execution of the project. Notwithstanding these sentiments, Fabi and Pettersen (1992) comment on work carried out by Tyson and Fell (1990) indicating that the present stage of knowledge on the subject seems to suggest that many organisations are still at a rather elementary stage in their human resource management development. [2]

Many surveys have been carried out with respect to human resource considerations. A useful survey was carried out by Posner (1987) on some 300 project managers in the United States with regard to the personal characteristics of an 'above average project manager'. [3]

'Human' considerations involving communications, team building and leadership were clearly deemed to be of much greater importance for a project manager than merely having a good technical knowledge of the works to be undertaken. Posner stated that the results :

" reaffirm the key role played by human aspects "

Further description is now given of some of the more significant management theories which can greatly influence the possibilities of success, or failure in the execution of construction projects.

7.3 EARLY MANAGEMENT THINKING

FW Taylor (1856-1915) [4] is generally recognised as the founder of scientific management. The result of his research carried out at the Bethlehem Steel Company, in the USA, was a scientific approach to the breakdown and measurement of work. Taylor divided work into separate elements and then attempted to find the most efficient method of working on each element. Taylor focused largely on economic reward and introduced the concept of 'a fair day's work for a fair day's pay', explaining his management principles as follows.

Firstly, he believed in the development of a science of each element of a man's work thereby replacing previously adopted rule-of-thumbs methods. *Secondly,* the selection of the best worker for each particular task (combined thereafter by appropriate teaching and training) was to be preferred, rather than allowing the worker to select his own task and train himself as best he could. *Thirdly,* the development of a good working spirit between the management and the men in the carrying out of the activities in accordance with the principles of the development science. *Fourthly,* Taylor believed in the division of the work into balanced shares between the management and the workers, each department taking over the work for which it was better equipped. This was to be in contrast with the former condition, where almost all the work and the greater part of the responsibility were thrown on the men.

H L Gantt (1896-1919) [5] and FB Gilbreth (1868-1924) [6] continued on from Taylor's work with Gantt taking a more humanist view to aspects of men at work. Gantt is most well known as the originator of the 'Gantt Chart' or barchart as discussed in Chapter Four. He was an able industrial engineer and developed a number of incentive schemes and production planning and control systems as well as taking an interest in the important issue of modern methods of training workers. Gilbreth was best known for his work on motion study including his seminal work on brick laying. He was able to increase individual output of blocks laid per hour from 120 to 350. His wife (1878-1972) a trained psychologist, assisted him in his work and continued it after his death.

These early concepts of management did not, however, address the wide range of operations normally associated with a company in a business environment.

7.4 MANAGEMENT THEORIES AND PRINCIPLES

7.4.1 Henri Fayol

Henri Fayol (1841-1925) [7] addressed the whole spectrum of management within an organisation. He considered industrial organisations to contain six groups of activities: technical, commercial, financial, accounting, security and managerial. Fayol advocated that the management of these activities was made up of five elements, commonly referred to as the 'POC' elements. These were :

- the forecast and plan
- organisation
- command
- co-ordination
- control

He set out fourteen principles which he had used frequently, although he considered that there was no limit to their number and that they should be adapted to meet the needs of a particular situation. These are shown in Table 7.1.

Table 7.1 : Fayol's Fourteen Most Frequently Used Principles Of Management

	FAYOL'S FOURTEEN MOST FREQUENTLY USED PRINCIPLES OF MANAGEMENT
1.	Division of work
2.	Authority and responsibility
3.	Discipline
4.	Unity of command
5.	Unity of direction
6.	Subordination of individual interest
7.	Remuneration
8.	Centralisation
9.	Scalar chain
10.	Order
11.	Equity
12.	Stability Tenure
13.	Initiative
14.	Esprit de Corps

Source : Adapted From Fayol H. - General Industrial Management 1949

Fayol believed that task specialisations arising from *division of work* was a natural occurrence and allowed the best use to be made of individuals and groups of people. He referred to two kinds of *authority* that were necessary for effective management - firstly, that derived from the office held and secondly, that from personal abilities and experience. Authority was defined as the power to issue instructions and obtain compliance, with *responsibility* automatically resting where the authority was exercised. *Discipline* was considered to be essential to the well-being and success of an organisation and its nature would depend on how the rules of the organisation had been formulated (that is to say, improved or reached by consultation) and on the quality of leadership. Fayol's principles of *unity of command* and *unity of direction* dictated that an employee should only be given instructions from one superior and that all activities having the same objective should be the responsibility of one superior working to one plan. He believed that *subordination of individual interest*, that is to say, the selfish interests of individuals or groups of people, were ever ready to unsurp the interests of the organisation, but the general interest must at all times prevail over the individual interest. *Remuneration* should be satisfactory to both the employer and the employee. It should be fair, but not excessive, and should encourage effort. However, he believed that all systems of reward had advantages and disadvantages. Fayol considered that there was a natural tendency to *centralisation* in all organisations and that its extent would vary according to the size of the organisation and the nature of work carried out by its members. The *scaler chain*, that it, the hierarchy of authority, comprising of heads of sections each of whom was responsible for the next level in the chain should operate in such a manner that communications would take place at comparable levels in different departments rather than go up one chain and down another to the appropriate person in the other department. He advocated that *order* must be present within an organisation. Material order consisted of having a proper place for everything and ensuring that each item was in that place. Social order dictated that there should be an established place for every employee that the place should be the right one for a particular person and that the person, in turn, should be right for the place. Fayol defined *equity* as the product of kindliness and justice and concluded that it must be applied to obtain the best out of people. Furthermore, he understood that a person engaged on different work would take time to learn it and that *stability of tenure* was needed for the enterprise to gain recompense for its investment in the person it had trained. *Initiative* was described as being the quality of being able to devise a plan and carry it into effect. As it was a powerful stimulus to achievement, Fayol considered that initiative should be encouraged to the full in all employees. His principle of *esprit de corps* made reference to the fact that unanimity and accord were great assets to any organisation and should be encouraged. Discussion should be avoided and communication, if possible should be verbal, since he believed this method to be quick and clear.

7.4.2 L.F.Urwick

L.F. Urwick (1952) [8] advocated principles of management which closely followed those of Fayol. His ten principles which were considered to be universally applicable are shown in Table 7.2.

Table 7.2 : Urwick's Ten Principles Of Management

	URWICK'S TEN PRINCIPLES OF MANAGEMENT
1.	Objective
2.	Specialisation
3.	Co-ordination
4.	Authority
5.	Responsibility
6.	Definition
7.	Correspondence
8.	Span of control
9.	Balance
10.	Continuity

Source : American Management Association New York - Notes On The Theory Of Organisations - 1952

Urwick defined *objective* as being the need for every organisation and every part of an organisation to be an expression of the purpose of the undertaking concerned. *Specialisation* advocated that the work of every member of any organised group should be confined, where possible, to the carrying out of a single function. *Co-ordination* was considered to be the purpose of organising a manner to facilitate unity of effort within an organisation. *Authority,* within an organisation should be clearly defined with a line of authority from the supreme authority to every individual in the organisation. The *responsibility* of the superior for the acts of his subordinates was absolute. The *definition* of all parts within an organisation should be written down with details of the duties involved, the authority and responsibility contemplated and the relationships with other parties given. Urwick defined *correspondence* as the necessity of balancing responsibility and authority at every position in an organisation. He further advocated that the *span of control* within an organisation should be such that no one person supervises more than 5 or 6 direct sub-ordinates whose work interlocked. Urwick's principle of *balance* considered it essential to keep all the various units of an organisation in balance and *continuity* should be allowed for in terms of the continued process of re-organisation taking place in all organisations.

7.4.3 E.F.L Brech

Another writer on management principles E.F.L. Brech (1965) [9] considered management to contain four essential elements, or functions and eight principles. The four essential elements considered were planning, coordination, motivation and control.

Brech is a writer of particular interest to the construction industry, being a one time chief of The Construction Industry Training Board (CITB). His principles are shown in Table 7.3.

Table 7.3 : Brech's Eight Principles Of Management

	BRECH's EIGHT PRINCIPLES OF MANAGEMENT
1.	Organisation
2.	Structure
3.	Definitions
4.	Specialisation
5.	Delegation
6.	Hierarchy and span of control
7.	Authority and responsibility
8.	Flexibility

Source : Brech E.F.L. - Organisation, The Framework Of Management - 1965

Organisation, that is, the determination and specification of appropriate operational and functional responsibilities and their inter-relationships was considered as one aspect of planning. The *structure* of an organisation was described as the framework for managing, delegating, co-ordinating and motivating all persons within it. *Definitions* indicating the responsibilities and activities of all members of their inter-relationships should be stated. Brech advocated that when the scale of operations make sub-division necessary then it should be done by *specialisation* of function or operation. He also stated that when the scale of operations threatens to impair performance then *delegation* should be made to subordinates in direct line. With respect to *hierarchy and span of control* Brech believed that there should be a single head of the enterprise, decentralisation of decision making, clear lines of responsibility and a limited span of control. *Authority and responsibility* were considered inseparable, but at all times superiors were accountable for actions of sub-ordinates. *Flexibility* within an organisation's structure would aid an organisation to be capable of changing to suit changes in basic circumstances.

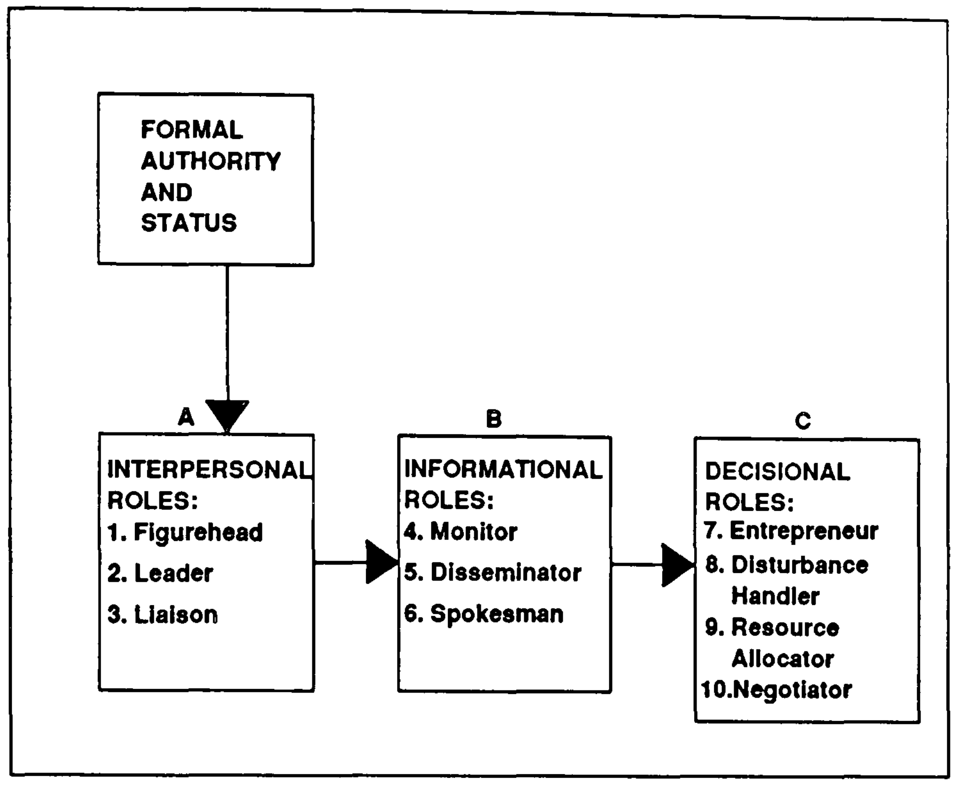
The management principles put forward by Fayol, Urwick and Brech have a number of similarities. Although useful in their own right, they do not necessarily reflect the activities that a manager undertakes on a daily basis. Kakabadse, Ludlow and Vinnicombe (1988) [10] state that a manager's daily contacts with other managers, employees and other people are mostly verbal (four out of five). They also relate that much of the information that managers glean is by means of informal channels and not formal lines of communication.

7.4.4 H. Mintzberg

Mintzberg (1975) addressed the work of managers by carrying out studies involving observations on managers actually doing their work. [11] His findings were quite different from those of the earlier management theorists. Essentially, Mintzberg described the job of a manager as a set of various roles (ten in number), normally carried out within the manager's position. These ten roles were further sub-divided into three categories, interpersonal roles, informational roles and decisional roles.

Mintzberg's model of the inter-relationship of these roles is shown in Figure 7.1.

Figure 7.1 : Mintzberg's Management Model



Source : Adapted From Mintzberg H. - 'The Manager's Job : Folklore And Fact' - Harvard Business Review - 1975

According to Mintzberg, these three sets of managerial roles form a complete picture of the manager's job. However, Kakabadse, Ludlow and Vinnicombe (1988) reckoned that managers [12] :

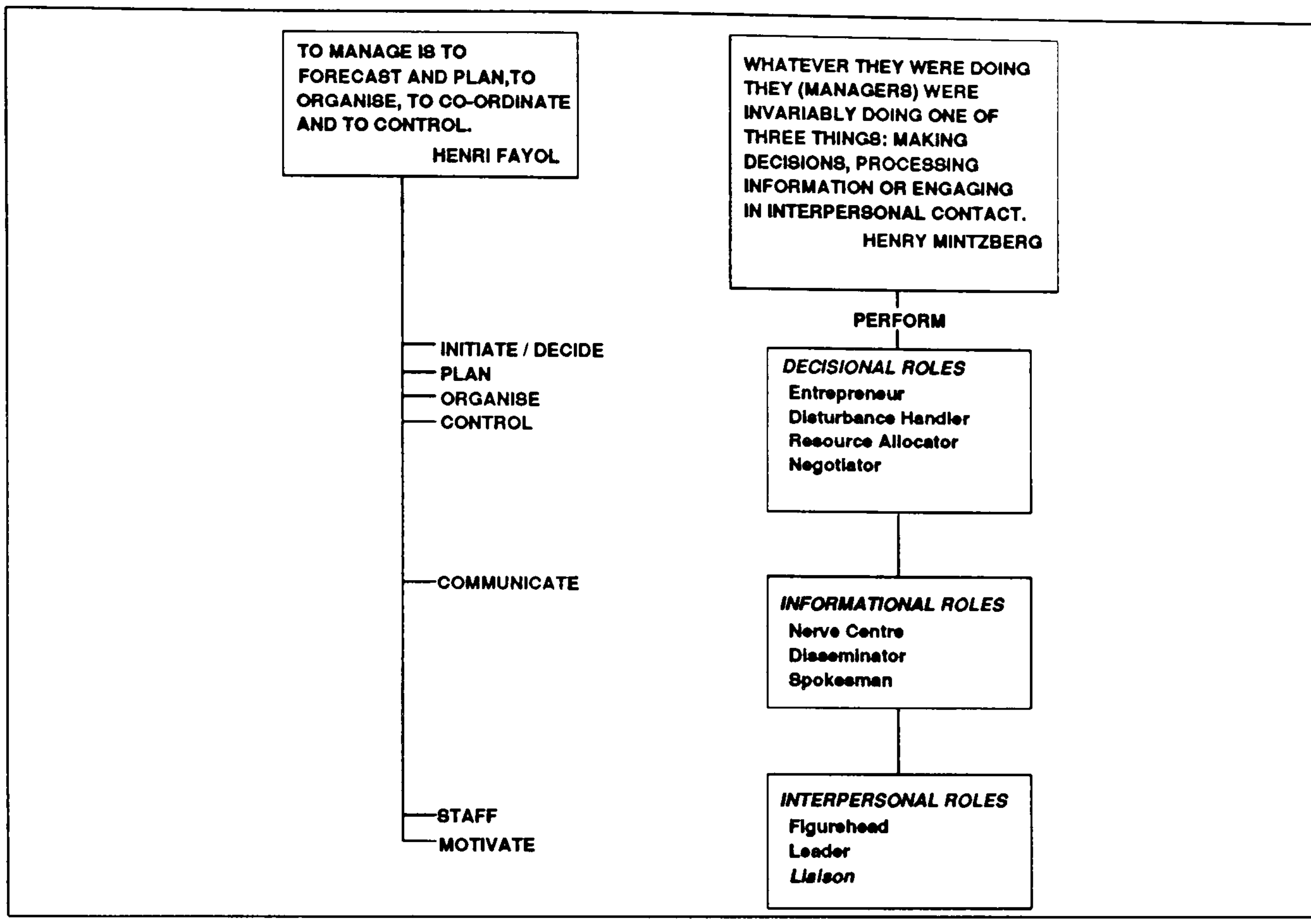
" are not normally measured on their quality of performance in their interpersonal roles, but mostly on their decisional roles "

They also comment that a manager must firstly develop skills of an interpersonal nature, at the same time encouraging informal communication channels to operate so that the manager can perform well in the information role.

7.4.5 Comparison Of Fayol's and Mintzberg's Theories

Figure 7.2 shows a comparison of Fayol's and Mintzberg's theories of the management process.

Figure 7.2 : Comparison Of Fayol's And Mintzberg's Theories



Source : Newcombe R., Langford D. And Fellows R. : Construction Management - Organisation Systems - 1990

Fayol advocated that a manager should perform a set of functions, whereas Mintzberg believed that a manager should concentrate on a series of roles. Essentially, both theories have their relative merits. Fayol puts forward a more theoretical model of the main elements, or functions of the management process. On the other hand, Mintzberg models the more practical issues involved in day-to-day management which stem from the more formal elements as portrayed by Fayol.

As can be seen from Figure 7.2, the POC elements of Fayol's theory can be compared directly with the decisional, informational and interpersonal roles as portrayed by Mintzberg.

7.5 DEFINITION OF A MANAGER

To many, management is a dynamic phenomena that is both an art and a science. The scientific elements can be learned but, in so far that it is an art, the ability to practise it must be partly inborn. The scientific principles put forward by Taylor and others have been discussed, but these merely aid a manager in the decision making process. When it comes to making decisions there has to be an art in sensing when is the right time to make a decision and how that decision should be made. This is different to deciding merely those duties which should be carried out by a manager.

Fayol advocated that managerial qualities were vested in the following personal characteristics : physical qualities, mental qualities, moral qualities, general education, technical knowledge and experience.

The physical qualities of a manager include leadership capabilities, the ability to handle people (not just to 'get along' with them) and the ability to work hard and possibly long hours. Mental qualities include the ability and willingness to delegate and to make decisions. (quickly when necessary) This also involves imagination to look ahead, initiative, self-control, adaptability to change with changing circumstances, good judgement, an ability to see things in perspective as well as self-confidence, loyalty and integrity. Moral qualities which a manager should possess include courage, will power and humanity, including understanding the faults of others. Educational qualities should mean having a good general education, a knowledge of general management theory and a technical knowledge of the work of one's own section or department.

The proportion of each of these personal characteristics will vary according to the managerial position concerned.

Theodore Roosevelt once said [13]

" the best executive is the man who has sense enough to pick good men to do what he wants done, and self restraint enough to keep from meddling with them while they do it "

Management in the construction industry involves getting things done by a variety of people from basic labourer through to board level. For singular projects, the culture of the management set-up has to be right to achieve satisfactory completion. Effectively everyone involved in a project from foremen level upwards is some sort of a manager and should possess the necessary personal characteristics for their position in the organisation.

7.5.1 Drucker's Perception Of The Work Of A Manager

Drucker (1965) believed that there are five basic operations in the work of a manager, namely, setting objectives, organising, motivating and communicating, measurement and developing people. [14]

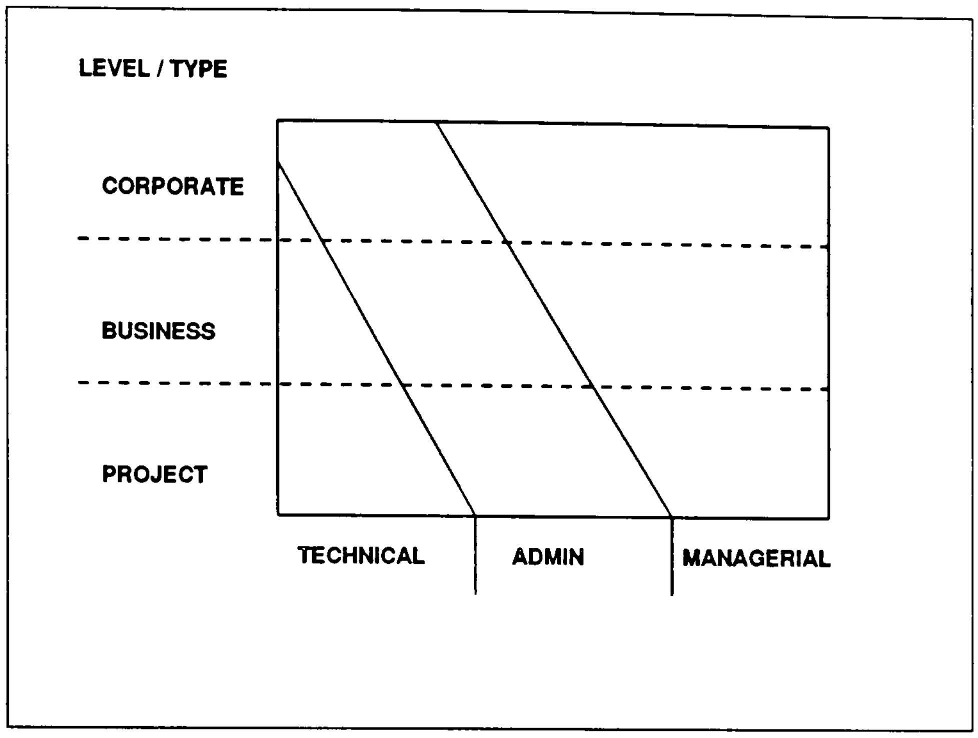
Initially a manager must *set objectives* and decide what has to be done to meet these objectives. In *organising* work, a manager divides the work into manageable activities and selects people for the carrying out of the jobs to be done. A manager must *motivate and communicate* effectively and make a team out of the people working for him. This is achieved through constant communication, through good employment practices and possibly also through incentives and rewards for successful work. Drucker describes the job of measurement :

> *" the manager establishes measurement yardsticks - and there are few factors as important to the performance of the organisation and of every man in it "*

Th manager assesses performance and takes appropriate corrective action should this be necessary. He is constantly attempting to *develop people* to enable them to perform at optimum performance in the work of the organisation .

However, the actual content of a manager's activities in terms of technical, administrative or managerial duties will depend upon the level of the manager within the organisation. At the project level, the technical content is much higher than at the corporate level. Similarly, managerial input is more predominant at the corporate level. Newcombe, Langford and Fellows (1990) put forward a diagrammatic representation of this principle, shown in Figure 7.3. [15]

Figure 7.3 : Content Of Managerial Activities



Source : Newcombe R, Langford D. And Fellows R. - Construction Management - Organisation Systems - 1990

It is important for all staff involved in projects to recognise at what level of management they are operating. This will help enable personnel to be aware of their position of managerial effectiveness and the relationship of their position to other managers in the organisation. This is essential for proper communication and good project morale from the very beginning of a project.

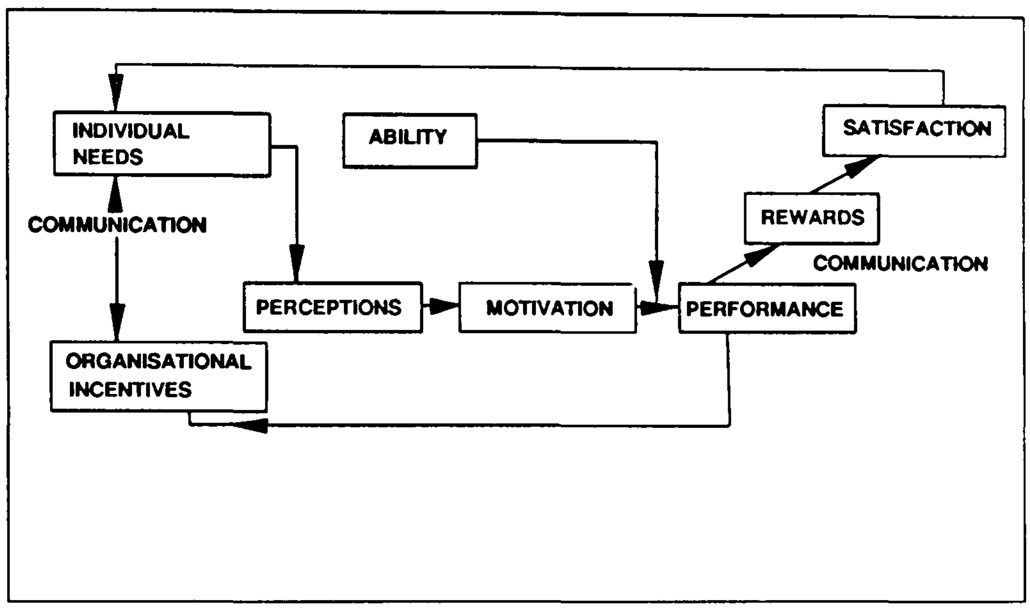
7.6 THEORIES OF MOTIVATION

An individual's motivation is the result of needs, incentives and perception. [16] Poorly motivated people are likely to perform at less than their optimum performance and may also influence other fellow workers' motivation, or morale.

Vroom and Deci (1970) [17] state that the performance of people at work varies greatly, the best worker in a group may be contributing tenfold compared to the poorest contributor. They put forward the idea that performance at work is composed of two factors. *Firstly,* it comprises of having skill in the work and *secondly,* motivation to exercise that skill. Performance is not the sum of the two factors, but it can be their product; that is to say, increasing the motivations of persons high in ability will lead to a greater increase in performance than just increasing the motivation of persons low in ability.

A useful flow chart depicting the motivation process is shown in Figure 7.4.

Figure 7.4 : The Motivation Process



Source : Kakabadse A, Ludlow R. And Vinnicombe S. - Working In Organisations - 1987

Douglas McGregor [18] was a social psychologist and considered the action of managers to be predetermined by the assumptions they themselves made about the employees in their organisations. He put forward two simplified theories, which he called 'X' and 'Y' to classify his views. Theory 'X' advocated that people in organisations were lazy, passive, had no ambition and shunned responsibility. They were also selfish, resisted improvement and were easily deceived. McGregor stated that management had a basic right to organise towards economic ends and that coercion, manipulation, persuasion, punishment and control would all have to be exercised in a Theory 'X' environment. Theory 'Y' advocated that people in organisations had plenty of good will and were willing to respond to the organisation's needs. There was considered to be a potential in everybody for development which included the taking of responsibility, with management being prepared to allow people to achieve their own aspirations.

Several important motivation theories have developed through the years, including :

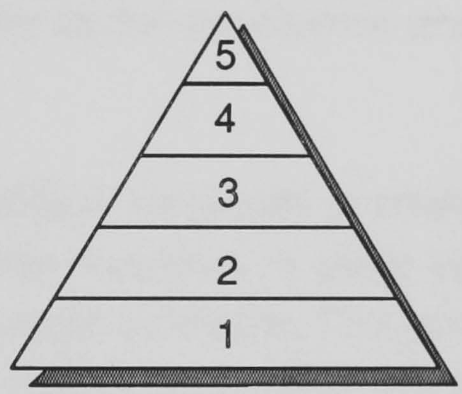
- **Needs Theories** - Maslow (1943), McClelland (1953) and Aldefer (1972)
- **Incentive Theories** - Herzberg (1959)
- **Expectancy Theories** - Vroom (1964) and Porter and Lawler (1968)

7.6.1 Maslow's Motivation Theory

Abraham Maslow (1943) [19] was a clinical psychologist and studied the reasons that induce people to work. He put forward a needs hierarchy based on five levels. Figure 7.5 shows Maslow's model.

Figure 7.5 : Maslow's Model Of Motivation

5. Self-actualisation
4. Egotistical
3. Social
2. Safety
1. Physiological



Source : Maslow A.H. - Psychological Review Vol 50 - 'A Theory of Human Motivation' - 1943

Maslow considered that these 'needs' were arranged in a hierarchy, that is to say, the appearance of one usually rests on the prior satisfaction of another need. Physiological needs include such things as hunger and thirst. Safety needs took in job security, protection from violence/crime, stability and order. Social needs encompassed love, affection and belonging. Egotistical needs included self-respect, achievement, independence, freedom and reputation. Self actualisation needs extended to the desire for self fulfilment and to become everything that one is capable of becoming.

In the 'real life' situation Maslow believed that the average person would fill all of his basic needs partially satisfied and partially unsatisfied at any one time. Nevertheless a 'higher' need was unlikely to emerge in a person until a 'lower' need had been substantially satisfied. A satisfied need ceased to become a motivator. For all this, he considered that most people would be unlikely to be aware of these needs in themselves, or the extent to which they had been satisfied.

7.6.2 McClelland's Theory Of Motivation

David McClelland (1953), [20] an American psychologist, argued that many needs were not as universal as Maslow had proposed, they were in fact socially acquired and varied from culture to culture. He defined these as the need for achievement, the need for affiliation and the need for power.

The need for achievement reflected the desire to meet task goals, the need for affiliation mirrored the desire to develop good interpersonal relationships and the need for power included the desire to influence and control other people.

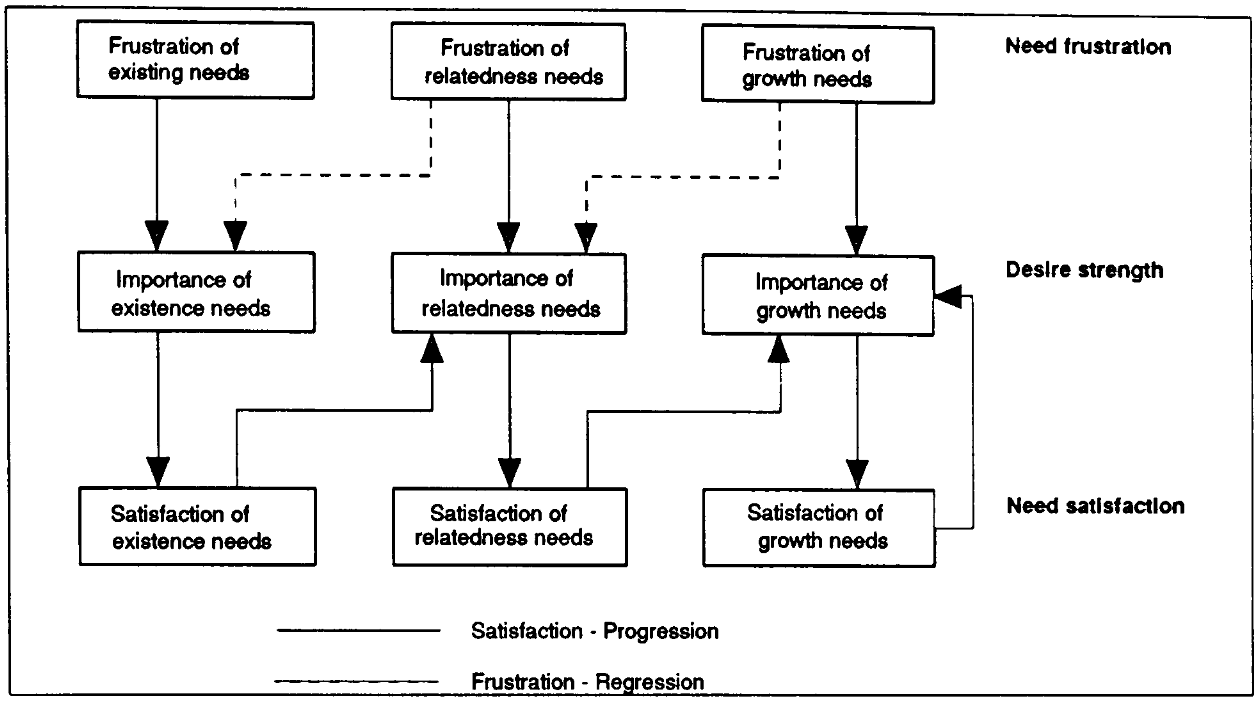
McClelland considered that it was difficult for people to change their needs once they had acquired them; it was important to place people correctly within organisations to match their perceived needs. This process stemmed ideally from the initial selection of people at the time of coming into the organisation.

7.6.3 Alderfer's Theory Of Motivation

Clayton Alderfer (1972) [21] developed a three factor theory of needs called ERG : Existence, Relatedness and Growth. The principles of Alderfer's theories are shown in Figure 7.6. His ERG theory relates closely to a number of needs put forward previously by Maslow.

Alderfer developed three important points. *Firstly*, the less a need was satisfied, the more important it became. *Secondly*, the more a lower level need was satisfied, the greater the importance of the next higher level need. *Thirdly*, the less the higher level need was satisfied, the greater the importance the lower need assumed.

Figure 7.6 : Satisfaction - Progression, Frustration - Regression Components Of ERG Theory



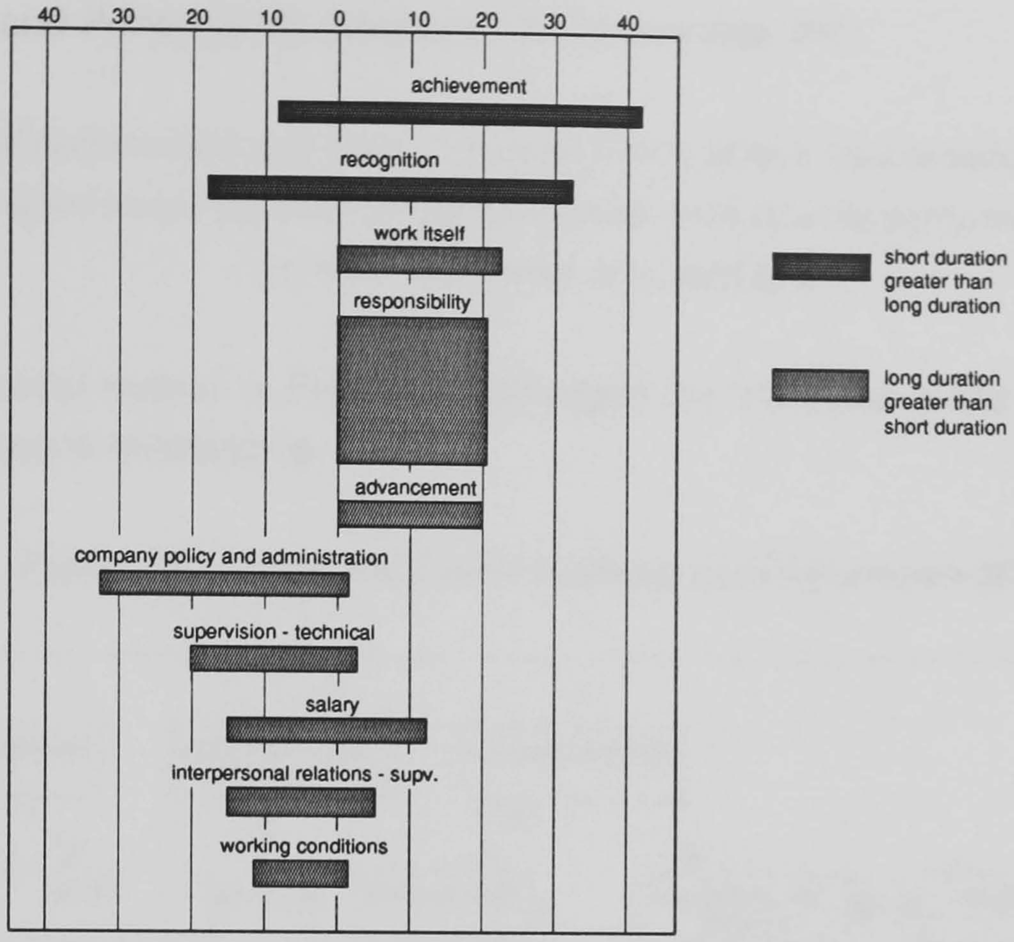
Source : Steers R.M. and Porter L.W. - Motivation and Work Behaviour 1979

7.6.4 Herzberg's Theory Of Motivation

Frederick Herzberg (1959) [22] carried out studies in the 1960's into motivation at work with particular reference to job satisfaction and mental health. His studies have shown, clearly, that a proper understanding of an individual's motivation at work encompassed both the individual himself and the total situation. Certain factors led to job satisfaction and were described as motivators. Other factors relating to a healthy working environment were termed hygiene factors, representing job dissatisfaction. Figure 7.7 shows Herzberg's theory of 'satisfiers and dissatisfiers'.

Herzberg advocated that the factors which led to job satisfaction (motivators) were separate and distinct from those which might lead to job dissatisfaction (hygiene factors). That is to say that satisfaction was not the opposite of job dissatisfaction, but rather no job satisfaction. Similarly, the opposite of job dissatisfaction was no job dissatisfaction and not job satisfaction. Herzberg also suggested in his concept of 'motivation-hygiene' that while there was nothing wrong in providing the maximum 'hygienic' benefits for employees, that it was quite wrong to view human needs solely in these terms. He also suggested that greater attention should be given to the motivating factors.

Figure 7.7 : Herzberg's Comparison of Satisfiers and Dissatisfiers



Source : Herzberg F. : 'The Motivation-Hygiene Theory' - 1966

7.6.5 Vroom's Theory Of Motivation

Victor Vroom (1964) [23] has been a strong believer in the expectancy theory and based his belief on four points. *Firstly,* people had preferences for various outcomes or incentives that were available to them. *Secondly,* people held expectations about the likelihood of an action or effort on their behalf that would lead to the intended outcome. *Thirdly* people understood that certain behaviours would be followed by desirable outcomes or incentive rewards, for example a pay rise or increased status. *Fourthly,* Vroom believed that the action that a person chose to take was determined by the expectancies and preferences that the person had at the time. In more simple terms Vroom put forward the idea that individuals would be highly motivated when they felt confident of achieving high performance. Here the attraction of the reward would be high; they would feel that they were likely to receive the rewards if they performed highly and they felt fairly rewarded relative to others around them.

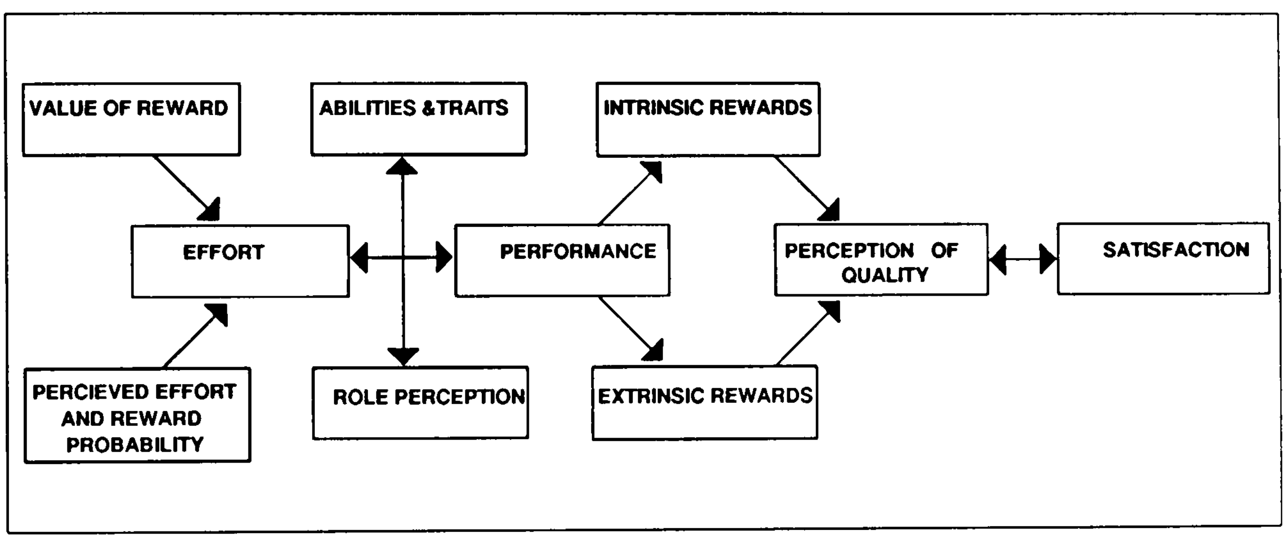
7.6.6 Porter and Lawler's Theory Of Motivation

Lawler and Porter(1973) developed the theory that [24] :

" Good performance may lead to rewards which, in turn lead to satisfaction, this formulation would say that satisfaction, rather than causing performance as was previously assumed, is caused by it "

Their model shown in Figure 7.8 arranges ten variables in the satisfaction/ performance relationship.

Figure 7.8 : Porter And Lawler's Satisfaction Performance Model



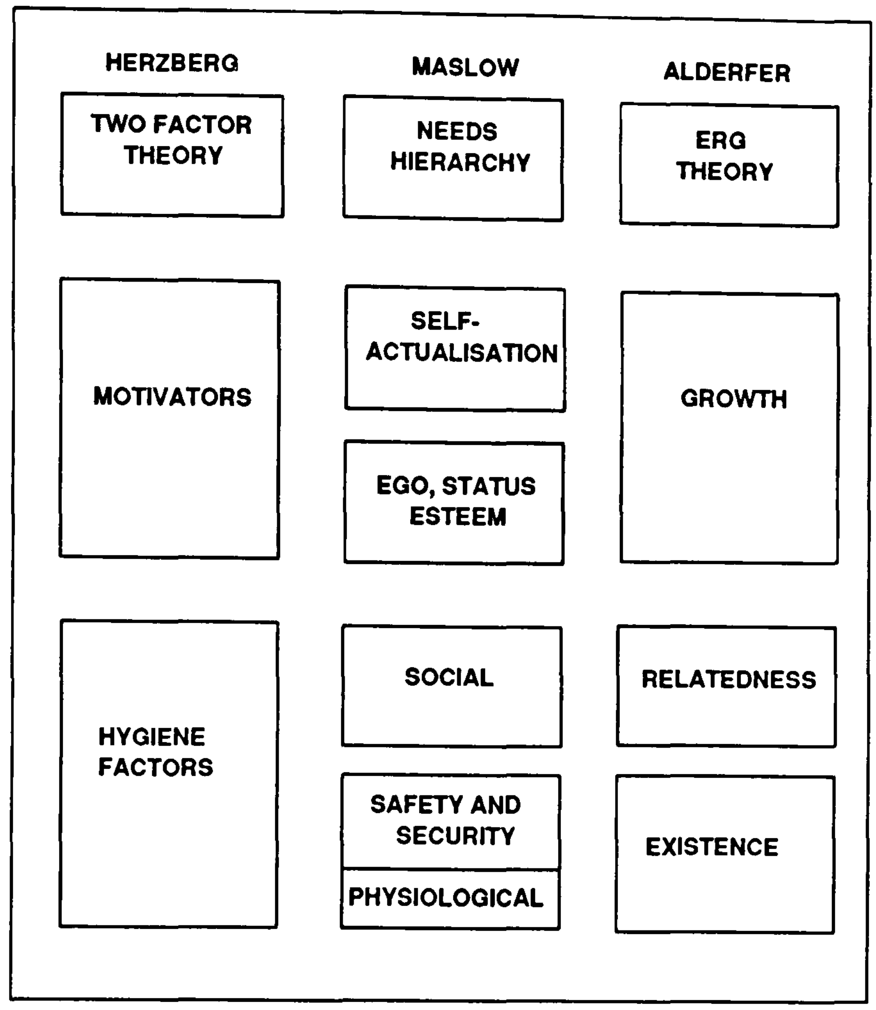
Source : Porter L. And Lawler E. : Managerial Attitudes And Performance - 1973

Newcombe, Langford and Fellows (1990) comment that the model and principles contained with it are often categorised as the expectancy - valency approach. [25] Assessments are normally made by an operative on expectation of a successful outcome and the valuation of consequent rewards.

7.6.7 Comparison Of Herzberg, Maslow and Alderfer

Kakabadse, Ludlow and Vinnicombe (1988) put forward a diagrammatic representation of the comparison of the motivation theories of Herzberg, Maslow and Alderfer which are now shown in Figure 7.9. [26]

Figure 7.9 : Comparison Of Herzberg's, Maslow's and Alderfer's Theories Of Motivation



Source : Kakabadse A, Ludlow R. And Vinnicombe S. - Working In Organisations - 1987

Maslow's and Alderfer's theories are very similar, with perhaps Alderfer representing the existence, relatedness and growth in a more 'broad brush' fashion than Maslow. Herzberg's theory, when divided into its motivation and hygiene factors, also depicts the clear difference between issues involved in 'maintaining the status quo' in terms of satisfaction at work and those which have a clear impact on motivating individuals to higher levels.

7.7 RESEARCH INTO MOTIVATION IN THE CONSTRUCTION INDUSTRY

Much research has been carried out into motivational aspects of the construction industry, especially in the United States.

Lauffer and Borcherding (1981) carried out research into financial incentives which may be used to attempt an increase in productivity. [27] Their findings are shown in Table 7.4.

Table 7.4 : Financial Incentives - Recommendations For Implementation

	FINANCIAL INCENTIVES - RECOMMENDATIONS (LAUFFER AND BORCHERDING - 1981)
1.	The system should not be complicated so that the workers will understand exactly how to benefit from it
2.	Incentive programmes can be more efficient when both management and workers are involved in the programmes' development
3.	The programmes should involve as many workers on the site as possible and the assessment of the outcome preferably based on group performance rather than individual
4.	The reward should be closely tied to performance criteria mainly quality and safety. To help obtain quality and safety, altering standards should be avoided unless mutually agreed and allowed for.
5.	Over and above the guarantee of an hourly base rate, there should be an adequate bonus rate (20 - 30%)
6.	Measurement of performance should be objective, based on short intervals of work and rewards should be paid immediately after achieving the desired outcome

Source : Adapted From Lauffer A. And Borcherding J.D. - 'Financial Incentives To Raise Productivity' - 1981

Salary was recognised as a hygiene factor within Herzberg's motivation model; it might have both a satisfying and dissatisfying effect on workers' motivation, and hence performance.

It was therefore necessary to mount incentive schemes (or bonus schemes as they were commonly referred to in the construction industry) to help achieve the positive side of the motivation equation. This involved the need for a straightforward bonus system which had to be seen to be fair to *all* workers. Where possible, bonus systems were applied to teams in an attempt to help improve team performance.

Abu-Hijleh and Ibbs (1989) commented that [28] :

" construction incentives can be useful devices to improve project performance, particularly the use of schedule-based incentives which can result in substantial time and cost savings "

However, it must never be too easy to achieve the maximum bonus with minimum effort, as might be the case on some projects. This simply defeated the purpose of such schemes and served to reduce workers' motivation. Furthermore, the limits set on bonus system must not be perceived as denying them the opportunity to earn more money through improved performance.

Tucker (1986) relates how productivity in the construction industry has been on the decline for over a decade. [29] He commented that on some projects only 20% of the theoretical work hours were actually used putting work into place.

Borcherding, Sebastian and Samelson (1980) put forward the following recommendations to improve motivation and productivity; that was to provide adequate lead design time, improve planning scheduling at the workface and improve project communications. [30]

Productivity is clearly related to motivation. Human factors such as absenteeism and changes of staff to teams will have an effect on the performance of that team. Likewise, if information of any kind is not supplied on time, or work not inspected timeously, unnecessary delays will be encountered in the project. Samelson and Borcherding (1980) carried out research into these and other factors which caused problems with tradesmen's productivity on construction projects. [31] Their results are shown in Table 7.5.

Table 7.5 : Problems Affecting Tradesmen's Productivity

	PROBLEMS AFFECTING TRADESMEN'S PRODUCTIVITY
1.	Materials and tool availability
2.	The rate of carrying out remedial work
3.	Gang interfacing
4.	Over-crowded work areas
5.	Instructional time delay
6.	Inspection delay
7.	Tradesmen turnover
8.	Absenteeism
9.	Foremen changes
10.	Foremen incompetence

Source : Adapted From Samelson N.M. And Borcherding J.D. : 'Motivating Foremen On Large Construction Projects' - 1980

Samelson and Borcherding (1980) also list a number of factors which were classified as being motivators or demotivators on construction of projects. These are shown in Table 7.6.

Table 7.6 : List Of Motivators And Demotivators On Construction Projects

LIST OF MOTIVATORS	LIST OF DEMOTIVATORS
Good working relationship among the trades	Disrespectful treatment
Adequate orientation programme	Little accomplishment
Good safety programmes	Material availability
Work itself	Tool availability
Overtime	Remedial work
Wages	Group discontinuity
Recognition	Project confusion
Goals defined	Lack of recognition
Open house and project tour	Productivity urged but no one cares
Good management	Ineffective utilisation of skills
Suggestion solicitation	Incompetence of personnel
	Lack of cooperation
	Overcrowding
	Poor inspection
	Communication breakdown
	Unsafe conditions
	No participative decision making

Source : Adapted From Samelson N.M. And Borcherding J.D. : 'Motivating Foremen On Large Construction Projects' - 1980

The factors covered the full spectrum of the needs, incentives, and expectancy theories of motivation previously discussed. It is therefore important to address the demotivating constituents in the project environment with a view to attempting to eliminate or minimise them. Similarly, care should be taken to maximise those elements which result in improved motivation.

Borcherding and Oglesby (1974, 1975) carried out studies into job satisfaction and job dissatisfaction in the project environment for different levels of management. [32,33] These included project managers, superintendents and foremen. Their results are shown in Table 7.7.

Table 7.7 : Job Satisfaction And Dissatisfaction In The Construction Industry

	Project Manager	*Superintendent*	*Foreman*
JOB SATISFIERS			
Job making a profit	1	4	
Customer (and client) satisfaction	3		
Job completed on schedule		1	2
Tangible physical structure	5		4
Good workmanship	2	3	3
Meeting challenging work		2	1
Good work relations within group	4	5	5
JOB DISSATISFIER			
Problems with the union		3	4
Company or personal mistakes	1	4	
Inability to maintain job schedule	2	1	
Poor engineering	3	2	
Inadequate site supervision	4		
Continuous criticism by home office		5	
Uncooperative workmen			1
Lack of incentive in workmen			2
Lack of information and material			3

Source : Adapted From Borcherding J.D And Oglesby C.H. - 'Construction Productivity And Job Satisfaction' (1974) and 'Job Dissatisfaction In Construction Work' (1975)

Their results showed that different aspects of a project give different levels of job satisfaction and job dissatisfaction depending on the level of management under consideration. For example, the most important job satisfier for each of the management levels was making a profit for a project manager, completion schedule for a superintendent and meeting challenging work for foremen. For job dissatisfaction, company, or personal mistakes for project managers, inability to maintain schedule for a superintendent and uncooperative workmen for foremen were the most influential.

Generally, the results confirmed that job satisfaction was not the equal, and opposite of job satisfaction. They also showed the need for taking into account the level of manager and the perceptions of job satisfaction and job dissatisfaction at that particular management level, for optimisation of working conditions for employees in the project environment.

Mansfield and Odeh (1989) carried out a review of empirical motivational studies in the United States construction industry. [34] Their findings concluded that much of the research carried out in the United States between 1970 - 1990 could be of assistance to project managers in the UK in improving the management of human resources and hence the development of more efficient projects. They state :

" Those seeking to improve performance on projects at the office or site level have often paid little attention to systematic management of human resources or they have assumed that the human factor would take care of itself "

Mansfield and Odeh (1991) commented that the construction industry, in the main, was labour intensive and that this should mean that proper emphasis is given to such matters as communications, participation and motivation. [35]

With respect to motivation they advocated that people must have an understanding of the way in which the construction industry operates, the types of individual with respect to their needs, behaviour and type of reward they prefer and the significant motivators for them. Industry characteristics prevalent in the construction industry include short term employment, construction site environments, labour availability, unusual problems and management effectiveness, which can be reduced significantly on multi-projects or complex projects. The types of individual engaged in construction projects involve those motivated by economic incentives, those motivated by social needs and interaction with others, those motivated by autonomy and independence, those motivated by economic, social and autonomous needs and those who may be motivated by a number of complicated or inter-related factors.

They identified nine areas which they considered to be significant motivators within the construction industry, namely, employee attitudes, achievement, challenges, appreciation of effort, responsibility, money, advancement possibilities, participation in decision making, competition and social relationships at work. *Firstly* they pointed out that employee attitudes can be enhanced by staff-orientation programmes within an overall environment of trust. *Secondly*, it should be easy to build in achievement challenges into project work. *Thirdly*, they considered that appreciation of effort expended by individuals should be openly expressed in a number of ways. *Fourthly*, if work is properly allocated the possible problems of boredom and frustration could be alleviated. *Fifthly*, money can count as either a weak or a strong motivator depending on economic circumstances. *Sixthly*, it was envisaged that the possibilities for advancement are reduced where short-term work or extremely specialised is the norm. Seventhly they also state that participation in the decision making process can engender a strong commitment from employees. *Eighth*, competition within the project environment should help stimulate innovation possibly effecting greater outputs. *Finally*, it was considered that social relationships at work could be improved by company sponsored courses and events.

7.8 THE ROLE OF TEAMS IN PROJECTS

Group performance is necessary from the very beginning of a project as mistakes made and time lost at the start can never be recovered, not to mention the effect on project staff morale. Any individual's performance on his job is essentially a function of their ability, motivation and the socio-technical system under which they work. The temporary nature of the project group means the members of it are together for a limited period and that there is little time for interpersonal relationships to develop into a static state, as could be expected in other non-project operational environment. A further hindrance may be that more often than not the composition of the group will be constantly changing throughout the course of the project.

Thamhain and Wilemon (1987) list a number of factors which can either act as aids, or barriers, to achieving performance. [36] (Table 7.8)

Table 7.8 : Drivers/Barriers To Team Performance

DRIVERS FOR IMPROVING TEAM PERFORMANCE	*BARRIERS TO PROJECT TEAM PERFORMANCE*
1. Professionally interesting and stimulating work	1. Unclear project objectives and directions
2. Recognition of accomplishment	2. Insufficient resources
3. Experienced engineering management personnel	3. Power struggle and conflict
4. Proper technical direction and leadership	4. Uninvolved, disintegrated upper management
5. Qualified project team personnel	5. Poor job security
6. Professional growth potential	6. Shifting goals and priorities

Source : Thamhain H.J. And Wilemon D.L. : 'A High Performing Project Team - IEEE Transactions On Engineering Management - Aug 1987

'Drivers' are considered to be factors associated with the project environment which are perceived as enhancing team effectiveness. 'Barriers' are those factors perceived as impeding project performance. Many of these drivers and barriers, (such as recognition, poor job security and unclear objectives) can be compared to the various motivational theories previously discussed or they can indeed lead to poor project planning.

Gabriel (1991) identified four key components that are essential ingredients of effective teamwork, these were, clear objectives, organisational relationships, compatibility and methods and mechanisms. [37]

The project manager must demonstrate commitment to the project objectives as well as to the other team members and convince them of their validity and credibility. Thamhain (1988) identified a number of factors, characteristic of effective and ineffective teams. [38] These are shown in Table 7.9.

Table 7.9 : Project Team Characteristics - Effective versus Ineffective

LIKELY CHARACTERISTICS OF EFFECTIVE TEAM	*LIKELY CHARACTERISTICS OF INEFFECTIVE TEAM*
• High performance and task efficiency	• Low performance
• Innovative/creative behaviour	• Activity orientated
• Committed, results oriented	• Low level of involvement and enthusiasm
• Professional objectives of team members coincide with project requirements	• Low commitment to project objectives
• Technically successful	• Unclear project objectives and fluid commitment levels from key participants
• On-time/on-budget performance	• Schedule and budget slips
• Team members highly interdependent, interface effectively	• Uninvolved management
• Capacity for conflict resolution, but conflict encouraged when it can lead to beneficial results	• Anxieties and insecurities
• Communicates effectively	• Unproductive, gamesmanship, manipulation of others, hidden feelings, conflict avoided at all costs
• High trust levels	• Confusion, conflict, inefficiency
• High achievement needs	• Subtle sabotage, fear, disinterest or foot-dragging
• Result oriented	• Frequent surprises
• Interested in membership self-development	• Quality problems
• High energy levels and enthusiasm	• Cliques, collusion, isolating members
• High morale	• Image problems (credibility)
• Change oriented	• Lethargic/unresponsive

Source : Thamhain H.J. - 'Team Building In Project Management' - Project Management Handbook Edited By Cleland D.I. And King W.R. - 1988

Thamhain states that :

" the project manager must foster an environment where team members are professionally satisfied, are involved and have mutual trust "

and furthermore,

" Effective team building is a critical determinant of project success "

It is therefore necessary for a project manager to be aware of team characteristics which may influence the effectiveness of the works to be undertaken.

The great majority of human beings have a natural desire to seek the companionship of other human beings in informal or social groups. They seek this for reasons such as satisfactory human needs for friendship, association with others, increased security and solid home base support. One of the most relevant groups for most people is the working group which includes peers, superiors and subordinates. Such groups, if healthy in nature, can make a considerable contribution to achieving an organisation's objectives. On the other hand, if the group is unhealthy, it may lead to disharmony between the group's and the organisation's objectives which could clearly have a detrimental effort on the organisation.

In the project environment, the project manager must be aware of the characteristics of groups or teams under his responsibility

Harrison (1985) [39] has cited five principal factors contributing to the formation of a group. *Firstly*, the people involved are engaged together in a task or operation. *Secondly*, they come into day-to-day contact with each other. *Thirdly*, they are interdependent. *Fourthly*, they have the same backgrounds, skills and sense of values. *Finally*, there will be leadership and management within the group.

Several different kinds of group may exist within a project environment. These may be described as vertical groups which consists of people of different levels in the same company, department or function; horizontal groups which consist of a group of managers at the same level but not necessarily in the same profession; mixed groups consisting of people at different levels and from different departments or companies associated with a project.

There is clearly a great difference between a number of individuals working together and an effective group or managerial team. An effective group will exhibit team spirit, enthusiasm for the project with the members being supportive of one another, whereas an ineffective group will show apathy, jealousy, bickering amongst themselves, disjointed effort and pessimism towards the project. An effective group will have a 'go and make it' attitude and an ineffective group will 'point out all the difficulties involved and will be negative about achievement'. Effective groups or teams do not just happen or form themselves. Groups are generally dynamic and changing in nature. The formation of an effective group can be considered as a series of four stages. Initially the development of mutual acceptance and trust leading to a diminishing of defensive behaviour will occur. This will be followed by open communication, co-operation and sustained productivity. The resolution of any problems or control are likely to be by means of mutual agreement. Thus it can be seen that an effective group takes time to develop.

Belbin (1981) identified eight types of people as being useful in the formulation of groups, or teams. [40] Each type represented a particular resource necessary to the effective operation of teams. His team roles are shown in Table 7.10.

Clearly, in small teams, each member may have to undertake a number of 'team' roles, along with their own contribution to the work of the organisation. Belbin advocated that team members had two distinct contributions to make in the achievement of team objectives, that of an individual role and a team role. Belbin states that :

" No overall sense of design governs the composition of the group which, in human terms, is little more than a random collection of senior managers with a wide spread of human foibles and personality characteristics as one might expect to find in the population at large "

Table 7.10 : Belbin's Definition Of Team Member Roles

Type and Symbol	***Typical Features***	***Positive Qualities***	***Allowable Weaknesses***
Company Worker (CW)	Conservative, dutiful, predictable	Organising ability, practical common sense, hard working, self-discipline	Lack of flexibility, unresponsiveness to unproven ideas
Chairman (CH)	Calm, self-confident, controlled	A capacity for treating and welcoming all potential contributors on their merits and without prejudice. A strong sense of objectives.	No more than ordinary in terms of intellect or creative ability
Shaper (SH)	Highly strung, out-going, dynamic	Drive and readiness to challenge inertia, ineffectiveness, complacency or self-deception	Proneness to provocation, irritation and impatience
Plant (PL)	Individualistic, serious minded, unorthodox	Genius, imagination, intellect, knowledge	Up in the clouds, inclined to disregard practical details or protocol
Resource Investigator (RI)	Extroverted, enthusiastic, curious	A capacity for contacting people and exploring anything new An ability to respond to challenge.	Liable to lose interest once the initial fascination has passed
Monitor - Evaluator (ME)	Sober, unemotional prudent.	Judgement, discretion, hard-headedness	Lacks inspiration or the ability to motivate others
Team Worker (TW)	Socially orientated rather mild, sensitive	An ability to respond to people and to situations, and to promote team spirit	Indecisiveness at moments of crisis
Completer - Finisher (CF)	Painstaking, orderly, conscientious, anxious	A capacity for follow-through Perfectionism	A tendency to worry about small things. A reluctance to 'let go'

Source : Adapted From Belbin R.M. - Management Teams - Why They succeed Or Fail - 1981

This led him to research further and develop ideas and principles for considering the 'make up' of teams to optimise the performance of the group as a whole. He considered that a management team can combine all qualities necessary for success which a single individual alone could not possess. He analysed the constituents of 'good' teams and he identified a number of factors that should be considered when 'designing' a team and these are shown in Table 7.11.

Table 7.11 : Belbin's Principles For Designing a Team

	PRINCIPLES INVOLVED IN DESIGNING A TEAM
1.	Members of a management team can contribute in two ways to the achievement of team objectives. They can perform well in a functional role in drawing on their professional and technical knowledge as the situation demands. They also have a potentially valuable team role to perform. A team role describes a pattern of behaviour characteristic of the way in which one team member interacts with others in facilitating the progress of the team.
2.	Each team needs an optimum balance in both functional and team roles.This ideal blend will depend on the goals and tasks the team faces.
3.	The effectiveness of a team will be promoted by the extent to which members correctly recognise and adjust themselves to the relative strengths within the team both in expertise and ability to engage in specific team roles.
4.	Personal qualities fit members for some team roles while limiting the likelihood that they will succeed in others.
5.	A team can deploy its technical resources to best advantage only when it has the requisite range of team roles to ensure efficient teamwork.

Source : Adapted From Belbin R.M. - Management Teams - Why They succeed Or Fail - 1981

His findings essentially showed how the compatibility of members of a management team would be critical to its effectiveness.

7.9 LEADERSHIP IN THE PROJECT ENVIRONMENT

Hamburger (1992) states that [41] :

" the project manager is faced with the challenge of integrating a group of diverse individuals into a productive unit that has accepted the common goal of ensuring project success "

The project manager must therefore act as a leader to develop the groups, or teams, that he is responsible for, the benefit of operational performance. Barnard (1938) lists five qualities of leadership in descending order of importance : vitality and endurance, decisiveness, persuasiveness, responsibility and intellectual capacity which have stood the test of time. [42]

A leader can be described as a person who usually gives instructions to his sub-ordinates and generally inspires and enthuses them and gives them guidance. A supervisor, for example, as the first level of management requires to have a degree of leadership. A good leader can be described as a person who uses his leadership capabilities to make his subordinates attain their objectives without using force, or at any rate using it only in the last resort.

The attributes of a leader will not always be the same. They will depend on the kind of leadership called for, which in turn will depend on the philosophy of top management, the personal characteristics of the leader himself and the circumstances of the business.

7.9.1 Leadership Styles

Three types of leadership styles have developed historically, namely autocratic, paternal and democratic. In theory an autocratic leader is the only person who makes decisions and gives orders, a paternal leader gives guidance advice and instruction to subordinates using force only when necessary, but rarely, and a democratic leader as much as possible puts the decisions to be made to the 'vote' of those under his control.

Vroom and Yetton (1973) classified them slightly differently as autocratic, consultative and participative. [43]

An autocratic leader solves a problem alone, based on the information available. A consultative leader shares the problem and then makes a decision which may, or may not, reflect the influence of the consultation process. A participative leader shares the problem with his colleagues as a group and implements any solution that has the support of the group.

7.9.2 Approaches To Leadership

Newcombe, Langford and Fellows (1990) identified three different approaches to understanding leadership : trait approach, behavioural approach and functional approach. [44]

The trait approach has the underlying theory that people become leaders in relation to their personal characteristics. Stogdill (1974) in a review of 15 studies of trait leadership found that the average person occupying a position of leadership exceeds the average member of the team in the following areas. [45] These are shown in Table 7.12.

Table 7.12 : Characteristics Of Leaders

• Intelligence	• Sociability
• Scholarship	• Initiative
• Dependability in exercising responsibilities	• Persistence
• Activity and social participation	• Knowing how to get things done
• Socio-economic status	• Self confidence
• Alert to, and insight into, situations	• Cooperativeness
• Popularity	• Adaptability
• Verbal facility	

Source : Adapted From Newcombe R, Langford D. And Fellows R. - Construction Management - Organisation Systems - 1990

The behavioural approach focuses on what leaders actually do. Bayles and Slater (1955) [46] , Fleishman (1973) [47] and Katz and Kahn (1979) [48] all identified two different behavioural styles. These were *task* centred leadership and *people* centred leadership.

The functional approach looks upon leadership as being composed of three functions : defining the task (procedural functions), achieving the task (substantive functions) and maintaining the social cohesion of the group (maintenance functions).

Pearson and Davies (1981) [49] have further claimed that proper implementation of network techniques (discussed in Chapter Four) can aid project managers and team members if seen as components of leadership style. Specifically they argue that there is a different leadership style appropriate for different levels of group development. Four different styles of leadership were put forward : structuring, coaching, encouraging and delegating style.

In the *structuring* leadership style the organisation and direction of the work of others, (assigning responsibility for specific activities to each person and motivating by demonstrating what needs to be done) is carried out by the project manager. At this stage the network chart is 'handed down' to the team. The *coaching* style requires the project manager to set standards of performance and explanations of what needs to be done, to give feedback and to be personally involved. This style involves the network being drawn up jointly by the team and the project manager. In the *encouraging* style the project manager recognises and praises good work, is open and supportive and motivates to the letter other peoples' structure of the work. This style involves the network being drawn by the team itself. The *delegating* style of leadership involves the project manager assigning task responsibilities and letting others carry them out. Motivation is given by maintaining control and showing respect to others. This leadership style is most appropriate for the execution of the project where emphasis is on meeting scheduled milestones.

Pearson & Davies (1981) have likened these four leadership styles to the project management process and group or team development stages. These are depicted in Table 7.13.

Table 7.13 : Process, team development and leadership behaviour

	Project Management Process	Team Development Stages	Leadership Behaviour
1.	*Initiation* : decide who is on team. What is contribution of each member?	*Forming* : group decides purpose, composition, leadership patterns and life span.	*Structuring* : organise and direct work of others. Produce rough outline of project.
2.	*Idealisation* : team constructs ideal network diagram.	*Storming* : initial conflict stage. People reveal hidden agendas.	*Coaching* : set high standards. Network jointly drawn.
3.	*Iteration* : negotiate for assets to move to initial project plan.	*Norming* : the group establishes degrees of openness, trust and confidence.	*Encouraging* : let others structure work. Network is follower drawn.
4.	*Implementation* : feasible solution found. Execution of project plan begins.	*Performing* : the group is now mature. Project execution begins.	*Delegating* : assign task responsibilities; let others carry them out.

Source : Adapted From Pearson A.W. and Davies G.B - Leadership Styles And Planning And Monetary Techniques - 1981

Fielder (1978) has put forward a leadership theory which advocates that leadership effectiveness is achieved when the leader's style matches the demands of a particular situation, especially the task or work group and the position of the leader with respect to the work group. [50] He has defined situations in terms of their favourableness to the leader and described them as consisting of three main factors. These were the leader and member relationship, the degree of structure of the task and the leader's formal position power. Specifically, the most favourable leadership situation was considered to be one in which there were good leader or member relationships, the tasks were well-defined and highly-structured and the leader had a high degree of formal authority.

7.9.3 Problems Associated With Leadership

Leadership is not without its problems. Problems may arise as a result of problem attribute pressures, leader personality pressures or organisational pressures. Table 7.14 shows three categories of leadership style pressures as described by Slevin and Pinto (1988). [51]

Table 7.14 : Leadership Style Pressures

	LEADERSHIP STYLE PRESSURES
	Problem attribute pressures
1.	Leader lacks relevant information; problem is ambiguous
2.	Leader lacks enough time to make decision adequately
3.	Decision is important or critical to organisation
4.	Decision is personally important to leader
5.	Problem is structured or routine
6.	Decision implementation by subordinates is critical to success
	Leader personality pressures
1.	Leader has high need for power
2.	Leader is high in need for affiliation; is 'people orientated'
3.	Leader is highly intelligent
4.	Leader has high need for achievement
	Organisational pressures
1.	Conflict is likely to result from the decision
2.	Good leader/group relations exist
3.	Centrality, formalisation of organisation is high
4.	Highly participative culture - strong norm for power sharing
5.	High level of intergroup conflict

Source : Slevin D.P. And Pinto J.K. : 'Leadership, Motivation And The Project Manager' - 1988

Bresnen, Bryman and Ford (1986) reviewed the ways in which leadership is conceptualised and taken into consideration in the context of construction projects. [52] They carried out a survey of 43 site managers in the UK. The results indicated that variations in leader orientation have an impact on project effectiveness and that this relationship is contingent upon a number of factors, including project length, value and the extent of the reliance on sub-contract labour.

7.10 APPLICATION OF CHAPTER SEVEN

The effective management of human resources in the project environment was identified as being essential for successful project completion. Despite this, project management human resource considerations appeared to be treated less favourably than the management of other project management procedures, including the management of time, quality or cost.

A sub-system for the management of human resources in the early part of the chapter showed how a conversion process of getting the most out of people might be possible through the processes of motivation, leadership and teamwork. This was seen to be essential in striving to achieve satisfied, committed and more effective project personnel.

The theories behind management, motivation, teamwork and leadership were considered in view of their importance in the conversion process. Coupled with ability, motivation often determines the performance of individuals on projects. This was therefore analysed in some depth by referring to several pieces of research in this area.

A number of points have arisen from the review which are further pursued in subsequent empirical chapters. (chapters ten and eleven). For example, an attempt is made to ascertain the importance given to human resource management by private and public sector construction contractors. This helps establish the 'yardstick' of the human element in comparison to other project management procedures, such as time, quality or cost.

Two further specific aspects are investigated. Firstly, factors which cause job satisfaction and job dissatisfaction are analysed in both sectors in view of their influence on people and subsequent motivation to perform at work. Secondly, a further key issue, namely that of how construction contractors assess the performance of their project managers, is looked into, to see how construction organisations gauge the effectiveness of their project managers on projects.

The findings of the empirical chapters (chapters ten and eleven) are later considered in relation to the literature review.

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CHAPTER EIGHT : SYNTHESIS OF LITERATURE REVIEW AND GENERATION OF HYPOTHESES

8.1 INTRODUCTION

Chapters One to Seven have looked at several important areas where the use of project management procedures may be used in the execution phase of construction projects. The Chapters discussed :

- Overview Of Project Management And Systems Theory
- Private And Public Sector Construction Output
- Strategic Management And Organisational Profile
- Project Planning And Control
- Project Management Software
- Quality Management
- Management Of Human Resources

Within each Chapter of the literature review an attempt was made to look at the current views on the use of project management procedures. This was carried out with a view to subsequently putting forward a number of hypotheses on the use of such procedures in the private and public sectors in the UK construction industry.

The thesis, or argument, adopted throughout the entirety of this research has been that :

' **where project management procedures are adopted in the management of projects, a project manager will have the potential to better manage the project, than would otherwise be the case** '

8.2 OVERVIEW OF CHAPTERS ONE, TWO AND THREE

Chapter One set the scene for the research and began initially with an overview of project management. *Chapter Two* discussed the contribution of the private and public sector to the UK's construction output and Gross Domestic Product. The effects of the introduction of compulsory competitive tendering (CCT) were looked at in detail to emphasise the 'shift' in workload from the the public to private sector since 1980. *Chapter Three* analysed the strategic approach to construction projects and the forms of organisational structures that may be applicable in the project environment.

Within the three chapters a number of authors were referred to who had put forward views on particular aspects of the operation and organisation structure for construction contractor organisations. In the light of the literature review, it is proposed to investigate via hypothesis formulation and testing, the following :

- The approaches to construction projects in the private and public sectors
- The extent of the use of project management procedures in the private and public sectors
- The most important objective(s) considered when executing projects

Barnes (1985), Morris (1989) and Kerzner (1992) all emphasised the importance of carrying out projects to time, quality and budgetary requirements. Although these are the main common objectives behind organisations involved in projects in the private and public sectors, there appears to be differences in approach between them.

Furthermore, organisational structures tend to be functionally oriented in the public sector but more akin to the nature of projects in the private sector. Payne (1993) and Heredia (1993) have concluded that in the public sector the project concept is still not yet understood.

It is therefore hypothesised :

O_1 : There are differences in the approach to construction projects between private and public sector construction contractors

There is much literature on how projects have not achieved the desired objectives of completion on time, within budgeted costs and to the correct performance, or specification. Gibble (1986) believes that many such failures are a result of improper management. A number of authors including Warren (1978), Graham (1985), Morris and Hough (1987) and Williams (1993) give detailed accounts of such failures. A project management approach is recommended by many as a means of achieving project success and reducing the possibility of failure. Badiru (1988) and others previously mentioned give details of the benefits that can be achieved by the adoption of a project management approach to the management of projects. However, there are still many failures being recorded of projects failing to meet desired objectives in terms of time, cost or specification.

It is therefore hypothesised :

O_2 : *That project management procedures are not extensively used by either private or public sector construction contractors*

Profit is often considered as the single most important primary objective of construction contractors. Wearne (1989) and Barnes (1993) describe how profit is such a major consideration. However, some authors, including Lock (1987) and Newcombe, Langford and Fellows (1990) comment on the importance of client satisfaction as well as profit motives. This research will investigate profit being the *single* most important project objective.

It is therefore hypothesised :

O_3 : *That making a profit continues to be the most important project objective for both private and public sector construction contractors*

8.3 OVERVIEW OF CHAPTERS FOUR AND FIVE

Chapters Four and Five dealt with project planning and control, including the use of computerised methods. A brief overview of the principles of work breakdown structures and linear responsibility charts was also considered. In the light of the literature review, it is proposed to investigate via hypothesis formulation and testing, the following :

- The difference in approach to planning between the private and public sectors
- The integration of costing with planning and control procedures
- The use of computerised planning and control methods
- The use of planning and control procedures in the monitoring and control phase of projects

The public sector side of the construction industry has always been considered inferior to those contractors working in the private sector. Baker, Murphy and Fisher (1988) carried out research which identified that the general public's perception of the public sector was one of being inefficient, behind schedule, overrun on budget and poorly planned. The private sector were considered to be the opposite of the public sector scenario.

It is therefore hypothesised :

P_1 : That private construction contractors operate more sophisticated project planning and control methods than public sector contractors

Harrison (1985) indicated that one of the major factors which may lead to overall poor project control is that control systems are cost accounting oriented. Stevens (1986) and Kerzner (1992) emphasise the need for proper integration of time and cost to enable the accurate status of a project in terms of time or cost to be established. Oberlender (1993) also relates problems that have been experienced on projects where decisions have been made when using only partial information for project monitoring and control purposes.

It is therefore hypothesised :

P_2 : Costing of projects is carried out independently of the planning and control process by private and public sector construction contractors

Maxwell (1985), Meredith and Mantel (1985) and Artemis (1993) describe the great influence that microcomputers can have on the planning and control process. Abang and Beasley (1986), Naylor (1987) and Kerzner (1992) all comment on the advantages of using a computerised approach to project planning and control. Kerzner and Thamhain (1986), Levine (1986) and Nathan (1991) all look at project management planning and control systems in detail. The study will look into the utilisation of computerised methods of project planning and control in light of the potential benefits that may arise from such methods.

It is therefore hypothesised :

P_3 : The adoption of a computerised approach to project planning and control provides advantages over manual methods for both private and public sector construction contractors

Kerzner (1992) and Shapira and Laufer (1993) comment that planning must be looked at right through from project inception to completion, that is to say both initial planning and subsequent monitoring and control. Clough and Sears (1979), Harrison (1985) and Reiss (1992) all emphasise the need for monitoring and control, or 'follow through' planning once initial plans have been formulated. However, the inadequacy of many project planning techniques, especially networks, has led to deficient project monitoring and control against the initial project plan. Schlomo (1974), Kharbanda and Stallworthy (1983), Pinto (1990) and Reiss (1992) have all commented upon problems that have been experienced in the control phase of projects. The study will consider the extent of use of planning procedures in the control phase, gauged against front end planning methods.

It is therefore hypothesised :

P_4 : Planning is not considered to the same degree in the control phase of projects as it is in the formulation of a 'baseline' schedule

8.4 OVERVIEW OF CHAPTER SIX

Chapter Six considered aspects of quality management ranging from the need for adequately addressing quality planning, through to how an organisation would go about designing and implementing a quality management system. In the light of the literature review, it is proposed to investigate via hypothesis formulation and testing, the following :

- Reasons for the implementation of quality management systems
- Methods of providing Quality Assurance
- Areas of business to which quality management systems are applied to

Friend (1990) commented that the majority of contractors in both the private and public sectors are either planning to operate, or are already operating a quality management system. Ashford (1990) put forward that those who gain most benefit from the adoption of quality systems are those who do so for the purpose of improving their own efficiency. In this respect McLellan (1993) has described the public sector as entering the quality management arena purely as a means of satisfying client or contractual obligations.

It is therefore hypothesised :

Q_1 : Private and public sector construction contractors adopt and implement third party quality management systems for different reasons

Private sector companies have recognised the need for quality for a considerable period of time in order to maintain their client base and to improve their future marketability. Different forms of providing Quality Assurance are discussed by Oliver (1992). However, McLellan (1993) comments that in the public sector only the third party method of providing Quality Assurance appears to have been adopted.

It is therefore hypothesised :

Q_2 : Different methods of providing Quality Assurance are operated by private and public sector construction contractors

McLellan (1993) describes that in the public sector quality management systems are only applied to relatively small areas of their business. whereas in the private sector such systems are generally applicable to all areas of work. Clearly, clients who wish to engage a construction contractor should be satisfied that the scope of accreditation for a quality management system covers the type of work that is to be undertaken.

It is therefore hypothesised :

Q_3 : Private sector construction contractors have third party quality management systems which are more comprehensive than those operated by public sector construction contractors

8.5 OVERVIEW OF CHAPTER SEVEN

Chapter Seven considered a number of important aspects relative to the management of human resources in the project environment. These included management theories, theories of motivation and team building and leadership. In the light of the literature review, it is proposed to investigate via hypothesis formulation and testing, the following :

- The extent that human resource management is considered to the same degree as time, cost or quality
- Different levels of management perceive issues relating to job satisfaction or dissatisfaction differently
- Project manager performance is assessed primarily on human resource skills such as team building and leadership

Tyson and Fell (1986) and Fabi and Petterson (1993) all comment that the state of knowledge in the subject area of human resource management is still at an elementary stage in many organisations. This is further amplified by the many definitions put forward for project management which tend to concentrate on the time, cost and performance aspects of contracts, rather than human resource considerations. Mansfield and Odeh (1989) also comment that at the site level little attention is often paid to the systematic management of human resources, or it is assumed the human factor will take care of itself. It is therefore hypothesised :

H_1 : Attempts to improve human resource management within private and public sector construction contractors are eclipsed by considerations of time, cost and quality

Borcherding and Oglesby (1974, 1975) carried out research into issues which caused satisfaction and dissatisfaction at different managerial levels in the project environment, including foremen and project managers. Results showed that different factors cause satisfaction and dissatisfaction for the various management levels.

It is therefore hypothesised :

H_2 : The perception between private and public sector construction contractors on motivational issues relating to job satisfaction or job dissatisfaction from a project manager's viewpoint is different

Posner (1987) has concluded that communication, team building and leadership were considered much more important than technological skills for project managers and reaffirms the key role played by human aspects in the project environment. Oberlender (1993) comments that the role of the project manager is to lead the project team to meet the objectives of the project. Stuckenbruck (1976) lists attributes of a 'proficient project manager', almost all of which relate to human managerial traits.

It is therefore hypothesised :

H_3 : Project manager performance is assessed primarily on human management skills such as team building, communication and leadership skills in both private and public sector construction contractors

CHAPTER NINE : RESEARCH METHODOLOGY

9.1 SUMMARY OF CHAPTER NINE

This chapter is essentially divided into three sections dealing with the research design, the population sample and the questionnaire design for the study.

The *research design* discusses the purpose of the study, outlines the research design process and examines the selection of the method of data collection and measurement technique to be adopted.

The *population sample* is divided into two groups, namely, private contractor organisations and Direct Labour Organisations. The sampling frame, size, method and anticipated response rates are analysed for both.

The *questionnaire design* looks in detail at the decisions to be made regarding the types of question to be used in the research. Furthermore, the physical characteristics, pre-testing and implementation of the questionnaire are analysed.

The chapter concludes by looking at the survey response rate for the study.

SECTION ONE : THE RESEARCH DESIGN

9.2 PURPOSE OF THE STUDY

Research design is concerned with the specification of procedures for the collection and analysis of data necessary to investigate the related research objectives. For a particular study, the research design is greatly influenced by the straightforward definition of the initial research proposal. It is for this reason that a description of the purpose of the study is put forward here, prior to formulating a research design.

The main purpose of the study is to assess the extent of use of a number of different project management procedures in private contractor and direct labour organisations in the execution, or construction phase of projects and to identify and analyse the differences in approach between them.

Thirteen hypotheses were developed in Chapter Eight, both from the literature review and from the author's current working environment. These are to be examined and tested after survey data has been collected and analysed. These are now restated together for ease of reference.

9.3 RE-STATEMENT OF HYPOTHESES

9.3.1 Organisation Profile :

O_1 : *There are differences in the approach to construction projects between private and public sector construction contractors*

O_2 : *That project management procedures are not extensively used by either private or public sector construction contractors*

O_3 : *That making a profit continues to be the most important project objective for both private and public sector construction contractors*

9.3.2 Planning And Control :

P_1 : *That private construction contractors operate more sophisticated project planning and control methods than public sector contractors*

P_2 : Costing of projects is carried out independently of the planning and control process by private and public sector construction contractors

P_3 : The adoption of a computerised approach to project planning and control provides advantages over manual methods for both private and public sector construction contractors

P_4 : Planning is not considered to the same degree in the control phase of projects as it is in the formulation of a 'baseline' schedule

9.3.3 Quality Management

Q_1 : Private and public sector construction contractors adopt and implement third party quality management systems for different reasons

Q_2 : Different methods of providing Quality Assurance are operated by private and public sector construction contractors

Q_3 : Private sector construction contractors have third party quality management systems which are more comprehensive than those operated by public sector construction contractors

9.3.4 Management Of Human Resources

H_1 : Attempts to improve human resource management within private and public sector construction contractors are eclipsed by considerations of time, cost and quality

H_2 : The perception between private and public sector construction contractors on motivational issues relating to job satisfaction or job dissatisfaction from a project manager's viewpoint is different

H_3 : Project manager performance is assessed primarily on human management skills such as team building, communication and leadership skills in both private and public sector construction contractors

9.4 RESEARCH DESIGN PROCESS

A number of steps are present in the research design process ranging from the initial definition of the research problem (or purpose of the research) to the preparation of the research proposal. According to Tull and Hawkins (1987), the 'early' decisions made in the course of a piece of research are made with a simultaneous consideration of the 'later' decisions and furthermore, that there is a constant reconsideration of earlier decisions in the light of subsequent decisions. [1] Elrick and Lavidge Inc. (1977) classified the typical steps in the research design process, their 'model' is shown in Table 9.1. [2]

Table 9.1 : Typical Steps In The Research Design Process

STEP	***DESCRIPTION***
1. Define the research problem	Specify the information required to help react to the management problem
2. Select the data collection method	Determine whether secondary data, a survey, or experimentation will produce the required data and choose the form of the selected method(s) to use
3. Select the measurement technique	Determine whether and how to use questionnaires, attitude scales, observation, and/or projective techniques
4. Select the sample	Determine who and how many respondents or objects to measure
5. Select the analytical approach	Determine the appropriate means of analysing the data to provide the required information
6. Prepare and research proposal	Summarise the results of the preceding five steps in the form of a research proposal

Source : Adapted From Elrick and Lavidge Inc : Marketing Today (1977)

The various steps in the research design process for this study will now be considered from step 2 onwards, the definition of the research problem and associated hypotheses having already been stated.

9.5 SELECTION OF DATA COLLECTION METHOD AND MEASUREMENT TECHNIQUE

Tull and Hawkins (1987) comment that there are essentially three basic data collection approaches which may be used in carrying out research. [3] These are the use of secondary survey data, new survey data and experimental survey data.

The use of *secondary survey data* is not considered in this study for the following reasons. Firstly, there have been only a limited number of surveys previously carried out on the use of project management procedures. More importantly, however, they tend to concentrate on the analysis of a single particular procedure, for example, the use of project management software. This type of data is not considered to be of any assistance to this study seeing that the author wishes specifically as part of this study to investigate the use of a *range* of project management procedures within construction contractor organisations.

Likewise the author did not consider that an *experimental research*, (where one or more variables are manipulated in such a way that their effect on other variables can be measured) would be suitable for the research problem involved.

Of the three basic data collection approaches the author believes that the most appropriate method for this particular research is a *survey research*. There are of course a number of different types of surveys which may be carried out including telephone interview, mail interview and personal interview surveys.

Essentially telephone interview methods relate to the collection of information from respondents via telephone; mail interview methods are concerned with the collection of information from respondents via mail or similar techniques and personal interview methods relate to situations where information is collected from respondents in a face-to-face manner. The relative merits of these survey research methods are now considered.

Dillman (1978) discusses a number of factors that appear to be relevant in the evaluation process and his results are summarised in Table 9.2. [4]

Table 9.2 : Rating Of Face-To-Face Interviews, Telephone Interviews And Mail Questionnaires For Selected Performance Characteristics

PERFORMANCE CHARACTERISTIC	FACE-TO-FACE	MAIL	TELEPHONE
Section 1 : Obtaining A Representative Sample			
A : Known opportunity for all members of of population			
to be included in the sample			
1. completely listed populations	high	high	high
2. populations which are not completely listed	high	medium	medium
B : Control over selection of respondents within			
sampling units	high	medium	high
C : Likelihood that selected respondents will be located	medium	high	high
D : Insensitivity to sub-situation of respondents	medium	low	low
E : Response rates			
1. Heterogeneous samples (eg general public)	high	medium	high
2. Homogeneous specialised samples (eg ministers etc)	high	high	high
F : Likelihood that unknown bias from refusals will be			
avoided	high	low	high
Section 2 : Questionnaire Construction/Design			
A : Allowable length of questionnaire	high	medium	medium
B : Type of question			
1. success with open ended questions	high	low	high
2. success with screen questions	high	medium	high
3. success with controlling sequence	high	low	high
4. success with tedious or boring questions	high	low	medium
C : Success in avoiding item non-response	high	medium	high
D : insensitivity to questionnaire construction	high	low	medium
Section 3 : Obtaining Accurate Answers			
A : Likelihood that social desirability bias can be avoided	low	high	medium
B : Likelihood that interviewer distortion can be avoided	low	high	medium
C : Likelihood that contamination by others can be			
avoided	medium	medium	high
D : Likelihood that consultation will be obtained when			
needed	medium	medium	low
Section 4 : Administrative Requirements			
A : Likelihood that personnel requirements can be met	low	high	high
B : Potential speed of implementation	low	low	high
C : Keeping costs low			
1. Overall potential for low interview costs	low	low	medium
2. Insensitivity of costs to increasing geographical			
dispersion	low	high	medium

Source : Adapted from Dillman D.A. : Mail And Telephone Surveys - 1978

Dillman has considered the merits of the different survey methods on how well each handles a particular problem, although the process remains partly subjective. It is further recognised that there are few surveys in which all dimensions will be relevant and each particular performance category does not necessarily have an equal weighting. Clearly, the final decision relating to the choice of survey method cannot be made until the subjective weight of relevant performance characteristics for each survey method has been considered.

The over-riding factor in the determination of the research method in this study has been the *nature of the study itself*. The sample to be considered will consist of private and public sector construction contractors from all over Great Britain, a vast geographical area rendering the use of purely personal interviews both impractical and prohibitive in terms of cost.

The type of questions to be asked of respondents are not suitable for telephone interview surveys either. Similarly a large number of personal interviews are likely to be very expensive in view of the geographical area involved.

The author considered carefully Dillman's findings and decided on a mail questionnaire survey as the most practical method for carrying out this research. There are several advantages of the postal questionnaire survey method. Bryman (1989) points out that postal survey methods are invariably cheaper than interviewing, especially when large samples, large geographical areas and large time periods re involved. [5]

Hoinville and Jowell (1978) also comment that the method allows respondents time to reflect on the questions, unlike many other methods. [6] In making this decision the author has been aware of some areas in representation sampling and questionnaire design and construction where personal and telephone interview methods may be deemed to be more suitable. A conscious effort has thus been made to design the research in such a manner so as to reduce, or eliminate any adverse factors to make the mail questionnaire survey method as 'strong' as possible in all areas in terms of performance characteristics.

In order to augment the results of the postal questionnaire survey, the author opted to execute a number of personal interview surveys. It was reckoned that this would 'balance out' any weaknesses which may be inherent in the postal method.

SECTION TWO : THE POPULATION SAMPLE

9.6 PRIVATE AND PUBLIC SECTOR CONSTRUCTION CONTRACTORS

The main purpose of this study is to assess the extent of use of a number of different project management procedures in private contractor and direct labour organisations in the execution, or construction phase, of projects and to compare the differences in approach between them. The population sample has therefore been categorised into two areas, namely, private sector construction contractors and public sector construction contractors.

9.6.1 Private Sector Construction Contractors

Many different kinds of projects may be carried out by private contractor organisations, for example, roads, buildings or sewerage schemes etc. Generally, the management of construction for each kind of project will be similar with time, cost, quality and human resource factors being of predominant importance. The author does not believe that it would be beneficial to the study to restrict respondents from the private sector to one particular market area of work. All types of projects will therefore be considered in the course of the study and respondents will be asked questions which relate to the use of project management procedures which may be used in the execution of any construction type project. The size and annual turnover of those companies can vary from well under £1M to upwards of £2,300M.

In attempting to decide on a suitable sample size from such a diverse range of companies, the author believes that two important factors must be taken into account. Firstly, the sample size must be big enough to allow the varying nature of the responding companies to be represented. Secondly, the sample size must be large enough to achieve a response from at least 50 companies and at a response rate of no less than 15%. A study carried out by Orsaah (1984) into the perception and management of risk in the construction industry used a sample frame consisting of the top 200 No construction contractors in terms of annual turnover. [7] Although Orsaah's investigation appears to have been successful, in this study it is considered important to achieve a wide range of construction companies within the sample and not just those with the larger turnovers.

Many civil engineering contractors are members of the Federation Of Civil Engineering Contractors (FCEC). An initial approach to the Federation showed that their members consist of companies of all sizes. [8] It was therefore decided to adopt a two tier approach to the selection of construction contractors from the private sector. All those contractors who were registered members of the FCEC were selected, and where companies were in top 200 No in terms of annual construction turnover (and who were not members of the FCEC), they too were added to the sample. The companies considered had annual turnovers varying from £950K to £1386M. The sample of private sector construction contractors, participating in this study, is shown in Table 9.3.

Table 9.3 : Private Sector Construction Contractors - Sample Frame

DESCRIPTION	***NUMBER***
Private Sector Construction Contractors Who Are Members Of The FCEC	305
Private Sector Construction Contractors Who Are Not Members Of The FCEC But Who Are In The Top 200 No Construction Contractors In The UK Based On Annual Construction Turnover	48
TOTAL	***353***

9.6.2 Public Sector Construction Contractors

The study further concentrated on the Local Authority Direct Labour sector of the public sector side of the construction industry. In order to help achieve consistency of results, the author decided to concentrate on a particular area of direct labour operations, namely the new works or maintenance sector (excluding housing), which constitutes a large proportion of public sector works outside the housing maintenance sector. This area 'mirrors' most closely those operations carried out by the public sector which are similar in nature to competitive projects undertaken by private contractors in industry.

The number of such organisations in Great Britain responsible for this function is fifty-seven. (46 in England and Wales and 11 in Scotland) which allows the author the opportunity to carry out an analysis of all such Local

Authority Direct Labour Organisations within the study.

The public sector construction contractor sample has been described here as all the Local Authority Direct Labour Organisations in Great Britain who may carry out new works or maintenance works (excl.housing). The breakdown between England and Wales and Scotland is shown in Table 9.4.

Table 9.4 : Public Sector Construction Contractors - Sample Frame

DESCRIPTION	***NUMBER***
Public Sector Construction Contractors Who Carry Out New Works Or Maintenance (excl. housing) - England and Wales	46
Public Sector Construction Contractors Who Carry Out New Works Or Maintenance (excl housing) - Scotland	11
TOTAL	***57***

The author in the course of his employment has been able to gain access via the County Surveyors' Society of Senior Management representatives of Direct Labour Organisations (DLOs) in Scotland. It was proposed, to utilise this 'advantage' in the research by carrying out pre-testing of the questionnaire in Scotland by firstly forwarding the questionnaire to these pre-identified contact sources and then by carrying out some personal pilot interviews to gather information on any amendments which may be necessary.

Full implementation of the mail questionnaire throughout the UK followed. Various organisations assisted in providing information for contact names within the relevant organisations, including the Association of Direct Labour Organisations, the County Surveyors Society, the Municipal File contained annually in the New Civil Engineer Magazine and other various public services directories. [9, 10]

SECTION THREE : QUESTIONNAIRE DESIGN

9.7 NATURE OF QUESTIONNAIRE DESIGN

It is considered appropriate initially to define the term 'questionnaire' which may simply be described as a formalised group of questions for eliciting information, usually in association with survey research. Questionnaire design is of crucial importance to ensure that any sources of non-sampling error present are kept to a minimum. In this respect Tull and Hawkins (1987) state that [11] :

" a sound questionnaire requires applying applicable principles, common sense, concern for the respondent, a clear concept of the needed information, and thorough pre-testing "

They further describe that questionnaire construction can be divided into seven major decision areas. These are shown in Table 9.5.

Table 9.5 : Decisions On Construction Of Questionnaires

	Decisions On Construction Of Questionnaires
1	***Preliminary Decisions***
	Exactly what information is required?
	Exactly who are the target respondents?
	What method of communication will be used to reach these respondents?
2	***Decisions about question content***
	Is the question really needed?
	Is the question sufficient to generate the needed information?
	Can the respondent answer the question correctly?
	Will the respondent answer the question correctly?
	Are there any external events that might bias the response to the question?
3	***Decisions concerning question phrasing***
	Do the words used have but one meaning to all the respondents?
	Are any of the words or phrases loaded or leading in any way?
	Are there any implied alternatives in the question?
	Are there any unstated assumptions related to the question?
	Will the respondents approach the question from the frame of reference desired by the researcher?
4	***Decisions about the response format***
	Can this question best be asked as an open-ended, multiple choice or dichotomous question?
5	***Decisions concerning the question sequence***
	Are the questions organised in a logical manner that avoids introducing errors?
6	***Decisions on the layout of the questionnaire***
	Is the questionnaire designed in a manner to avoid confusion and minimise recording errors?
7	***Pretest and revise***
	Has the final questionnaire been subjected to a thorough pretest, using respondents similar to those who will be included in the final survey?

Source : Adapted From Tull D.S. and Hawkins D.I. : Marketing Research - Management and Method : 1987

The seven areas involve preliminary decisions, decisions about question content, decisions about response format, decisions concerning question phrasing, decisions about the response format, decisions concerning the question sequence, decisions on the layout of the questionnaire and pretest, including revision, if necessary, of the questionnaire.

Tull and Hawkins (1987) summarise factors which may affect survey response rates. [12] They are classified under two headings; those which the researcher has limited control over and those over which the researcher has full control. Their findings are shown in Table 9.6.

Table 9.6 : Summary Of Factors Affecting Survey Response Rate

FACTORS AFFECTING SURVEY RESPONSE RATE	EFFECT
Limited Control	
Respondents' interest in topic	Strong
Questionnaire length	Limited
Identity of survey sponsor	Moderate
Full Control	
Preliminary notification	Moderate
Type of postage	Limited
Monetary incentives	Strong
Nonmonetary gifts	Variable
Physical characteristics	Very limited
Degree of personalisation	Variable
Anonymity and/or confidentiality	Variable
Type of appeal	Limited
Return deadlines	None
Follow-up contacts	Strong
Foot-in-the-door	Limited

Source : Adapted From Tull D.S. and Hawkins D.I. : Marketing Research - Management and Method : 1987

Efforts have been carried out by many different researches in an attempt to improve response rates of mail questionnaires. Dillman (1978) puts forward a list of methods which can be utilised to try and improve response rates of mail questionnaires. [13] These are shown in Table 9.7.

According to Kanuk and Berenson (1975), despite the large number of research study reporting techniques designed to improve response rates, the most effective are straightforward follow up and the use of monetary incentives. [14] The author believes that a number of the factors in Table 9.7 with respect to the physical characteristics, (for example attractive layout), may help achieve a higher response rate in addition to these two criteria of Kanuk and Berenson.

Table 9.7 : Methods tried to improve response rates of mail questionnaire surveys

	Methods Tried To Improve Response Rates Of Mail Questionnaire Surveys
1	Advance notification by letter or telephone that a questionnaire is being sent
2	White or off-white stationery
3	More expensive methods of delivering mail, eg certified delivery
4	Denomination of stamps ie: first or second class post
5	Inclusion of stamped address return envelopes
6	Shorter questionnaires
7	Attractive questionnaire layout
8	Personalisation of correspondence
9	Addition of title under sender's name
10	Anonymity and confidentiality
11	Cover letter's composition
12	Offers of incentives
13	Enclosure of incentives (as opposed to promise)
14	Use of repeated follow-ups by mail and/or telephone
15	Timing of follow-ups

Source : Adapted from Dillman D.A. : Mail And Telephone Surveys - 1978

9.8 DECISIONS ABOUT TYPES OF QUESTION AND QUESTION CONTENT

Questionnaires may contain a variety of question types. Essentially there are three, based on the nature of response behaviour asked of the respondent that may be used : open-ended, close-ended or multiple-choice and dichotomous. Attitude scales are also frequently used in surveys and these are discussed after considering question types.

Open ended questions leave the respondent free to offer any reply that appears to be appropriate to a particular question. They have the advantage that response is not influenced by a pre-stated set of response categories. However, most respondents will not normally write elaborate answers and furthermore such questions can be subject to two important sources of error, namely respondent articulateness and interview coding problems. [15] The former may result in a respondent, who may have equal knowledge of a particular issue being more reluctant to express themselves. The latter relates to the fact that all answers from respondents require to be coded and categorised to enable deductions to be made from the survey data. This type of question is clearly not suitable for mail questionnaires because it is not possible to probe (as in a personal interviews) to gain information which is relevant, complete and interpretable. Open-ended questions in mail questionnaires will probably result in a high level of non-conformance with respect to those characteristics.

Close-ended or multiple choice type questions present either in the question or immediately following the question a list of possible answers from which the respondent may choose their desired response. Jankowicz (1991) describes that multiple choice is the most common and straightforward form of response format. It allows respondents to choose a single alternative from a list which the researcher has provided. [16] It is always useful to provide an additional box, allowing for an 'other' response to be given, if so desired. Such questions may contain ordered answer choices in which each choice offered for a particular question represents a gradation, or scale of some sort. This type of question structure is ideally suited for determining such things as degree of involvement and frequency or participation. Close-ended or multiple choice type questions may also be structured with unordered answer choices. These differ from ordered answer choices in that respondents are asked to choose an independent alternative from a choice which represents different concepts. This type of question, therefore, can be used to establish priorities among such issues.

Both close ended or multiple choice questions with ordered or unordered answer choices require the researcher to know precisely what dimensions of thought are wanted from the respondent in providing an answer. This necessitates in the researcher having a good knowledge of the subject area to allow meaningful answer choices to be given to help achieve useful response.

Close-ended or multiple choice questions are ideally suited for mail questionnaires and can be considered almost essential for receiving adequate co-operation in response to them. Furthermore, they are generally easier for the respondent to complete and the researcher can carry out analysis of data received much more simply and accurately than in open-ended questioning.

It is essential that much preparation is taken by the researcher in developing a sound group of multiple choice type questions to ensure that all possible alternatives are listed, otherwise no information can be gained on the omitted alternatives. However, the use of partially close-ended questions with an 'other' category present, as previously described, should be adopted in all cases where there may be doubt about the completeness of choices offered to respondents.

Dichotomous questions are essentially those which offer an extreme form of the close-ended or multiple choice type questions. They normally consist of only two alternatives such as 'Yes or No', but may be supplemented by, for example, by a neutral category, such as 'don't know' or 'no opinion'.

Attitude scale testing of respondents serves to seek information from respondents on their attitudes, or changes in attitude to particular statements by the organisation putting out a survey research. An attitude is generally conceived as having three components, these being a cognitive component, an affective component and a behavioural component. The cognitive element relates to the person's belief about the object, the effective element relates to the person's feelings of likes or dislikes about the object and the behavioural element relates to action tendencies or predispositions toward the object. Standard attitude scales require the respondent to express explicitly some aspect of their attitude towards a particular subject.

Attitude scales may be structured in various forms such as comparative rating scales dealing with measurement of a single, or several, attitudes of a respondent to a subject. Such attitude scales should normally have between five and nine response categories according to Neelankavil, O'Brien and Tashjain (1985). [17] Care must also be taken as to whether the scale adopted has been balanced or unbalanced when subsequently analysing data.

Much attention has been paid to the type of questions that may be used in the design of questionnaires. An equally important factor is the choice of words used in questions. Essentially wording should be kept simple, clear and precise, short, specific, avoiding bias, and care should be taken to avoid objectionable hypothetical questions. Two further important characteristics of the wording of questions are that the researcher must not assume that the respondents have too much knowledge of the subject in question (although it is correct to assume a certain amount) and that the question must not be too demanding of the respondent with respect to their patience which would clearly lead to 'guesswork' rather than objective answering. The numerous factors involved in the types of question to be asked (and the question format) pose a dilemma for the researcher. For example, Payne (1951), in his classic book *"The Art of Asking Questions"* presented 41 ways of structuring a single question before finding one that he considered was acceptable for a survey! [18]

The author believes that much thought has been given to the topics in this section prior to deciding on the order, structure and the wording of questions used in the questionnaire(s) associated with this research.

9.9 CONTENT OF MAIL QUESTIONNAIRE

The author decided to divide the questionnaire into five different sections as shown in Table 9.8.

Table 9.8 : Content Of Mail Questionnaire Used In Study

SECTION	DESCRIPTION OF CONTENT
One	Organisation Profile
Two	Project Planning And Control
Three	Quality Management
Four	Management Of Human Resources
Five	Attitude Scales On Various Elements Of Project Management

No difference was made in the questionnaire design for the two sample population frames. Likewise no reference was made in the questionnaire to the research involving a comparison of the private and public sectors. In other words, each believed that they were the sole sample frame, which contributed to a better quality of answer.

This was carried out for the following reason. Private contractors, in general, have a very low opinion of DLOs and to include any reference to CCT or DLOs in questions, the author believes, would have led to a 'half-hearted' approach by private contractors to the questionnaire. DLOs, similarly, tend to view themselves as 'equal' to contractors operating in the private sector, but tend to try and justify their existence, rather than merely paralleling the performance of the private sector. Again, this was avoided by not making reference to the comparison in the questionnaire survey.

The covering letters, however, were deliberately made different for the two sectors in the private and public arenas. The letter to private sector construction contractors was typed out on standard University of Strathclyde notepaper. The letter to public sector construction contractors was mailed out on the researcher's own Local Authority notepaper. It was believed that this would encourage the better response rate from the public sector.

The types of question used in the questionnaire were generally confined to close-ended questions with ordered or unordered answers and attitude scales. The latter was used in particular to assess respondents beliefs or attitudes to comments put forward by the author on the apparent lack of use in practice of a number of important project management techniques.

9.10 PHYSICAL CHARACTERISTICS OF QUESTIONNAIRE

Dillman (1978) has described the difference between a list of questions and a questionnaire as being much like the difference between individual flowers and a floral arrangement. [19]

He also stated :

> *" the attitude of some researchers about questionnaire design seems to have been that if the wording was scientifically sound and the recipient could understand the questions, the questionnaire was satisfactory, thus neglecting most of what the questionnaire construction process is about "*

It is necessary to realise that careful construction of a questionnaire is vitally important in mail survey research as it alone comes under the respondent's control; no personal interview occurs to sort out any badly constructed or worded questions, which have been poorly constructed.

The author considered that the following two factors put forward by the Social and Community Planning Research (SCPR), an institute for survey research would have a distinct influence on achieving a good response rate in this particular study. [20] These were firstly the tasks asked of the recipients and the standard and presentation of the questionnaire.

Clearly, recipients will need to spend some time completing the research enquiry, but this can be kept to a reasonable length by designing the questionnaire so that it can be completed with ease (for example, ticks in boxes). It is imperative to ensure that the questions and the instructions for answering them can be clearly understood and are not ambiguous. If the respondent has to retrieve any information, then these questions must be kept to a minimum to help achieve a satisfactory response rate. Jankowicz (1991) comments that [21] :

" if the questionnaire is perceived as too long the responses are likely to be careless, or indeed, non-existent "

Howard and Sharp (1983) offer a rule of thumb for postal questionnaires indicating that anything greater than ten pages, or taking longer than 15 minutes to complete is likely to be too long. [22]

The author has been aware of the problems that may be associated with the length of the questionnaire. However, the very nature of the study itself, (which covers a meaningful area of the topics involved in the use of project management procedures), has led to the questionnaire being substantially larger than the above recommendations. (approximately 24 pages, and up to one hour response time). Much care was therefore taken to make the presentation of the questionnaire and ease of answering questions straightforward to help alleviate any possible problems that may be associated with the length of the questionnaire.

The standard of presentation of a questionnaire from the author's own experience, as being a respondent to a great many questionnaires, has a great deal of influence over the enthusiasm and accuracy of response which may be gleaned from a mail survey. In this respect the author has taken a great deal of time and effort in ensuring that the questionnaire is of a high quality specification with quality printing in a desk top publishing format, a visually 'appealing' front cover with graphic illustration and presented in a bound booklet. A copy of the covering letter, discussed earlier, was placed in the inside front cover as many respondents of previous surveys have claimed for one reason or another that they have been unable to complete questionnaires because the covering letter had been misplaced, or lost.

These factors, it was hoped, would encourage the respondents as to the importance of the research enquiry and hence maximise response rates.

9.11 PRE-TESTING OF QUESTIONNAIRE

Once the questionnaire had been designed, taking into account all the relevant issues raised in other sections of this Chapter, the author decided to pilot, or pretest it. In doing so the author had a small number of discussions with representatives of the selected sample DLOs and private organisations where they were based locally in the central Scotland area.

For all organisations involved in the pilot study the questionnaire was mailed to them (with self-addressed stamped envelopes) along with a covering letter asking them to go through and analyse the questionnaire, but without answering it, carefully noting their views on the following questions which were detailed at the end of the covering letter.

- *Q1. Does the questionnaire create a positive impression, one that motivates people to answer it?*

- *Q2. Do you find any particular questions difficult to understand? (if so please state which questions and give details)*

- *Q3. If this questionnaire was sent to you would you be prepared to answer the questions? (if not, please give reasons).*

Questions 2 and 3, as put forward by Orsaah (1984) were designed to ensure that the questions were not ambiguous or difficult to understand and to ensure that the final questionnaire would give a meaningful response. [23]

The reasons for carrying out a pre-test with respondents drawn from the population to be analysed enabled people with substantial knowledge of the survey topics to offer constructive feedback on the merits, or otherwise of the questionnaire. Furthermore, in a number of local instances where the questionnaire was completed in the presence of the author much valuable 'verbal' and 'non-verbal' information was collected. Such information ranged from comments on the categories offered in particular questions to 'body-language' information such as hesitation or skipping to a later question giving the researcher a clear indication of where possible improvement to the questionnaire could be made.

Although much care had been taken by the author in the design and construction of the questionnaire several changes were made to the questionnaire on the basis of the pre-test highlighting the importance of the use of the technique prior to full implementation of the 'full' survey.

9.12 IMPLEMENTATION OF THE MAIL QUESTIONNAIRE SURVEY

The author considered that a further three important areas, other than those already discussed, required serious consideration prior to full implementation of the questionnaire. These were :

- The design of the covering letter
- The mail-out date
- The use of follow-up procedures

9.12.1 Design Of Covering Letter

The covering letter is the first element of the researcher's work that will be viewed by respondents. It serves to introduce the survey and should encourage and motivate respondents to fill out the questionnaire and return it expeditiously to the researcher. It is essential that the covering letter is kept as concise as possible, but containing all relevant information necessary to guide respondents in completing the questionnaire. In this respect the researcher believes that the covering letter must be kept to a single A4 page size and should preferably be of the same colour of paper as the cover of the questionnaire (and a different colour from most mail sent out) to make the questionnaire stand out from hundreds of other items of mail which are sent daily to busy construction companies. In this particular study the author did not undertake to offer any great incentives, other than a copy of the summary research results.

However, on the covering letter and on the cover of the questionnaire the researcher pledged an undertaking to contribute to the British Heart Foundation Charity for every complete questionnaire returned. The researcher believed that this would serve two purposes. Firstly, it is more probable that respondents would respond more positively to the questionnaire if a donation was made to a very worthwhile charity rather than a small insignificant donation to their company and secondly, and by far more importantly, a successful response to the survey by a large number of private sector companies and DLOs would generate a reasonable sum of money for the charity and hence make the meaning of the researcher's work all that more worthwhile. Robertson and Bellenger (1982) have commented that the effectiveness of charity contributions in increasing response rates is not clear. [24] However, the author believes that the adoption of such an approach would not hinder the anticipated response rate, but would, if anything serve to elicit greater responses.

9.12.2 Mail Out Date And Use Of Follow Up Procedures

The author was conscious of several factors when selecting a mail-out date for the survey. It was decided to post questionnaires on the Monday of week one of the survey which the researcher hoped would allow the questionnaire to be 'in the hands of' the person most suitable for responding to it by the end of the first week. The author also took into account holidays which fortunately are reasonably consistent within the construction industry.

It was decided to allow the respondents *three* weeks (including the first 'lost' week) to respond to the questionnaire. Thereafter, the researcher believes that the use of follow-up mailings to help the respondent reply expeditiously is important, but unfortunately costly. Yu and Cooper (1983) comment that repeated mailings, or other contacts, can be used in an attempt to increase the response rates of mail surveys. [25]

The author decided that the first follow-up letter would be mailed-out on the Thursday of the *third* week of the survey, that is to say giving the respondent, if receiving the questionnaire in week one of the survey, approximately 2 weeks to respond. This first follow-up was intended to 'gently' remind respondents that a reply would be welcomed to the research enquiry. A further, second, follow up reminder was proposed to be sent out *three* weeks later after the first reminder, as a final request for completion.

9.13 MAIL QUESTIONNAIRE SURVEY RESPONSE RATE

Table 9.9 shows the responses to the mail postal questionnaire survey divide into the private and public sector constituents.

Table 9.9 : Survey Response Rate - Public And Private Sector Construction Contractors

Survey Response Rate - Public Sector Construction Contractors	***No.***	***%***
Questionnaires Mailed Out	57	100.0
Usable Replies	17	29.8
Non-Usable Replies	12	21.1
Total Response - Public Sector......	***29***	***50.9***
Survey Response Rate - Private Sector Construction Contractors	***No.***	***%***
Questionnaires Mailed Out	353	100.0
Usable Replies	63	17.8
Non-Usable Replies	38	10.8
Total Response - Private Sector......	***101***	***28.6***
Survey Response Rate - Private And Public Sector Construction Contractors	***No.***	***%***
Questionnaires Mailed Out	410	100.0
Usable Replies	80	19.5
Non-Usable Replies	50	12.2
Total Response - Private and Public Sector......	***130***	***31.7***

In the main, most completed questionnaires were returned within the first three weeks of the survey (including the week for 'delivery') and thus before the first follow up reminder had been implemented. However, the use of the first follow up letter appeared to increase response rates by approximately 5-10%. The second follow up letter, however, did not have any noticeable effect on generating further responses. The researcher considers that the use of follow up techniques was still found to be beneficial in achieving further responses from what was a particularly long research enquiry.

Hodgekinson (1986) quotes that a criteria for a response rate of around 25-30% for studies directed at managers can be looked at as a realistic target. [26] Nathan (1991) in his study into the use of project management software in the UK construction industry achieved a response rate of 29%, which is comparable with the response rate achieved in this study. [27] Similarly, Friend (1991) in his research into quality management in the construction industry achieved a response rate of some 33% from construction contractors. [28] Orsaah (1984), who carried out research into the management and perception of risk in the construction industry achieved a response rate of 56%. [29] This may be making the point that research enquiries, in tandem with all other information enquiries made of construction contractors, appear to have had an effect over time of reducing response rates. (see Table 9.10).

Although the questionnaire was particularly long to cover the large area of the research, the response rate appears to be consistent with other research which has been carried out recently, albeit, where less exhaustive questionnaires were adopted.

Various reasons were given from respondents who took the effort to return the incompleted questionnaire. These are shown in Table 9.10.

Table 9.10 : Reasons For Non-Completion - Public And Private Sector Construction Contractors

Survey Response - Reasons For Return But Non-Completion - Public Sector	***No***	***%***
No Direct Labour Organisation	6	50.0
Very Small Organisation	1	8.3
Length And Complexity Of Questionnaire	1	8.3
Lack Of Staff Resources	1	8.3
Declined To Reply - No Reason Given	2	16.7
Many Similar Types Of Questionnaire Received - Company Policy Not To Reply	1	8.3
Survey Response - Reasons For Return But Non-Completion - Private Sector	***No***	***%***
Closed Contracting Division	6	15.8
Out Of Business / Returned From Postal Address	10	26.3
Very Small Organisation	1	2.6
Length And Complexity Of Questionnaire	0	0.0
Lack Of Staff Resources	3	7.9
Declined To Reply - No Reason Given	10	26.3
Many Similar Types Of Questionnaire Received - Company Policy Not To Reply	8	21.0

Only one such respondent specifically mentioned that an unanswered questionnaire had been returned because of its length and complexity. Of the reasons given, one concerning one is that a significant number of companies, particularly in the private sector, indeed have an 'inhouse' company policy not to respond to such questionnaires; of concern is that this may have an impact on future research in the construction industry.

9.14 PERSONAL INTERVIEWS

As previously outlined, a prominent method of obtaining survey data in the research enquiry was by means of a structured mail questionnaire. It was also decided to carry out a series of personal interviews to further validate the data from the main survey and to analyse further areas where there were differences in approach between construction contractors in the private and public sectors.

The number of face to face interviews to be carried out was decided once the response rate to the mail questionnaire survey was known. It was felt that a sample size of 25% of the respondents of the mail questionnaire, that is, approximately 20 No, should be carried out and in approximately the same proportions as the previous response. (three private to a single public). This would also bring the overall sample size of the complete research to 100 No.

The personal interviews were carried out at the offices of the appropriate companies using a semi-structured list of questions. (see questionnaire in Appendix B). In order to allow the author to concentrate solely, rather than note taking, the interviews were all recorded on a dictaphone. No companies objected to this process and the transcription of the interviews was made that much easier than would otherwise have been the case.

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CHAPTER TEN : SURVEY RESULTS, ANALYSIS AND DISCUSSION OF HYPOTHESES

10.1 SUMMARY OF CHAPTER TEN

By way of literature review Chapters One to Seven have introduced the nature of the research. Chapters eight and nine developed the research methodology and hypotheses to be explored in the surveys. This Chapter details the responses from the mail questionnaire and personal interview surveys carried out.

Section One of the Chapter looks at the use of statistical tests in research and in particular discusses the nonparametric statistical tests which are to be subsequently used in the analysis of the results from the survey.

Section Two of the Chapter begins by stating the hypotheses relative to organisation profile prior to looking at the survey results in this particular area. This section concludes by evaluating the results against the hypotheses developed in Chapter Eight.

Section Three of the Chapter initially recalls the hypotheses relative to project planning and control. Results in these areas are analysed in detail prior to considering their relevance to these hypotheses.

Section Four of the Chapter looks at quality management. After briefly looking at the prestated hypotheses the results from the survey are compared against them.

Section Five of the Chapter, after presenting the research hypotheses investigates the results pertaining to the use of human resource management procedures gleaned from the survey, which in turn are compared to the hypotheses.

The Chapter concludes by 'setting the scene' for Chapter Eleven, which will present conclusions and recommendations, including contribution and implication of the findings.

10.2 THE USE OF STATISTICAL TESTS IN RESEARCH

In order to test the hypotheses which have been stated in Chapter 8 it is necessary to analyse the data collected from the mail questionnaire and personal interview surveys to make a decision on each individual hypothesis. Clearly, such a decision may result in the acceptance *or* rejection of the hypothesis. An objective procedure used to 'test' a hypothesis is detailed in Table 10.1.

Table 10.1 : Procedure For Testing A Hypothesis

STAGE	PROCEDURE FOR TESTING HYPOTHESIS
1.	State null hypothesis (H_0) and its alternative (H_1)
2.	Choose a statistical test for testing H_0
3.	Specify a significance level (Alpha)
4.	Find the sampling distribution of the statistical test under the assumption H_0 is true
5.	Define region of rejection for the statistical test
6.	Collect the data
7.	Compute the value of the test statistic
8.	If the value is in the region of rejection the decision is to reject H_0
9.	If the value is outside the region of rejection the decision is that H_0 cannot be rejected at the chosen level of significance

Source : Adapted From Siegel S. & Castellan J.N. - Nonparametric Statistics For The Behavioural Sciences - 1988

10.3 THE NULL HYPOTHESIS AND LEVEL OF SIGNIFICANCE

Siegel and Castellan (1988) [1] describe the null hypothesis as being a hypothesis of 'no effect' and is normally formulated for the express purpose of being rejected. If it is rejected, the alternative hypothesis H_1 is supported. It is important to realise that such decisions on a hypothesis must be made in advance of data collection. Essentially the procedure can be summarised as follows :

" H_0 can be rejected in favour of H_1 if a statistical technique yields a value whose associated probability of occurrence under H_0 is equal or less than some small probability, usually denoted Alpha (α). That probability is called the level of significance "

The purpose of setting a significance level is to define a rare event under H_o, when the null hypothesis is true. Therefore, if H_o, were, in fact, true, and if the result of a statistical test has a probability of less than or equal to Alpha, it is the occurrence of a rare event that would lead us, on a probabilistic basis to reject H_o. Clearly, it can be seen that Alpha gives the probability of mistakenly or falsely rejecting H_o. This false rejection is known as a *Type 1* error. There are, in fact, two types of error which may be made in arriving at a decision about H_o. The first, described above, involves rejecting the hypothesis H_o when it is in fact true; the second *Type 2* error involves failing to reject the null hypothesis H_o when in fact it is false.

10.4 NONPARAMETRIC STATISTICAL TESTS

Prior to defining exactly what is meant by the term 'nonparametric' it is considered important to look at the parametric form of statistical tests and then distinguish the differences between them.

Parametric tests specify certain conditions about the distribution of responses in a population from which a research source was drawn and require that data be measured in at least an interval scale. The correct interpretation of the results relies on the validity of the underlying distribution of the research population.

A nonparametric statistical technique, however, relies only on very general conditions and none regarding the specific form of the distribution from which the sample was drawn. Usual assumptions associated with most nonparametric statistical tests are :

that the observations are independent
that the variable under study has underlying continuity

There are varying types of nonparametric tests which may be used appropriately for data measured in an ordinal scale, and others to data in a nominal or categorical scale. There are various advantages, according to Siegel and Castellan (1988), which can be attributed to the use of nonparametric statistical tests. [2] These are shown in Table 10.2.

Table 10.2 : Advantages Of Nonparametric Statistical Tests

	ADVANTAGES OF NONPARAMETRIC STATISTICAL TESTS
1.	If sample size is small there may be no alternative to using a nonparametric statistical test unless the nature of the population distribution is known exactly.
2.	Nonparametric tests typically make fewer assumptions about data and may be more relevant for a particular situation
3.	Nonparametric statistical tests are available to analyse data which are inherently in ranks as well as data whose seemingly numerical scores have the strengths of ranks.
4.	Nonparametric tests are available to test data which are simply classificatory or categorical (ie measured on an ordinal scale). No parametric techniques apply to such data.
5.	There are suitable nonparametric statistical tests for treating samples made up of observations from several *different* populations which parametric tests cannot handle without making seemingly unrealistic assumptions, or making cumbersome calculations.
6.	Nonparametric tests are often easier to learn and apply than parametric tests. In addition, their interpretation is often more direct that the interpretation of parametric tests

Source : Adapted From Siegel S. & Castellan J.N. - Nonparametric Statistics For The Behavioural Sciences - 1988

Where there are advantages, there are usually associated disadvantages. However, the main observation that Siegel and Castellan make in this regard is as follows. If the assumptions of a parametric statistical model are met in the data and the research hypothesis could be tested with a parametric test then it would be wasteful to use a nonparametric test. The degree of wastefulness can be expressed by the power-efficiency of a nonparametric test. For example, if a nonparametric test has a power-efficiency of 90% this means that when all of the conditions of the parametric test are satisfied the appropriate parametric test would be only as effective with a sample which is 10% less than that used in the nonparametric analysis.

It is considered in this research that the use of nonparametric statistical tests are applicable to the type of data involved. However, it must be borne in mind that to use a nonparametric statistical test with a power efficiency of 90% will mean, *at worst*, that the 63 No sample drawn from private sector construction contractors would be 'reduced' to '57' and the 17 No respondents from the public sector would be 'reduced' to '15' based on the assumption that a corresponding parametric test had *all* conditions associated with such tests satisfied.

This is considered to be an acceptable *maximum* deviation from the sample populations and the use of nomparametric statistical tests with relative efficiencies of this level are therefore considered appropriate.

10.5 STATISTICAL TESTS USED IN THE RESEARCH

It should be noted that in instances where it is believed that the results cannot, or may not, be more meaningfully improved by further use of statistical techniques conclusions have been reached solely from the information contained in frequency or contingency tables. However, the use of nonparametric statistical analysis has been used in analysing data in circumstances where more meaningful interpretation of data can be obtained from frequency or contingency tables.

Three tests have been used in this respect :

1. The Chi-Square Test
2. The Fisher Direct Test
3. The Spearman Rank-Order Coefficient

Where the data consists of frequencies in discrete categories the Chi-Square test has been used to determine the significance of differences between the two independent groups (ie private and public sector construction contractors). The method of the Chi-Square test is detailed in Paragraph 10.5.1 onwards.

Where it is desirable to measure the degree of association between two variables (which are at least ordinal in scale) the Spearman Rank-Order Coefficient has been used. The method of using the Spearman Rank-Order Coefficient is detailed in Paragraph 10.5.4. onwards. Each of these nonparametric statistical tests is now discussed.

10.5.1 The Chi-Square Test For Independent Samples

Where data to be analysed consist of frequencies in discrete categories, the Chi-Square test may be used to determine the significance of the differences between two independent groups.

The hypothesis being tested is that the groups differ with respect to some particular characteristic, and, therefore, with respect to the relative frequency which group members fall into several categories.

In order to test this hypothesis the proportion of cases from one group which fall within the categories are compared with the proportion of cases from the other group. The focus of the test is on whether the differences in proportions exceed those expected as chance or random deviations from proportionality. Initially the data are normally arranged into a frequency or contingency table, such as the one shown in Table 10.3.

Table 10.3 : Frequency Or Contingency Table

VARIABLE	GROUP 1	GROUP 2	COMBINED
1	n_{11}	n_{12}	R_1
2	n_{21}	n_{22}	R_2
3	n_{31}	n_{32}	R_3
TOTAL	C1	C2	N

Source : Adapted From Siegel S. & Castellan J.N. - Nonparametric Statistics For The Behavioural Sciences - 1988

The null hypothesis is that groups are sampled from the same population and may be tested by the following formula : $(n_{ij} - E_{ij})^2 / E_{ij}$,

where n_{ij} = observed number of cases categorised in the i^{th} row of the j^{th} column

Eij = number of cases expected in the i^{th} row of the j^{th} column when H_o is true

The value of Chi-Square is distributed asympotically (as N gets large) as Chi-Square with df = (r-1) (c-1) where r is the number of rows and c is the number of columns in the frequency or contingency table.

Under the assumption of independence, the expected frequencies of observations in each cell *should* be proportional to the distribution of row and column totals.

Clearly, if the observed frequencies are in close agreement with the expected frequencies, the differences $(n_{ij} - E_{ij})$ will of course be small and consequently the value of Chi-Square will also be small. Similarly, the larger the value of Chi-Square the more likely that the two groups will differ.

The probabilities associated with the various values of Chi-Square for various degrees of freedom can be obtained directly from statistical tables. Essentially, the computed value of Chi-Square is compared to the value given in the statistical tables for a particular level of significance. If greater than the value in the table then the null hypothesis H_0 may be rejected at that level of significance.

The exact power of the Chi-Square test is difficult to compute in view of the fact that it is normally used when there is no clear alternative. However, Cochran (1952) has shown the limiting power of the test to tend to 1 as the value of N becomes large. [3] In view of the numbers involved in the mail questionnaire survey analysis (63 private and 17 public sector construction contractors) the use of the Chi-Square test is considered appropriate.

10.5.2 Restrictions On The Use Of The Chi-Square Test

The Chi-Square test requires that the expected frequencies are not too small. If they become too small then the test may not be properly, or meaningfully used. Cochran [4] (1954) and others make the following recommendations on the use of the Chi-Square test based on the total number of independent observations (N) for a frequency or contingency table with only one degree of freedom. The recommendations are shown in Table 10.4.

Table 10.4 : Rules For The Use Of The Chi-Square Test

DESCRIPTION	*RECOMMENDATION*
Where N is less than/equal to 20	Use the Fisher Exact Test
Where N is between 20-40	Use the Chi-Square Test if all the expected frequencies are 5, or more
Where N is greater than 40	Use the Chi-Square Test corrected for continuity

Source : Adapted From Cochran W.G. - Some Methods For Strengthening The Common Chi-Square Tests - 1954

For frequency or contingency tables where df > 1, then Chi-Square may only be used if fewer than 20% of the cells have an expected frequency of less than 5, and if no cell has an expected frequency of less than 1.

It can be seen that the Chi-Square test is applicable to data in a frequency or contingency table *only* if the expected frequencies are sufficiently large. When the expected values do not meet this requirement their *values may be increased by combining cells.* Clearly, this must be carried out carefully and properly if such combining is to be meaningful.

Furthermore for frequency or contingency tables with df >1 the researcher, on calculating the value of Chi-Square and finding that it is significant, knows that there is a difference between the two groups on the measured variable.

However, in order to identify where the differences are it is necessary to partition the contingency table into sub-tables and analyse each thereafter.

The partitioned values of the sub-tables should approximate to the overall value of Chi-Square allowing the determination of the factor(s) causing the difference and also serving as a useful check that the arithmetic within the statistical process has been carried out correctly.

10.5.3 The Fisher Direct Test

The Fisher exact probability test is applicable for 2 x 2 frequency or contingency tables where the two independent samples are relatively small (ie where N is less than, or equal to 20).

The procedure for the test is similar to that of Chi-Square and tests H_0 by asking the question :

What is the probability, when H_0 is true, of the occurrence of the observed outcome, or one more extreme ?

The 2 X 2 matrix, as per the Fisher Direct Test is now shown :

X	-	S1 (smallest frequency)
-	-	
S2 (second smallest frequency)		N

- where S_1 denotes smallest row or column total
- where S_2 denotes second smallest row or column total
- where X denotes the observed frequency in the cell where the row and column total containing the smallest and second smallest marginal frequencies intersect
- where N denotes the number of independent observations

From statistical tables for N, S_1, S_2 and X three values of probability can be obtained. These are commonly known as observed, other and total.

The 'observed' probability is the 'one-tailed' probability of observing a difference equal to or more extreme than the one observed. The 'other' probability is the possibility of observing a difference as great, or greater in the opposite direction. The 'total' probability is the 'two-tailed' probability of observing a difference as great, or greater than that observed in either direction. The Fisher exact test is one of the most powerful one-tailed tests for the analysis of 2 x 2 table data, where numbers are small.

10.5.4 The Spearman Rank Order Correlation Coefficient (r_s)

This test measures the association between variables, which must be at least ordinal in scale. Furthermore, if the data used in computing r_s are drawn randomly from a population, it is possible to determine whether the variables are associated in the population by formulating a null and alternative hypothesis.

That is to say, the null hypothesis H_o that the two variables are not associated can be tested ; likewise, the alternative hypothesis H_1, that there is an association between the two variables. The summary for the procedure for the Spearman Rank Order Correlation Coefficient is as follows.

The two variables are ranked from 1 to N, with equal values being assigned the average value of the associated ranks. The difference for each association, d_i, is calculated by subtracting the second variable rank from the first. Then, d_i, is squared to give d_i^2 and the sum of d_i^2 calculated.

If the observations are drawn at random from a population, it is possible to test whether the observed value of r_s indicates an association between the two variables. The hypotheses are H_0, that there is no association between the two variables and H_1 that there is an association between the two variables.

Statistical tables can be used for values of N up to about 50, thereafter, the probability associated with a value as large as the observed value of r_s may be approximated by computing the z associated with the value calculated from

$$z = N - 1$$

and then determine the significance of z from statistical tables relative to probabilities associated with the normal distribution.

The relative efficiency of the Spearman Rank Order Correlation Coefficient compared to the most powerful parametric correlation test, the Pearson Product-Moment Correlation Coefficient is about 91%.

10.6 COMPUTER ANALYSIS OF SURVEY DATA

Analysis of the survey data was carried out using an Archimedes A 4000 computer with a 120 Mb hard disc and 8 Mb of RAM and an Archimedes A4 portable computer with a 60Mb hard disc and 4Mb of RAM in conjunction with a statistical software package called Fully Interactive Regression statistics (FIRST).[5] Presentation of data was carried out using the 'Impression' desk top publishing package, from Computer Concepts. [6] Graphical output has been produced via means of a data presentation package called 'Graphbox Professional', from Minerva [7] enhanced by importing graphs into a package called 'Draw' from Archimedes [8] prior to importing into the 'Impression' Desk top publishing package.

The data from the survey questions were collated into matrices and stored for future analysis by the appropriate statistical tests. However, in order to ensure the validity of the statistical software a number of 'trials' were carried out against worked examples in a number of statistical textbooks. [9, 10, 11 &12]

The use of computer analysis allowed much greater flexibility in the analysis of the survey data than would have been the case if only manual methods had been adopted. Survey data has been stored in a 'matrix' and statistical tests have been carried out by selecting the appropriate data for the particular enquiry.

SECTION TWO : ORGANISATION PROFILE

10.7 RESTATEMENT OF HYPOTHESES

In Chapter 8 a number of hypotheses were stated with respect to the organisational profile of private and public sector construction contractors. It is worth restating them.

O_1 There are differences in the approach to construction projects between private and public sector construction contractors

O_2 Project management procedures are not extensively used by either private and public construction contractors

O_3 Making a profit continues to be the most important project objective for both private and public sector construction contractors

The *main* objective in this Section is to analyse results from the mail questionnaire and personal interview surveys and compare them with the prestated hypotheses with a view to drawing some valid conclusions about the hypotheses.

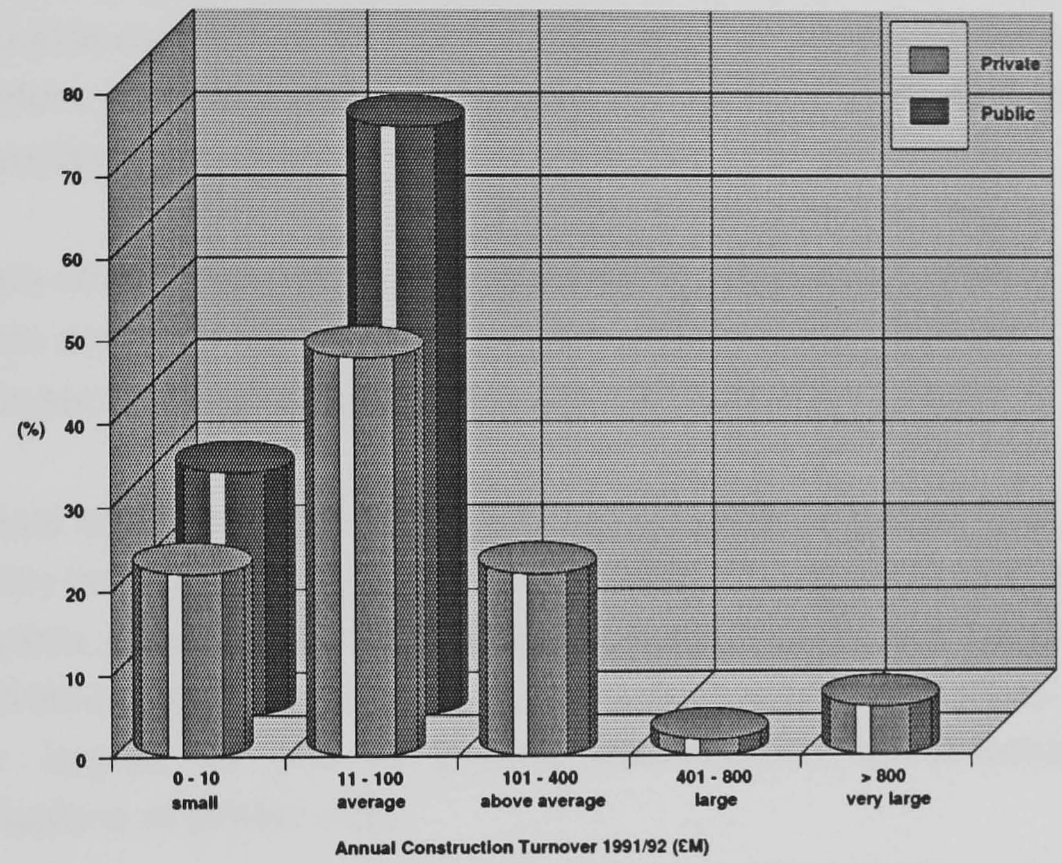
To achieve this objective many factors particular to construction contractor organisations are looked at including the size in terms of annual turnover, the number of salaried and manual staff, the use of sub-contractors, the 'average' value of a single contract and the number of activities modelled in a particular project. Furthermore, additional issues are analysed such as the project objectives, the most appropriate skills for project managers, project management procedures operated (and their adequacy), factors considered important in assessing project manager performance, forms of organisational structures adopted and the relevance and adoption of BS 6046 and BS 5750.

The analysis of all these points helps give an insight into the 'thinking' of the responding organisations with respect to organisational strategy. The Section concludes by analysing the survey results against the prestated hypotheses.

10.8 Size Of Private And Public Sector Construction Contractors

There was a significant difference in the relative size of private and public sector construction contractors in terms of annual civil engineering construction turnover. (Figure 10.1)

Figure 10.1 : Annual Civil Engineering Construction Turnover 1991/92



Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the size of responding organisations between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 1A, 1B & 1C

The bands for the classification of the sizes are similar to those used in research carried out by Orsaah (1984) [3] into the perception and management of risk in the construction industry.

Around half of the respondent private sector construction contractors (48%) were classified as 'average' in size with an annual turnover of between £11M and £100M. Approximately one in five (22%) were classified as 'small' with the same amount (22%) being 'above average' with an annual turnover of between £101M and £400M. The remainder (8%) were classified as 'large' or 'very large' with turnovers of over £400M and £800M respectively. Clearly, the majority (70%) of private sector construction contractors had annual construction turnovers of less than £100M and were therefore classified as average, or small.

In the public sector all respondents were classified as being either 'small' (29%) or 'average' (71%) with turnovers of up to £10M and between £11M and £100M respectively.

Further analysis was carried out to establish whether there was a difference in the size of construction contractors between the two sectors if a 'cut-off' turnover of £100M was adopted. At this level of turnover *all* public sector construction contractors and *44* of the possible 63 private sector construction contractors were included. In essence the sample frame was divided into three sections :

- private sector construction contractors with turnover < £100M
- private sector construction contractors with turnover > £100M
- public sector construction contractors with turnover < £100M

Statistical analysis showed *(Source : Survey Results - Derived from Appendix C, Table 1D)* that there was not a significant difference in the size of construction contractors between the two sectors for organisations with turnovers of less than £100M. Therefore it seems reasonable to expect that there would be a similar degree of use of project management procedures in these organisations of similar size.

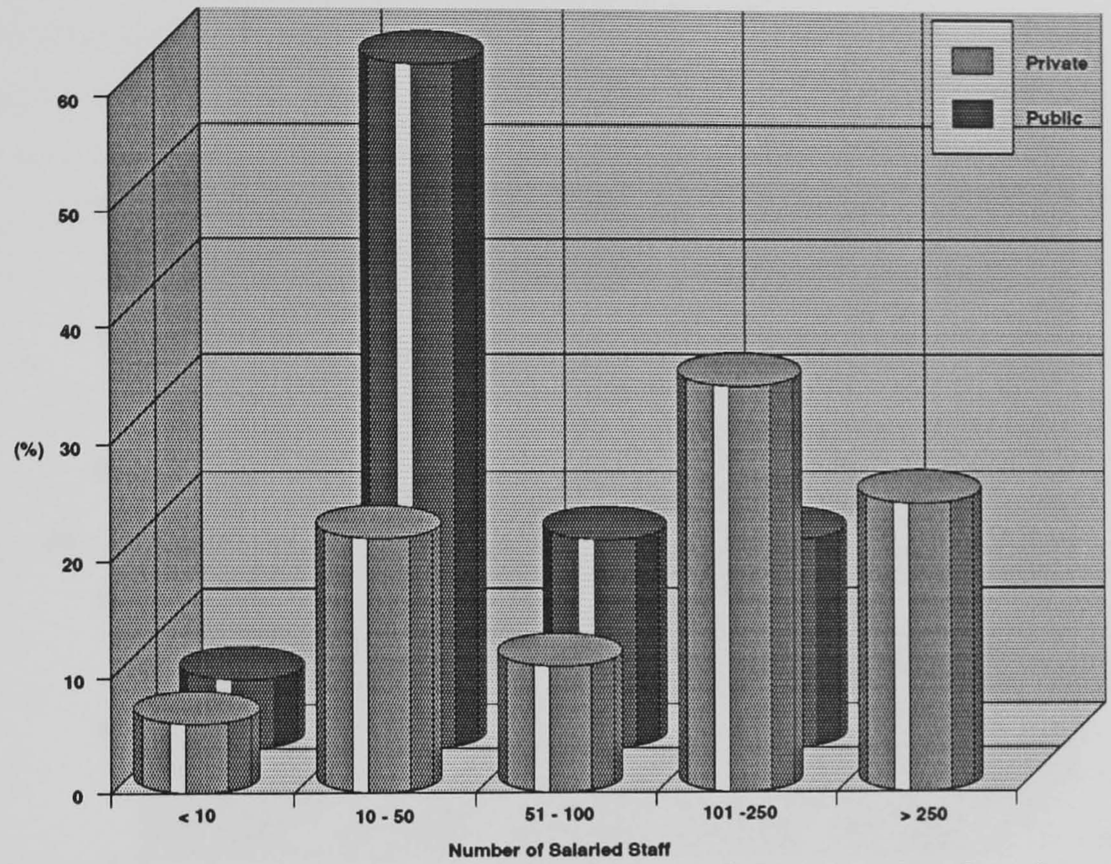
However, in larger construction firms the main reason for the difference in annual turnovers between private and public sector construction contractors was the ability of the private sector to work in a free market environment. In contrast public sector construction contractors were constrained to a relatively small number of allowable *public* bodies by The Local Authorities (Goods And Services) Act 1970. In the private sector this freedom is utilised to the full by companies undertaking a variety of contract types and utilising extensive use of sub-contractors to maximise potential turnover.

In future sections of the analysis of survey data this 'cut-off' value of £100M for turnover will be used in appropriate circumstances to consider the effect of turnover on the adoption, or otherwise, of project management procedures.

10.9 Number Of Salaried Staff Employed

There was a significant difference in the number of salaried, or 'white collar' employees, employed between private and public sector construction contractors.(Figure 10.2)

Figure 10.2 : Number Of Salaried Staff Employed 1991/92



Statistical analysis showed there was a 99% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the number of salaried employees employed between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 2A, 2B & 2C

Responses to the numbers of salaried staff employed within the private sector were varied, although three out of four (74%) had less than 250 salaried staff. All of the responding public sector construction contractors had salaried staff levels of less than 250. The majority (59%) employed between 10 and 50 staff, much less than the norm in the private sector.

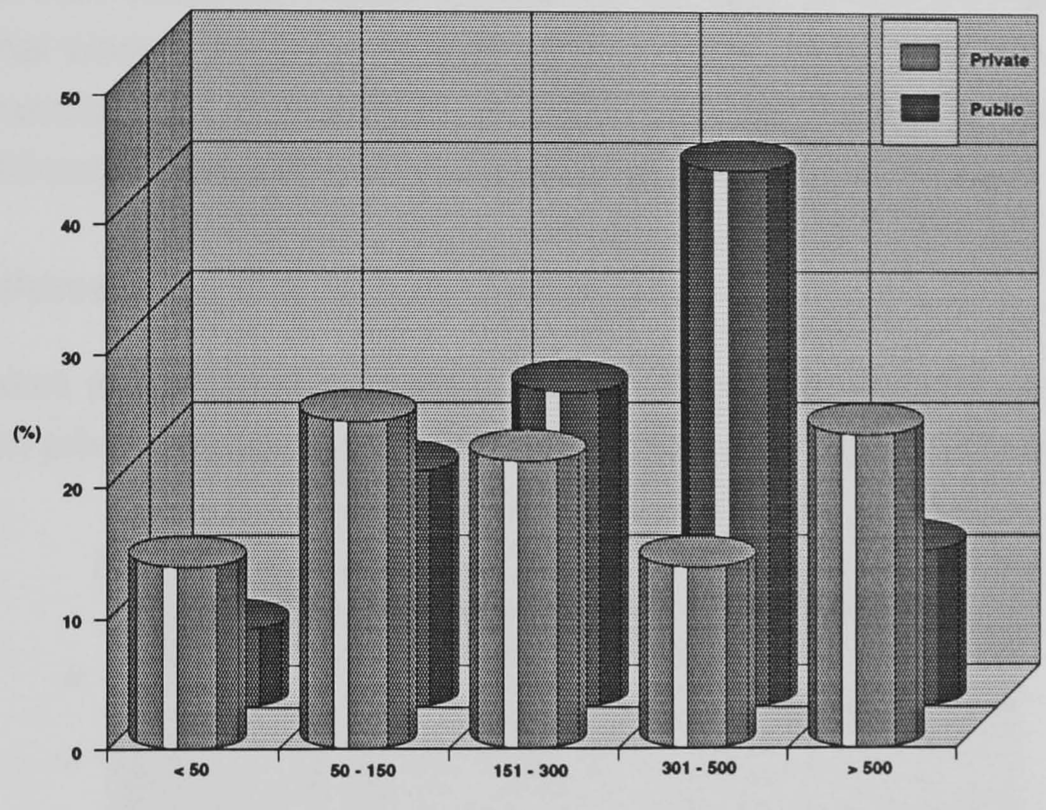
When the number of salaried staff in the private and public sectors was considered for organisations with turnovers of less than £100M there was no such significant difference. *(Source : Survey Results - Derived from Appendix C, Table 2D)* Therefore it was generally only larger construction firms within the private sector who employed the larger numbers of salaried staff.

These companies had larger annual turnovers than those in the public sector, who were not allowed to tender for work outside extremely limited boundaries.

10.10 Number Of Manual Staff Employed

There was no significant difference in the number of manual staff employed between private and public sector construction contractors. (Figure 10.3)

Figure 10.3 : Number Of Manual Staff Employed 1991/92



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the number of manual staff employed between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 3A, 3B & 3C

Just over one third (40%) of private sector respondents employed less than 150 manual employees with only a quarter (24%) employing greater than 500. A quarter (24%) of public sector construction contractors employed less than 150 manual staff, three out of four (65%) between 150 and 500 staff and only around 10% employed more than 500.

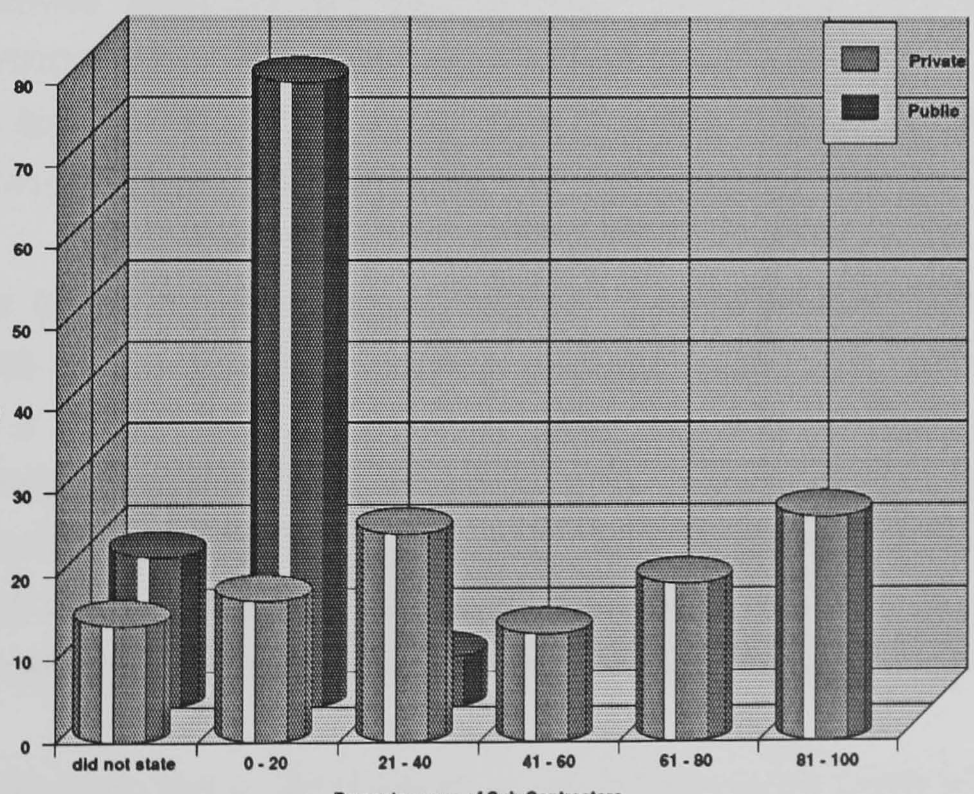
When only organisations with turnovers of less than £100M were considered the results remained the same, that is, there was no significant difference between private and public sector construction contractors on the number of manual staff employed. (*Source : Survey Results - Derived from Appendix C, Tables 3D*). In the private sector those firms with larger turnovers generally employed a greater number of manual staff than their smaller counterparts.

Although the number of salaried staff was significantly greater in private sector construction contractors with turnovers greater than £100M, the number of manual staff employed was not. This can be explained by the extensive use of sub-contracting in the private sector (discussed in paragraph 10.11) which allows a greater turnover of work to be undertaken, without a corresponding increase in the number of manual, or blue collar, employees. This underpins the different manner in which private and public sector construction contractors operate. The private sector have a 'core' manual staff which is supplemented by the use of sub-contractors when additional work is ongoing. In contrast the public sector maintain a constant 'core' manual staff, operating in effectively a single market without the need for additional resources.

10.11 Percentage Use Of Sub-Contractors

There was a significant difference in the percentage use of sub-contractors between private and public sector construction contractors. (Figure 10.4)

Figure 10.4 : Percentage Use Of Sub-Contractors 1991/92



Statistical analysis showed there was a 99% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the percentage use of sub-contractors between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 4A, 4B & 4C

Just over half (57%) of private sector construction contractors stated that they utilised sub-contractors on 40% or more of their work. Slightly over a quarter of these (27%) did, in fact, use sub-contractors on more than 80% of their work. Under a fifth (17%) of private sector construction contractors used sub-contractors on less than 20% of their projects in terms of annual turnover. In the public sector, very little use was made of sub-contractors with more than three quarters (76%) using them for less than 20% of their workload. The extent of use of sub-contractors was not dependent on the size of the organisation. (*Source : Survey Results - Derived from Appendix C, Table 4D*). All private sector construction contractors irrespective of size extensively utilised sub-contractors. Of interest was the significant difference in approach to the use of sub-contractors between public sector construction contractors, all with turnovers of less than £100M and those private sector construction contractors with similar turnovers. This further emphasised the lack of use of sub-contractors in the public sector.

This extensive use of sub-contractors in the private sector of the construction industry has allowed such contractors to maintain a 'base' level of salaried and manual employees in relation to the types of work which they wish to undertake. The use of sub-contractors also provides the opportunity of expanding workload, or allows diversification into different areas of work where 'inhouse' skills may not be available. Furthermore, their use facilitates the apportionment of risk between main and sub-contractors which is an important factor in the 'tight margin' market environment which is currently prevalent in the construction industry.

For public sector construction contractors, 'base' levels of staff have been established for completely different reasons, generally with a view to providing a certain level of service within available budgets. Virtually no outside work may be undertaken and hence there is no real need to utilise sub-contractors - except for certain peaks in their own workload or for a few specialised areas. Indeed there is a great reluctance within the public sector to the principles of sub-contracting at all. Many were of the opinion :

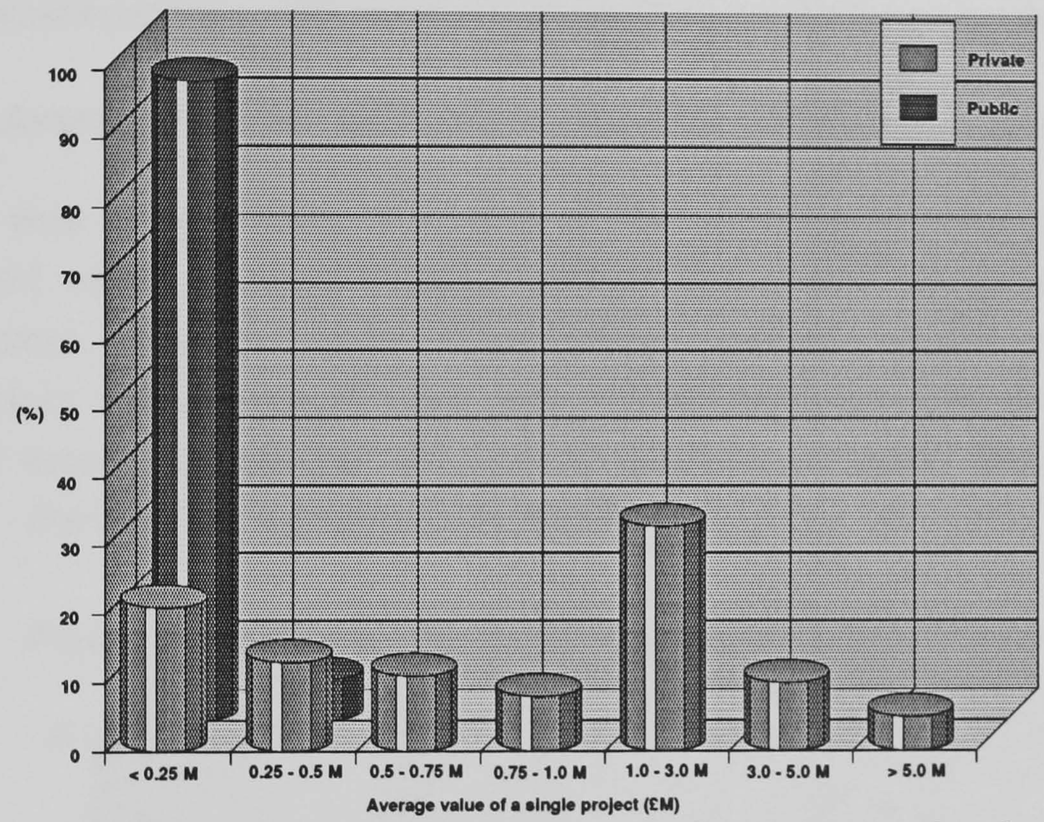
" we do not wish to sub-let any of our works to private sector companies as they are our competition in the single market that we are allowed to operate within .... furthermore we must keep all available work, which is limited by available budgets, to ourselves to keep our workforce gainfully employed "

The effects of Compulsory Competitive Tendering (CCT) has had an effect on the staffing levels of DLOs in terms of reducing the number of both salaried and manual staff employed by DLOs, but definitely not in the way that they have gone about their business in terms of the use of sub-contractors.

10.12 Average Value Of Single Project

There was a significant difference in the average value of a single project between private and public sector construction contractors. (Figure 10.5)

Figure 10.5 : Average Value Of A Single Project 1991/92



Statistical analysis showed there was a 99% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the average value of a single project between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 5A, 5B & 5C

One half (50%) of projects in the private sector had an average value of less than £1M, with a third (33%) between £1M and £3M. Only a small number of private sector construction contractors (5%) worked on projects whose average value was greater than £5M. In the public sector the vast majority (94%) of projects were less than £250K with the remainder being less than £500K. No projects were undertaken greater than this value.

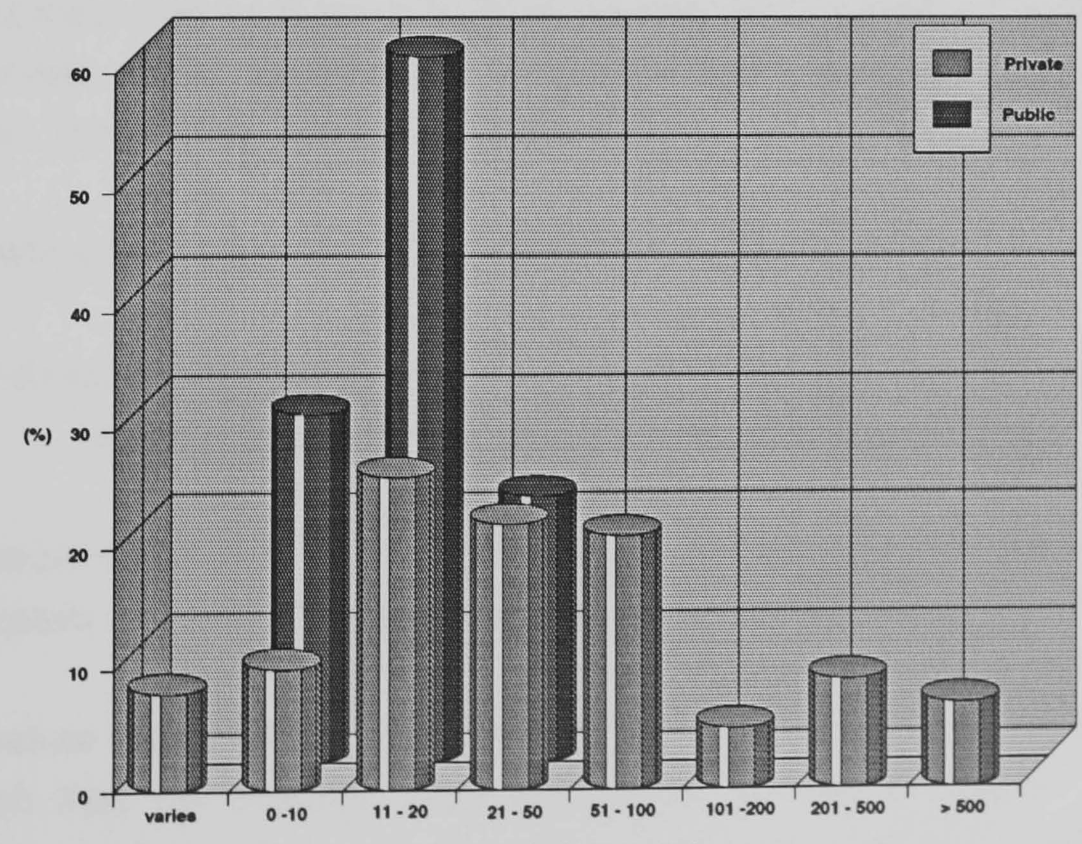
It was evident that private sector construction contractors carried out projects which had a far greater value on average than those executed in the public sector. Furthermore, although the private sector have been eligible to tender for the majority of public sector works since the introduction of CCT legislation in 1980 this has, clearly, not had any noticeable effect on the average size of projects that they undertake. Therefore, works won in competition against public sector construction contractors appear to account for only a *small* proportion of a private sector construction contractor's workload.

In private sector construction contractors, economy of scale by clients generally results in larger contracts being let than in the public sector. The public sector, on the other hand, tend to distribute available budgets on a geographical, politically oriented basis, rather on an objective needs assessment process, with smaller type projects being the end result.

10.13 Average Number Of Activities Modelled Within Projects

There was a significant difference in the average number of activities modelled within projects between private and public sector construction contractors. (Figure 10.6). Furthermore private sector construction contractors with turnovers more than £100M modelled their projects to a greater extent than smaller sized private sector contractors. *(Source : Survey Results - Derived from Appendix C, Table 6D)*

Figure 10.6 : Average Number Of Activities Modelled On Projects



Statistical analysis showed there was a 99.9% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the average number of activities modelled within projects between private and public sector construction contractors. - Source : Survey Results - Derived from Appendix C, Tables 6A, 6B & 6C

Over half (59%) of private sector construction contractors modelled less than 50 activities in the planning of their projects, with just over a third (41%) modelling more than 50 activities. It was of interest to note that a mere 16% of respondents modelled more than 200 activities when formulating a plan for their projects.

The general opinion put forward by private sector construction contractors was that :

" 'baseline' planning and modelling information with respect to time and costs are the most important aids to a project manager for the subsequent management of projects "

All public sector construction contractors modelled 50 activities, or less, in the planning of their projects with nearly nine out of ten (88%) respondents modelling under 20 activities. It was apparent that projects in the public sector were generally straightforward in nature and therefore required only a small number of activities to be modelled.

When the analysis was confined to organisations with turnovers of £100M, or less, it was verified that there was still a significant difference in the extent of project modelling between private and public sector construction contractors, the private sector carrying out a more 'in-depth' process. (*Source : Survey Results - Derived from Appendix C, Table 6D)*

A common theme prevalent throughout the public sector was :

" we do not consider 'baseline' planning or modelling of our projects to any great extent as projects undertaken are relatively straightforward "

This casts doubt over whether adequate 'baseline' planning and modelling is adequately addressed by public sector construction contractors.

The nature of projects carried out by private sector construction contractors, is such that, on average, they will require to have a greater number of activities modelled than projects in the public sector. In many instances the size and complexity of projects will affect the level of detail of the planning process and hence the number of activities that require to be modelled. However, what must be borne in mind is that plans must be able to be interpreted. Therefore, there is also an optimum solution in terms of the number of activities to be modelled when dividing up a project, if the project plan is to be readily understood. In all cases the level of planning and the number of activities modelled must be kept to a manageable level to allow the future control of a project against an original 'baseline' plan to be as practical as possible.

In this study, for both private and public sector construction contractors, it was clear that only a very small amount of projects required to have more than 100 activities modelled. This, therefore, appears to be the realistic 'cut-off' point with respect to keeping planning manageable in practice, perhaps with the exception of either extremely large, or complex projects.

10.14 Correlation Between Organisational Characteristics

Results previously evaluated in this section of the Chapter have shown differences between private and public sector construction contractors in terms of their organisational characteristics. The inter-relationship between these variables is now analysed to try and identify any correlation between them and hence any underlying trends in the management of both private and public sector construction contractor organisations.

Table 10.5 shows the relationships between turnover, average value of a single contract, average number of activities modelled, number of salaried and manual staff and the use of sub-contractors.

In the private and public sectors there was a strong degree of correlation between annual construction turnover and the average value of a single project at a 99% level of confidence. This indicated that annual turnover was closely associated with individual project values. In general terms organisations with a small turnover will carry out smaller projects than organisations with a greater turnover and vice versa.

There was also a strong degree of correlation between the annual construction turnover of private and public sector construction contractors and the number of salaried and manual staff employed. This was to be expected; although the annual construction turnover and average size of a project may differ between the private and public sectors the number of staff employed is commensurate with the size and number of projects carried out.

Table 10.5: Correlation Between Organisational Characteristics

Correlation Between Variables	***DLOs***	***PRIVATE***
	Significant (Y/N)	***Significant (Y/N)***
Annual Turnover vs Average Value Of A Single Contract	Y (1% level)***	Y (1% level)***
Annual Turnover vs Number Of Salaried Staff	Y (1% level)***	Y (1% level)***
Annual Turnover vs Number Of Manual Workers	Y (5% level)**	Y (1% level)***
Annual Turnover vs % Use Of Sub-Contractors	N	Y (10% level)*
Number Of Salaried Staff vs Number Of Manual Workers	N	Y (1% level)***
Number Of Salaried Staff vs Average Value Of A Single Contract	Y (5% level)**	Y (1% level)***
Number Of Manual Workers vs Average Number Of Activities	N	Y (1% level)***
Number Of Manual Workers v s % Use Of Sub-Contractors	Y (10% level)*	N
Number Of Manual Workers vs Ave Value Of A Single Contract	N	Y (5% level)**
% Use Of Sub-Contractors vs Ave Value Of A Single Contract	N	Y (1% level)***
% Use Of Sub-Contractors vs Average Number Of Activities	N	Y (10% level)*
Ave Value Of A Single Contract vs Ave Number Of Activities	N	Y (1% level)***

* : denotes significant relationship at a 90% level of confidence

** : denotes significant relationship at a 95% level of confidence

*** : denotes significant relationship at a 99% level of confidence

In the private sector there was a further strong degree of correlation between annual construction turnover and the use of sub-contractors which was not mirrored in the public sector. In addition when the number of salaried and manual staff were compared to one another there was a difference between the private and public sectors. In the private sector there was a strong degree of correlation at a 99% level of confidence between the number of salaried and manual staff. However, there was no such correlation in the public sector. This appeared to indicate a difference in the approaches between the two types of organisations.

To investigate this further the relationship between salaried and manual staff, annual construction turnover, the average value of a single project and the use of sub-contractors was looked at.

When manual workers were considered there was only a strong degree of correlation in the private sector with the average value of a single project at the 95% level of confidence. Furthermore, there was only such a correlation between the use of sub-contractors and the average value of a single project in the private sector at a 99% level of confidence in the private sector.

Furthermore, in the private sector, the number of manual staff and the degree of use of sub-contractors were related to the average value of a project, whereas in the public sector they were not. This might be explained by the lack of use of sub-contractors by public sector construction contractors and also that more manual staff were required to carry out the smaller type of projects undertaken in the public sector.

When considering the number of activities modelled in a project to the average value of a single project there is a strong degree of correlation at a 99% level of confidence in the private sector. There was no such relationship in the public sector. This appeared to indicate that the number of activities modelled in the public sector was not related to the size of project in the public sector, but was in the private sector. This seems to suggest that planning procedures were not adequate in the public sector.

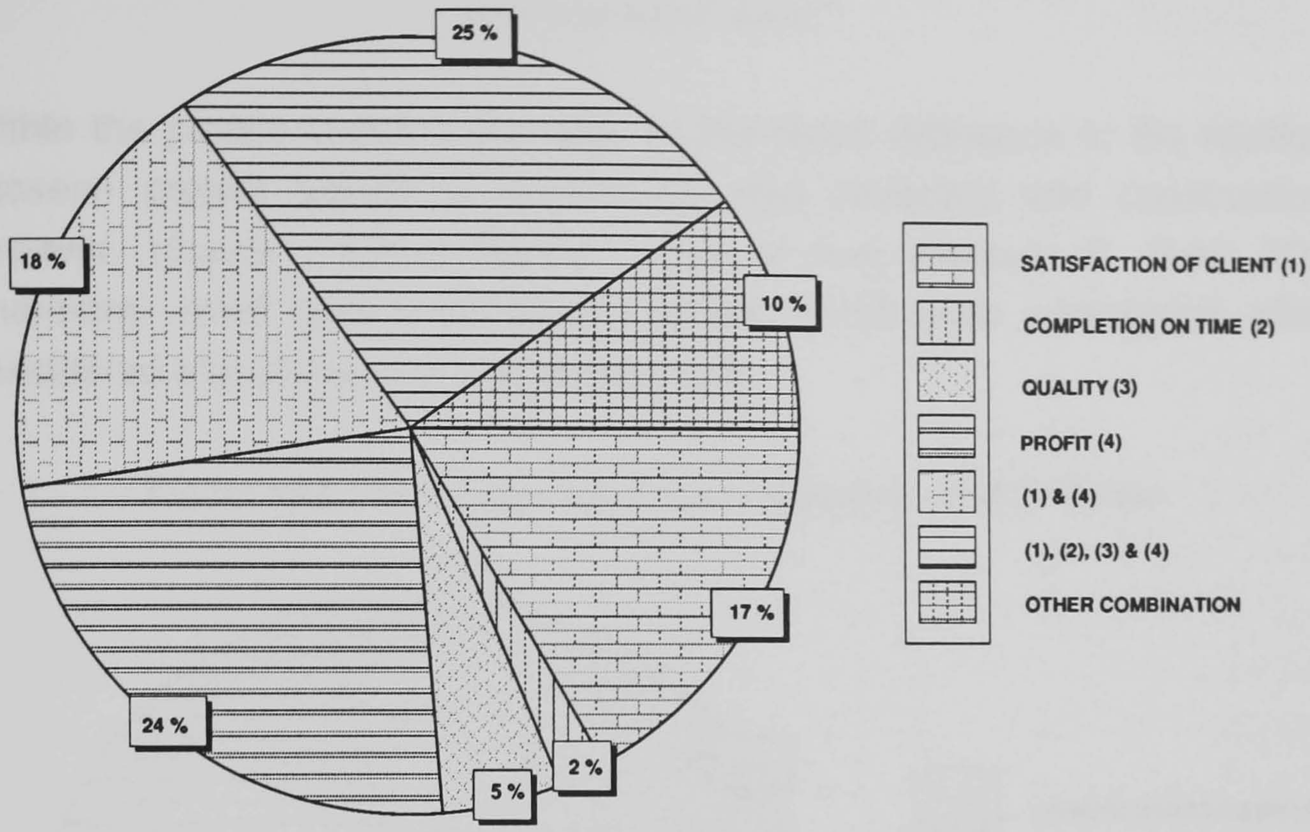
10.15 Most Important Project Objective

There was a significant difference in the project objective considered *most* important between private and public sector construction contractors in the management of their projects. (Figures 10.7 & 10.8)

The private sector, typically, viewed a number of different project objectives as being equally *most* important, whereas, the public sector viewed profit alone, as being the *most* critical project objective.

Only one in four (24%) of private sector construction contractors believed that achieving completion within budgeted costs and making a profit alone was the *most* important project objective. A similar amount (25%) considered that *all* of the four listed objectives (satisfaction of Client, completion on time, quality and profit) were equally important. The remaining half offered a mixture of responses, but this served to further emphasise that profit was *not* the main consideration in the private sector.

Figure 10.7 : Most Important Project Objective - Private Sector



MOST IMPORTANT PROJECT OBJECTIVE - PRIVATE SECTOR CONSTRUCTION CONTRACTORS

Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H1 can be accepted - that is, there was a difference in the project objective(s) considered most important between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 7A & 7C

Within the private sector there was no significant difference in the relation between project objectives considered *most* important and construction turnover. (*Source : Survey Results - Derived from Appendix C, Tables 7A & 7C*). Therefore, small and large private sector construction contractors alike considered objectives over and above profit.

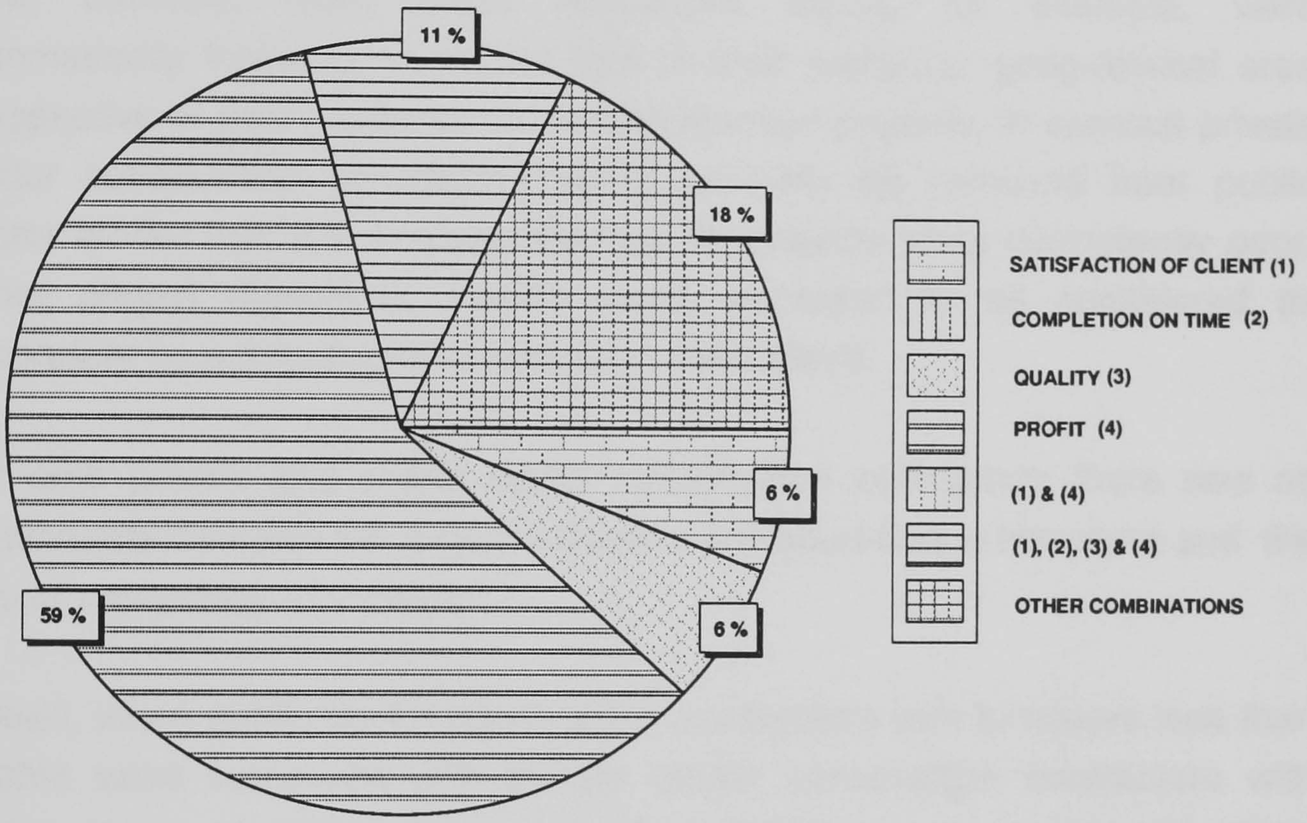
It was evident that contractors in the private sector must consider objectives over and above profit to ensure a continuity of work. Client satisfaction and quality were seen as being extremely important in this respect in order to achieve follow-up work and gain or maintain a 'good' image and reputation in the industry. Future work is *not* guaranteed. Hence the reason why most contractors in the private sector must take cognisance of other equally important project objectives as well as merely profit.

The position of private sector construction contractors with respect to project objectives can be summed up from some of the personal interviews, where they commonly :

" believed that profit would be the resultant outcome of a properly managed contract with a satisfied client "

Within the private sector there was no significant difference in the relation between project objectives considered *most* important and construction turnover. (*Source : Survey Results - Derived from Appendix C, Table 7D).* Therefore, small and large private sector construction contractors alike considered objectives over and above profit.

Figure 10.8 : Most Important Project Objective - Public Sector



Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H1 can be accepted - that is, there was a difference in the project objective(s) considered most important between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 7B & 7C

The majority (59%) of public sector construction contractors did not consider that project client, quality or time objectives were as important as completion within budgeted cost and making a profit. This was somewhat unexpected in view of the 'service oriented' approach that is generally perceived of such organisations and served to indicate the negative effects that the introduction of CCT legislation has had on the public sector. However, even though public sector construction contractors are required to make a specified rate of return on capital employed (ROCE), it was surprising to find the degree of unity in considering profit as the *most* important project objective.

Personal interviews revealed that CCT legislation has had a marked impact on the approach to construction contracts in the public sector, for example :

" CCT has stipulated that we must make a 5% rate of return on capital employed, and this must be our primary objective in the approach to all our projects "

Looking closer, however, it must be noted that in the public sector environment there was little need to 'satisfy' clients to secure future work as a substantial proportion of works (20-30%) were awarded 'inhouse', without the need for competition, as a matter of course, despite CCT legislation to date. Similarly, most Local Authorities' DLOs, for example, were automatically included on tender lists in their particular geographical area irrespective of past performance on construction projects. In contrast private sector construction contractors would normally be removed from public sector tender lists if their performances on projects were consistently poor. Other project objectives, outwith profit, appeared to be considered as secondary by public sector construction contractors.

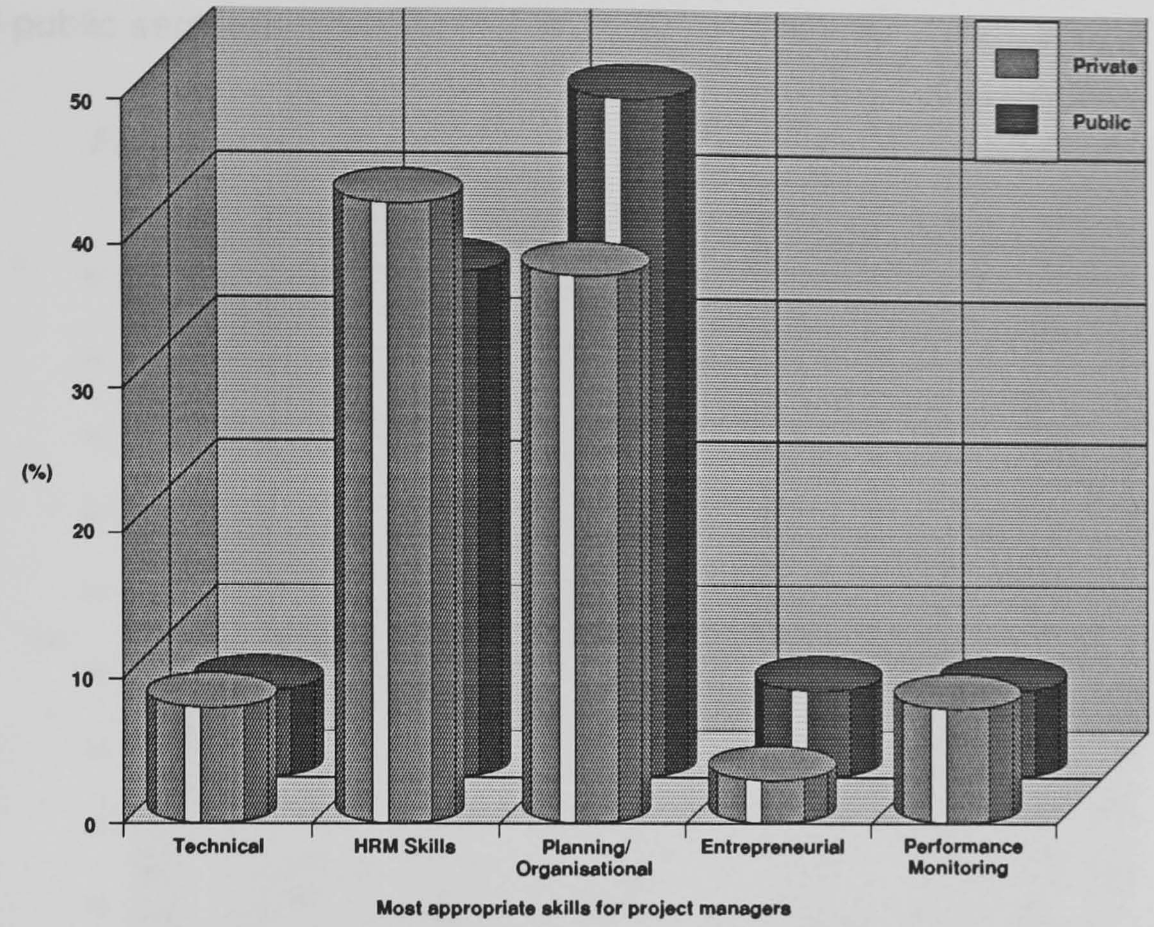
For both private and public sector construction contractors there was no relationship between the project objective considered *most* important and the size or complexity of projects.

Indeed, when public sector construction contractors with turnovers less than £100M were compared with private sector construction contractors with similar turnovers, there was a significant difference in project objectives considered *most* important. (*Source : Survey Results - Derived from Appendix C, Table 7D*). Profit was almost always considered singularly as the *most* important project objective within public sector construction contractors.

10.16 Most Appropriate Skills For Project Managers

The skills considered most appropriate for project managers in private and public sector construction contractors were similar. (Figure 10.9)

Figure 10.9 : Most Appropriate Skills For Project Managers



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the skills considered most appropriate for project managers between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 8A, 8B & 8C

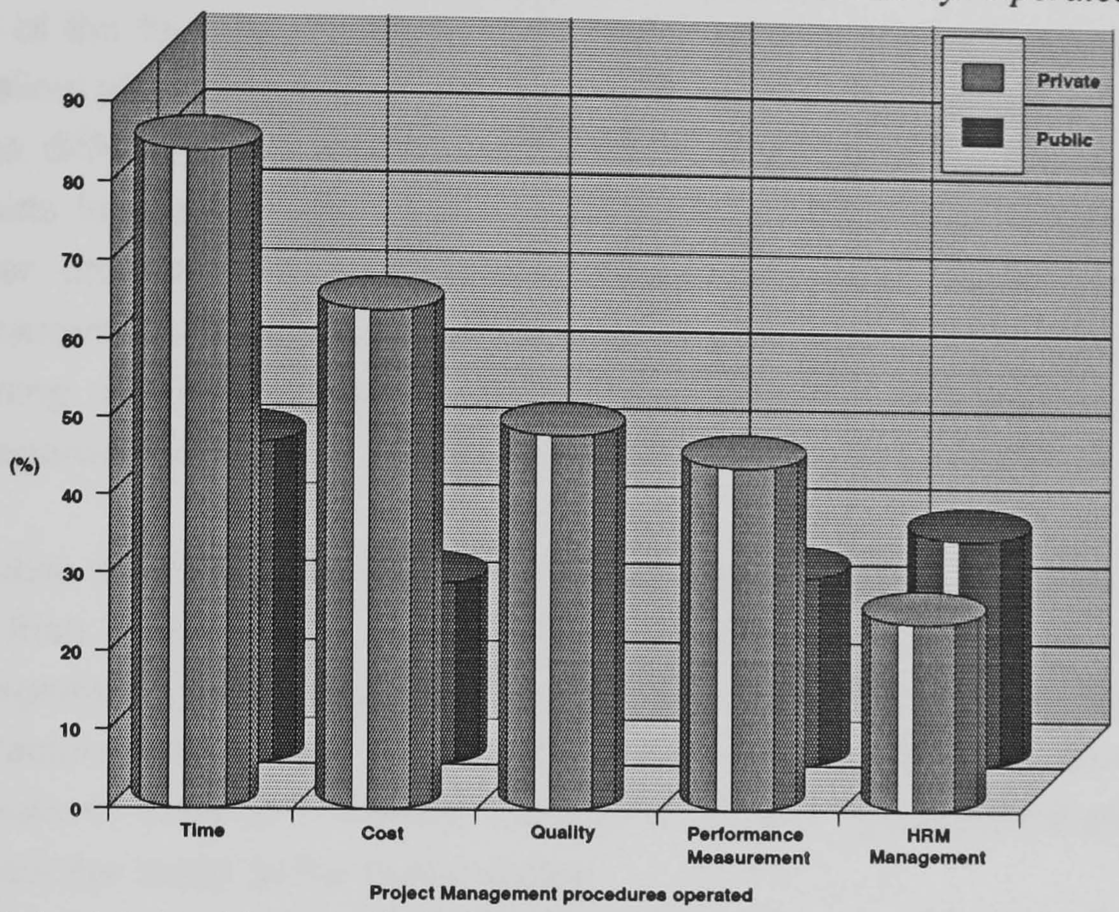
Equally respondents in the private sector (81%) and in the public sector (82%) considered that planning and organisational skills alongside team building and management of human resource skills were the most appropriate skills required of a project manager.

Clearly, these 'human' skills are thought to be more relevant than others such as technical expertise or performance management. This emphasises the importance of proper planning beside proper interpersonal and communication skills which are essential to help ensure subsequent project success. Only a very small proportion of construction contractors deemed technical expertise to be the most appropriate skill for a project manager.

10.17 Procedures Operated With Respect To Project Planning & Control, Quality And The Management Of Human Resources

The use of project management procedures *always* operated with respect to project planning and control, quality and the management of human resources were significantly greater in private sector construction contractors. (Figure 10.10). However, it was evident that the use of project management procedures was, in fact, found to be limited in both the private and public sectors.

Figure 10.10 : Project Management Procedures Always Operated



Statistical analysis showed there was a 90% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the use of procedures always operated with respect to project planning and control, quality and the management of human resources between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 9A, 9B & 9C

More than three quarters (84%) of private sector construction contractors *always* operated procedures with respect to the planning of time and almost two thirds (64%) also *always* planned with respect to cost on projects. However, less than half the respondents *always* operated procedures with respect to quality (48%), performance measurement standards (44%) and human resource management (24%). The use of project management procedures appeared to be 'tiered' in nature in the private sector with time being considered the most important, followed by cost, and then by the other parameters.

The use of project management procedures was considered in relation to turnover. *(Source : Survey Results - Derived from Appendix C, Table 9D).* There was no significant difference in the procedures *always* adopted with respect to time, cost, quality and human resource management between private sector construction contractors with turnovers of less than £100M and those with turnovers greater than £100M.

Less than half (41%) of public sector construction contractors *always* carried out planning with respect to time on their projects. This was concerning in view of the fact that it was not possible to monitor progress effectively if a 'baseline' plan against time had not previously been formulated. Furthermore it was difficult to see how present and future workload for the smaller type projects in question might be assessed without such basic information. Of further concern, only around one in four of public sector construction contractors *always* operated procedures with respect to cost (23%), quality planning (0%), performance measurement (23%) and human resource management (29%).

In public sector construction contractors, where annual turnovers were all less than £100M, there was a significant difference in the use of project management procedures when compared to private sector construction contractors with similar turnovers. *(Source : Survey Results - Derived from Appendix C, Table 9D).* Clearly, the use of project management procedures was not the 'norm' in the public sector.

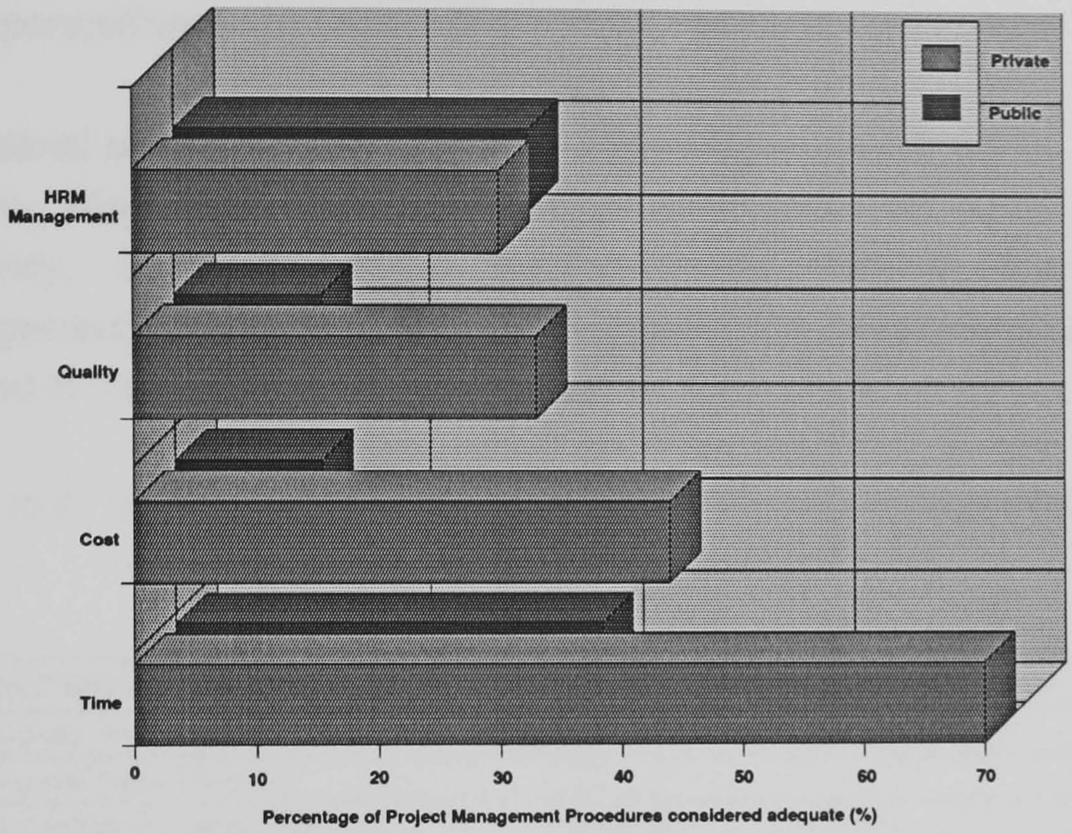
The results indicated that private sector construction contractors operated project management procedures more frequently than those contractors in the public sector. However, as previously stated, the use of a *number* of project management procedures by either private or public sector construction contractors was, still, limited.

10.18 Are Project Management Procedures Operated Adequate?

There was no significant difference in the perceived adequacy of project management procedures between private and public sector construction contractors. (Figure 10.11).

In private sector construction contractors around two thirds (70%) believed that project management procedures, operated with respect to time, were sufficient. Almost half (44%) considered that procedures for the management of cost were alright, but less deemed that procedures were adequate to enable quality (33%) and human resource management (30%) objectives to be met. The results indicated that the overall adoption of project management procedures in the private sector was clearly *not* sufficient, perhaps with the exception of the management of time.

Figure 10.11 : Percentage Of Project Management Procedures Operated Considered Adequate?



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there is no difference in the adequacy of project management procedures as considered between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 10A, 10B & 10C

In the public sector, only around a third (35%) believed that project management procedures, operated with respect to time, were adequate. A similar amount (29%) considered that procedures for the management of human resources were sufficient. Even less deemed that procedures were adequate to enable cost (12%) and quality (12%) objectives to be met. The results indicated that project management procedures in the public sector were clearly *not* sufficient.

Between a third (30%) and three quarters (76%) of private and public sector construction contractors stated that project management procedures could be *improved* in one, or more, of the critical areas. Likewise, up to a third (29%) considered that current procedures being operated were *inadequate*.

The results appeared to indicate that a 'preference' was given in the application of such procedures, especially in the private sector, where time, in general, was perceived to be planned well enough; however, it was evident that procedures relative to quality, cost and management of human resources could be improved.

The results also emphasised that both private and public sector construction contractors believed that many of the project management procedures that they operated were *not* adequate.

In personal interviews with project managers from both the private and public sectors, information was requested on what effect, in terms of loss in efficiency, could reasonably be expected when particular project management procedures were *not* adopted. The average responses are detailed in Table 10.6.

Table 10.6 : Percentage 'Loss' In Efficiency If Project Management Procedures Are Not Adopted In The Management Of Projects

PROJECT MANAGEMENT PROCEDURE	*PERCENTAGE LOSS IN EFFICIENCY*
Planning with respect to time	10 - 20
Planning with respect to cost	5
Quality management procedures	10 - 25
Effective management of human resources	5 - 10

To enable a comparison to be made of the relative 'efficiency' of private and public sector construction contractors, these average values of percentage 'loss in efficiency', were then applied to the percentage of the use of a particular project management procedure (see Figure 10.11) which were *not* considered to be adequate.

For example, project management procedures with respect to cost were only considered to be adequate for 44% of the time on projects in the private sector. Therefore on 56% of projects a 'loss' in efficiency will be experienced. This is shown below, in the same manner for time, cost, quality and human resources for both private and public sector construction contractors to indicate the overall potential 'loss in efficiency' which might arise as a result of *not* adopting project management procedures.

Private sector

Time	15% x 30%	= 4.5%
Cost	5% x 56%	= 2.8%
Quality	17.5% x 67%	= 11.7%
Human	7.5% x 70%	= 5.2%
Total loss of efficiency		**= 24.2%**

Essentially, it was estimated that private sector construction contractors believed that a 'loss in efficiency' of up to 24% would be experienced if project management procedures with respect to time, cost, quality, or human resources were *not* utilised *100%* of the time on *all* of their projects.

Public sector

Time	15% x 65%	= 9.8%
Cost	5% x 88%	= 4.4%
Quality	17.5% x 88%	= 15.4%
Human	7.5% x 71%	= 5.3%
Total loss of efficiency		**= 34.9%**

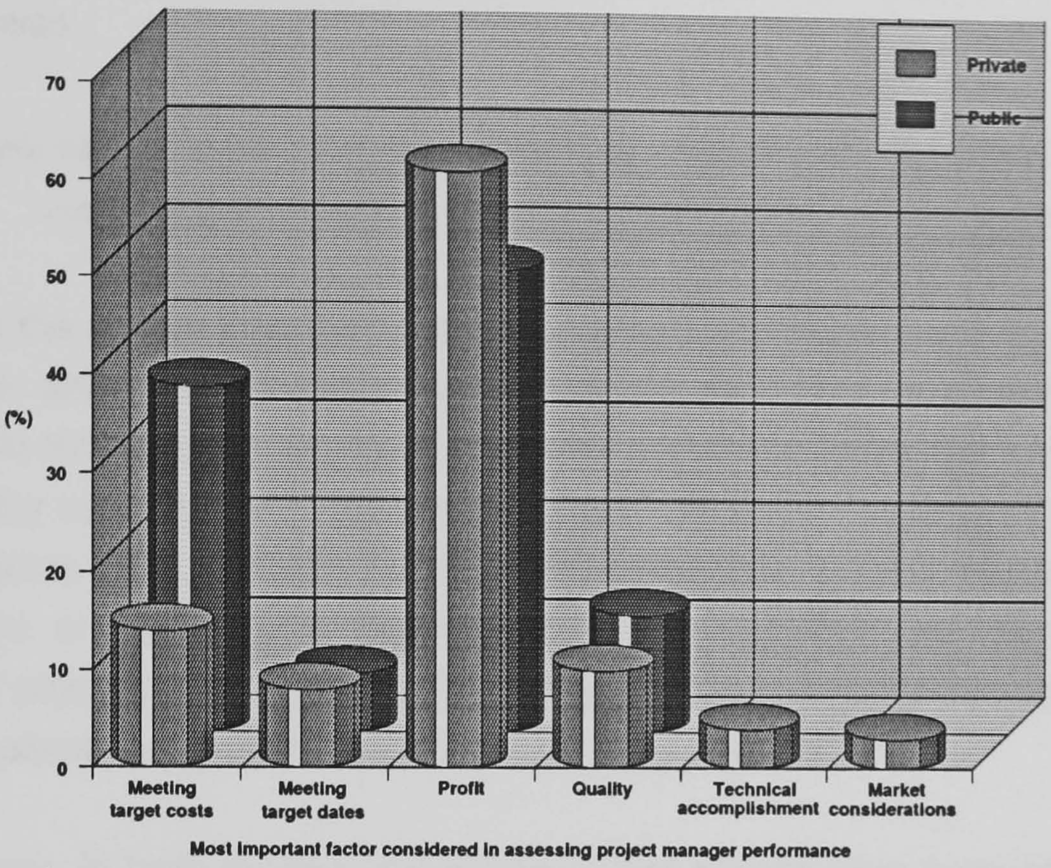
In a similar manner, it was estimated that public sector construction contractors believed that a 'loss in efficiency' of up to 35% would be experienced if project management procedures with respect to time, cost, quality, or human resources were *not* utilised *100%* of the time on *all* of their projects.

It was seen that there was a difference in the apparent 'efficiency' in favour of the private sector with respect to the adoption and use of vital project management procedures. Hence, private sector construction contractors were likely to be *more efficient* than public sector construction contractors in the management and execution of their projects.

10.19 Most Important Factor In assessing Project Manager Performance

There was no significant difference in the most important factor considered in assessing project manager performance between private and public sector construction contractors. (Figure 10.12)

Figure 10.12 : Most Important Factor In Considering Project Manager Performance



Statistical analysis showed that the null hypothesis H0 can be accepted - that is, there was no difference in the most important factor considered in assessing project manager performance between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 11A, 11B & 11C

Only a quarter (24%) of private sector construction contractors considered making a profit the *most* important project objective; however, it can be seen that almost two thirds (61%) judged the performance of their project managers on their ability to meet target costs and to make a profit. Clearly, the project manager must satisfy other important objectives in carrying out projects such as quality and client satisfaction, but ultimately, the manager's performance will be assessed on whether a profit has been made.

Many project managers in private sector construction contractors were quoted as saying :

" Profitability is all that the company are interested in. Although, I must maintain good site and client relations in the management of projects and satisfy other project objectives such as time, cost, quality and performance. "

Almost two thirds (59%) of public sector construction contractors considered completion within budgeted costs and making a profit as the *most* important project objective. Similarly, almost half (47%) of project managers in the public sector were judged on their ability to make a profit. The common theme stemming from comments made by project managers in the public sector was :

> *" People believe that we are not commercially aware in the true sense, but we are continually striving to achieve our stipulated 5% rate of return "*

In both the private and public sectors, project managers were largely judged on their ability to complete a project within budgeted costs and making a profit. In this respect organisations were ultimately interested in maintaining a healthy cash flow and subsequent profit, but project managers had to look at projects with a much wider perspective in order to ensure the best chances of achieving a successful project outcome. All other important project objectives such as quality, future market considerations and technical accomplishment were considered secondary to profit.

It is clear, in both private and public sector construction contractors, that a project manager must satisfy all project objectives in the management of projects, but will be judged primarily on whether the project has made a profit.

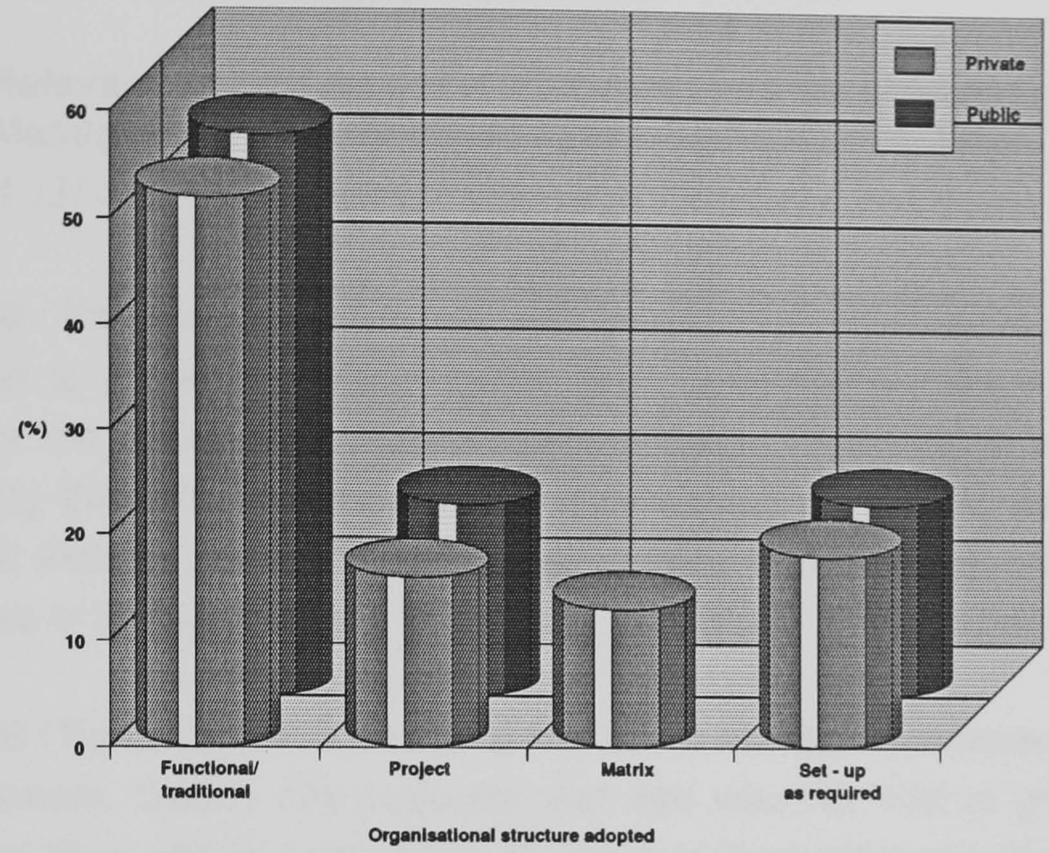
10.20 Form Of Organisational Structure Adopted For Projects

There was no significant difference in the form of organisational structure adopted for projects between private and public sector construction contractors. (Figure 10.13).

The functional or traditional form of organisational structure was still the most common form that private sector construction contractors *always* adopted in the management of their projects. Both the matrix (32%) and project (62%) forms were *sometimes* used with less than half (44%) of respondents either *always*, or *sometimes* setting up a structure as required for a particular project.

Many project managers commented that in many instances little 'lead-in' time was given for thorough consideration of the organisational structure to be adopted for a project or that they were too actively involved in multiple projects to consider structuring of projects until they were underway.

Figure 10.13 : Form Of Organisational Structure Adopted For Projects



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the form of organisational structure adopted for projects between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 12A, 12B & 12C

Around one in two (53%) of public sector construction contractors *always* favoured the functional or traditional form of organisational structure. Approximately a third *sometimes* used the project (30%) or matrix (35%) form and almost half (47%) *sometimes* set up a structure as required for each project. Project managers in public sector construction contractors commented that little attention was paid to the form of organisational structure adopted, because :

" Projects are relatively small and straightforward with a number ongoing at any one time "

The functional, or traditional, form of organisational structure was still the most commonly used in both sectors of the industry. It was also of interest to note that in the private sector more than half (56%) *never* adopted and set up an organisational structure as required for a project and even less (35%) did so in the public sector.

The widespread range of organisational forms adopted would seem to indicate that *not* a great deal of attention is paid to the setting-up of an organisational structure in the management of projects.

10.21 Relevance And Adoption Of BS 6046 And BS 5750 In The Management Of Projects *(Derived From Appendix C, Tables 13A, 13B & 13C)*

BS 5750 : Part 2 relates to the situation whereby an organisation carries out a project to a pre-determined specification, drawings and such like, as is normally the case in the construction industry. Therefore, it was hardly surprising that 84% of private sector respondents considered the standard relevant; likewise, around two thirds of respondents currently practised the principles of the standard.

BS 6046 : Parts 1,2,3 & 4 relates to the use of network techniques in project management. Clearly this particular standard was not held in great regard with less than one in four (24%) stating that they practised the principles contained within it.

BS 5750 : Part 1 includes the same procedures as Part 2, but with the addition of two sections, namely design and servicing. Many private sector construction contractors are required to carry out design in the form of temporary works design or indeed design and build tenders, which have become popular in recent years. More than a third (35%) already operated a quality management system to BS5750 : Part 1, thus incorporating the design function into their quality management systems.

In the public sector, all respondents considered BS 5750 : Part 2 relevant to their works and more than two thirds (71%) practised the principles contained there. BS 6046 Parts 1,2,3 & 4 were not considered relevant to the management of projects by the majority of responding construction contractors (82%).

The views of the private and public sectors on BS 5750 and BS 6046 are similar. Clearly, the rise in adoption of BS 5750 has been colossal over the last few years. Both the private and public sectors have been actively involved in recognising the relevance of the standards and indeed many organisations have subsequently implemented quality management systems based on the standards and practise them accordingly.

10.22 DECISIONS ON ORGANISATION PROFILE HYPOTHESES

Each of the three prestated hypotheses is now considered in conjunction with the survey results with respect to organisation profile.

Hypothesis O_1

O_1 There are differences in the approach to construction projects between private and public sector construction contractors

Section Two of this Chapter has identified several areas which were in support of *Hypothesis O_1*.

Overall consideration of private and public sector construction contractors has shown that there was a significant difference between the annual construction turnovers of construction contractors working in the private and public sectors. However, there was no such significant difference in turnover when analysis was restricted to firms with turnovers of less than £100M. Furthermore, the number of salaried staff employed in the private sector was significantly greater than that employed in the public sector which has been shown to be related to the greater turnover of work undertaken by the private sector and also to the extensive use of sub-contractors which required supervision and coordination. Similarly, for turnovers of less than £100M there was no significant difference in the number of salaried employees employed between the two sectors.

The number of manual staff employed between the private and public sectors was not significantly different; this remained the case, irrespective of annual construction turnover.

This might be explained by the extensive use of sub-contractors in the private sector, but very limited use in the public sector. Projects in both sectors were carried out with a 'base' level of manual staff which exhibited a strong degree of correlation to the annual construction turnover undertaken. However, in the private sector there was also a strong degree of correlation between the use of sub-contractors and annual construction turnover.

The degree of utilisation of sub-contractors in the private sector was not dependant on company size. Both small and large private sector construction contractors extensively used sub-contractors in their works. However, for organisations with turnovers of £100M, or less, there remained a distinct difference in the approach to the use of sub-contractors between the two sectors.

Clearly, in the public sector, where 'outside' work was effectively prohibited by legislation, staff levels were 'fixed', normally based on the budget available within a single market area but also with regard to the provision of certain services, for example, winter weather emergency duties. All work was carried out 'inhouse' with little, or no, consideration given to the use of sub-contractors.

The average value of projects undertaken by private and public sector construction contractors differed significantly. Projects in the private sector varied greatly in size, but had a much greater average value than projects undertaken in the public sector.

Projects carried out in the public sector were carried out from a budget which was limited to the extent of monies that an authority was legally allowed to attempt to recover from either central government, or its own rate, poll tax or council tax payers. Such spend was therefore not 'needs based' and in a political arena money was quite often reported as being distributed on a geographical 'keep everybody happy' basis. This explained to an extent why projects in the public sector were smaller in value. However, clearly the prime reason for the smaller value of projects, undertaken by public sector construction contractors, was the fact that they could not legally compete in a free market against their counterparts, even within their own geographical area.

There was a significant difference in the number of activities modelled in a project between private and public sector construction contractors. The number of activities modelled also had a strong degree of correlation with the average value of a single project in the private sector. This appeared to indicate that the number of activities modelled by private sector construction contractors was related to the size of the project, but was not in the public sector.

In all instances private sector construction contractors carried out more extensive modelling of their projects than their counterparts in the public sector. However, it was also evident within the private sector, that more extensive modelling was related to the size of company. This may mean that such companies allocate greater resources to the planning and modelling processes.

The above points served to emphasise that there were differences in approaches to construction contracts between the private and public sectors. Specifically, the methods of staffing projects (particularly with respect to the use of sub-contractors), the volume of turnover and size of individual projects and the degree of modelling of projects all appeared to be addressed differently.

Therefore, there was support for *Hypothesis* O_1, that is, *there are differences in the approach to construction projects between private and public sector construction contractors.*

Hypothesis O_2

O_2 Project management procedures are not extensively used by either private and public construction contractors

A number of factors have been identified in Section Two of the Chapter which were in support of *Hypothesis* O_2.

It has been established that there was a significant difference in the project management procedures (including time, cost, quality and human resource management) operated between private and public sector construction contractors. However, this difference has essentially indicated that the use of such procedures was more extensive in the private sector than in the public sector, not that such procedures were necessarily extensively used. The use of project management procedures in both sectors was, in fact, limited. It was established that there was a significant difference in the project management procedures (including time, cost, quality and human resource management) operated between private and public sector construction contractors. Of further interest was that the adoption of such procedures was not influenced by the turnover, or size, of the organisation.

Planning with respect to time was the most commonly used project management procedure in both sectors, with 84% and 41% *always* adopting such principles in the private and public sectors respectively.

Planning with respect to cost was *always* carried out by 63% of private sector construction contractors, but by only 23% in the public sector. Project management procedures operated with respect to quality, performance management and human resource management were even more sparsely utilised by both private and public sector construction contractors. In the private sector only 48% always operated procedures with respect to quality, 44% with respect to performance management and 24% with respect to human resource management. Likewise, in the public sector 0%, 23% and 29% always operate procedures for quality, performance management and human resource management respectively. It was evident that there were two important factors to be noted when the survey results were analysed against the *Hypothesis* O_2, these were : that project management procedures are not extensively used by either private and public sector construction contractors and also that private sector construction contractors operate project management procedures to a greater extent than construction contractors in the public sector.

There is clear support for *Hypothesis* O_2, that is, *project management procedures are not extensively used by private or public construction contractors.*

Hypothesis O_3

O_3 Making a profit continues to be the most important project objective for both private and public sector construction contractors

Several areas have been discussed in this Section which support *Hypothesis* O_3. However, a number of points raised within have also indicated views which would involve the rejection of the Hypothesis. In this respect it has been decided to divide *Hypothesis* O_3 into two sub-hypotheses in order to allow meaningful decisions to be made. Therefore *Hypothesis O_3* becomes :

$O_{3.1}$ Making a profit alone is not considered to be the most important project objective for private sector construction contractors

$O_{3.2}$ Making a profit continues to be the most important project objective for public sector construction contractors

Sub-hypothesis $O_{3.1}$ was supported by the fact that three quarters (76%) of private sector construction contractors considered a number of project objectives such as satisfying clients, quality, completion on time as well as making a profit in varying combinations as being equally important. Only a quarter (24%) believed profit alone to be the single *most* important project objective. In the private sector client satisfaction was important to bring in payment on time, to help maintain an even cash flow and to encourage follow-up work. These were looked upon as being equally as important as making a profit. Project objectives were not influenced by the size of the construction contractor organisation in the private sector.

Sub-hypothesis $O_{3.2}$ was supported by the fact that almost two thirds (59%) of public sector construction contractors believed that completion within budgeted costs and making a profit as the single most important objective.

When public sector construction contractors, all with turnovers of less than £100M, were compared to similar sized private sector construction contractors, there was a significant difference with respect to the project objective(s) considered most important. In most instances the public sector placed all emphasis on making a profit.

Although public sector construction contractors were funded, in the main, by central and local government finance to provide some form of 'public service' it appeared that profit and not customer or client satisfaction was the dominant project objective. This was not surprising, to a certain extent, in view of the implementation and importance placed on compulsory competitive tendering on such organisations, from around 1980, requiring the public sector to make a specified rate of return. This aspect, in tandem with the fact that most local authorities automatically included their direct labour organisations on tender lists, irrespective of past performance, has shifted the emphasis to profit rather than other important objectives such as client satisfaction and to a lesser extent quality.

However, although future work 'inhouse' has been guaranteed, the public sector cannot operate in a free market environment. Hence, if competition was to get tougher in their 'inhouse' market area, public sector construction contractors commented that they might concentrate further on the profit motive, in view of probable tighter margins prevailing, because they were not able to look for potentially 'better' work elsewhere.

The survey results have shown that there was a difference in the attitude towards the importance of profit in carrying out projects between private and public sector construction contractors. Project objectives were not influenced by the size of the construction contractor organisation in the private sector.

The revised *Hypothesis* O_3 has allowed the following conclusions to be made in support of *Sub Hypotheses* $O_{3.1}$ and $O_{3.2}$, that is :

Making a profit alone is not considered to be the most important project objective for private sector construction contractors.

Making a profit continues to be the most important project objective for public sector construction contractors.

SECTION THREE : PROJECT PLANNING AND CONTROL

10.23 Restatement Of Hypotheses

In Chapter 8 a number of hypotheses were stated with respect to the planning and control procedures operated by private and public sector construction contractors. It is now appropriate to restate them.

P_1 Private construction contractors operate more sophisticated project planning and control methods than public sector contractors

P_2 Costing of projects is carried out independently of the planning and control process by private and public sector construction contractors

P_3 The adoption of a computerised approach to project planning and control provides advantages over manual methods for both private and public sector construction contractors

P_4 Planning is not considered to the same degree in the control phase of projects as it is in the formulation of a 'baseline' schedule

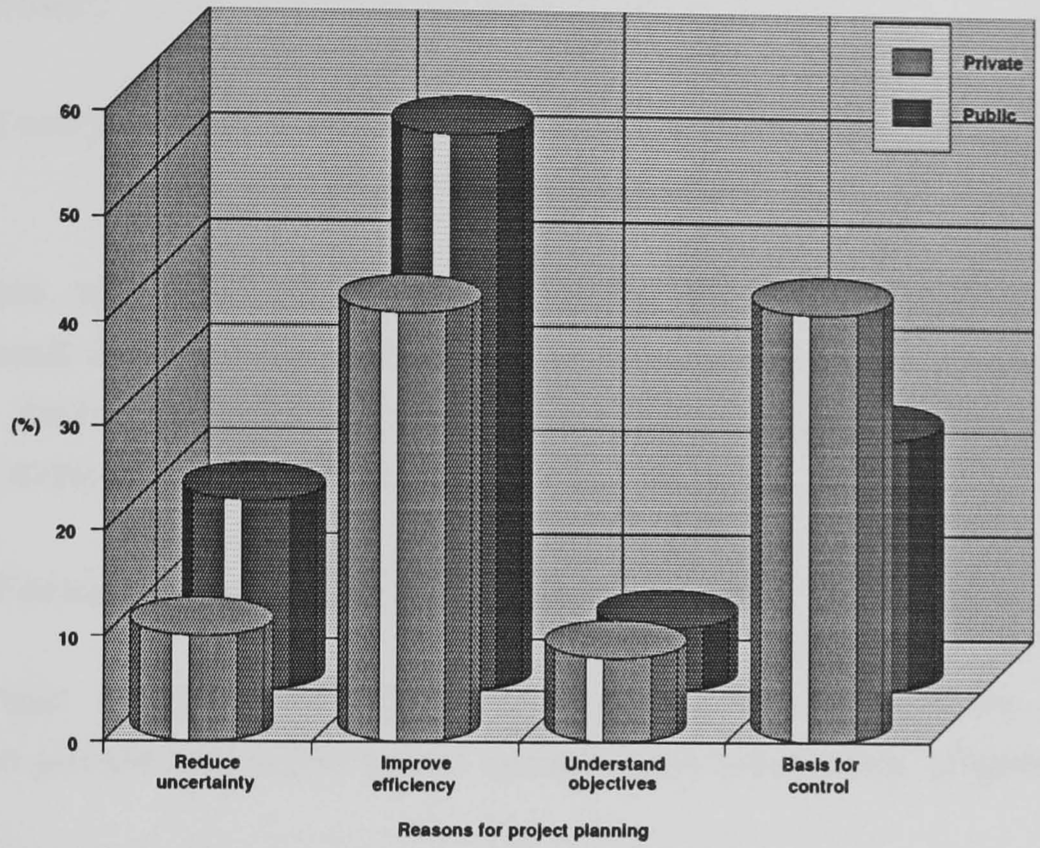
The main objective of this Section is again to analyse the results from the mail questionnaire and personal interview surveys in order to be able to draw some valid conclusions with regard to the hypotheses.

In order to achieve this objective, the Chapter covers extensively the reasons for planning, planning techniques utilised, resource management and the use of computerised methods in the planning and control process within private and public sector construction contractors.

10.24 Reasons Considered Most Important For Planning

There was no significant difference in the reasons considered *most* important for planning between private and public sector construction contractors. (Figure 10.14)

Figure 10.14 : Reasons Considered Most Important For Planning



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the reasons considered most important for planning between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 14A, 14B & 14C

More than three quarters of private (83%) and public (76%) sector construction contractors stated that the *most* important reasons for project planning were either to improve operational efficiency or to provide a basis for monitoring and controlling the work. Clearly, it was thought to be of fundamental importance in the construction phase of a project to have a firm foundation for measuring future progress of the works and to have all available resources planned in operational terms at all times throughout the project.

This is essential, because without proper planning procedures it is not possible to monitor the efficiency or control of operations in a meaningful manner in the construction phase.

Project managers in private sector construction contractors believed :

" that proper planning methods provide a firm foundation for the subsequent control of time and costs in the project execution phase "

However, public sector construction contractors in a rather different manner commented :

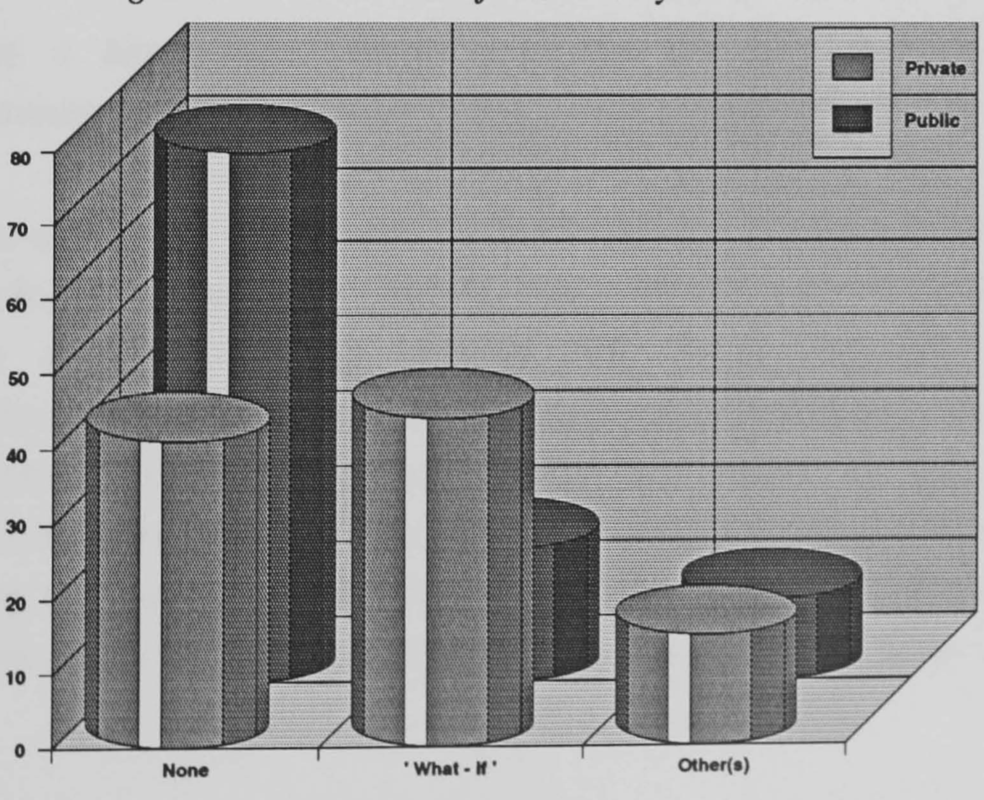
" We carry out limited 'baseline' planning on our projects - they are generally straightforward in nature "

Therefore, although both private and public sector construction contractors recognised the need for planning, it would appear that in practice, that the private sector adopted and followed through planning procedures to a greater extent than their public sector counterparts.

10.25 Forms Of Risk Analysis Considered

There was a significant difference in forms of risk analysis considered between private and public sector construction contractors. (Figure 10.15)

Figure 10.15 : Forms Of Risk Analysis Considered



Statistical analysis showed there was a 90% level of confidence that the alternative hypothesis H1 can be accepted - that is, there was a difference in forms of risk analysis considered between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 15A, 15B & 15C

Risk analysis was considered to a greater degree by private sector construction contractors. The most common form used was 'what-if' analysis (44% used it in the private sector) which has been made much more readily available and easier to carry out by the increase in availability of suitable planning and control software. Those using 'what-if' analysis used the technique to test different scenarios in terms of order of sequence of works, or different resourcing and such like to try and perceive possible problems and hence formulate an optimised project schedule. More than two thirds (71%) of public sector contractors did *not* use any form of risk analysis. The use of 'what-if' analysis was limited to less than one in five (18%) of respondents.

Other more sophisticated and strategic forms of risk analysis appeared to be seldom used in the planning of projects. There was a significant relationship between the use of risk analysis techniques and annual construction turnover and the use of sub-contractors. Therefore, companies with greater turnovers were more likely to adopt such methods. Similarly, the extensive use of sub-contractors in the private sector must be planned properly and the risk of using them in projects established.

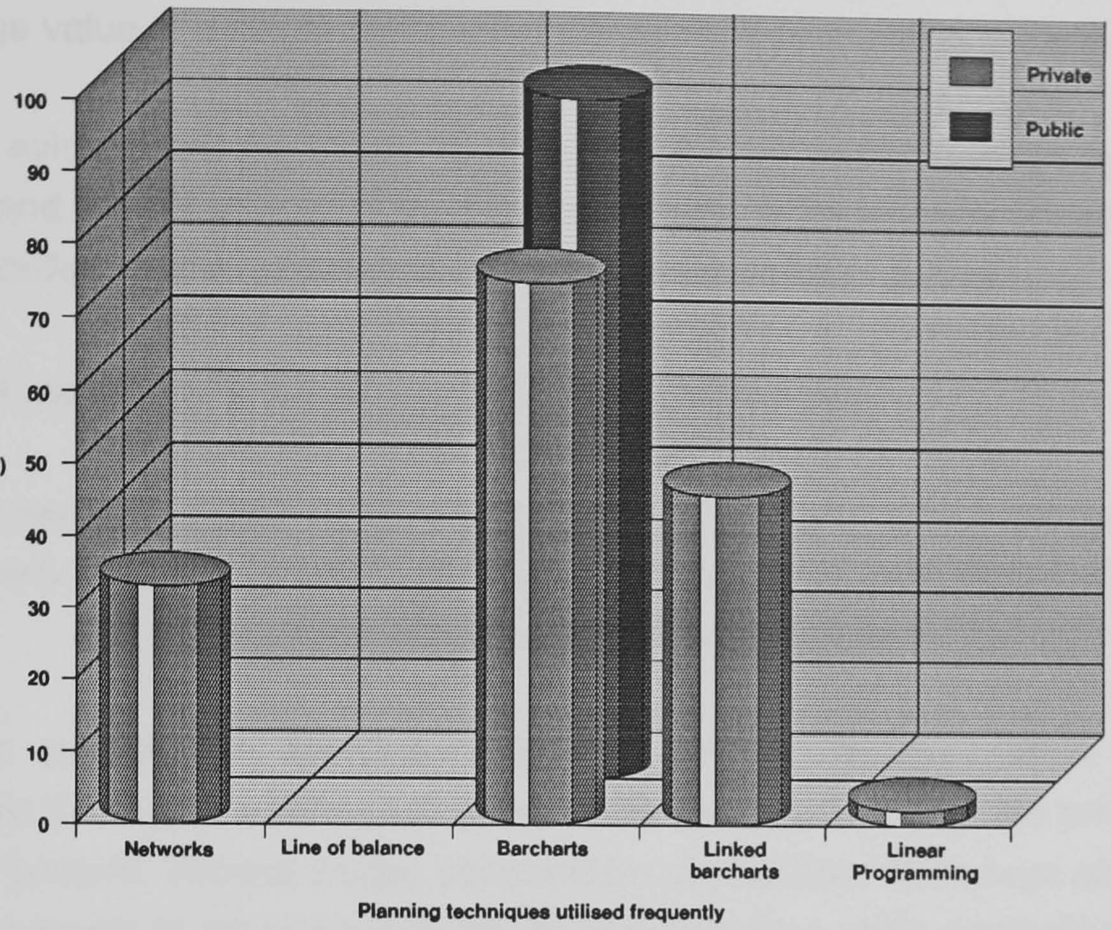
10.26 Planning Techniques Utilised In Projects

There was a significant difference in the planning techniques utilised between private and public sector construction contractors. (Figure 10.16)

Clearly, the use of bar charts was the predominant planning technique in the private sector (75% *frequently* used it); however, the use of linked bar charts was also commonplace in around half (46%) of the responding organisations. Network analysis techniques were *frequently* used in a third (33%) of private sector firms, and almost half (43%) *sometimes* used the method. Linear programming and line of balance techniques were identified as planning techniques not in frequent use with more than two thirds (65% and 73% respectively) of contractors in the private sector *never* using these methods.

The use of bar charts was also extensive in the public sector. Almost all (94%) of the respondents stated that they *frequently* used this technique.

Figure 10.16 : Planning Techniques Utilised



Statistical analysis showed there was a 99% level of confidence that the alternative hypothesis H1 can be accepted - that is, there was a difference in the planning techniques utilised between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 16A, 16B & 16C

Many project managers in public sector construction contractors stated :

" the projects that we undertake do not merit the use of any planning techniques more sophisticated than the normal barchart "

However, almost three quarters (71%) *sometimes* used the linked bar chart method which is a more sophisticated form of the basic bar chart. Though none of the public sector respondents *frequently* use network analysis, around half (53%) indicated that they *sometimes* used it. Line of balance and linear programming methods were not commonly used techniques in the public sector.

Private sector construction contractors, in the main, operated more sophisticated planning methods on a more regular basis than their public sector counterparts. However, the use of barcharts was by far the most commonly used planning technique in both the private and public sectors.

In the private sector there was a significant relationship between the planning technique adopted and the annual construction turnover, the average value of a single project and the number of activities to be modelled.

It was evident that the choice of planning technique is influenced by project value and the complexity of the project in terms of the number of activities to be modelled. In the public sector no such relationships existed.

Project managers in the private sector also commented :

" the complexity of projects dictates the form of planning technique to be adopted - but nearly always the output is of the linked barchart form, even if network analysis has been adopted in the planning process "

Of the construction contractors who *always*, or *sometimes* used network analysis there was a difference in the forms adopted between the private and public sectors. Private sector construction contractors have kept abreast of developments in planning techniques and utilised a more sophisticated and modern form of network analysis, ie Precedence, unlike construction contractors in the public sector who still preferred Activity - On -The - Arrow.

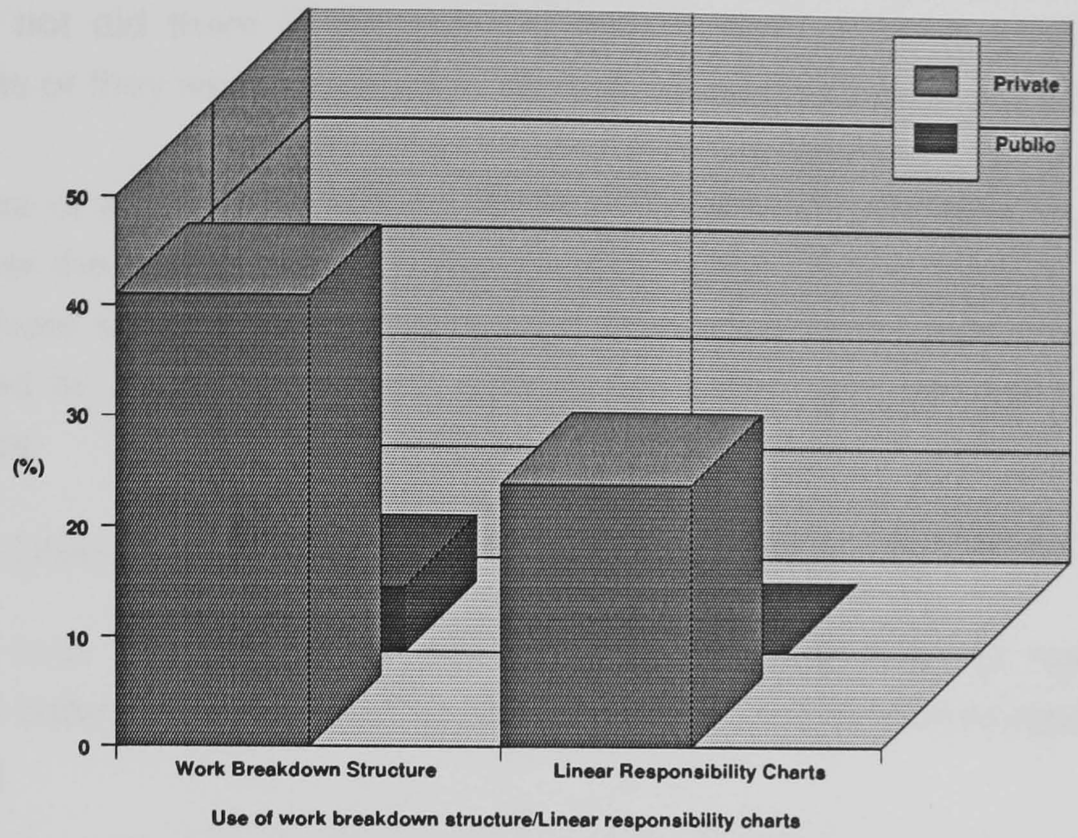
Opinions also differed between the private and public sectors on whether the number of activities to be modelled affected the choice of planning technique. *(Derived From Appendix C, Tables 18A, 18B & 18C)* Private sector construction contractors believed that the number did influence choice, but the public sector did not.

On smaller projects such as those undertaken by public sector construction contractors it is more likely that the choice of planning technique will not be influenced by the number of project activities. However, on larger projects it is considered that the number of activities may affect the choice of planning technique.

10.27 Adoption Of Principles Of Work Breakdown Structures

There was a significant difference in the adoption of work breakdown structures between private and public sector construction contractors. (Figure 10.17)

Figure 10.17 : Use Of Work Breakdown Structures/Linear Responsibility Charts



Statistical analysis showed that there was a 99% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the adoption of work breakdown structures between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 19A, 19B & 19C

Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the utilisation of linear responsibility charts between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 20A, 20B & 20C

Just under half (41%) of private sector construction contractors used the principles of work breakdown structures in the management of their projects. The use of a WBS effectively divides a project into a number of distinct 'levels' in order that project status may be reported more easily and meaningfully. It was surprising that the remainder (59%) did not adopt this simple, but extremely powerful technique. In the private sector there was a clear relationship between the use of work breakdown structures and annual construction turnover, the average value of a single project and the number of activities to be modelled.

Thus, project size and complexity influenced the decision to adopt the use of a WBS approach.

In the public sector no such relationships were present and in fact only one public sector construction contractor reported that they used the WBS technique. Clearly, the public sector either considered that the use of a WBS would not aid them in the management of their relatively straightforward projects or they were not aware of the technique as a management tool.

The use of work breakdown structures cannot be considered to be extensive in either the private or public sectors of the construction industry. However, the private sector appear to recognise, to an extent, the benefits that may be gleaned by the use of such techniques as part of the planning and control process.

10.28 Utilisation Of Linear Responsibility Charts

There was a significant difference in the adoption of linear responsibility charts between private and public sector construction contractors. (Figure 10.17)

A quarter (24%) of private sector construction contractors used linear responsibility charts. This limited use is surprising in view of the advantages that such charts can provide in highlighting the responsibility, authority or reporting structures in a particular project environment. Those who did use linear responsibility charts used them to indicate items such as those shown in Table 10.7.

Table 10.7 : Reasons For The Use Of Linear Responsibility Charts

Use Of Linear Responsibility Charts	*No.*	*%*
To Depict General Management Responsibility	15	100.0
To Depict Specialised Responsibility	13	86.7
To Specify Who Must Be Consulted	7	46.7
To Specify Who May be Consulted	4	26.7
To Specify Who Must Be Notified	6	40.0
To Specify Who Must Approve	9	60.0

All private sector respondents who used linear responsibility charts utilised them to depict general management responsibility with the vast majority (87%) also utilising them to depict specialised responsibility. The charts were used to a differing degree to specify persons who must be consulted, notified or referred for approvals. The use of linear responsibility charts served to state more precisely than a mere organisational structure diagram, or form, the particular authorities and responsibilities of specific project personnel and their inter-relationships.

The public sector did not utilise linear responsibility charts in the management of their projects and did not appear to be aware of the technique or its possible applications.

Private sector construction contractors believed to a limited extent that it might be worthwhile to adopt the principles of linear responsibility charts, or matrices to clearly specify responsibility, authority or reporting parameters to be adopted in the project environment. However, there was no clear relationship between the use of linear responsibility charts and project size or complexity, identifying that, in general, their use was not widely recognised in either private or public sector organisations.

10.29 Factors Taken Into Account In The Formulation Of A Time Based Plan For Projects

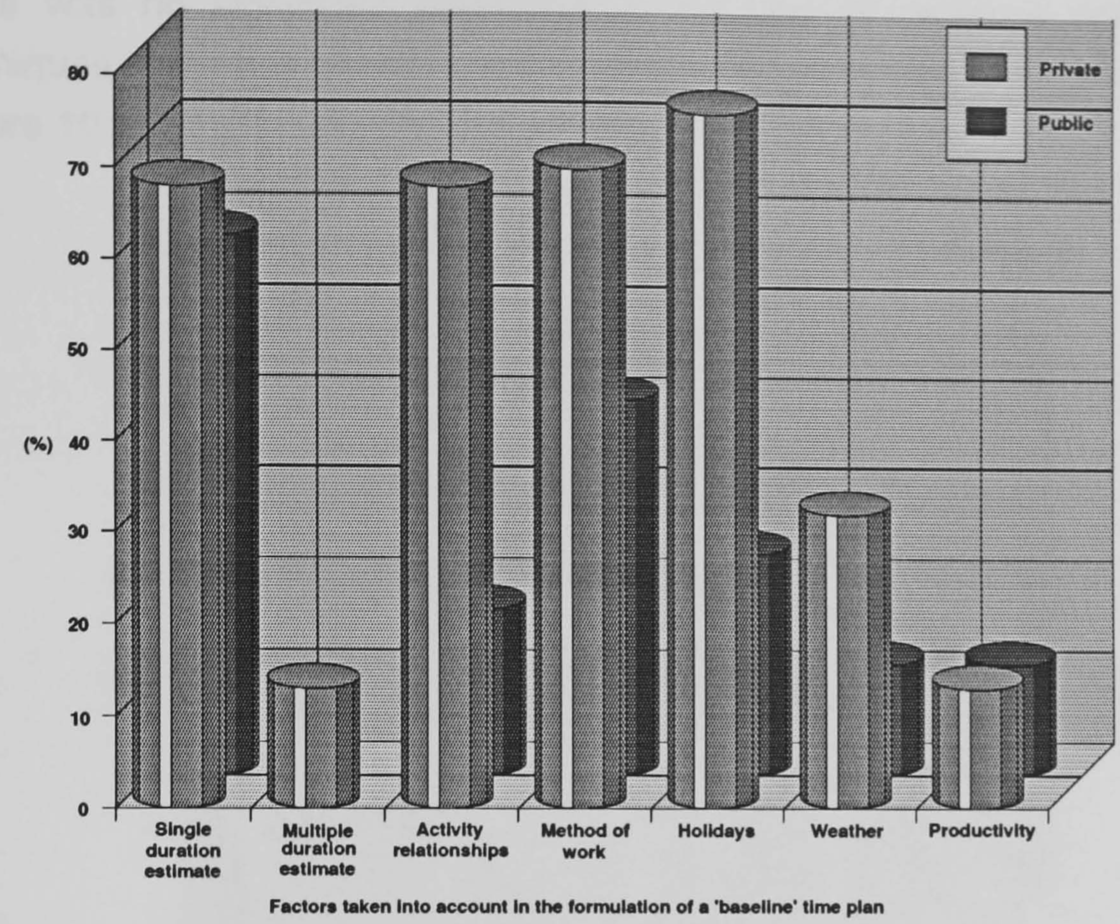
There was no significant difference in the factors taken into account in the formulation of a time based plan for a project between private and public sector construction contractors. (Figure 10.18)

More than two thirds of private sector construction contractors took the following into account in the formulation of a time based plan for a project :

- single duration estimate for an activity
- activity relationships
- method of work
- holidays

Clearly, these were the most easily quantifiable of the factors which were normally considered in the management of time aspects of a project. Less than one in three always made allowances for variable productivity or poor weather.

Figure 10.18 : Factors Taken Into Account In The Formulation Of A Time-Based Plan



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the factors taken into account in the formulation of a time based plan for a project between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 21A, 21B & 21C

Around half of public sector construction contractors took the following into account in the formulation of a time based plan for their projects:

- single duration estimate for an activity
- method of work

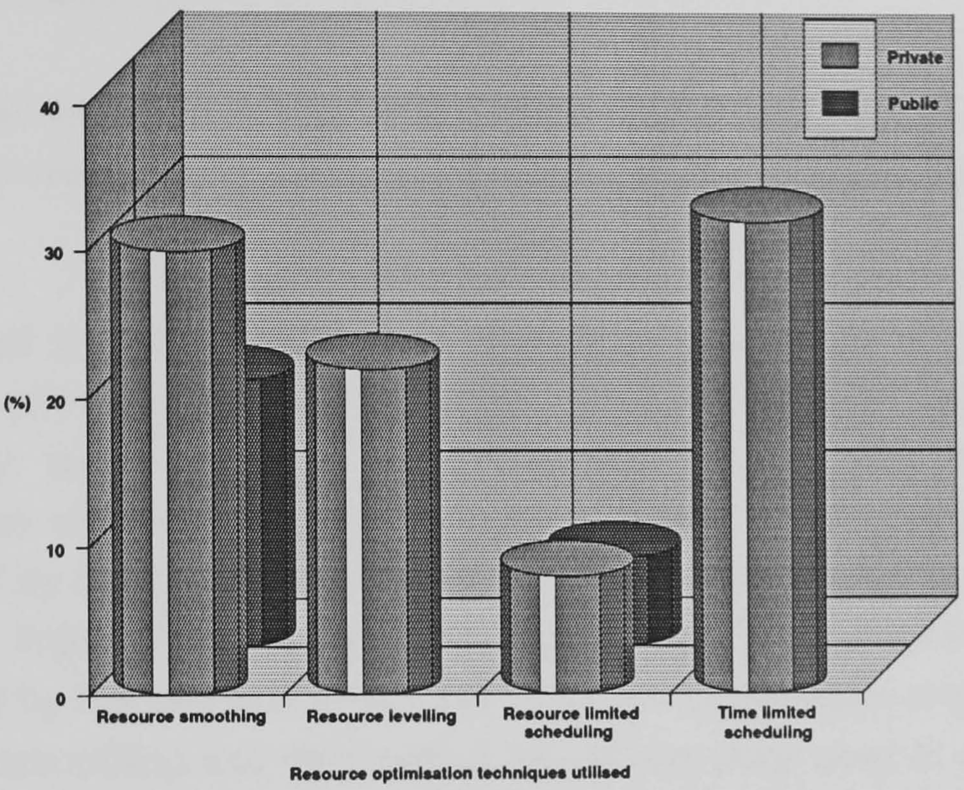
Only a quarter (23%) took holidays into account and even less (12%) made either allowances for variable productivity or poor weather. A mere 18% considered activity relationships when formulating the baseline plan for a project.

Generally, both private and public sector construction contractors formulated a time based plan for a project taking into account a single duration for each activity and the method of work to be employed. Furthermore, the private sector took activity relationships and holidays into consideration in the planning process. However, there was no overall significant difference in the factors considered in the formulation of a time based plan for a project.

10.30 Resource Optimisation Techniques

There was no significant difference in the use of resource optimisation techniques between private and public sector construction contractors. (Figure 10.19)

Figure 10.19 : Use Of Resource Optimisation Techniques



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the use of resource optimisation techniques between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 22A, 22B & 22C

Less than a third of private sector construction contractors *always* carried out some form of resource optimisation in the management of their projects. Once a time based schedule is prepared for a project, it is important to realise that this is initially carried out assuming that all resources for activities are available. Thereafter availability of resources are normally taken into account to finalise the plan.

It was evident that resource management was not considered an essential element of the planning process and only *sometimes* were techniques used to optimise 'baseline' plans in terms of resource availability. In the construction industry many private sector construction contractors were of the view :

> *" we make extensive use of sub-contractors and as most resources, except in extremely specialist areas, are almost always readily available, there is not much need for the use of resource optimisation techniques "*

The use of resource optimisation techniques in the public sector was virtually non-existent. Less than a third *sometimes* used the available techniques and more than two thirds, in general, *never* used any form of resource optimisation.

Project managers in public sector construction contractors were quoted in general as believing :

> *" although we carry out many small projects simultaneously, there is no need to carry out resource optimisation, as all our projects are relatively straightforward and use similar types of resources "*

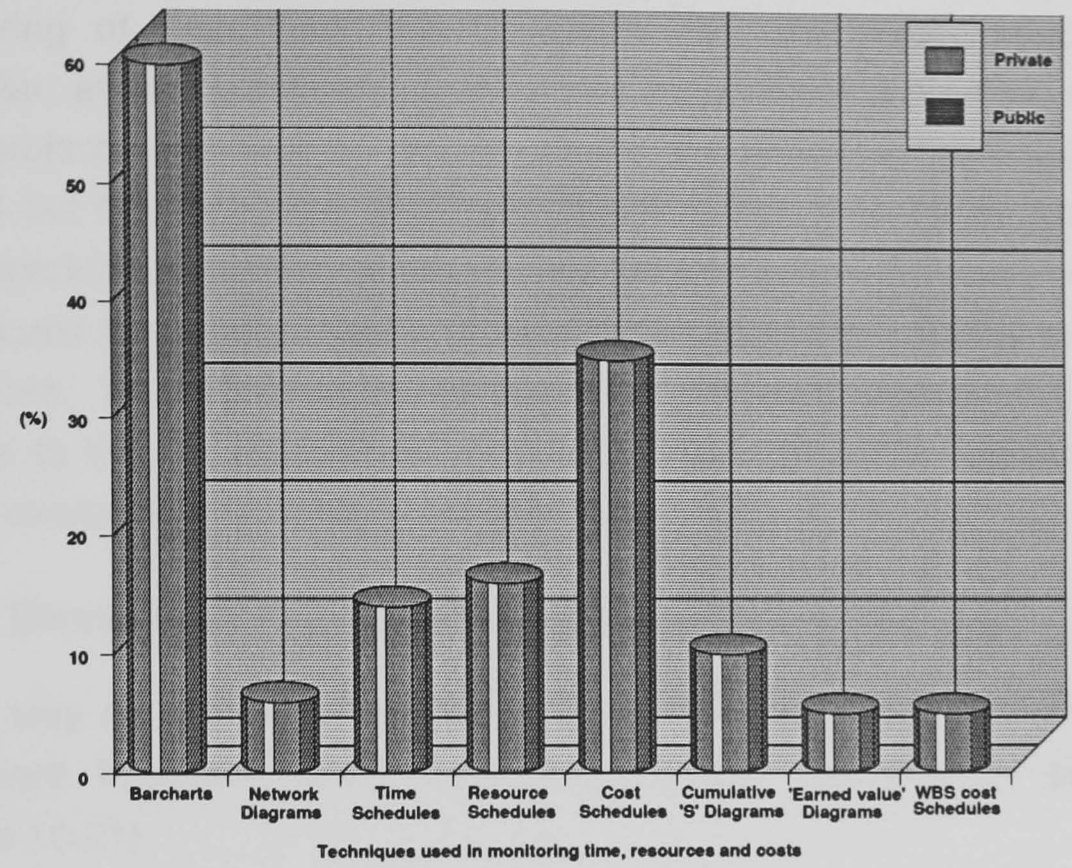
The use of resource optimisation techniques was clearly not extensive in either the private or public sectors. This was somewhat surprising in view of the many techniques that were available for analysing resources in conjunction with a time based plan for a project. Clearly resources were 'assumed' by construction contractors to be readily available at all times and have no implications on the time based planning schedule. This was confirmed by the fact that where any resource optimisation was carried out, resource smoothing and time limited scheduling were used in preference to techniques which are based on resource availability, such as, resource limited scheduling.

10.31 Techniques Used In Monitoring Time, Resources and Costs

There was a significant difference between private and public sector construction contractors with respect to the techniques used in monitoring time, resources and costs.(Figure 10.20)

A number of methods are available for monitoring/controlling time, resources and costs in the management of projects. It was apparent, in private sector construction contractors that the barchart, to compare 'planned versus actual', was the most popular method of monitoring/controlling these aspects. More sophisticated techniques such as Cumulative 'S' diagrams, 'Earned value diagrams' and WBS cost schedules were not used to any great extent, although they are extremely useful and powerful techniques.

Figure 10.20 : Techniques Always Used To Monitor Time/Resources/Costs



Source : Survey Results - Derived from Appendix C, Tables 23A, 23B & 23C

Private sector construction contractors commonly stated :

" barcharts are the most commonly used control tool to analyse 'planned versus actual' measurement of time and costs, and the graphical output is readily understood by all project personnel "

Evidently, public sector construction contractors *did not always* monitor or control time, resources or costs in the management of *any* their projects. The limited 'baseline' planning carried out in the public sector is clearly considered as the 'end result' of the planning process, with apparently no control being exercised in the subsequent implementation phase. Even though many of the public sector projects are relatively small in size this does not excuse the apparent lack of planning, monitoring and control of time, resources and costs. In effect most public sector construction contractors commented :

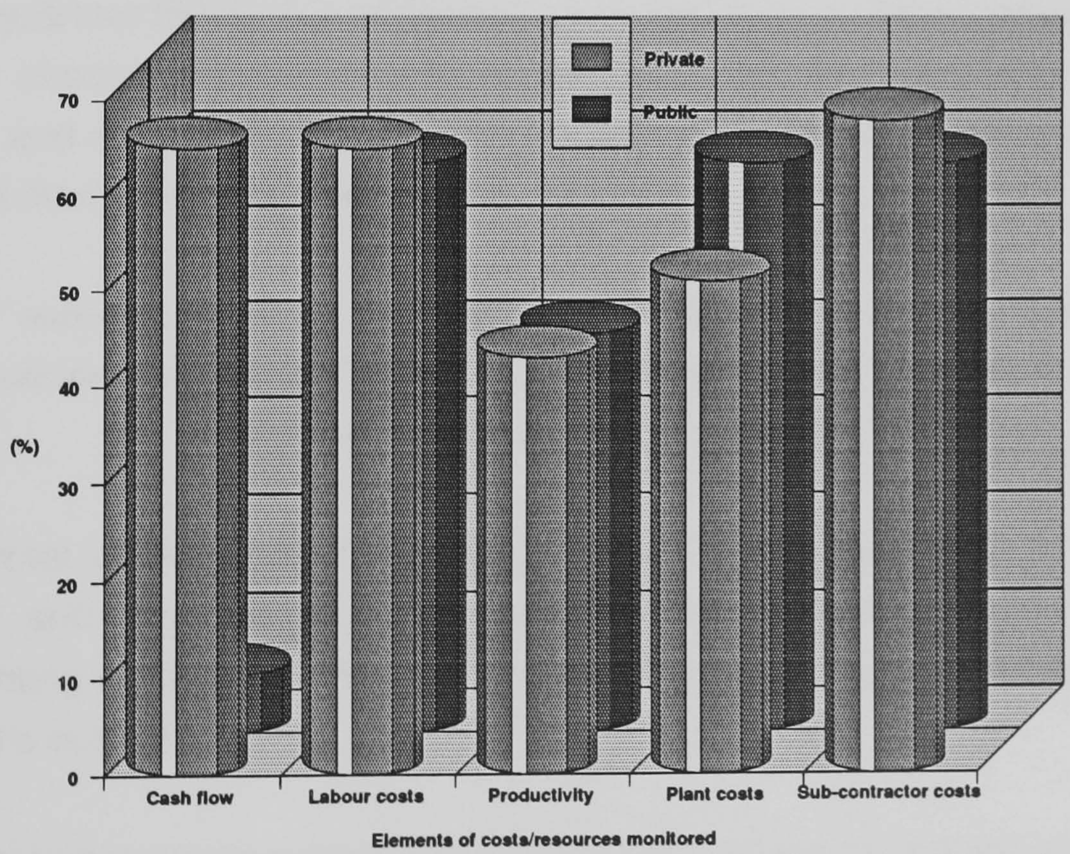
" that control of the smaller type projects that are commonly undertaken was based solely on a retrospective reconciliation of actual versus estimated costs, with no, or little monitoring during the execution of the project "

It was evident that private sector construction contractors carried out more monitoring of time, cost and resources than the public sector did. In particular, almost two thirds *always* monitored/controlled the time aspects of their projects whereas *no* public sector construction contractors *always* carried out this extremely important function. This was hardly surprising in public sector construction contractors bearing in mind the limited use of such procedures in the formulation of a baseline plan with respect to time and resources. To a lesser extent the private sector also carried out procedures relative to the monitoring/control of resources and costs; again the public sector exercised no control in these areas.

10.32 Elements Of Costs/Resources Monitored

There was no significant difference in the elements of costs or resources monitored between private and public sector construction contractors. (Figure 10.21)

Figure 10.21 : Elements Of Costs/Resources Monitored



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the elements of costs/resources monitored between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 24A, 24B & 24C

Around two thirds of private sector construction contractors monitored cash flow (65%), labour (65%) and sub-contractor costs or resources (68%) in the management of *all* their projects. Plant costs and productivity, on the other hand, were only monitored on less than half of all projects.

The importance of maintaining a healthy cash flow is fundamental to the survival and success of a construction contractor operating in the private sector; much more so than profit on isolated projects. Likewise, the control of sub-contractors in the private sector is clearly important in view of their extensive use. Private sector construction contractors commented :

" that all aspects of monitoring of costs and resources were important to ensure project success, and in particular the importance of maintaining a healthy cash flow could never be overlooked "

Contractors in the public sector, although required to make a return on capital employed (ROCE), were generally not overly concerned with the management of cash flow in carrying out their business. This was reflected in the results with less than a tenth (6%) of public sector construction contractors monitoring cash flow on *all* of their projects. Similarly, more than three quarters (82%) did not monitor cash flow on *any* of their projects. Public sector construction contractors concentrated on the monitoring of labour, plant and sub-contractor costs in the management of their projects. Many project managers commented :

" making a 5% rate of return on capital employed is our prime financial consideration and cash flow within the overall budget of the public sector environment does not give cause for concern "

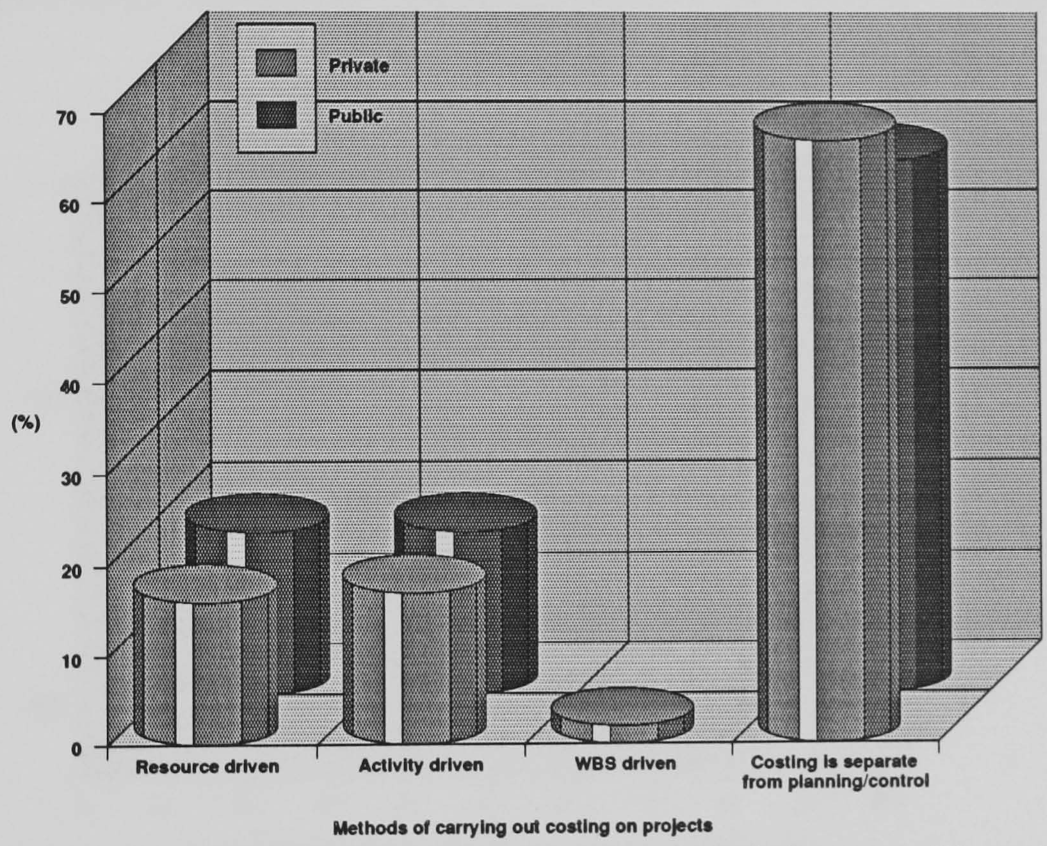
No formal control from a 'baseline' project plan is exercised in the public sector and these costs must therefore be extracted from the project accounting system, which is *not* the best approach to maintain control over a project's outcome.

Private sector construction contractors nearly always monitored cash flow on their projects, whereas the public sector did not. Clearly, if public sector construction contractors were to operate in an environment where all of their works were required be won in competition, then much more attention would have to be placed upon the cash flow lifeline that all private sector construction contractors have to endure continuously, and not just at the end of the financial year. However, withstanding this fact, there was no overall significant difference between the elements of costs or resources monitored between the private and public sectors.

10.33 Methods Of Carrying Out Costing On Projects

There was no significant difference in the method of carrying out costing on projects between private and public sector construction contractors. (Figure 10.22)

Figure 10.22 : Methods Of Carrying Out Costing On Projects



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the method of carrying out costing on projects between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 25A, 25B & 25C

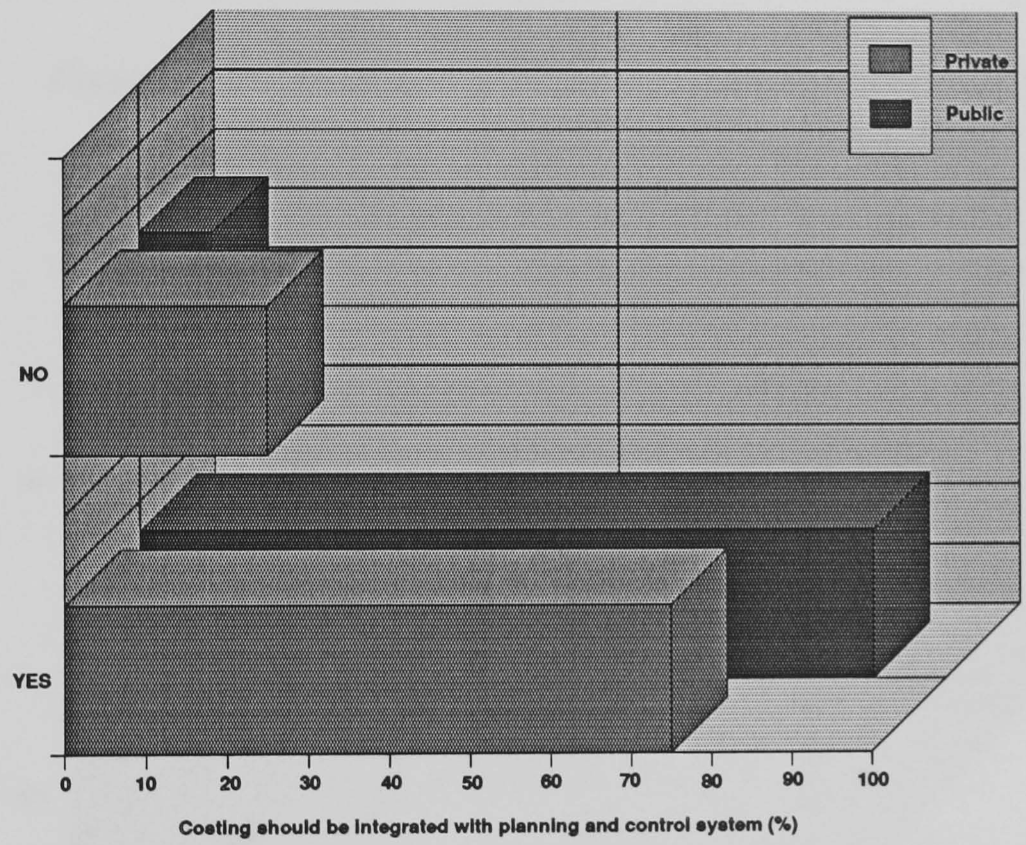
It was evident that, in the main, costing is carried out separately from the planning and control function. Some two thirds of private (67%) and public (59%) sector construction contractors carried out costing adopting this approach. This was somewhat surprising bearing in mind the fundamental inter-relationship of time and cost, which must mean that 'parallel' systems exist in practice to control a project in terms of time and cost parameters.

Perhaps the main reason for this finding is the 'standardisation' of many project management planning and control software packages. Whilst being very powerful with respect to planning and control of time, they tend not to be flexible with respect to the incorporation of cost data. This would seem to indicate that existing methods of planning and control do not have the capability or flexibility to easily incorporate cost data into the same system.

10.34 Integration Of Costing With Planning/Control Methods

There was no significant difference in the opinions of private and public sector construction contractors on whether costing should be integrated with the planning and control function. (Figure 10.23)

Figure 10.23 : Costing Should Be Integrated With Planning/Control System



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the opinions of private and public sector construction contractors on whether costing should be integrated with the planning and control function.

Source : Survey Results - Derived from Appendix C, Tables 26A, 26B & 26C

Of those who operated costing systems independent of the planning and control function more than three quarters in private (76%) and public (91%) sector construction contractors alike believed that they should both be integrated together.

Project managers interviewed commented similarly :

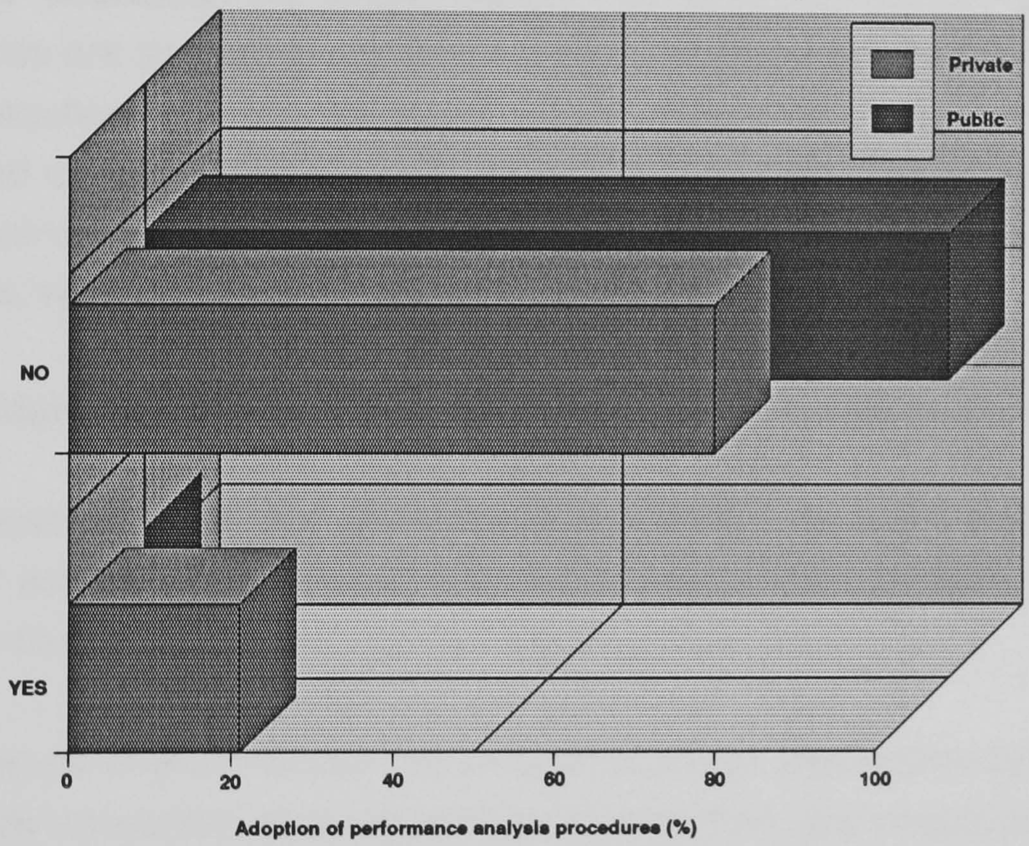
" that costing and planning information must be considered together to accurately obtain the true status of a project in terms of time and cost "

There was no doubt in the minds of both private and public sector construction contractors that costing should be integrated with the planning and control function. Quite clearly contractors were reluctantly operating separate systems for planning and control and costing when they would prefer them to be integrated.

10.35 Use Of Performance Analysis Techniques

There was a significant difference in the use of performance analysis techniques between private and public sector construction contractors. (Figure 10.24)

Figure 10.24 : Adoption Of Performance Analysis Procedures



Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the use of performance analysis techniques between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 27A, 27B & 27C

Less than one in four (21%) private sector construction contractors used performance analysis techniques, despite the fact that such techniques allow the status of a project to be analysed by considering the integration of time and cost together. There was evidently not a great deal of use of such methods and this tied in with responses received with respect to costing, which indicated that this was carried out separately from the planning and control process. There was no usage whatsoever of performance analysis techniques in the public sector.

Time and cost appeared to be looked at independent of one another; therefore projects could not be analysed in an integrated manner to assess their true status in terms of performance achieved. This limited use of performance analysis techniques appeared to be only related to the number of activities to be modelled in a project.

Hence, the complexity of a project appeared to be the influencing factor with regard to performance analysis. In the public sector no such relationship existed.

In other countries, the United States, for example, certain performance standards are specified in contracts and contractors must abide by these in the execution of their contracts. Such standards include the C/SCSC specified on military projects. The majority of project management planning and control systems available have facilities for dealing with performance analysis, which is normally termed 'earned value analysis'.

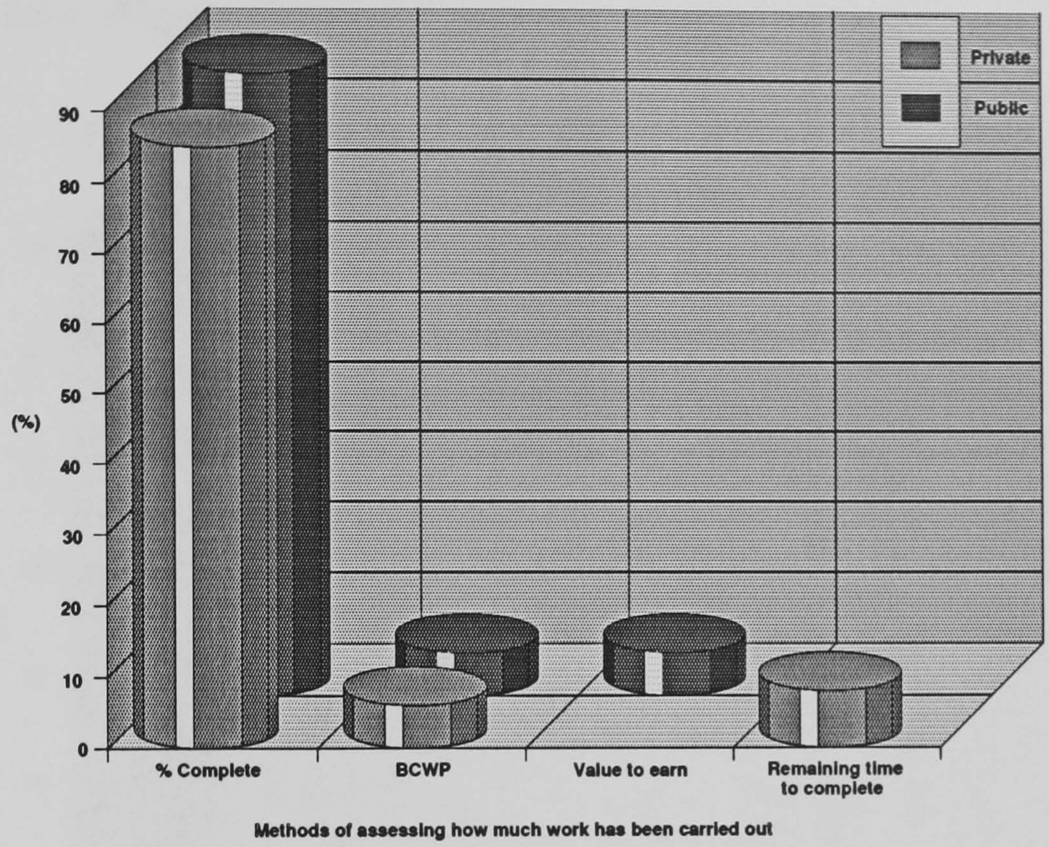
10.36 Methods Of Assessing How Much Work Has Been Carried Out

There was no significant difference in assessing how much work had been carried out between private and public sector construction contractors. (Figure 10.25)

The amount of work carried out on a project was predominantly determined by simply assessing what percentage of work had been executed. This was considered the easiest method of reporting project status with more than three quarters of private (86%) and public (88%) sector construction contractors adopting this method.

It was interesting to note that almost two-thirds (62%) of private sector construction contractors *sometimes* used the remaining time to complete an activity as the method of measuring project status in terms of how much work has been carried out. This method was looked upon as being of more benefit than merely estimating percentage complete as it takes into account a prediction of what is to happen rather than just what has, or, may have happened. The value earned (BCWP) and balance to earn methods were seldom used by private sector construction contractors.

Figure 10.25 : Methods Of Assessing How Much Work Has Been Carried Out



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in assessing how much work has been carried out between private and public sector construction contractors

Source : Survey Results - Derived from Appendix C, Tables 28A, 28B & 28C

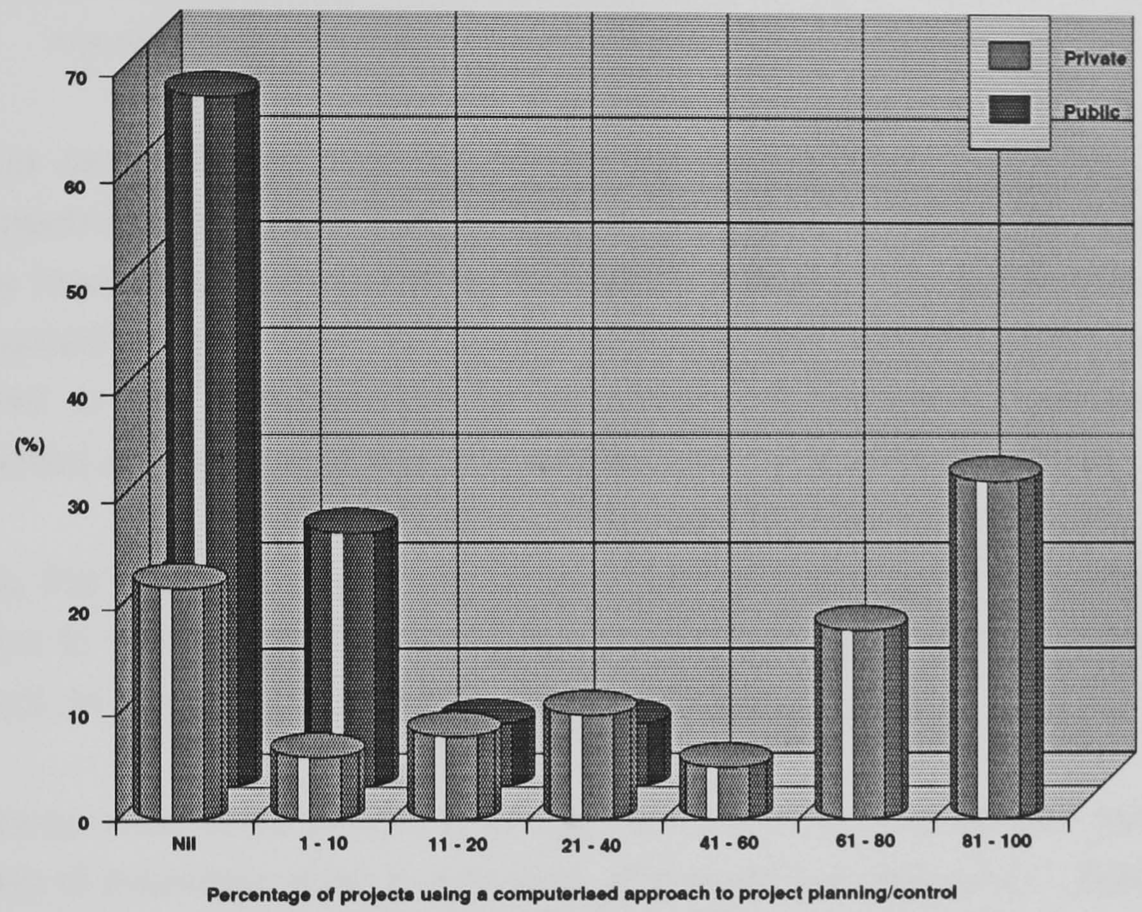
Generally, public sector construction contractors *always* used the percentage complete method to assess the amount of work carried out in the updating process of their projects. Around half (47%) *sometimes* used the more meaningful remaining time to complete an activity in the updating process. The value earned (BCWP) and balance to earn methods, contained within performance analysis procedures, were hardly ever adopted in the public sector.

Both private and public sector construction contractors favoured the percentage complete assessment method as the means for updating their projects. Although this method appears to be the easiest to implement it does not take account of what work remains to be completed. In many instances projects may look as if they are being executed to schedule at each update period, but often a lull occurs, at say 90% completion, which when further examined is the result of 'over optimistic' reporting in the earlier stages of a project.

10.37 Computerised Approach To Project Planning And Control

There was a significant difference in the use of a computerised approach to project planning and control between private and public sector construction contractors. (Figure 10.26)

Figure 10.26 : Computerised Approach To Project Planning



Statistical analysis showed there was a 99% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the use of a computerised approach to project planning and control between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 29A, 29B & 29C

Of those private sector construction contractors who used computerised methods a little over half (54%) used them on more than 40% of their projects. Almost a third (32%) of respondents adopted a computerised approach on more than 80% of projects. Only a fifth (22%) of private sector construction contractors did not use a computerised approach to project planning and control on any of their projects. Many project managers in the private sector commented :

" advantages can be gained in the 'baseline' planning and subsequent monitoring, control and updating of projects by adopting a computerised approach "

Very few public sector construction contractors used a computerised approach to project planning and control and of those who did, it would appear that such techniques are utilised for only a small proportion of their works. None of the public sector construction contractors used computer methods for more than 40% of projects. Universally project managers in the public sector commented :

" the projects we undertake are relatively straightforward in nature and therefore do not require the sophistication of adopting a computerised approach "

It has been shown that private sector construction contractors used a computerised approach for project planning and control on a much larger scale than contractors in the public sector. In the private sector the use of a computerised approach to project planning and control was significantly related to the average value of a project, the number of activities to be modelled and the use of sub-contractors.

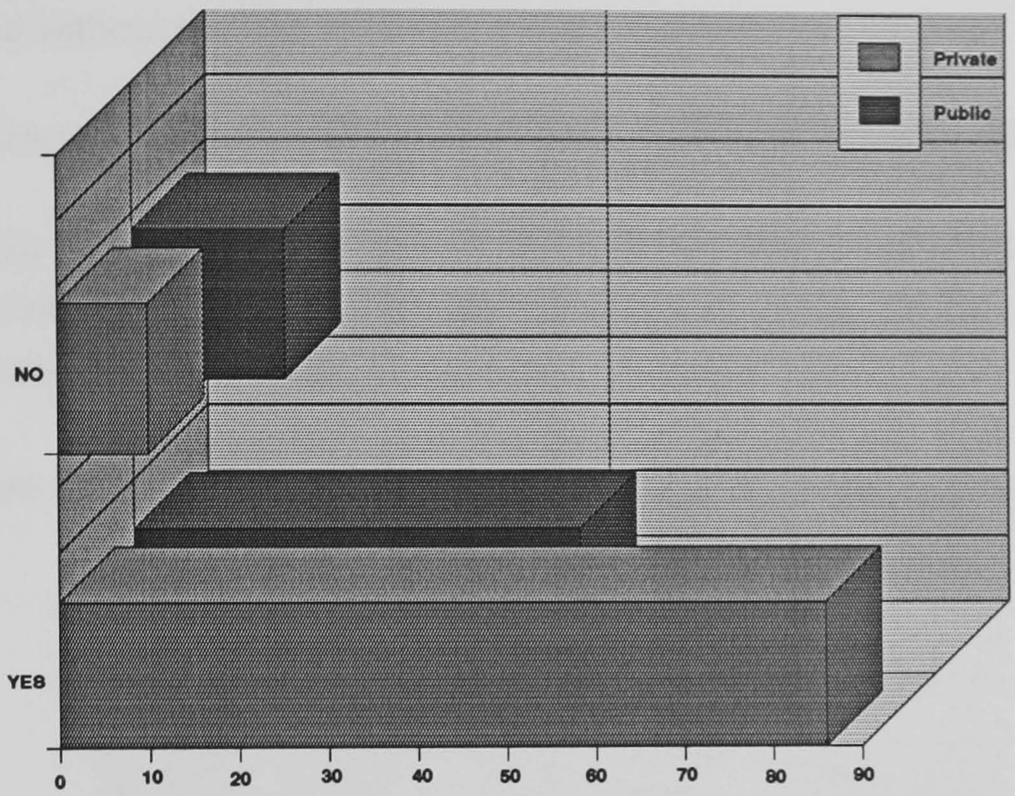
Thus, the size and complexity of a project were the influencing factors with regard to the adoption of a computerised approach to project planning and control. In the public sector no such relationship existed.

Of those who used project management planning and control software, a variety of packages were in evidence. (*Derived From Appendix C, Tables 30A & 30B*). This was not surprising in view of the fact that almost all project management planning and control software offer similar facilities. In the private sector no single software house appeared to dominate the market but, Pertmaster, Power-Project and Hornet were the most frequently utilised. Those few public sector construction contractors who used project management planning and control software also used a variety of packages. Pertmaster appeared to be the most popular software utilised in the public sector.

10.38 Does Planning And Control Software Contribute Significantly Over Manual Methods?

There was a significant difference in the opinion of those who used project management planning and control software in private and public sector construction contractors as to the benefits that might be obtained. (Figure 10.27)

Figure 10.27 : Does Computerised Approach To Project Planning Contribute Significantly Over Manual Methods?



Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the opinion of those who use project management planning and control software as to the benefits that may be obtained between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 31A, 31B & 31C

The vast majority (86%) of private sector construction contractors who used project management planning and control software believed that it contributed significantly in improving the planning and control process. It was much easier to model and re-model projects when the data were stored in a computer environment. The updating process was much quicker, even for small projects, and various 'what-if' scenarios could be investigated with ease.

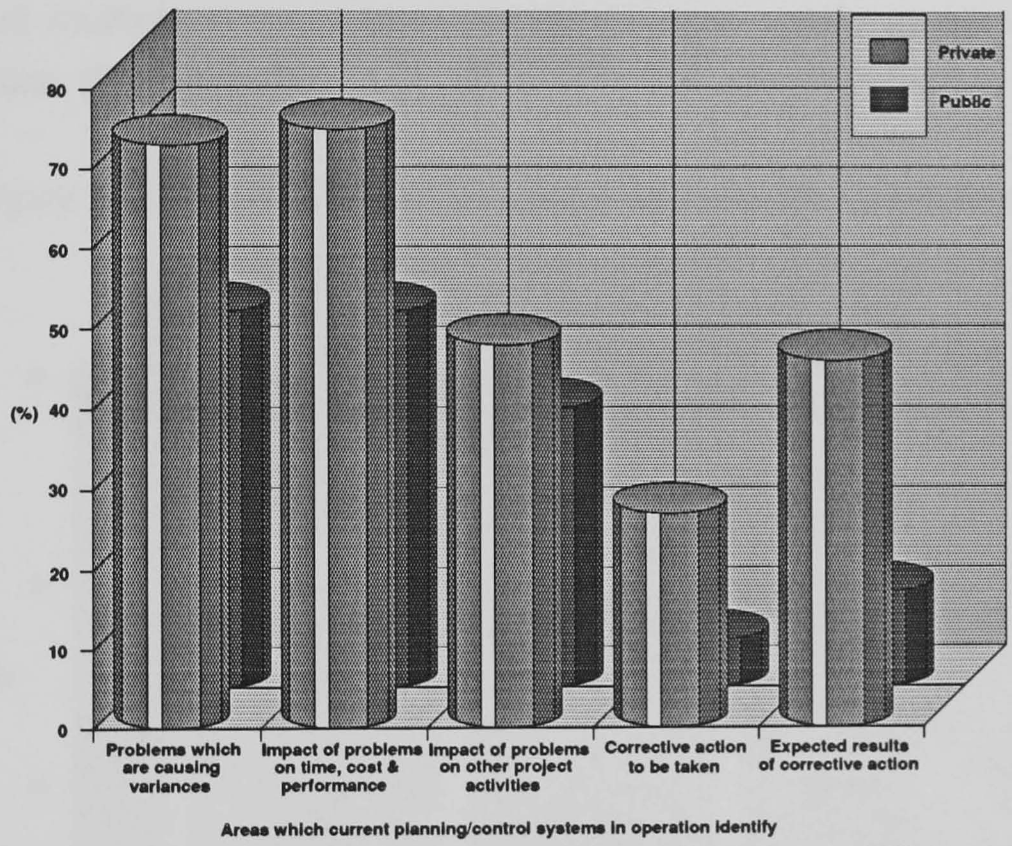
Surprisingly, only half (50%) of the public sector construction contractors who used a computerised approach to planning and control believed that it provided benefits over manual methods. It was possible that the limited extent of use (35%) combined with the fact that only a few (12%) used such software on more than one in ten of their projects might indicate that the response to this question was again based on very limited experience.

It was evident that public sector construction contractors did not adopt computerised methods to any great extent. Although many project managers in the public sector considered the projects that they undertook as being relatively straightforward, it is difficult to see how many smaller projects running simultaneously might be adequately monitored, updated and controlled without the use of computerised methods.

10.39 Areas Which Current Planning and Control Systems Identify

There was no significant difference in the areas which current planning and control systems identified between private and public sector construction contractors. (Figure 10.28)

Figure 10.28 : Areas Which Current Planning And Control Systems Identify



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the areas which current planning and control systems identify between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 32A, 32B & 32C

Private and public sector construction contractors believed that planning and control systems identified problems and the impact of problems on other project parameters such as time, cost and performance. However, in general terms, such systems were not perceived as being capable of assessing what corrective action should be taken to resolve a particular problem, or the expected results of this. Many project managers, predominantly in the private sector, commented :

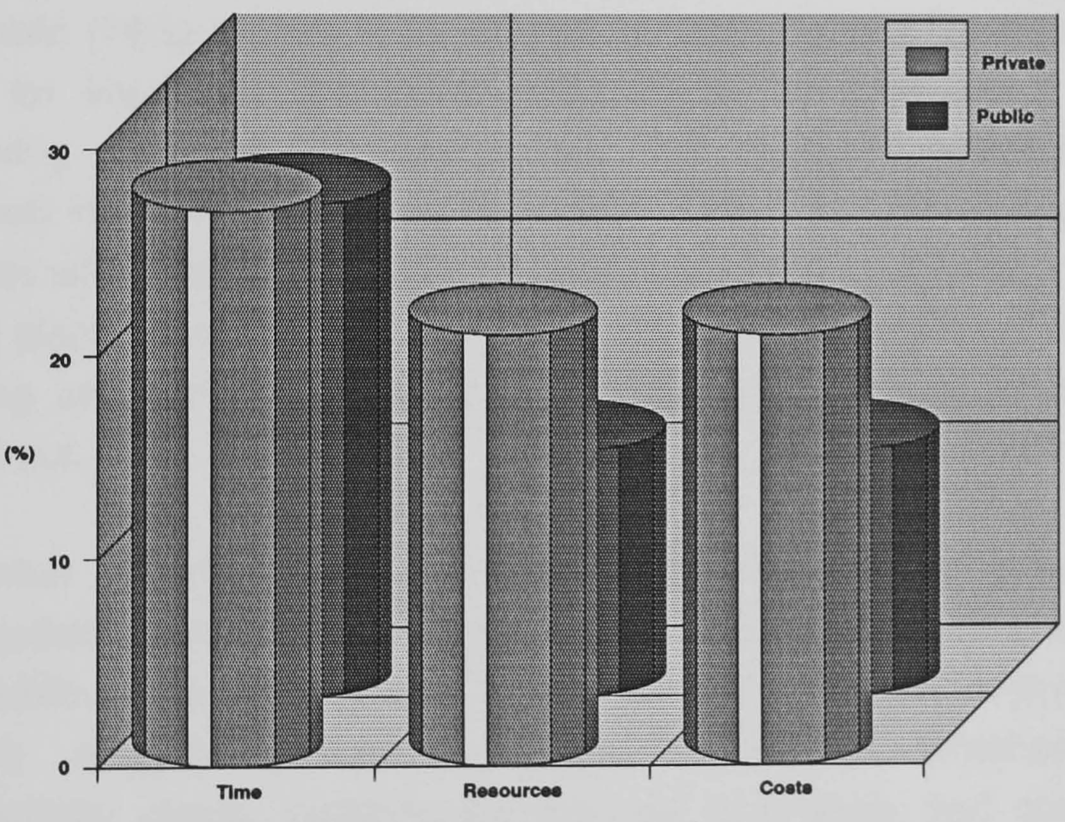
> *" while problems might be identified by adopting planning and control systems, possible courses of action to take are not put forward "*

Although such systems helped greatly in assessing problems and the impact of problems on a project's time, cost and performance parameters, the 'human' element was still required to judge and decide on the best course of action to be taken on the basis of all the information available. Furthermore, many companies were concerned at the variance in results that are obtained when using different software packages, particularly in the area of resource optimisation.

10.40 Planning And Control Of Multiple Projects

There was no significant difference in the approaches to the planning and control of multiple projects between private and public sector construction contractors. (Figure 10.29)

Figure 10.29 : Multi Project Scheduling Of Time, Resources And Costs



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the planning and control of multiple projects between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 33A, 33B & 33C

Multi-project scheduling of time, resources and costs rarely took place in either the private or public sectors. On 'one-off' larger projects this was, perhaps, understandable; however, where a large number of smaller type projects were being undertaken simultaneously, such as in smaller private sector contractors or in the public sector, this appeared to be somewhat surprising. Typically, a large number of smaller projects should be considered as elements of a larger project.

10.41 DECISIONS ON PLANNING AND CONTROL HYPOTHESES

Each of the four prestated hypotheses are now considered in conjunction with the survey results with respect to project planning and control.

Hypothesis P_1

P_1 Private construction contractors operate more sophisticated project planning and control methods than public sector contractors

Section Three of this Chapter has identified a number of important points which were in support of Hypothesis P_1. Initially it is important to comprehend that more than three out of four construction contractors in the private (83%) and public (76%) sectors believed that the main reasons for planning were either for improving operational efficiency or for providing a basis for monitoring and controlling future work. This 'baseline' common belief is extremely important as it allows evaluation of the actual planning and control methods utilised to be related to the same underlying fundamental reason for project planning and subsequent control. Therefore, a realistic comparison of planning and control techniques utilised between the two sectors can be carried out.

A number of areas were identified which showed that private sector construction contractors operated more sophisticated planning methods than their public sector counterparts. These included the use of 'what-if' analysis, network analysis procedures, work breakdown structures, linear responsibility charts, performance analysis techniques and computerised methods for project planning and control. Each of these areas is now discussed briefly.

Almost half (44%) of private sector construction contractors use the 'what-if' method of *risk analysis* to evaluate different possibilities and outcomes in project planning. Less than one in five (18%) in the public sector did likewise. Furthermore, more than 70% in the public sector did not adopt any form of simplistic risk analysis in the management of their projects. In the private sector the use of risk analysis techniques was significantly related to annual construction turnover and the use of sub-contractors, which had previously been identified as being used extensively. Clearly, planning processes must establish as best as possible the influence of all parties to a project. In the public sector the very limited use of risk analysis procedures was not related to any of the above named factors.

Of the construction contractors who used *network analysis procedures* a third (33%) frequently operated them in the private sector, but none did so in the public sector. In private sector construction contractors the use of networks was significantly related to annual construction turnover, the average value of a project and the number of activities to be modelled within a project. No such relationships existed in the public sector. Clearly, contractors operating in the private sector use networks to model projects, whose value and complexity in terms of number of activities to be modelled, so required it. The more 'simple' type of project undertaken in the public sector did not merit the use of network techniques in many instances.

Almost three quarters (73%) of private sector construction contractors used the Precedence form of network analysis which allowed more precise modelling of projects to be undertaken in terms of activity relationships. Only a fifth (22%) of public sector construction contractors used this method (and on an infrequent basis) and many preferred, albeit infrequently, to use the activity-on-arrow method which has become very much outdated.

The use of *work breakdown structures* was not extensive in either the private or public sectors. However, just under half (41%) of private sector construction contractors used such methods with a mere 6% doing likewise in the public sector. In the private sector their use was significantly related to annual construction turnover, the average value of a project and the number of activities to be modelled. This indicated that the use of work breakdown structures was related to the size and complexity of a project.

The use of *linear responsibility charts* was not extensive in either the private or public sectors. However, one in four (24%) of construction contractors in the private sector used such techniques to depict authorities, responsibilities and reporting functions of individuals associated with projects. No public sector respondents used such methods. The use of linear responsibility charts in the private sector was not related to the size or complexity of a project.

Performance analysis techniques were carried out by around 20% of private sector construction contractors although no public sector respondents carried out performance analysis. The use of such techniques in the private sector was related to the number of activities to be modelled in a project; it appeared that the complexity of a project influenced the adoption, or otherwise of performance analysis techniques.

A *computerised approach to project planning and control* can greatly aid the planning process. One third (33%) of construction contractors in the private sector used a computerised approach on more than 80% of their projects with only around a fifth (22%) not adopting such methods on any of their projects. In the public sector two thirds (65%) of respondents never adopted a computerised approach for project planning and control. Furthermore, of the small amount who did, less than 10% use computerised methods on more than 20% of their projects. In the private sector the use of a computerised approach to project planning and control was significantly related to the average value of a project, the number of activities to be modelled and the use of sub-contractors. It appeared, therefore, that the size and complexity of projects along with the modelling of sub-contractors in the private sector influenced the adoption of computerised planning and control methods on projects.

Although some of the above procedures were not extensively utilised by either private or public sector construction contractors there has been extensive evidence for the support of Hypothesis P_1, that is, *private construction contractors operate more sophisticated project planning and control methods than public sector contractors.*

Hypothesis P_2

> P_2 *Costing of projects is carried out independently of the planning and control process by private and public sector construction contractors*

Results from the survey supported Hypothesis P_2.

Two thirds of private (67%) and public (59%) sector construction contractors carried out costing separately from the planning and control process. Furthermore, of those who carried out independent costing, 75% of private and 91% of public sector construction contractors believed that costing should be integrated with the planning and control function.

It was evident that there was no doubt in the minds of private and public sector construction contractors that cost should be integrated with planning and control rather than was currently the case with two separate 'parallel' systems.

Therefore support for *Hypothesis* P_2 is proven, that is, *costing of projects is carried out independently of the planning and control process by private and public sector construction contractors.*

This hypothesis, in retrospect, might have been rephrased to emphasise the fact that construction contractors were operating dual systems against their own beliefs of how the planning, control and cost processes should be carried out.

<u>Hypothesis P_3</u>

P_3 The adoption of a computerised approach to project planning and control provides advantages over manual methods for both private and public sector construction contractors

It has been previously established that the private sector practised the use of more sophisticated planning procedures than their counterparts in the public sector, including the use of a computerised approach to project planning and control. This hypothesis is specifically related to the perceived benefits that may be achieved by construction contractors who adopt such computerised methods.

The results of the survey were not conclusive with respect to the acceptance, or rejection of *Hypothesis* P_3 as originally put forward. In order to allow more meaningful decisions to be made it was decided to divide *Hypothesis* P_3 into two sub-hypotheses, namely $P_{3.1}$ and $P_{3.2}$. These are now stated :

$P_{3.1}$ Private sector construction contractors consider that the adoption of a computerised approach to project planning and control provides advantages over manual methods

$P_{3.2}$ Public sector construction contractors consider to a limited extent that the adoption of a computerised approach to project planning and control provides advantages over manual methods

Sub-Hypothesis $P_{3.1}$ was supported by the fact that more than three quarters (86%) of private sector construction contractors believed that a computerised approach to planning and control contributed significantly over manual methods. Some 10% did not think that there was any difference between computerised and manual methods, with as few as 4% stating that computerised methods did not offer advantages over manual methods.

Therefore *sub-hypothesis $P_{3.1}$* is supported, that is, *private sector construction contractors consider that the adoption of a computerised approach to project planning and control provides advantages over manual methods.*

Sub-Hypothesis $P_{3.2}$ was supported by the following. Around 50% of public sector construction contractors believed that computer methods for project planning and control provided significant advantages over manual methods. However, a third (33%) believed that there was no particular advantage offered by adopting a computerised approach with the remainder stating that there was no particular difference between the two methods. The smaller, less complex projects undertaken in the public sector combined with the relatively small amount (20-30%) who only infrequently used a computerised approach to project planning and control appeared to indicate that the results from the public sector in this area had been based on limited experience. In this respect it was encouraging to note the half who did support a computerised approach.

Therefore the *Sub-Hypothesis $P_{3.2}$* is supported, that is, *public sector construction contractors consider to a limited extent that the adoption of a computerised approach to project planning and control provides advantages over manual methods.*

Hypothesis P_4

P_4 Planning is not considered to the same degree in the control phase as it is during the formation of a 'baseline' schedule for a project

It has been previously established that there was no significant difference between private and public sector construction contractors in the factors that were taken into account in the formation of a 'baseline' plan for a project. However, this was not the case with respect to the subsequent monitoring and controlling of time, cost and resources.

In the private sector barcharts were *always* used on two thirds (60%) of projects to monitor progress. Other techniques were also used including the adoption of cost schedules.

In contrast, public sector construction contractors did not *always* adopt monitoring or control procedures on any of their projects. This, therefore raised the question of what purpose the initial 'baseline' planning had been carried out for.

In the private sector, 84% of construction contractors stated that they *always* operated procedures with respect to the planning of time, but only 64% subsequently *always* carried out monitoring and control procedures.

Similarly, in the public sector 41% of construction contractors *always* operated procedures with respect to the planning of time, but none *always* followed this through to the monitoring and control phase.

In both private and public sector construction contractors, planning is not looked at as extensively in the project execution phase as it is in the initial formation of a 'baseline' plan for a project. Clearly, the benefits from planning do not therefore appear to be fully realised.

Therefore, there was evidence to support *Hypothesis P_4*, that is, *planning is not considered to the same degree in the control phase as it is during the formation of a 'baseline' schedule for a project.*

SECTION FOUR : QUALITY MANAGEMENT

10.42 Restatement Of Hypotheses

In Chapter 8 a number of hypotheses were stated with respect to quality management procedures operated by private and public sector construction contractors. It is appropriate here to restate them.

Q_1 Private and public sector construction contractors adopt and implement third party quality management systems for different reasons.

Q_2 Different methods of providing Quality Assurance are operated by private and public sector construction contractors.

Q_3 Private sector construction contractors have third party quality management systems which are more comprehensive than those operated by public sector construction contractors.

The main objective of this Section is again to analyse the results from the mail questionnaire and personal interview surveys in order to be able to draw some valid conclusions about the prestated hypotheses.

In order to achieve this objective the Chapter looks at commitment to quality, forms of quality assessment adopted, forms of quality assurance adopted, accreditation bodies used, areas of work registered, reasons for third party accreditation, number of staff employed in quality assurance and the number of pages in quality system documentation.

10.43 Commitment To Quality

There was no significant difference in the commitment to quality between private and public sector construction contractors. *(Derived From Appendix C, Tables 34A, 34B & 34C)*

More than four out of five (84%) private sector construction contractors stated that they had a written policy of a commitment to quality. Clearly, there was a high degree of awareness of the importance of quality in the private sector in the execution of projects. Similarly, in the public sector, more than three out of four (76%) public sector construction contractors responded as having such a written commitment to quality.

Both private and public sector construction contractors had a strong commitment to quality and had formulated written policies in order that they might convey this commitment to all their clients, customers and of course their own employees. Many respondents from both the private and public sectors forwarded copies of their quality policies and other material relating to the marketing of quality within their organisations. Most literature received referred to a commitment to the provision of the final product, and the importance of internal resources within, to achieve objectives. Specific mention of adequate resources, training and education were noted in a number of quality statements and policies.

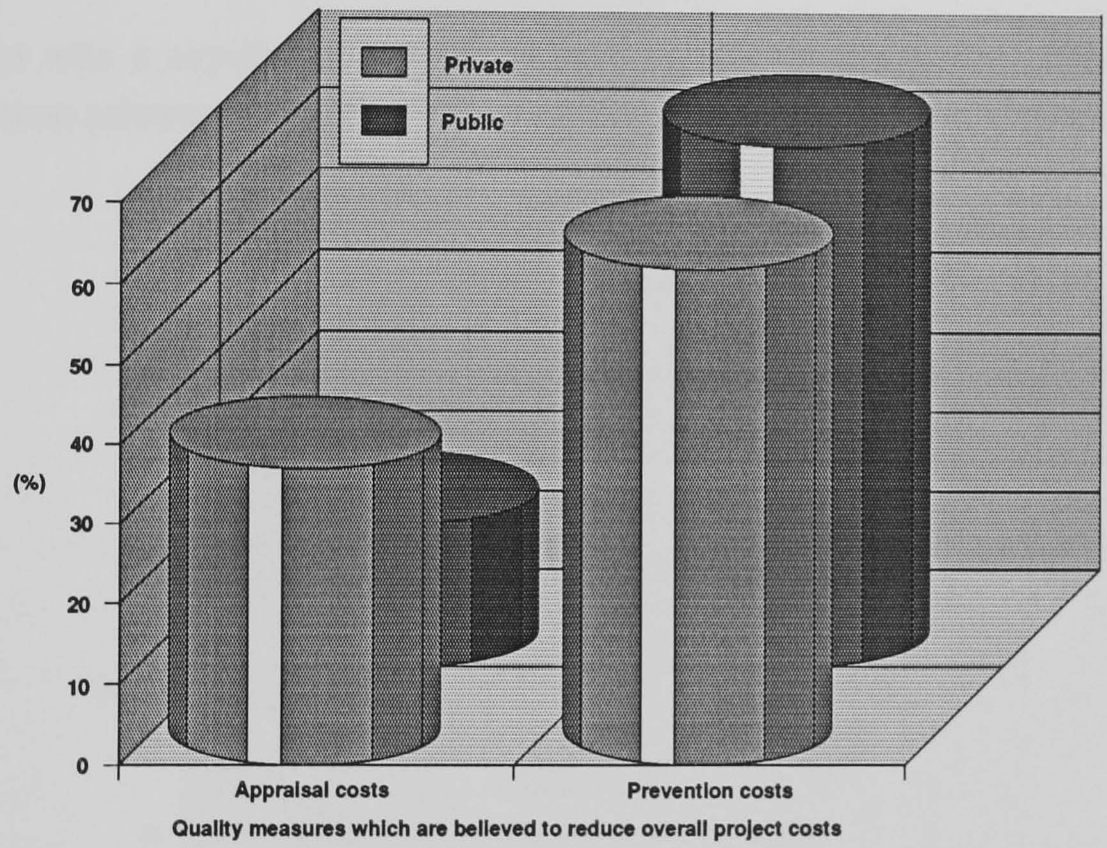
10.44 Factors Relating To Quality Which May Increase Or Decrease Project Costs

There was no significant difference in the factors relating to quality which might increase or decrease project costs between private and public sector construction contractors. (Figure 10.30)

Virtually all private (97%) and public (94%) sector construction contractors believed that any internal or external failures would have the effect of increasing overall project costs.

Around a third (35%) in the private sector considered that appraisal costs would increase final project costs with a similar amount (36%) stating that appraisal might reduce final costs. Clearly, private sector construction contractors did not feel that the principles of quality control through inspection and testing offered any significant advantages in controlling project quality and hence overall project costs. However, nearly two thirds (62%) of private sector construction contractors believed that prevention costs in terms of 'assuring' quality might lead to an overall decrease in project costs. Quality management systems that considered quality, throughout the complete process, appeared to be much more successful in terms of reducing overall costs than quality control methods such as inspection and testing.

Figure 10.30 : Quality Measures Which Are Believed To Reduce Overall Project Costs



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the factors relating to quality which may increase or decrease project costs between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 35A, 35B & 35C

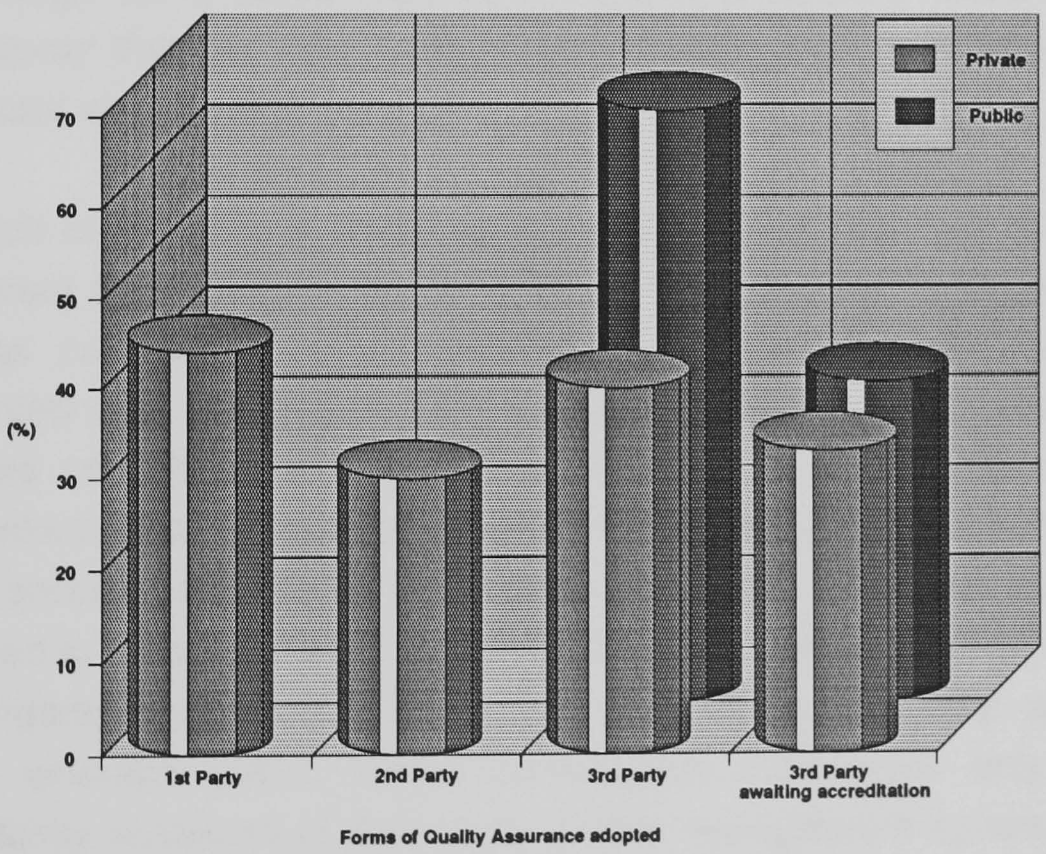
All of the responding public sector construction contractors considered that internal and external costs would lead to an increase in overall project costs. Around half (47%) believed that appraisal costs might increase project costs with one in five (18%) stating that appraisal might decrease overall costs - a clear indication that inspection and testing alone were not seen as being effective measures for ensuring quality. However, nearly two thirds (65%) of public sector construction contractors believed that prevention costs in terms of 'assuring' quality may lead to an overall decrease in project costs.

The majority of both private (62%) and public (65%) sector construction contractors believed that prevention costs in the form of quality assurance systems served to assist in decreasing overall project costs. This was clearly one of the main reasons why construction contractors in the private sector had opted for such quality management systems. However, although the public sector believed that overall project costs might be reduced, they, in the main, have adopted such systems as a result of client or contractual requirements in certain areas of their work. To a much lesser extent the private (36%) and public (18%) believed that quality appraisal measures, such as quality control, might serve to reduce overall project costs.

10.45 Forms Of Quality Assurance Adopted

There was a significant difference in the forms of quality assurance adopted between private and public sector construction contractors. (Figure 10.31)

Figure 10.31 : Forms Of Quality Assurance Adopted



Statistical analysis showed there was a 99% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the forms of quality assurance adopted between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 37A, 37B & 37C

Three quarters (75%) of private sector construction contractors operated either a first or second party quality assurance system with some organisations operating more than one form of quality assurance, depending on the nature of the projects that they undertook. Just over a third (40%)

operated a third party quality assurance system which was monitored by a certification body. Many project managers in the private sector commented :

" we provide quality assurance in a number of different manners "

For first party quality assurance, it is entirely up to the particular organisation as to how they wish to manage quality. Second party quality assurance is put forward by prospective clients, and contractors must follow the required procedures and specification in this respect. Third party quality assurance is monitored by an independent, or third party source, against a pre-determined standard, usually BS 5750 : Part 2 in terms of construction contractors.

Public sector construction contractors, as a rule, did not operate first or second party quality assurance systems. Around two-thirds (65%) of public sector construction contractors operated third party, independently assessed quality systems. The remaining third (35%) of organisations were currently going through the process required to achieve third-party status. Thus, it would appear that the only form of quality assurance considered by the public sector was the third party form.

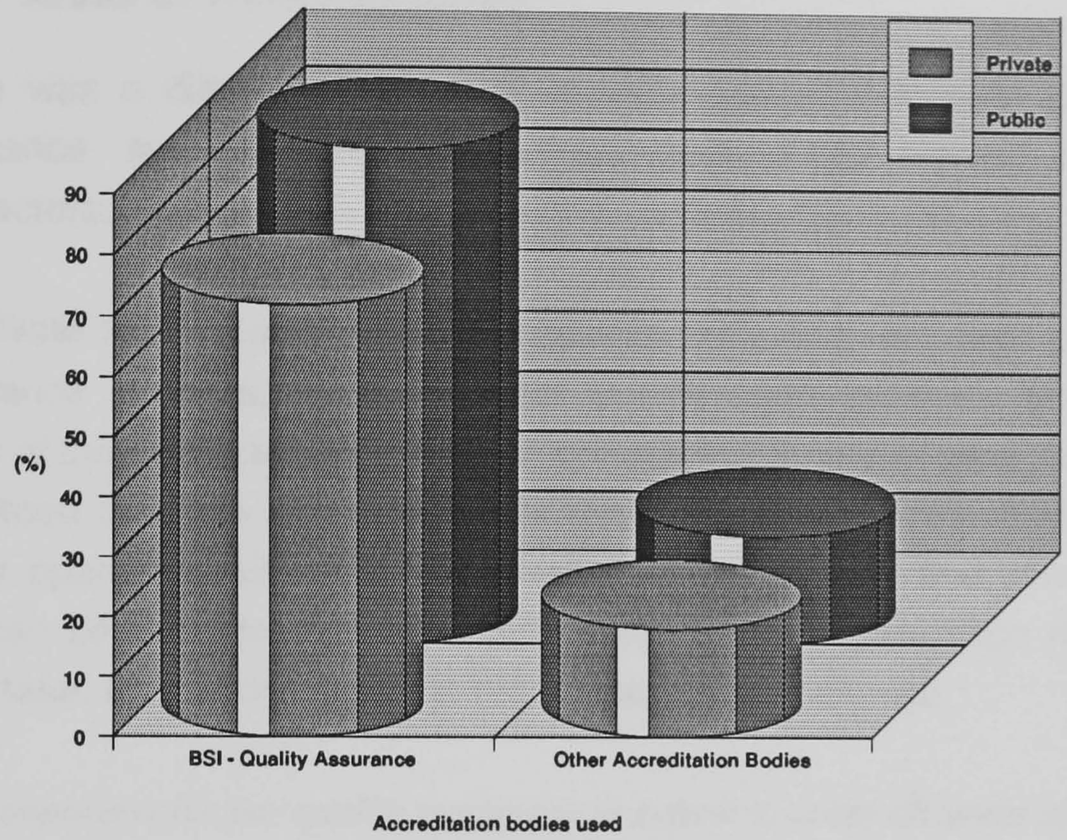
Almost half of the private sector operated and monitored their own quality management systems on a first party basis. This showed the importance of quality as considered by contractors in the private sector, who had implemented such systems of their own volition. Private sector construction contractors operate in a free market environment and undertake some projects which stipulate quality procedures to be followed by a contractor in terms of second party quality assurance. The public sector, by statute, are not allowed to tender for such works. This explains why a number of private sector organisations have carried out second party quality assurance projects, whereas public sector construction contractors only operate independently assessed or third party quality management systems. These systems have been implemented to allow the public sector to tender for certain areas of work where QA systems have been designated mandatory.

There is now a tendency for the private sector to adopt third party quality systems. This will in time 'replace' first party QA and will also allow tendering on projects where an independently assessed quality system is specified.

10.46 Accreditation Bodies Used

BSI - Quality Assurance dominated the assessment of third party quality assurance systems in both the private and public sectors. (Figure 10.32) .

Figure 10.32 : Accreditation Bodies Used



Source : Survey Results - Derived from Appendix C, Tables 38A & 38B

This was in spite of the fact that, in 1993, there were in excess of thirty accreditation bodies in the U.K. who were registered with the N.A.C.C.B. and therefore eligible for undertaking such assessments. Each accreditation body is assessed regularly by the N.A.C.C.B. to ensure that appropriate standards are maintained.

Thus, there appears to be a certain kudos associated with having BSI - Quality Assurance as the accreditation body although interestingly BSI - Quality Assurance is *not* the same organisation that is responsible for the production of British Standards and the like.

The cost of having a quality management system initially assessed, certified and thereafter monitored and maintained can be quite significant. Clearly, it is a commercial decision that construction contractors will have to make, normally asking for quotations from a number of suitable bodies before making a final decision. BSI - Quality Assurance will not always be the cheapest and so there must be other reasons for their popularity. Certainly, it looks as if most construction contractors are prepared to forgo 'the bottom line' cost with a view to looking at the medium and long term benefits of having their names associated with BSI.

10.47 Areas Of Work Registered

There was a difference in areas of work registered in third party quality assurance systems between private and public sector construction contractors. (*Derived From Appendix C, Tables 39A, 39B & 39C*)

All private sector construction contractors, who operated third party quality assurance systems, stated that the accreditation generally applied to all areas of their business and not just to a particular area of work, for example, reinforced concrete structures. This would seem to indicate that the private sector operate quality systems which are both flexible and comprehensive and can be used for any type of project that an organisation may wish to undertake. Project managers in the private sector believed :

" it is important for our quality management system to cover all areas of our work to give Clients the confidence that all aspects of a project are being executed under quality management conditions "

On the other hand, construction contractors in the public sector operated third party quality systems in only very selective areas of their work. Furthermore, such accreditation had predominantly stemmed from government legislation which had necessitated public sector construction contractors achieving such registration in order for them to be included on tender lists for works in these areas. Typically project managers in the public sector looked upon quality management systems in a 'narrow vision' :

" as covering areas which require to be QAd, to allow inclusion on tender lists "

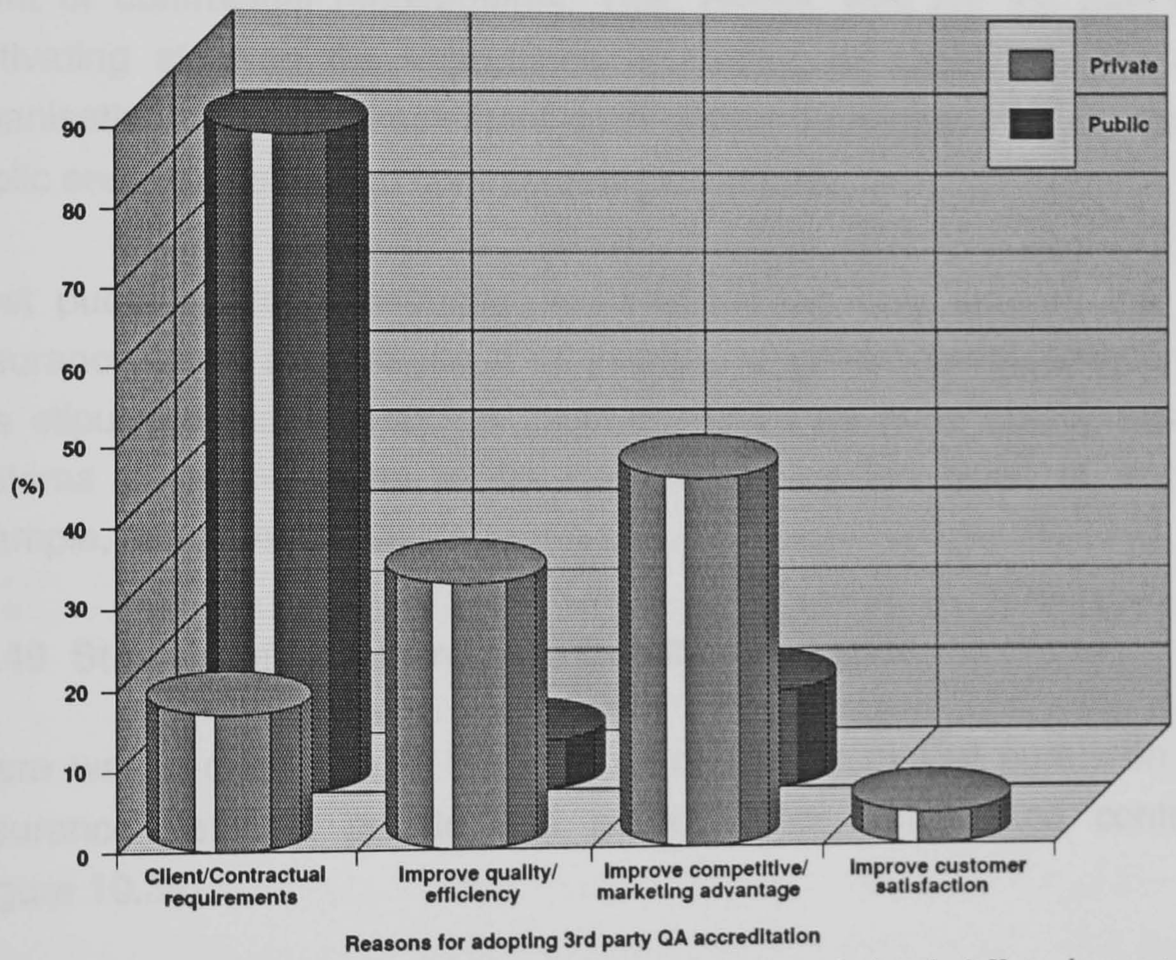
Private sector construction contractors operated third party quality management systems in all areas of their business, whereas, the public sector universally operated such systems in very specific areas of their business only. In fact, many public sector construction contractors tended to operate 'independent' quality systems for *each* of their specific areas of work.

A more practical method adopted by some public sector construction contractors and the majority of those in the private sector was to use a 'modular' approach where only certain elements of the system will apply to a specific project.

10.48 Reasons For Third Party Accreditation

There was a significant difference in the reasons for the adoption for third party accreditation of quality assurance systems between private and public sector construction contractors. (Figure 10.33)

Figure 10.33 : Reasons For Adopting Third-Party Quality Management Systems



Statistical analysis showed there was a 99.9% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the reasons for the adoption for third party accreditation of quality assurance systems between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 40A, 40B & 40C

It was evident that more than three quarters (83%) of private sector construction contractors operated third party quality assurance systems for 'positive' reasons and not merely to meet client and contractual requirements. Such systems were considered as being of an advantage in both operational terms and also as a marketing tool.

Many project managers in private sector construction contractors commented :

" third party quality management systems have improved our marketing potential and future work opportunities.... and it is likely that this form of providing quality assurance will replace all other forms in the near future in view of the independence of monitoring the management procedures "

Less than a fifth (18%) of public sector construction contractors considered the operation of a third party quality system served to either improve quality and efficiency or to improve their competitive and marketing advantage. The majority implemented such systems for 'negative' reasons in order to satisfy client or contractual requirements. This, clearly, was not the best way of motivating staff on the importance of quality, or setting up the correct organisation culture to implement such quality management systems within public sector construction contractor organisations.

Most public sector construction contractors had only entered the quality assurance arena as a means of responding to government legislation which has stipulated that contractors must operate third party quality assurance systems to enable them to be included for certain types of works, for example, safety fencing.

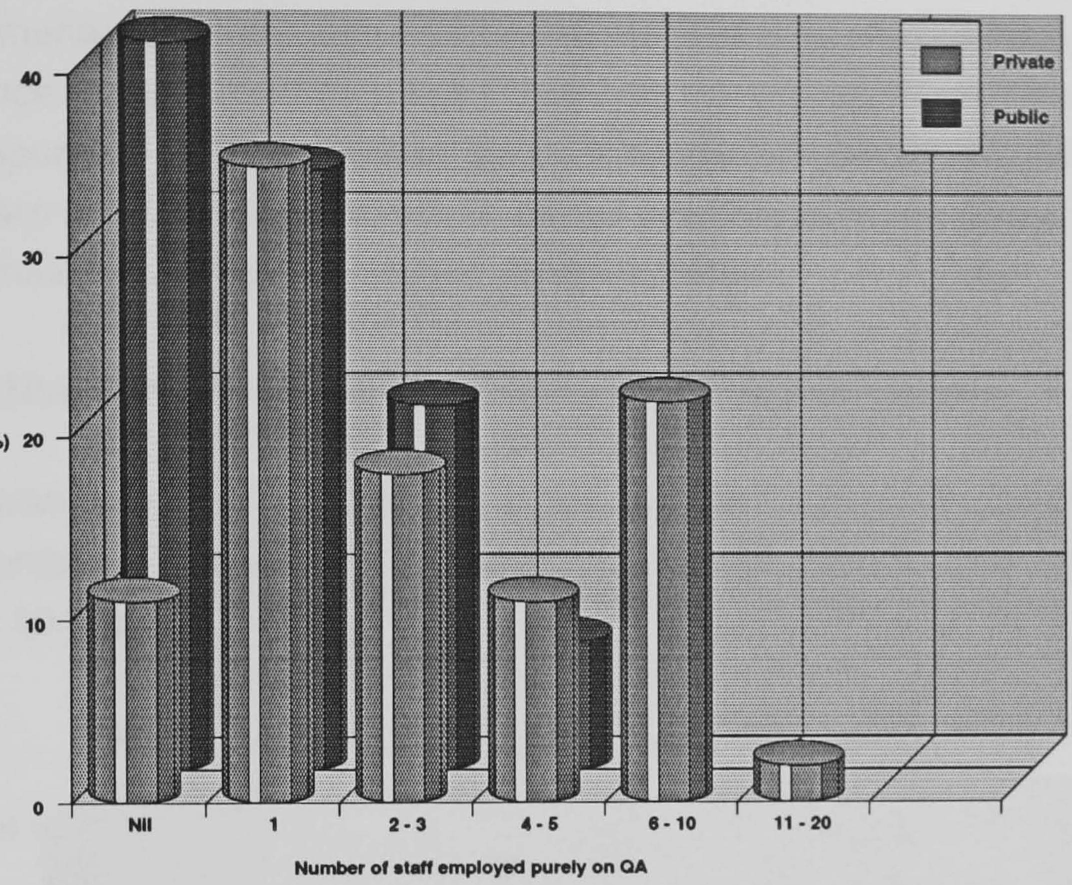
10.49 Staff Employed Purely On Quality Assurance

There was a difference in the number of staff employed purely on quality assurance between private and public sector construction contractors. (Figure 10.34)

Slightly over half (54%) of contractors in the private sector employed between one and three staff *purely* on quality assurance. Normally, staff whose duties were purely associated with QA were either quality managers or quality auditors. Evidently, in 'bigger' construction organisations there might be regional QA managers and a team of quality auditors and this explained the variances in the numbers of staff reported as being involved only in QA.

Less than half of public sector respondents (40%) did not employ *any* staff whose duties were *solely* associated with QA. Therefore, in the public sector it would appear that the role of quality managers and quality auditors were combined with other activities. This was very much reinforced during personal interviews. However, half of the respondents did employ between one and three staff purely on QA.

Figure 10.34 : Staff Employed Purely On QA



Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the number of staff employed purely on quality assurance between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 41A, 41B & 41C

Private sector construction contractors operated quality management systems in all areas of their business. Consequently, there was a need for a greater staffing than in the public sector who only applied quality management systems to relatively small areas of their work. This, combined with the difference in sizes of private and public sector organisations, accounted for the significant difference in staffing employed purely for QA purposes between the two sectors.

10.50 Quality Assurance Manager/Quality Auditor

There was no significant difference in the employment of quality managers or quality auditors between private and public sector construction contractors. *(Derived from Appendix C, Tables 42A, 42B & 42C)*

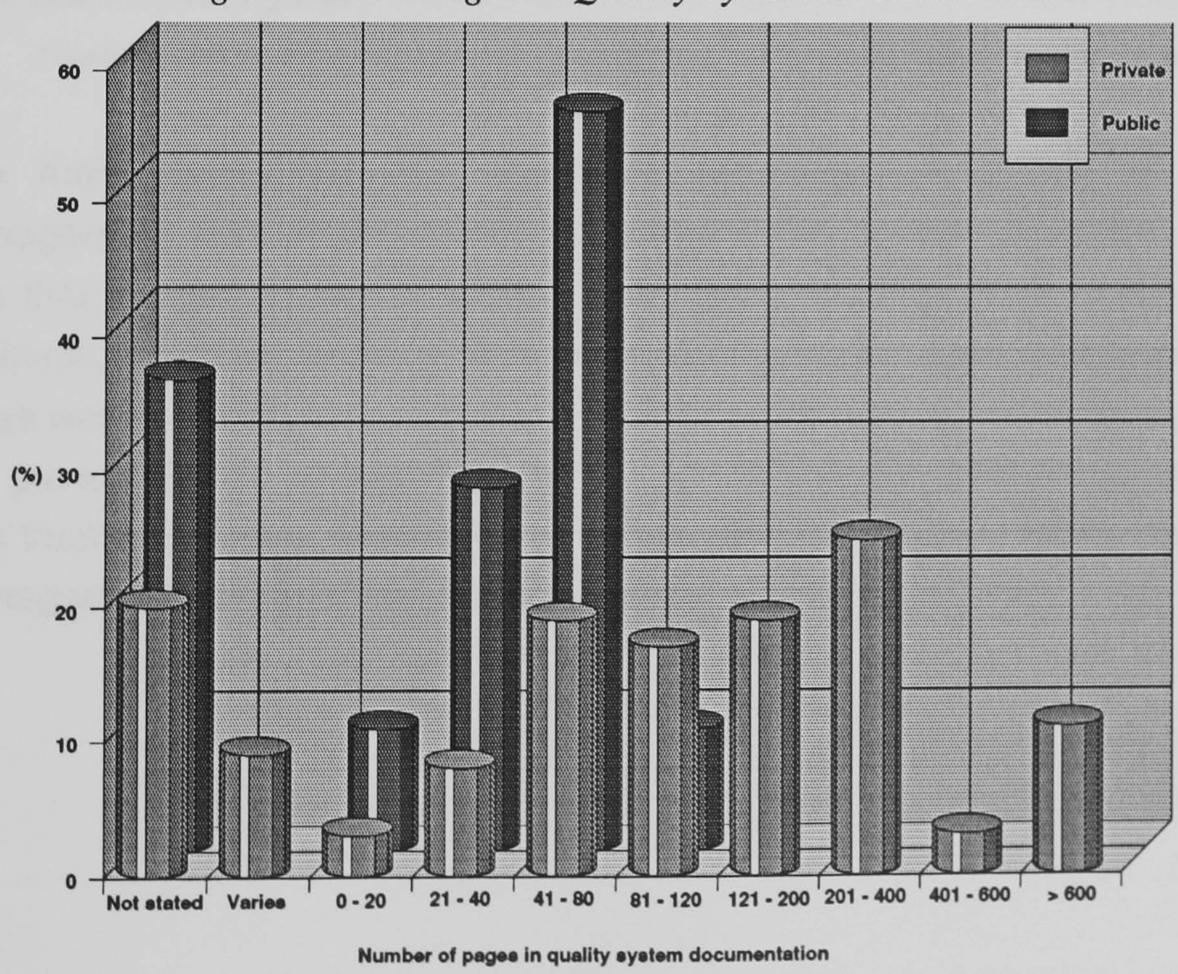
Almost all (91% & 94%) of private and public sector construction contractors respectively employed a quality assurance manager and around four out of five (78% & 88%) employed a quality auditor. This tied in closely with the number who use quality assurance management systems.

Both private and public sector construction contractors employed staff as quality managers or auditors commensurate with their commitment to quality assurance management systems. However, as can be seen from many of the responses to the number of staff employed purely on QA, quality managers or auditors in the public sector carried out these duties over and above their 'normal' day-to-day job responsibilities.

10.51 Number Of Pages In Quality System Documentation

There was a significant difference in the number of pages in quality system documentation between private and public sector construction contractors. (Figure 10.35)

Figure 10.35 : Pages In Quality System Documentation



Statistical analysis showed there was a 99% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the number of pages in quality system documentation between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 43A, 43B & 43C

Of those private sector construction contractors who responded only around a tenth (14%) had quality management systems with more than 400 pages of documentation. This was at the extreme end of the scale and the 'norm' in the private sector was as follows :

approximately a third operated quality systems with < 80 pages
approximately a third operated quality systems with between 80-200 pages
approximately a quarter operated quality systems with between 200-400 pages

Overall, around two thirds (67%) of the private sector operated quality management systems with less than 200 pages. Around half (55%) of public sector construction contractors operated quality management systems of between 80 and 120 pages. None had systems with more than 200 pages.

Although there was a difference in volume, in terms of the number of pages within quality management systems, project managers in both sectors unanimously commented :

" documentation in quality management systems must be kept to a manageable level, commensurate with the size and complexity of project being undertaken "

The main reason for the significant difference in volume of quality management system documentation between the private and public sectors was that the private sector applied their quality systems to all areas of their business, whereas, in the public sector only a small amount of specialised areas were normally covered. It was of interest to note, however, that even in the private sector, around two thirds of quality management systems had less than 200 pages. Clearly, in all instances it is important that a system is manageable in terms of its overall volume.

10.52 DECISIONS ON QUALITY MANAGEMENT HYPOTHESES

Each of the three prestated hypotheses are now considered in conjunction with the survey results with regard to quality management.

Hypothesis Q_1

Q_1 Private and public sector construction contractors adopt and implement third party quality management systems for different reasons.

The survey results indicated support for *Hypothesis Q_1*.

Initially it was interesting to note that more than three quarters of private (84%) and public (76%) sector construction contractors had written statements expressing their commitment to quality. Similarly, both believed strongly that prevention costs in the form of quality assurance management systems might assist in the reduction of overall project costs.

It was clear, therefore, that all concerned were extremely interested in the principles, and the adoption, of quality management systems. However, there was a divergence between private and public sector construction contractors when it came to the actual reasons for the implementation of such systems.

More than three quarters (83%) of private sector construction contractors sought third party quality system accreditation to improve quality and efficiency, competitive and marketing advantage or customer satisfaction. Less than one in five (17%) commented that the main reason for seeking third party accreditation was either to meet client or contractual requirements.

In the public sector the reasons for implementing third party quality management systems were completely different from the private sector. Four out of five (82%) of public sector construction contractors adopted such systems as a direct result of client or contractual requirements. Less than one in five (18%) operated such systems primarily for improving quality and efficiency or improving competitive and marketing advantage.

Although there was a common wish to operate quality management systems, the reasons for adoption were different and therefore *Hypothesis Q_1* is supported, that is, *private and public sector construction contractors adopt and implement third party quality management systems for different reasons.*

Hypothesis Q_2

Q_2 Different methods of providing Quality Assurance are operated by private and public sector construction contractors.

The survey results supported *Hypothesis Q_2*.

Construction contractors in the private sector operated in a 'free' market environment undertaking projects for a number of different clients. In some instances the client might wish to monitor quality (2nd party QA), or the contractor might use their own internal system (1st party QA). Where an independently assessed quality system was required, the contractor was required to operate a 3rd party QA system. Many private sector construction contractors therefore operate a variety of methods of providing quality assurance depending on the nature of the projects undertaken. Between a third and a half operated one, or more of the methods listed. A further 33% of those who did not currently operate a 3rd party QA system were working towards such accreditation at the time of survey.

In the public sector quality assurance was only provided through 3rd party independently assessed quality systems. Two thirds (65%) already had such accreditation with the remainder (35%) working towards that goal.

The various methods of providing quality assurance were closely related to the different reasons stated for the adoption of quality management systems by private and public sector construction contractors. In the private sector a number of methods of providing quality have evolved through time, with quality appearing to have always been a prime consideration. The public sector only operate third party quality assurance management systems, which have developed from clients wishing an independently quality management system to be in existence.

It should be noted that there appeared to be a common trend in both private and public sector construction contractors in moving towards third party quality management systems. It was commonly believed that this form of quality assurance might replace other forms within a relatively short period of time, with perhaps the exception of specialist quality systems operated by clients, for example, the petrochemical industry where stringent quality controls can only be established by the client.

Therefore *Hypothesis* Q_2 is supported, that is, *different methods of providing Quality Assurance are operated by private and public sector construction contractors.*

Hypothesis Q_3

Q_3 Private sector construction contractors have third party quality management systems which are more comprehensive than those operated by public sector construction contractors.

The survey results supported Hypothesis Q_3.

All responding private sector construction contractors, who had third party quality management systems had systems which applied to all areas of their business. These areas were as wide ranging as general construction to design, construction and management.

On the other hand all the responding public sector construction contractors operated third party quality management systems which applied to only very specific areas of their business. Typical examples included such areas as safety fencing and traffic signs, which, through regulation, were required to have quality assured contractors in these areas for inclusion on tender lists.

Quality management systems in private sector construction contractors were also more voluminous in terms of the number of pages of documentation, than in systems operated by public sector construction contractors.

Whereas no public sector construction contractors had quality systems in excess of 200 pages, around 40% of private sector did. Indeed around one tenth (11%) had systems greater than 600 pages. All, commented, however, of the need to keep quality system documentation to a manageable level. Many contractors in the private sector operated a modular approach with respect to the application of their quality systems with only certain elements of the system applying to particular contracts.

Therefore *Hypothesis* Q_3 is supported, that is, *private sector construction contractors have third party quality management systems which are more comprehensive than those operated by public sector construction contractors.*

SECTION FIVE : MANAGEMENT OF HUMAN RESOURCES

10.53 Restatement Of Hypotheses

In Chapter 8 a number of hypotheses were stated in relation to the procedures operated with respect to the management of human resources by private and public sector construction contractors. It is now time to restate them.

H_1 Attempts to improve human resource management within private and public sector construction contractors are eclipsed by considerations of time, cost and quality

H_2 The perception between private and public sector construction contractors on motivational issues relating to job satisfaction or job dissatisfaction from a project manager's viewpoint is different

H_3 Project manager performance is assessed primarily on human management skills such as team building, communication and leadership skills in both private and public sector construction contractors

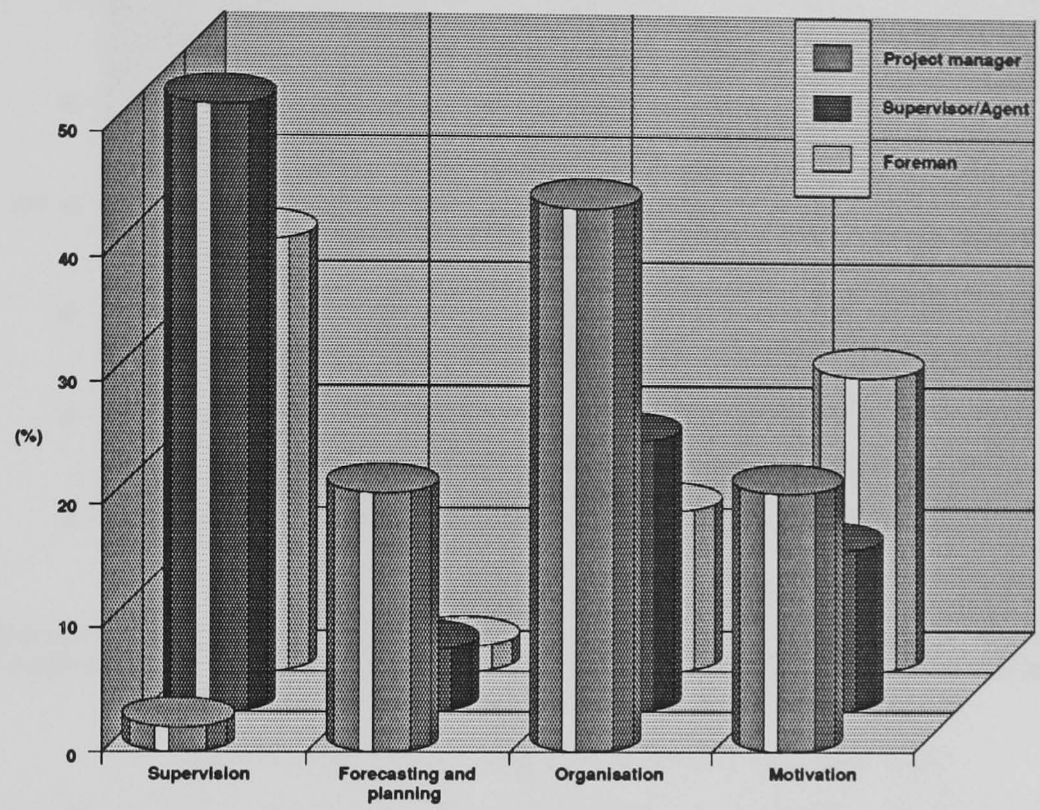
The main objective of this Section is as before to analyse the results from the mail questionnaire and personal interview surveys in order to be able to draw some valid conclusions about the prestated hypotheses.

In order to achieve this objective the Chapter covers general management principles, aspects of job satisfaction and dissatisfaction, factors affecting tradesmen's productivity, task and people related qualities, motivating factors, management training, factors which may cause problems in the management of projects and the personal characteristics of an effective project manager.

10.54 General Management Principles Considered Most Important

There was a significant difference in the general management principles considered to be *most* important at project manager level between private and public sector construction contractors. (Figures 10.36 & 10.37)

Figure 10.36 : General Management Principles Considered Most Important - Private Sector



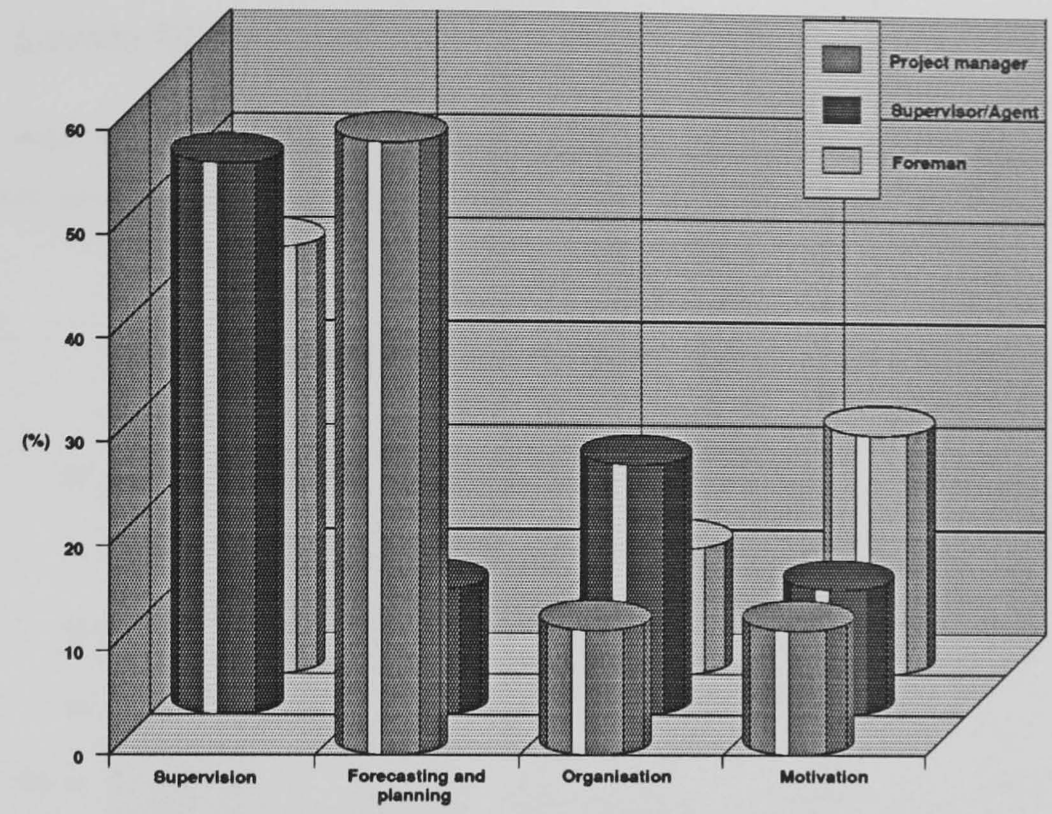
Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the general management principles considered by project managers to be most important at project manager level between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 44A & 44C

The results showed the *most* important general management principle (*all* from a project manager's viewpoint) that project managers, supervisors and foremen perceived as being the *most* important in the execution of projects.

In the private sector, it was interesting to note that 'organisation' was considered the *most* important general management principle for a project manager, but it was 'supervision' for supervisor, agent or foremen levels. It was apparent that the general management principles most appropriate varied depending on the level of manager under consideration. However, aspects such as motivation appeared to apply equally to all levels of management on a day-to-day basis and it was encouraging to note that a fifth (21%) of all project managers and almost one in four (24%) foremen considered motivation as the *most* important general management principle.

Figure 10.37 : General Management Principles Considered Most Important - Public Sector



Statistical analysis showed there was a 95% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the general management principles considered by project managers to be most important at project manager level between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 44B & 44C

In the public sector, project managers considered 'forecasting and planning' as the *most* important general management principle. They saw site supervisors, agents and foremen as believing that 'supervision' was the *most* important general management principle applicable to them.

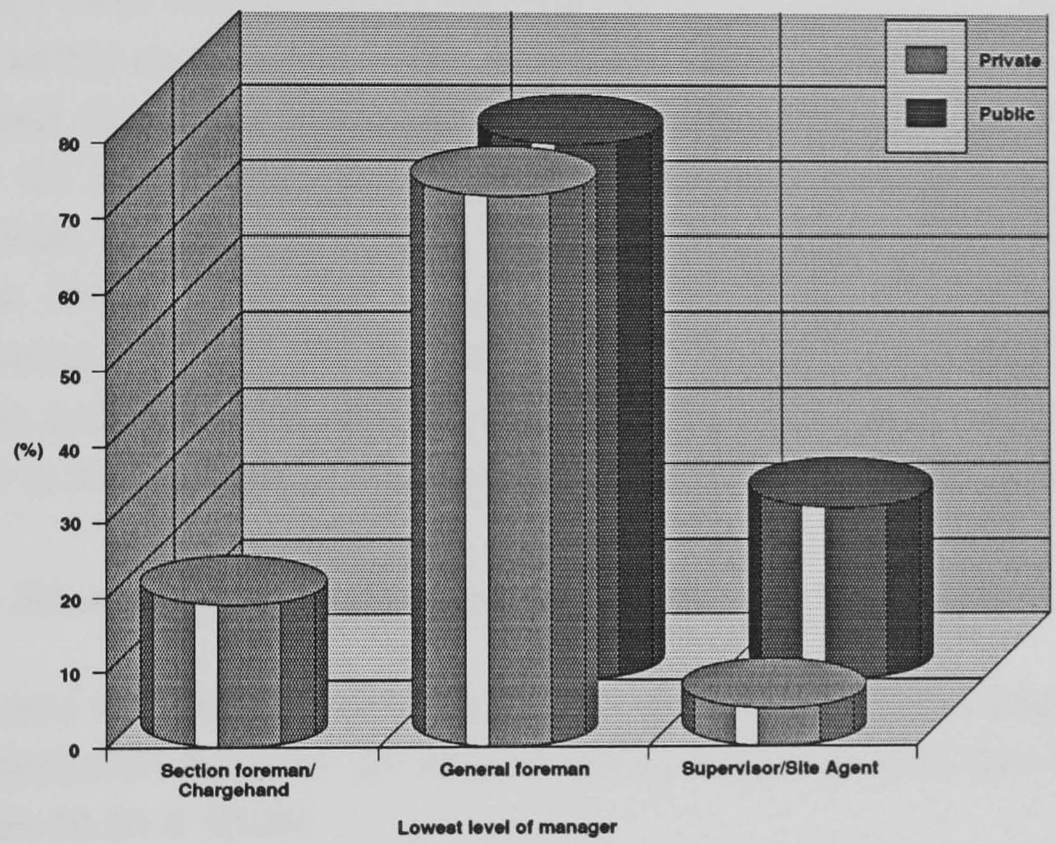
In the private sector the role of the project manager appeared to concentrate more on 'organisation', in the public sector more on 'forecasting and planning'.

No differences existed between the private and public sectors on project managers' perception of general management principles applicable to site supervisors or foremen. In both instances supervision was classified as being the *most* important element emphasising the need for ensuring that works were closely monitored and carried out expeditiously to the correct specification. In this respect, foremen in both sectors considered the method of work and motivation to be the critical factors. Clearly, the manner in which works are carried out must be agreed with the people who carry it out, as well as those who supervise it, and morale must be kept as high as possible at all times to help keep productivity targets on schedule.

10.55 Levels Of Management In Projects

There was no significant difference in the levels of management considered between private and public sector construction contractors. (Figure 10.38)

Figure 10.38 : Levels Of Management



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the levels of management considered between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 45A, 45B & 45C

Almost three quarters (73%) of private sector construction contractors looked upon general foremen as being 'managers' in the construction phase of a project. This is noteworthy and more so when around 20% of respondents referred to a section foreman or ganger as being classified as a 'manager'. In practice it is important to devolve managerial authority and responsibility to a level which can satisfactorily handle this aspect. Some would agree, the lower the level the better.

Similarly, almost three quarters (71%) of public sector construction contractors looked upon the general foreman as a manager. However, it was interesting to note that 25% of respondents viewed the site supervisor or agent as being the 'lowest' level of manager. In many of the smaller type of projects undertaken in the public sector the general foreman was not given the general management authority and responsibility given to foremen in private sector construction contractors. Project managers in the public sector commented in this respect :

> *" the poor quality foremen in the public sector has in many instances led to an additional supervisory tier being required, namely that of supervisors "*

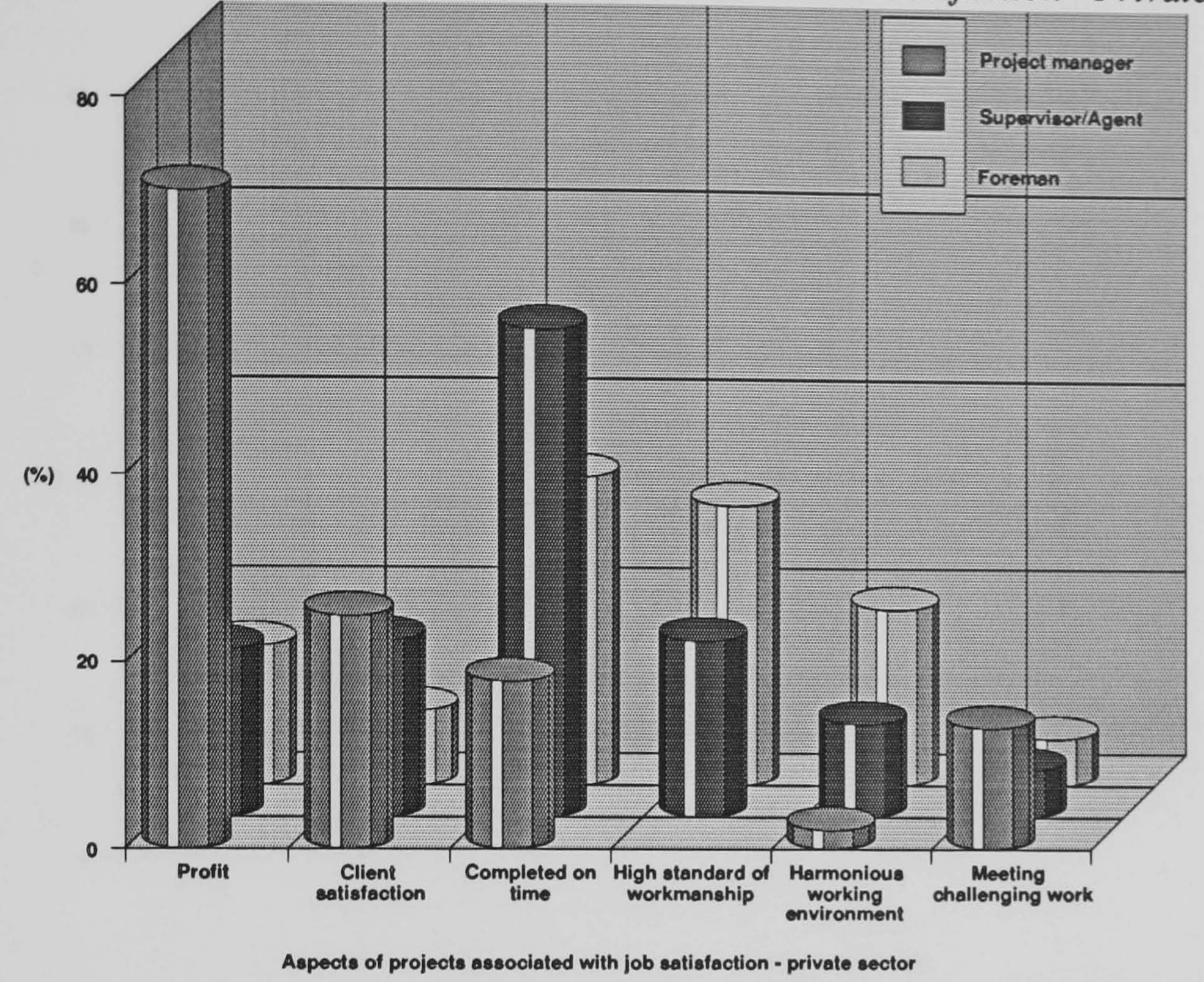
Although there was not an overall difference in the perceptions of private and public sector construction contractors on the lowest level of management, it was clear that around a quarter of site supervisors or agents in the public sector did not delegate any management responsibility and authority to a lower level in their organisations. This may have resulted from two possible causes. Firstly, there may just simply be duplication of roles between site supervisors or agents and foremen in view of the smaller, multiple number of projects undertaken simultaneously. Secondly, and more critically, this might be due to the standard of foremen employed within the public sector.

10.56 Aspects Of Projects Associated With Job Satisfaction

There was no significant difference in the aspects of projects associated with job satisfaction between private and public sector construction contractors. (Figures 10.39 & 10.40)

It appeared that different aspects of projects were associated with providing job satisfaction for different managerial levels. Not surprisingly, almost three quarters (70%) of project managers in the private sector saw profit to be the *most* satisfying aspect of their work; their performance, as has already been determined, was normally judged on their ability to make a profit. Project managers in the private sector perceived site supervisors or agents predominantly gaining job satisfaction from completing a project, or elements of a project on schedule and foremen gaining their job satisfaction from a combination of completing tasks on schedule and to a high standard of workmanship. This tied in well with the high degree of responsibility and authority that is devolved to foremen in the private sector.

Figure 10.39 : Aspects Of Projects Associated With Job Satisfaction - Private Sector



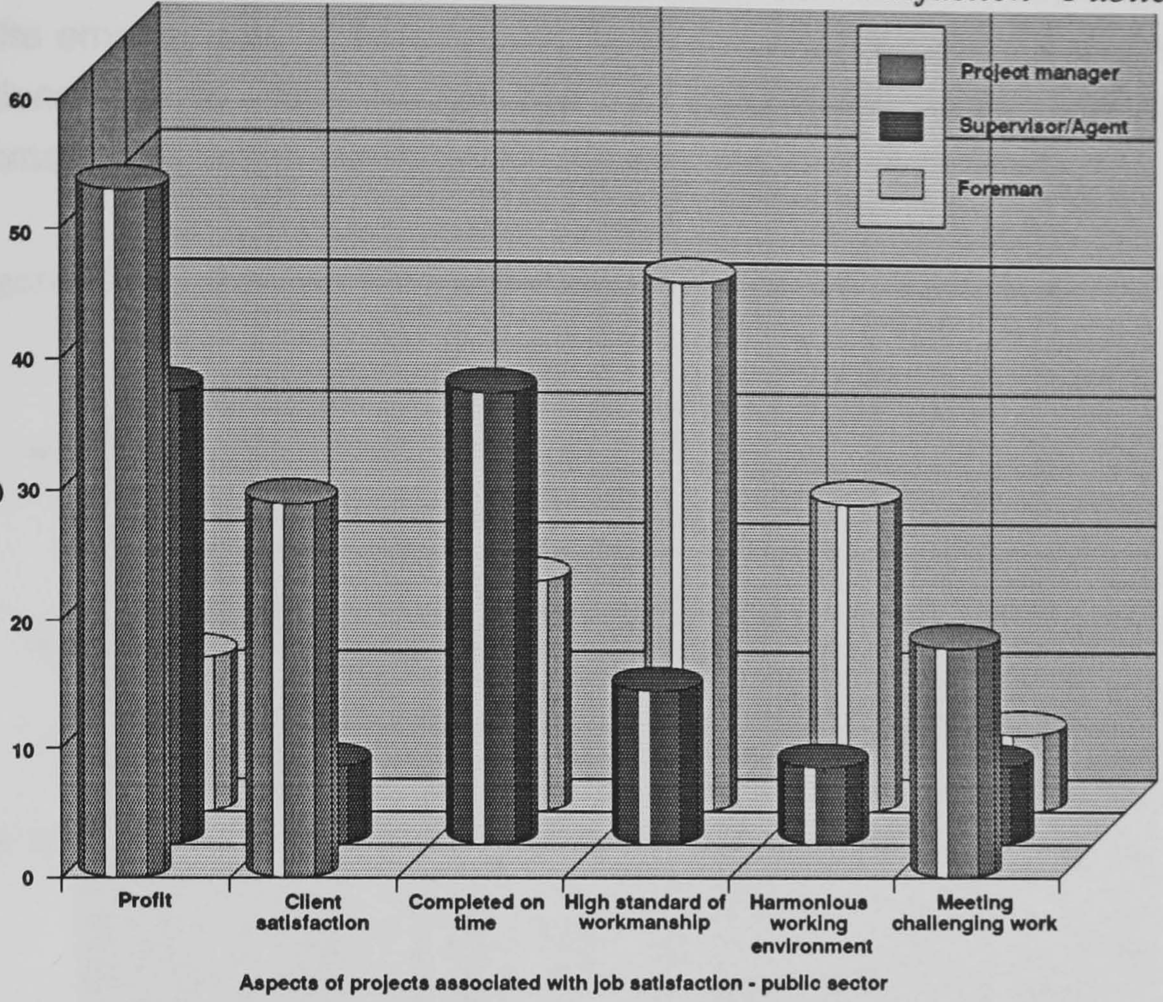
Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the aspects of projects associated with job satisfaction between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 46A & 46C

Around half (53%) of project managers in the public sector gained job satisfaction from achieving a profit on a project. They perceived site supervisors or agents as achieving job satisfaction equally from either making a profit, or from completing a project on schedule and foremen as predominantly gaining job satisfaction from a high standard of workmanship. In addition, project managers considered that almost a quarter (24%) of foremen believed that a harmonious working environment was the most important factor relating to job satisfaction.

In summary, in both private and public sector construction contractors project managers looked upon profit as being the most important job satisfier. They considered that site supervisors or agents viewed completion on schedule (along with profit in the public sector) likewise and that foremen believed that completion on schedule and a high standard of workmanship were the most relevant to them in this area.

Figure 10.40 : Aspects Of Projects Associated With Job Satisfaction - Public Sector



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there is no difference in the aspects of projects associated with job satisfaction between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 46B & 46C

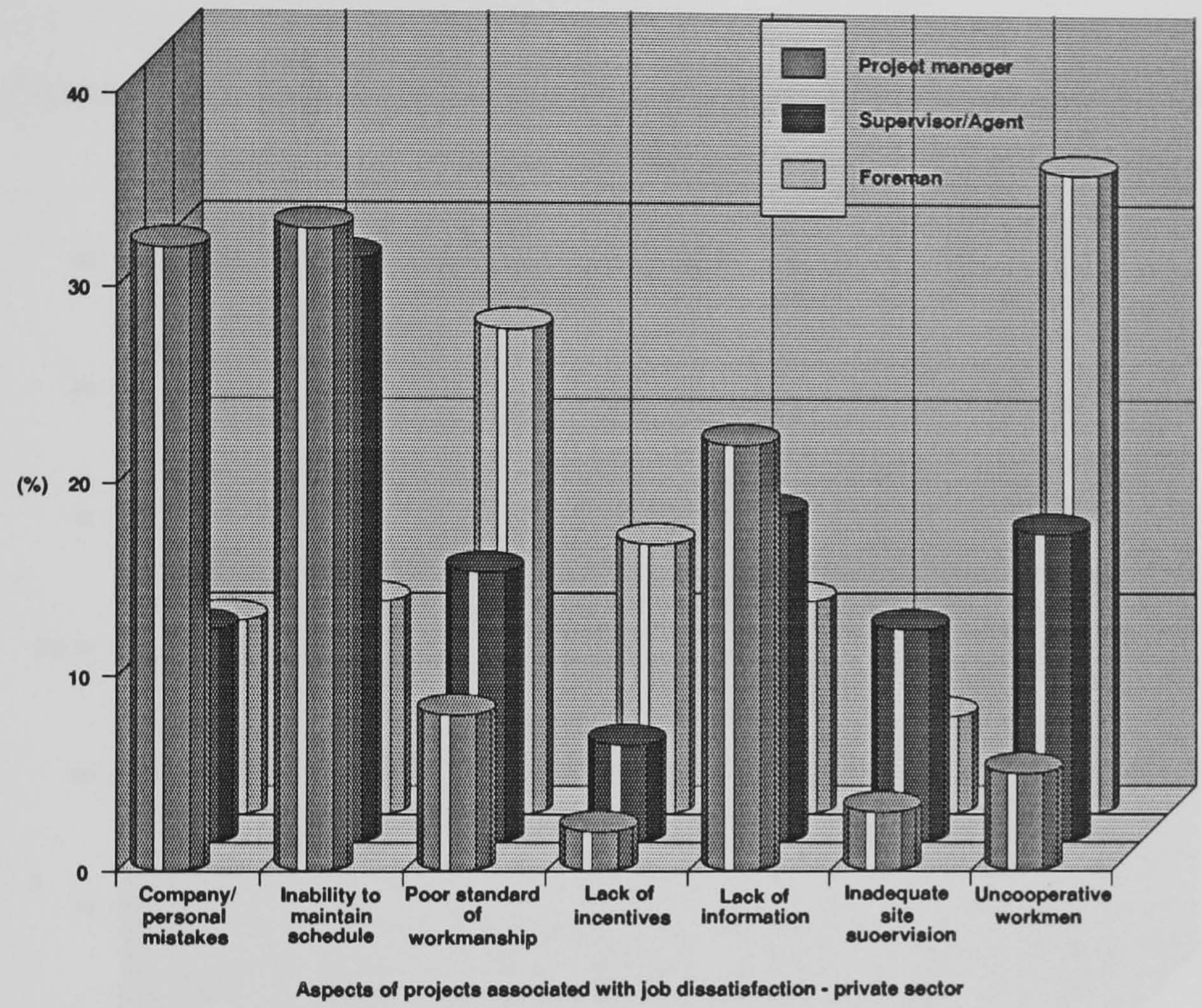
Of interest though was the fact that in the public sector twice the number of supervisors and agents, compared to the private sector, considered profit to be the main means of providing job satisfaction. This again emphasised the onus put on profitability in the public sector. Much more emphasis was placed in the private sector on keeping clients happy and it was encouraging to note that this actually also gave project staff satisfaction in the process.

10.57 Aspects Of Projects Associated With Job Dissatisfaction

There was a significant difference in the aspects of projects associated with job dissatisfaction, at the project manager level, between private and public sector construction contractors. (Figures 10.41 & 10.42)

Project managers in the private sector perceived company or their own mistakes and inability to maintain schedule as being the major contributors to job dissatisfaction. From a project manager's viewpoint, site supervisors or agents were likely to be dissatisfied if a project did not keep to schedule and foremen if workmanship was poor or if workmen were uncooperative. The results emphasised, at the foremen level, the need for good social working relationships to help encourage a consistently high standard of workmanship.

Figure 10.41 : Aspects Of Projects Associated With Job Dissatisfaction - Private Sector



Statistical analysis showed there was a 90% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the aspects of projects associated with job dissatisfaction at the project manager level between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 47A & 47C

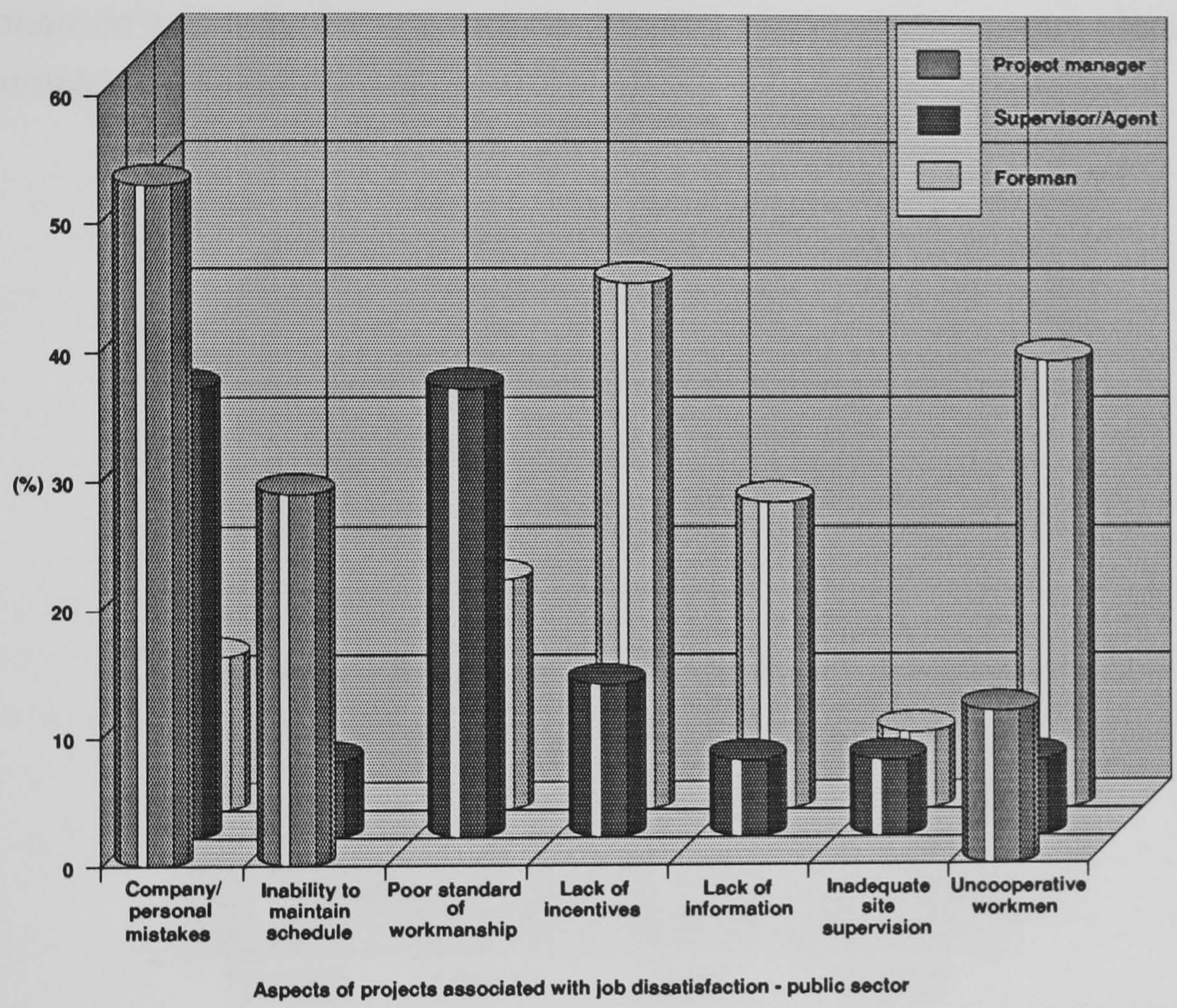
Project managers in the public sector perceived company or personal mistakes and inability to maintain schedule as being the major sources of job dissatisfaction. From a project manager's viewpoint, site supervisors or agents were perceived as being dissatisfied by company or personal mistakes and a poor standard of workmanship, and foremen by lack of incentives available and uncooperative workmen.

Foremen in the public sector placed a considerable weight on the lack of incentives available. Project managers in the public sector commented :

" foremen consider incentive schemes in operation to be restrictive and they believe that there should be no ceiling to bonus payments, but they should be purely performance related "

This was surprising in view of the fact that the working conditions and pay in the public sector for manual workers appeared to be generally more favourable than their counterparts in the private sector.

Figure 10.42 : Aspects Of Projects Associated With Job Dissatisfaction - Public Sector



Statistical analysis showed there was a 90% level of confidence that the alternative hypothesis H_1 can be accepted - that is, there was a difference in the aspects of projects associated with job dissatisfaction at the project manager level between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 47B & 47C

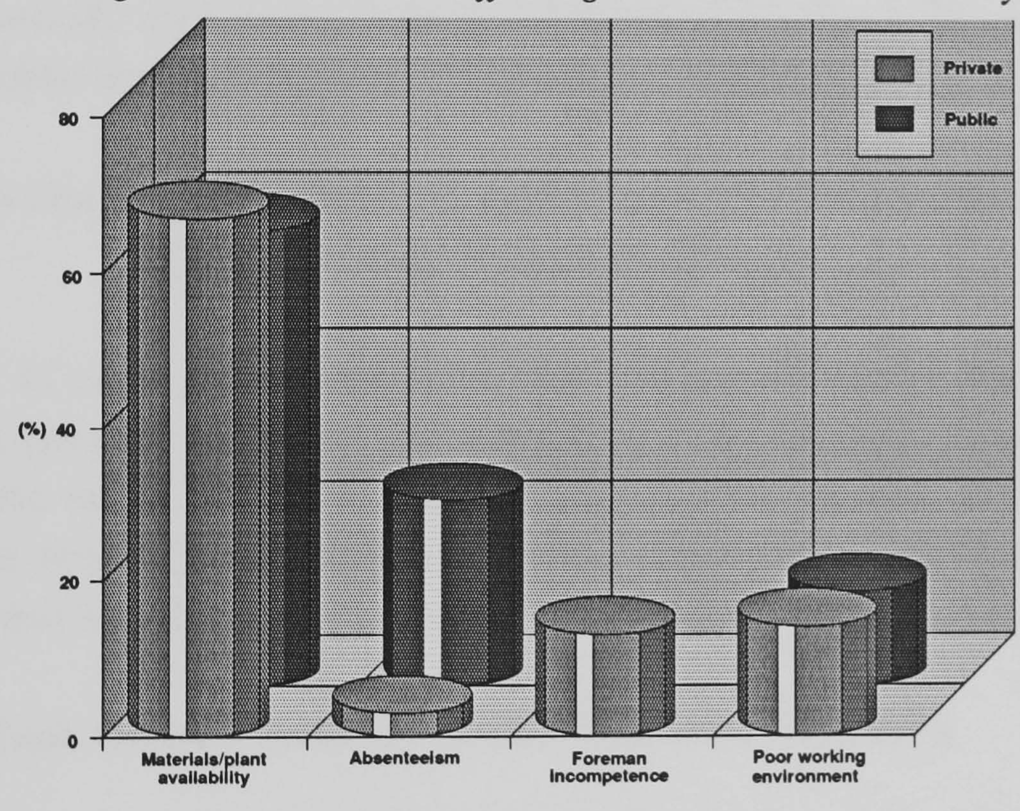
Project managers in both the private and public sectors viewed company or personal mistakes or inability to maintain schedule as the main factors associated with job dissatisfaction. However, in the private sector alone one fifth (22%) considered lack of information on a project as being a major dissatisfier. This explained the significant difference between the views of the two sectors. The larger, more complex projects undertaken in the private sector may account for the problems most associated with information.

Site supervisors, or agents in both private and public sector construction contractors were most dissatisfied from a mixture of company or personal mistakes, not keeping to schedule or poor workmanship.
Foremen in both sectors were mainly dissatisfied with poor workmanship and uncooperative workmen, with lack of incentives appearing to a significant issue in public sector construction contractors.

10.58 Factors Affecting Tradesmen's Productivity

There was no significant difference in the factors perceived as affecting tradesmen's productivity between private and public sector construction contractors. (Figure 10.43)

Figure 10.43 : Factors Affecting Tradesmen's Productivity



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the factors affecting tradesmen's productivity between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 48A, 48B & 48C

Two thirds (67%) of respondents in the private sector believed that 'non-human' aspects such as materials or plant availability were the *most* important factors in relation to tradesmen's productivity. Absenteeism, poor working environment, incompetence and other 'human' related issues appeared to have a much lesser part to play, than the simple availability of equipment or the 'tools' to do the job.

Similarly, nearly two thirds (59%) of public sector construction contractors believed that material or plant availability was the *major* factor affecting tradesmen's productivity. However, a noticeable proportion (23%) considered absenteeism to the *most* critical factor in relation to productivity. Clearly, there appeared to be a problem in the public sector in this respect and perhaps the generous general working conditions (afforded with respect to working hours, holidays and sickness pay to manual workers) played an important part here.

It was evident that material or plant availability was the single most important factor which affected tradesmen's productivity. The working conditions in the public sector which were more favourable than in the private sector including self-certified sickness schemes, fully paid sick leave (including bonus!) and ultimately the fact that much more protection is afforded to workers in terms of job security was found to be an underlying problem within public sector construction contractors. Project managers in the public sector commented :

" the working conditions afforded to manual workers are too generous and have led to problems of absenteeism "

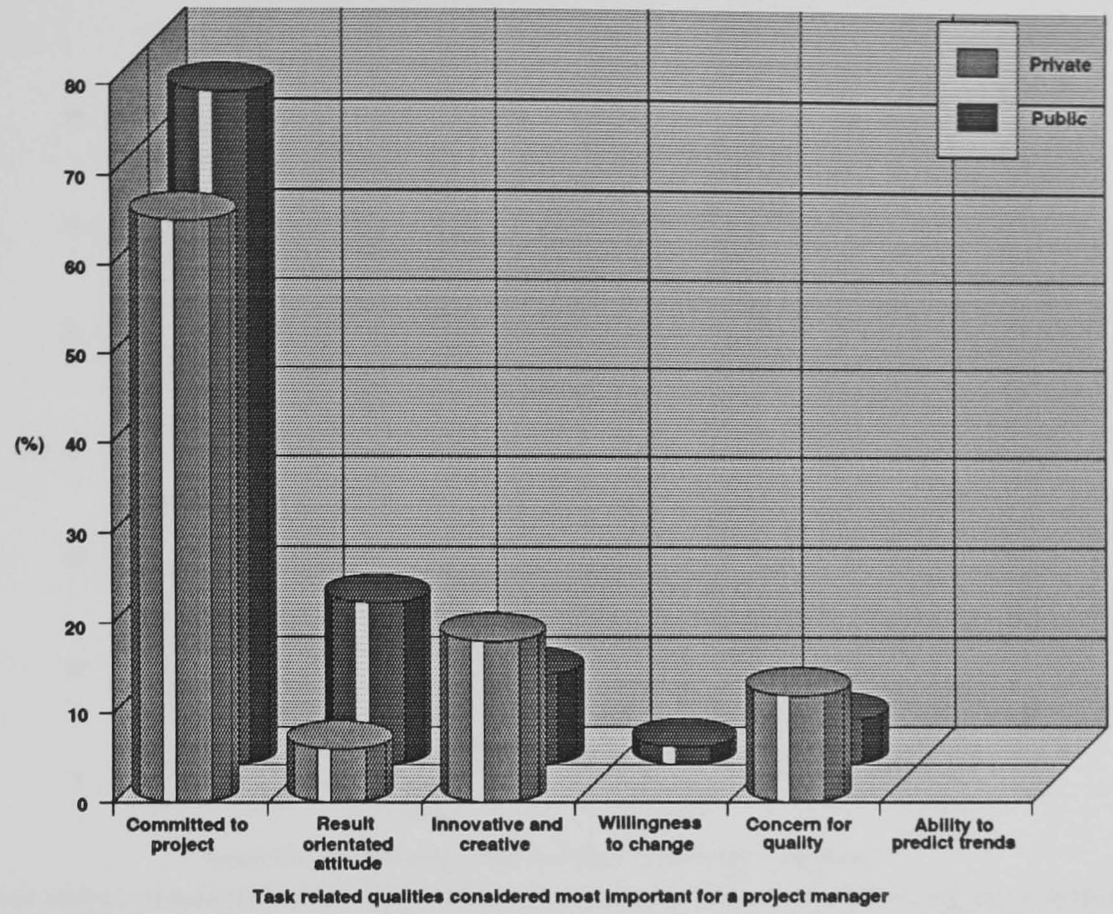
Clearly, in order to be competitive with the private sector, much attention must be paid to improve the current situation with respect to absenteeism in the public sector. In this respect some organisations had already initiated sickness absence management schemes in an attempt to identify, monitor and control the situation.

10.59 Task Related Qualities Considered Most Important

There was no significant difference in the project task related qualities considered most important between private and public sector construction contractors. (Figure 10.44)

Three quarters (75%) of private sector construction contractors believed that being committed to a project was the single *most* important task related quality in the management of projects. However, it was surprising in the private sector that more emphasis was not given to important task related qualities such as innovation, creativeness or ability to predict trends and the like. Overall, in terms of satisfying a client's prestated needs, commitment remained the critical factor.

Figure 10.44 : Task Related Qualities Most Important For project Managers



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the factors affecting tradesmen's productivity between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 49A, 49B & 49C

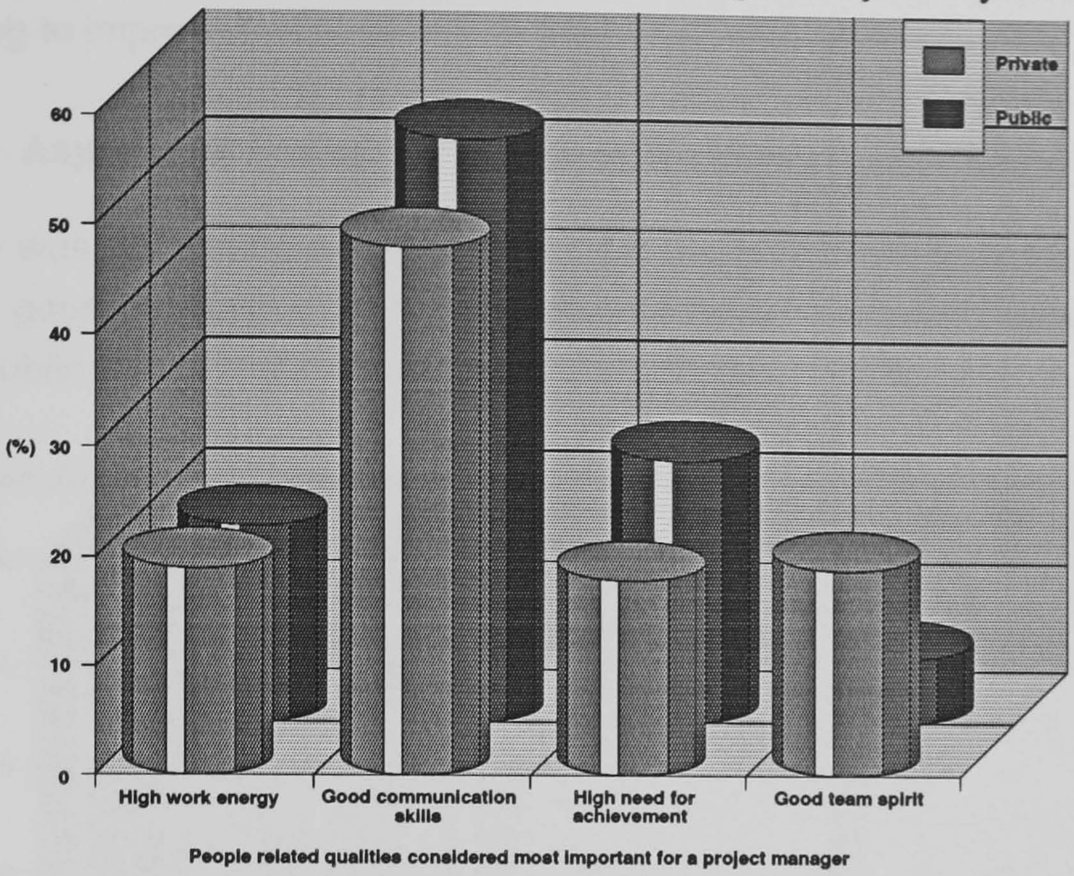
Similarly, almost two thirds (65%) of public sector construction contractors believed that being committed to a project was the single most important task related attribute required of project staff. Clearly project managers considered such aspects as creativity and innovation to be very much secondary. It was clear that commitment to produce what the client wanted to the correct specification and to the required timescale were the fundamental task objectives.

Commitment to a project was by far the most important factor required of personnel of any level when involved in the undertaking of a project. Such commitment will help in the formulation of good project groups, teams and promote good working relationships. This in turn should lead to a good 'all-round' harmonious environment.

10.60 People Related Qualities Considered Most Important

There was no significant difference in the people related qualities considered most important in private and public sector construction contractors from a project manager's viewpoint. (Figure 10.45)

Figure 10.45 : People Related Qualities Most Important for Project Managers



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the people related qualities considered most important in private and public sector construction contractors from a project managers viewpoint.

Source : Survey Results - Derived from Appendix C, Tables 50A & 50B

Almost half (48%) of construction contractors in the private sector considered good communication as being the *most* important people related quality in the management of projects. To a lesser extent high work energy, good team spirit and a deep need for achievement were considered *most* important by around one in five respondents in each category. The importance of 'human' elements such as communication were vital ingredients to the successful execution of a project. All activities within a project including planning, quality and control required formal and informal communications to translate information to the appropriate project personnel. Likewise, informal communications were vital in establishing a harmonious working environment via social interaction and would inevitably assist in achieving optimum 'human' performance.

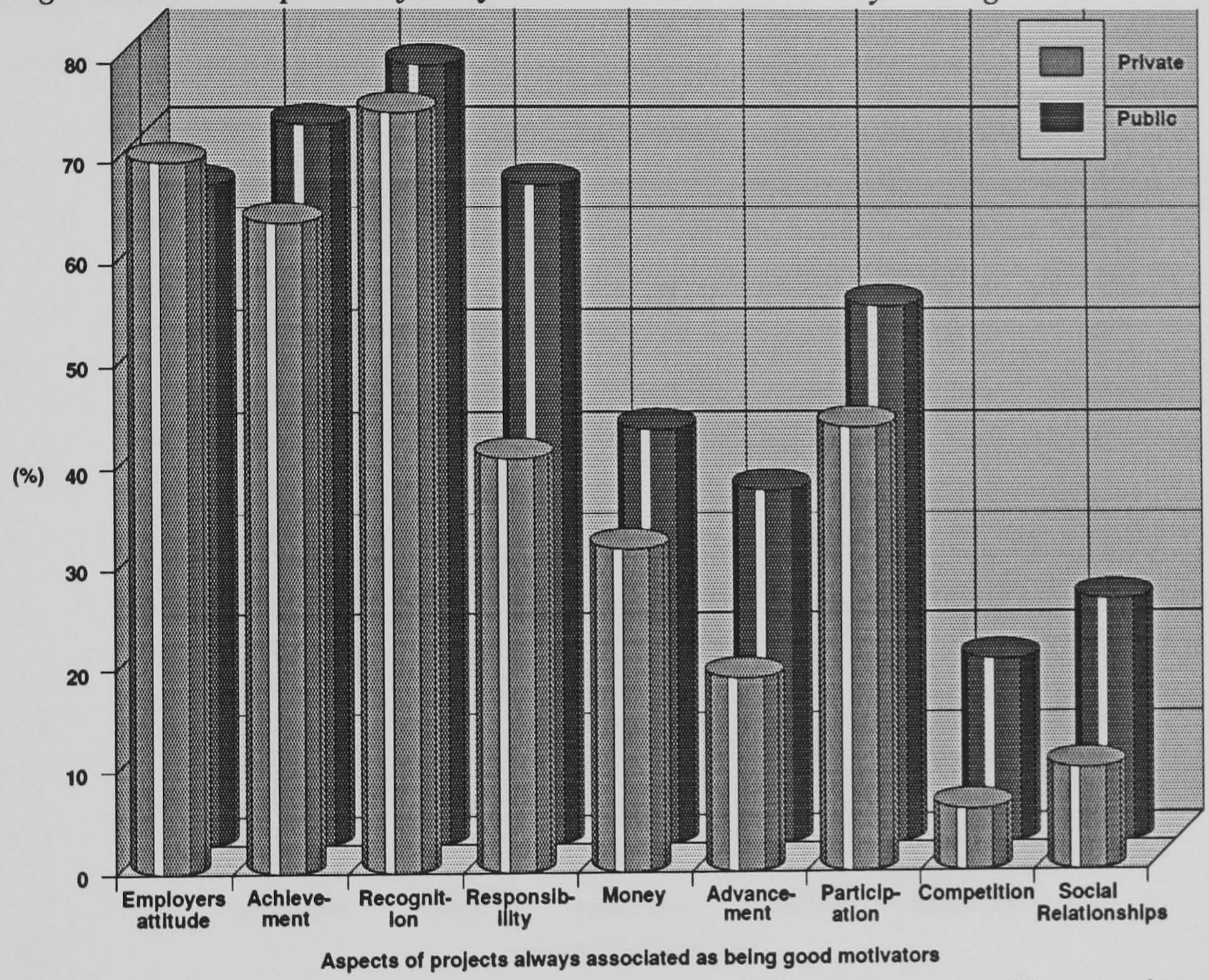
Just over half (53%) of public sector construction contractors, in a similar fashion, considered good communication as being extremely important.

The results from the private and public sectors were consistent; that is, good communication skills were looked upon as the *most* important people related factor for a project manager to be effective. Good communication skills will lead to informed project personnel, who in the main, will be better motivated, leading to improved performance in the project environment.

10.61 Aspects Of Projects Associated As Being Good Motivators

There was no significant difference in the aspects of projects associated as being good motivators from a project manager's viewpoint between private and public sector construction contractors. (Figure 10.46)

Figure 10.46 : Aspects Of Projects Associated As Always Being Good Motivators



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the aspects of projects from a project manager's viewpoint associated as always being good motivators

Source : Survey Results - Derived from Appendix C, Tables 51A, 51B & 51C

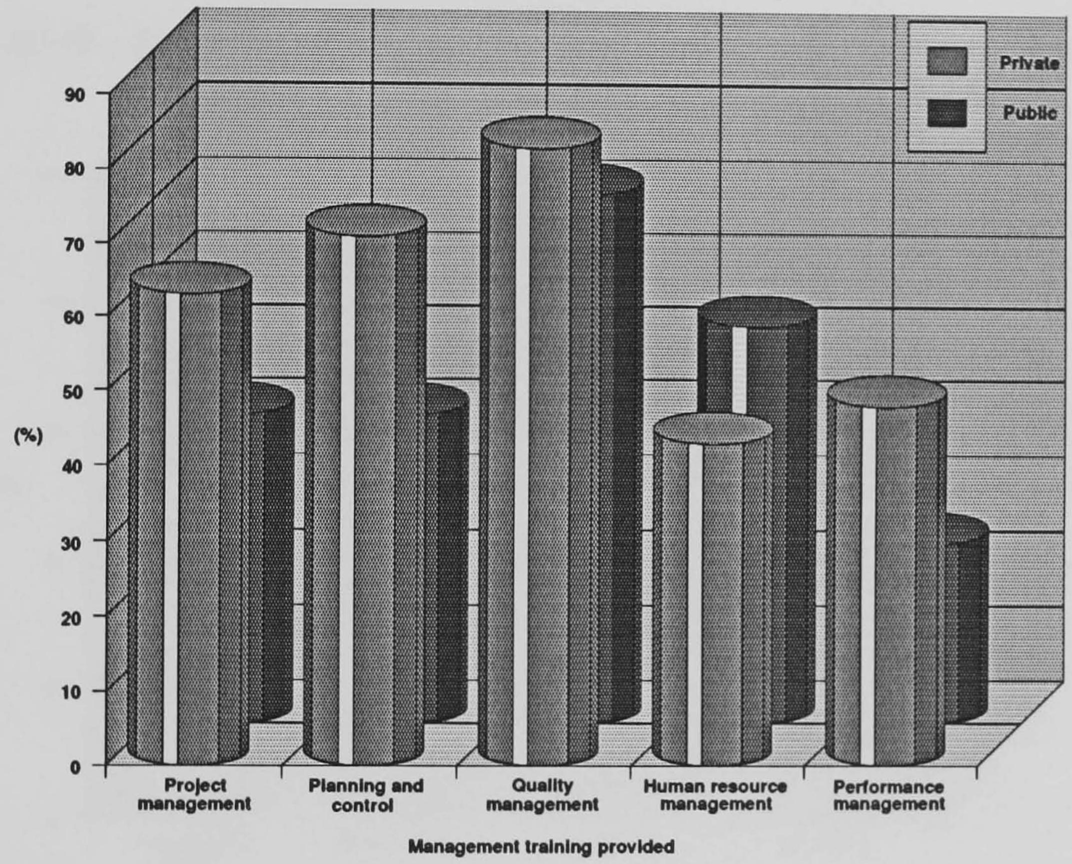
It was evident that certain factors appeared to be consistently looked upon as being good motivators, whereas, others did not. Main motivators in both private and public sector construction contractors included an employer's attitude, achievement, recognition and responsibility. Therefore, it is important that employers take note of these factors and attempt to match the needs of their employees, wherever possible.

Surprisingly, money and advancement were not considered to be major motivators which was encouraging from the perspective that employees were not solely motivated by promotional and salary issues, but more by taking on increased responsibility and being recognised for any achievements that they might make. Also of note was that social relationships within the project environment did not appear to improve motivation.

10.62 Management Training

Figure 10.47 shows the management training provided by private and public sector construction contractors.

Figure 10.47 : Management Training Provided



Source : Survey Results - Derived from Appendix C, Tables 52A & 52B

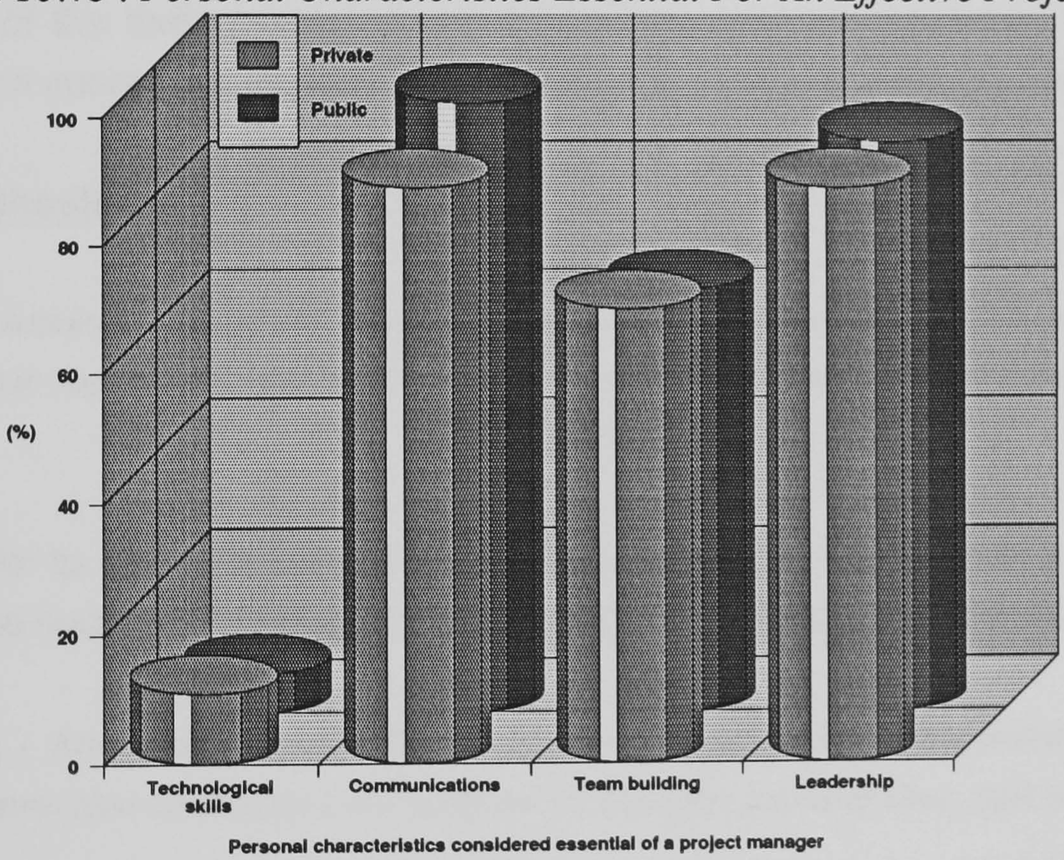
Around three quarters of private sector construction contractors provided management training in project management (63%), planning and control (71%) and quality management (82%). However, less than half provided training in human resource management (43%) or performance management (48%). It was clear that the traditional philosophy of project management being associated with purely time, cost or quality parameters was still prevalent within many private sector construction contractor organisations.

Around a half of public sector construction contractors provided training in project management (41%), planning and control (41%) and human resource management (53%). However, only a quarter (24%) provided training in performance management. With the exception of quality it appears that there was much room for improvement in the training of project management disciplines.This tied in with the general lack of use of such procedures by the public sector.

10.63 Personal Characteristics Of An Effective Project Manager

There was no significant difference in the personal characteristics considered essential for a project manager between private and public sector construction contractors. (Figure 10.48)

Figure 10.48 : Personal Characteristics Essential For An Effective Project Manager



Statistical analysis showed that the null hypothesis H_0 can be accepted - that is, there was no difference in the personal characteristics of a project manager between private and public sector construction contractors.

Source : Survey Results - Derived from Appendix C, Tables 53A, 53B & 53C

Modern management skills were considered much more important than technological skills with respect to being an effective project manager. In fact only a few contractors in the private (11%) and public (6%) sectors believed that technological skills were needed.

Communications (89%), leadership (89%) and team building (70%) were, however, considered essential qualities by the majority of private sector construction contractors. Likewise, construction contractors in the public sector looked upon communications (94%), leadership (88%) and team building (65%) in a similar fashion.

It was evident that human resource management skills including communications, team building and leadership were unanimously considered essential for project managers. Mere technological knowledge was not looked upon as being particularly important, further emphasising that managerial and not technical ability was deemed to be much more vital for project managers.

10.64 DECISIONS ON HUMAN RESOURCE MANAGEMENT HYPOTHESES

Each of the three prestated hypotheses are now considered in conjunction with the survey results with regard to human resource management.

Hypothesis H_1

H_1 Attempts to improve human resource management within private and public sector construction contractors are eclipsed by considerations of time, cost and quality

In order to allow meaningful decisions to be made with respect to *Hypothesis H_1*, it is necessary to divide it into two sub- hypotheses, as follows.

$H_{1.1}$ Attempts to improve human resource management within private sector construction contractors are eclipsed by considerations of time, cost and quality

$H_{1.2}$ Attempts to improve human resource management within public sector construction contractors are looked at in a similar fashion to considerations of time, cost and quality

It was previously discovered in the organisational section of this chapter, that there appeared to be a 'tiered' approach to the use of project management procedures. Table 10.8 shows this below.

Table 10.8 : Project Management Procedures Always Operated (All Turnovers)

Project Management Procedure Always Operated (all Turnovers)	Private Sector (%)	Public Sector (%)
Time	84%	41%
Cost	64%	23%
Quality	44%	0%
Human Resource Management	24%	29%

The results showed that in the private sector the consideration given to issues of human resource management was small compared to that given to other project management procedures, namely, time, cost and quality. Less than one in four (24%) of private sector construction contractors *always* took the human factor into account in the management of their projects.

In public sector construction contractors, where the adoption of project management procedures was very limited in all areas, there was no real difference between the considerations given to human resource management and time, cost or quality.

Furthermore, Table 10.9 shows that the extent of use of project management procedures was unaffected by the size of the organisation. In other words, the results were equally applicable to all organisations within the survey.

Table 10.9 : Project Management Procedures Always Operated (Turnovers < £100M)

Project Management Procedure Always Operated (Turnovers < £100M)	Private Sector (%)	Public Sector (%)
Time	86%	41%
Cost	61%	23%
Quality	48%	0%
Human Resource Management	20%	29%

Therefore, the revised *Sub-hypotheses* $H_{1.1}$ and *Hypotheses* $H_{1.2}$ were supported, that is *attempts to improve human resource management within private sector construction contractors are eclipsed by considerations of time, cost and quality ....and attempts to improve human resource management within public sector construction contractors are looked at in a similar fashion to considerations of time, cost and quality.*

Hypothesis H_2

H_2 The perception between private and public sector construction contractors on motivational issues relating to job satisfaction or job dissatisfaction from a project manager's viewpoint is different

The results of the survey were not conclusive with respect to *Hypothesis H_2* as it stands. Therefore, in order to allow more meaningful decisions to be made it is necessary to divide the Hypothesis into two sub-hypotheses as follows :

$H_{2.1}$ The perception between private and public sector construction contractors on motivational issues relating to job satisfaction from a project manager's viewpoint is not different

$H_{2.2}$ The perception between private and public sector construction contractors on motivational issues relating to job dissatisfaction from a project manager's viewpoint is different

Different aspects of projects provide job satisfaction for different managerial levels. In both private and public sector construction contractors, project managers predominantly gained job satisfaction from making a profit. They perceived site supervisors, or agents as getting satisfaction from completing a project, or elements of a project on time and foremen from keeping to schedule and achieving a high standard of workmanship. There were therefore no significant differences between the aspects of projects causing job satisfaction between private and public sector construction contractors. Therefore, *Sub-hypothesis $H_{2.1}$* was supported, that is, *the perception between private and public sector construction contractors on motivational issues relating to job satisfaction from a project manager's viewpoint is not different.*

There was a difference in viewpoint relating to issues which caused job dissatisfaction between private and public sector construction contractors. Although project managers in both the private and public sectors described company or personal mistakes as major dissatisfiers their perception of site supervisors or agents and foremen were different. Specifically, they saw site supervisors or agents in the private sector as being dissatisfied as a result of a project not keeping to schedule, but in the public sector it was a consequence of company or personal mistakes. Foremen in private sector construction contractors were perceived as being dissatisfied if workmanship was poor, or if they were uncooperative and in the public sector dissatisfaction was caused by a lack of incentives and uncooperative workmen.

Therefore, *Sub-hypothesis* $H_{2.2}$ was supported, that is, *the perception between private and public sector construction contractors on motivational issues relating to job dissatisfaction from a project manager's viewpoint is different.*

Hypothesis H_3

H_3 Project manager performance is assessed primarily on human management skills such as team building, communication and leadership skills in both private and public sector construction contractors

There was no support for *Hypothesis* H_3 from the survey results.

It has been shown that both private and public sector construction contractors considered team building, communications and leadership skills to be much more important personal personal characteristics of a project manager than technological skills. However, despite the importance of these personal attributes, they did not form part of the assessment process of how a project manager had performed on a particular project.

Almost two thirds (61%) of project managers in the private sector and more than half (59%) in the public sector, considered that making a profit on a project was the most critical factor involved in the assessment of a project manager's performance.

It was evident that organisations judged their project managers purely on a 'profitability' basis. Whilst profit was clearly important, private and public sector construction contractors might be better advised to look at a wider view of how their project managers had performed, by considering human resource considerations.

Therefore, *Hypothesis* H_3 was not supported, that is, *project manager performance is <u>not</u> assessed primarily on human management skills such as team building, communication and leadership skills in both private and public sector construction contractors.*

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CHAPTER ELEVEN : CONCLUSIONS AND RECOMMENDATIONS : INCLUDING CONTRIBUTION AND IMPLICATION OF FINDINGS

11.1 SUMMARY OF CHAPTER ELEVEN

The main objective of this Chapter is to present an executive summary of the findings, to draw conclusions, assess the contribution to literature and to discuss the implications of the findings. These are followed by recommendations under each subject heading.

Particular attention will be paid to how the findings relate to the background theory put forward in the literature review and the focal theory as discussed in the prestated hypotheses which were developed in Chapter Eight.

Concluding remarks, a brief critique and recommendations for further research are presented at the end of the Chapter.

EXECUTIVE SUMMARY

Organisational Profile

- Private sector construction contractors had larger turnovers than public sector construction contractors

- Private sector construction contractors employed more salaried staff than public sector construction contractors

- There was no difference between the number of manual workers employed in private or public sector construction contractors

- Private sector construction contractors used sub-contractors to a far greater degree than public sector construction contractors

- The average value of a single project carried out by private sector construction contractors was far greater than that carried out by public sector construction contractors

- Projects carried out by private sector construction contractors were more complex and required a greater degree of modelling of the 'baseline' plan than for projects carried out by public sector construction contractors

- A number of project objectives, including satisfaction of client, quality, completion on time and making a profit were considered equally important by private sector construction contractors

  Public sector construction contractors considered profit singularly as the most important project objective

- Both private and public sector construction contractors viewed human resource management skills and planning and organisational skills for project managers to be much more relevant than technical knowledge

- Project management procedures with respect to time, cost, quality and human resource management were not considered to a great extent by either private or public sector construction contractors

  However, private sector construction contractors did operate such procedures to a greater extent than public sector construction contractors

- Both private and public sector construction contractors believed that only some of the project management procedures that they operated were adequate. Time was perceived as being more adequately addressed than either cost, quality or human resource considerations

- Both private and sector construction contractors assessed project manager performance primarily on the project manager's ability to make a profit on a project

- Little attention was paid to the organisational structure to be adopted for a particular project by either private or public sector construction contractors

- Both private and public sector construction contractors considered the British Standard for quality management BS 5750 to be relevant to their businesses and many practised the principles contained within it

- Both private and public sector construction contractors did not consider the British Standard for the use of network techniques in project management BS 6046 to be of assistance to the management of their businesses

<u>Project Planning And Control</u>

- Both private and public sector construction contractors considered that the most important reason(s) for planning was to improve operational efficiency and to provide a basis for monitoring and controlling work

- Risk analysis in the construction phase was not considered to any great degree by private and public sector construction contractors

However, private sector construction contractors adopted the use of 'what if' scenarios and the like to a greater degree than public sector construction contractors

- Barcharts were considered the most frequently used planning technique used by private and public sector construction contractors

- Private sector construction contractors operated sophisticated planning methods more frequently than public sector construction contractors including the use of linked barcharts and network techniques

These were related to : the average value and the complexity of a project in terms of the number of activities to be modelled

- Private sector construction contractors adopted the principles of work breakdown structures to a far greater degree than public sector construction contractors

These were related to : the average value and the complexity of a project in terms of the number of activities to be modelled

- Private sector construction contractors adopted the principles of linear responsibility charts to a limited extent. No public sector construction contractors used this technique.

There was no clear relationship to the average value and the complexity of a project in terms of the number of activities to be modelled

- Private and public sector construction contractors took similar factors into account in the formulation of a time based plan for a project

- Little attention was paid to resource optimisation by either private or public sector construction contractors

- Private sector construction contractors monitored and controlled time, resources and costs to a far greater degree than public sector construction contractors

- Private sector construction contractors monitored cash flow to a far greater degree than public sector construction contractors

- Both private and public sector construction contractors carried out costing independently of the planning and control process

    However, both private and public sector construction contractors believed strongly that costing should be integrated with the planning and control process

- Performance analysis techniques, such as earned value analysis, were not extensively used by either private or public sector construction contractors

    However, private sector construction contractors adopted the use of such techniques to a greater degree than public sector construction contractors

- Both private and public sector construction contractors assessed how much work had been carried out on a project by using the percentage complete method

- Private sector construction contractors used a computerised approach to project planning and control to a much greater degree than public sector construction contractors

- Those private sector construction contractors who used a computerised approach to project planning and control believed strongly that it offered significant advantages over manual methods

    However, the limited number of public sector construction contractors who used a computerised approach to project planning and control did not have such a firm founded belief

• Both private and public sector construction contractors believed that planning and control systems did identify problems causing variances and the impact of these problems on projects

However, both private and public sector construction contractors commented that such systems did not give aid with respect to the corrective action to be taken to resolve a particular problem

Quality Management

• Both private and public sector construction contractors had a strong commitment to quality and generally had written quality policy statements

• Both private and public sector construction contractors considered that the adoption of Quality Assurance methods provided a greater opportunity for reducing overall project costs than other methods such as quality control

• Private sector construction contractors adopted a variety of forms of providing Quality Assurance, including first party, second party and third party

Public sector construction contractors only operated third party quality management systems

• BSI Quality Assurance, although a different organisation from BSI Standards, was by far the most frequently used accreditation body by both private and public sector construction contractors

• Private sector construction contractors applied quality management systems to all areas of their business, whereas public sector construction contractors applied such systems to relatively small areas of their business

• Private sector construction contractors adopted third party quality management systems to improve efficiency and improve competitive, or marketing advantage

On the other hand, public sector construction contractors adopted such systems primarily to meet client or contractual requirements

- Private sector construction contractors employed more staff purely involved in quality Assurance than public sector construction contractors

In public sector construction contractors, the role of the Quality Assurance manager or auditor, was normally considered in tandem with other duties

- Private sector construction contractors operated quality management systems which were more comprehensive than those operated by public sector construction contractors

Management Of Human Resources

- Project managers' perception of the most important management principles involved in the management of projects differed between private and public sector construction contractors

- Both private and public sector construction contractors considered general foremen to be managers in the project environment

- Factors causing job satisfaction in the execution of projects were similar between private and public sector construction contractors

- Factors causing job dissatisfaction in the execution of projects were different between private and public sector construction contractors

In public sector construction contractors lack of incentives for foremen was perceived as causing job dissatisfaction

- Factors affecting tradesmen's productivity were viewed similarly between private and public sector construction contractors

In public sector construction contractors absenteeism was identified as a continuing problem, attributable to the generous working conditions offered

- Commitment to the project was considered to be the most important task related attribute required of project managers by private and public sector construction contractors

- Good communication skills was the most important people related quality required of project managers by private and public sector construction contractors

- Private and public sector construction contractors viewed factors which give rise to improved motivation on projects in a similar fashion

- Communications, team building and leadership were considered to be the most important personal characteristics of project managers in both private and public sector construction contractors

11.2 ORGANISATION PROFILE

11.2.1 Summary of background theory and research findings

Chapter Three looked at the strategic and organisational environment of projects, analysing briefly the reasons why construction contractors undertook projects.

Before this Chapter Two had considered the background theory of how private and public sector construction contractors compete with one another for certain categories of works in the civil engineering construction industry. In particular, the introduction of compulsory competitive tendering (CCT) legislation which necessitated in DLOs having to make specific rate of returns on individual categories of works was studied. In tandem with CCT requirements, public sector construction contractors were seen to be also subjected to the Local Authorities (Goods and Services) Act 1970, which severely placed limitations on the markets in which public sector construction contractors could operate. Clearly, with public sector construction contractors really only being able to work in a single market area and in competition, many works which they used to carry out 'as a matter of right' have transferred to the private sector.

This background theory, described in Chapters Two and Three, led to the formulation of three hypotheses with respect to organisational profile. However before looking at each in turn it is worth looking at a summary of the results with respect to organisational profile shown in Table 11.1. This table essentially identifies the areas of similarities and the differences in approaches between private and public sector contractors with regard to organisation profile.

Table 11.1 : Organisation Profile Survey Results

Difference In approach between private and public sector construction contractors ?	*YES*	*NO*
Size of responding organisations	•	
Number of salaried employees	•	
Number of manual staff employed		•
Percentage use of sub-contractors	•	
Average value of a single project	•	
Average number of activities modelled within projects	•	
Project objective considered most important	•	
Skills considered most appropriate for project managers		•
Procedures always operated with respect to project planning and control, quality and H.R.M	•	
Most important factors considered in assessing project manager performance		•
Form of organisational structure adopted for projects		•
Attitudes to the relevance and adoption of BS 5750 : Part 2		•

Private sector construction contractors generally had larger annual construction turnovers than in the public sector, this being directly as a result of their ability to operate in a free market environment. In contrast, in the public arena, where construction contractors were only permitted to operate in very restricted areas as a result of The Goods And Services Act (1970), the turnover potential appeared to be extremely limited.

The numbers of salaried staff employed by the private and public sectors was different; however, the number of manual employees was similar. This might be explained by two reasons. Firstly, the greater turnover and use of sub-contractors in the private sector required more salaried staff to be employed. Secondly, as a result of the extensive use of sub-contractors in the private sector in the execution of their projects, the number of manually employed staff was not commensurate with the volume of work that they undertook. The public sector, in the main, carried out the vast majority of their works using their own manual workers.

Projects carried out by private sector construction contractors were also greater in value than those carried out in the public sector. Again, the limited markets that the public sector might legally operate in essentially dictated that they must work in effectively a single market; therefore, work undertaken was normally funded from Local Authority Council budgets which were limited in value and usually consisted of a number of smaller type projects rather than the major renewal of infrastructure. Projects undertaken in the private sector generally required more activities to be modelled in view of their larger size and frequently greater complexity.

The most important project objective when undertaking projects will influence the manner in which a company goes about its business. Profit was the underlying principal objective in the public sector, whereas a combination of satisfying the client, quality, completion on time and profit, either all together of in different combinations, were equally considered in the private sector.

The role of the project manager is vital to the successful execution of a project. Human resource skills alongside planning and organisational abilities were considered the most appropriate skills for project managers by both sectors of the industry in the management of projects. However, when it came to assessing how a project manager had performed in the management of a project, it seems they were judged primarily on their ability to make a profit on a particular project in private and public sector construction contractors alike.

The forms of organisational structure adopted for projects were found to be quite varied, although the traditional functional or pyramid type was still the most popular. However, it was identified that little attention appeared to be paid with regard to the setting-up of an 'appropriate' organisational type for a particular project.

The use of project management procedures with respect to time, cost, quality and human resource considerations was limited in the private and public sectors alike, but was particularly so in the public sector. In general the management of time was considered to a greater degree than cost, quality or human resource aspects. In essence, a 'tiered' approach to the use of such procedures appeared to be the norm.

It was identified that private sector construction contractors were estimated to be more 'efficient' than public sector construction contractors with respect to the adoption and use of vital project management procedures. Project managers in both sectors of the industry believed that the frequent use of project management procedures could result in increased efficiency, the degree of improvement dependent on the extent of such procedures that were already in operation. These results indicated that both private and public sector construction contractors did realise the potential benefits that the adoption of project management procedures might provide.

Clearly the organisational differences between the private and public sectors in terms of the size of a particular organisation, the number of staff employed, the average value of a contract, the number of activities modelled within a project, the most important project objective and the extent of use of project management procedures will influence the planning, quality and human resource procedures operated within that same organisation.

11.2.2 Organisation Profile : Contribution And Implication Of Findings

<u>Approach to construction projects</u>

The first hypothesis (O_1) suggested that there are differences in approach to construction projects between private and public sector construction contractors. It is worthwhile, at this stage, restating that for organisations with turnovers of £100M, or less, there was not a significant difference in size between private and public sector construction contractors.

Although private and public sector construction contractors carried out projects in competition with each other, they adopted different approaches to the management of projects.

The introduction of compulsory competitive tendering (CCT) and the inability of contractors in the public sector to be able to operate in a free market environment, as restricted by the Goods and Services Act (1970), has had a marked affect on their approach to their business. The public sector construction share of the repair and maintenance contribution to GDP has fallen from 66% in 1982 to 53% in 1991, and is continuing to fall further still. Not being able to compensate for this by venturing into new markets has resulted in the public sector having to reduce their staffing levels (both salaried and manual) by a considerable amount.

Projects were identified as being staffed differently in the private and public sectors. The private sector maintained a base level of manual and salaried staff and augmented the manual side by the extensive use of sub-contracting depending on the volume of work they were undertaking. The public sector, however, had staff numbers relative to a single 'fixed' market area of work and their ability to sustain their manpower levels was dependent on whether they won enough of this work. This was further complicated by the fact that many public sector construction contractors operated 'no redundancy' policies within their organisations, which if work was not obtained, were still held to be applicable. Furthermore, many public sector construction contractors tended not to employ sub-contractors on the vast majority of their works.

The legislation imposed on DLOs in terms of CCT and the Goods and Services Act, (which limits markets in which they may legally operate), is contrary to the principles of good business planning and was perceived by public sector construction contractors as *not* being in the spirit of promoting *fair* competition between the two sectors to encourage value for money in the execution of projects. In view of this it is hardly surprising that public sector construction contractors have either 'gone to the wall', or have privatised, to allow greater freedom in going about their business.

In the main, private sector construction contractors undertook larger, more complex projects than their public sector counterparts because of their ability to operate in a free market environment, which also allowed them to 'balance out' the inevitable problems that might occur in such a competitive industry if all effort was concentrated on a single market area. Public sector construction contractors cannot optimise their workload by operating in different markets and it is difficult to see, under such constraints, how these organisations can provide value for money and gain sufficient commercial experience to allow long term survival.

Furthermore, public sector construction contractors did not appear to focus their operations on a project oriented basis. This matches closely the views put forward by Payne (1993) and Heredia (1993) who both concluded that in the public sector the concept of 'projects' was not readily understood.

Extent Of Use Of Project Management Procedures

The second hypothesis *(O_2)* suggested that project management procedures are not extensively used by either private or public sector construction contractors.

Project managers in both private and public sector construction contractors believed that the frequent use of project management procedures could result in improved operational efficiency. Both operated in competition with one another for works and it was reasonable to expect the extent of the use of project management procedures would be similar in both sectors. However, the use of project management procedures was found to be limited in both private or public sector construction contractors, although their use was greater in the private sector. Gibble (1986) has put forward that many project failures are a result of improper management and much literature exists on failures associated with many projects including, Warren (1978), Morris and Hough (1987) and Williams (1993) where basic time, cost or quality objectives have not being met. The benefits of using project management procedures have been advocated by many authors, including Badiru (1988).

Indeed, there appeared to be a 'tiered' effect with respect to the adoption of project management procedures which could be explained to a limited degree by the fact that construction contractors considered time in projects to be the significant control factor with costs being strongly related to the time taken. However, time and cost are clearly related and should be considered together to get an accurate perspective, or snapshot, of a project's status at any moment in time.

Overall, it was established that an organisation's turnover did not influence the adoption of project management procedures. However, in smaller private sector construction contractors with turnovers of less than £100M, the use of such procedures, when compared with public sector construction contractors, was significantly greater.

In instances where project management procedures are not being operated, a project manager will not have the best available 'tools' for the management of a project. It is therefore probable that less than optimum performance will be experienced. In essence, efforts should be made to improve the frequency of use of all project management procedures and, in particular, cost, quality and human resource management considerations by both private and public sector construction contractors. The potential for improvement is clearly greater in the public sector, where the use of project management procedures was very limited.

Project Objectives

The third hypothesis *(0_3)* put forward the principle that making a profit continues to be the most important project objective for both private and public sector construction contractors.

It was evident that the effect of CCT legislation, including a specified rate of return to be achieved, the restrictions placed upon DLOs by the Goods and Services Act and continually changing legislation, has had the effect of introducing a 'must make a profit' culture throughout these organisations. Whilst this might have been a primary aim in order for DLOs to be more favourably perceived by tax payers, it has been achieved to the detriment of other important project objectives such as client or customer satisfaction or quality. However, the emphasis on profit is consistent with the views of Wearne (1989) and Barnes (1993) who both described the importance of profit as a major consideration in the management of projects.

However in stark contrast, there was virtually no monitoring of cash flow throughout the concurrency of their projects. This essentially epitomised the nature in which most DLOs operated; that was, they calculated their profitability on a project by project basis, at the end of project, and calculated an overall rate of return at the end of each financial year. Cash flow, the 'lifeblood' or sometimes even 'lifeline' of all private sector companies on a month-to-month basis was normally conveniently ignored.

The private sector must continually satisfy their clients or customers to obtain payment and with a view to enhancing their reputation in order to encourage opportunities of follow-up work. Although profit was considered important, it was looked at in conjunction with other important project objectives, particularly in relation to satisfaction of the client. Many private sector construction contractors took this even further and believed that completion of a project on time, satisfaction of the client, quality and completion within budgeted costs and making a profit might all be considered equally important. This wider view of the most important project objective(s) was similar to those put forward by Lock (1987) and Newcombe, Langford and Fellows (1990) who both looked at issues such as client satisfaction, over and above that of making of a profit.

Private sector construction contractors did, however, consider cash flow as being of critical importance in the financial management of their projects, and monitored it on a frequent basis to ascertain the current liquidity of their organisation.

11.2.3 Organisation Profile : Recommendations

(1) Public sector construction contractors must adopt a project orientated approach to the management of their projects.

(2) Public sector construction contractors, when considering staffing for their projects, should look at the optimum configuration of their own salaried and manual staff along including the use of sub-contractors, on occasions.

(3) Both private and public sector construction contractors must make themselves more aware of the various project management procedures that are available to aid the project manager in the management of projects. In particular cost, quality and human resource management should be considered equally along with the management of time.

(4) Attention should be paid by both private and public sector construction contractors not to judge their project managers solely on their ability to make a profit on a particular project.

(5) Much greater consideration should be given at the outset of projects with respect to the organisational form to be adopted in the subsequent management of the project.

11.3 PLANNING AND CONTROL

11.3.1 Planning and control : Summary of background theory and research findings

Chapter 4 analysed the planning function in the management of projects. The reasons and purpose of planning set the scene on how projects can be represented in plan form and used to set pre-determined targets for time, cost and resources for all activities associated with a project.

A number of planning techniques were analysed including the use of bar chart and network analysis. This initial analysis was developed further to show how time and activity relationships form an important part in the preparation of a 'baseline' plan for a project. Only then was it relevant to take into account resource planning into the overall planning process. The output from the planning process was a series of project schedules identifying the critical activities within a project and those areas where there was some 'flexibility' within the overall programme with respect to the available duration for completion.

The use of work breakdown structures to define what work is to be done and by who was shown as being useful in providing a common framework for a project from which costs and budgets can be established, and thereafter tracked in the execution phase. Similarly linear responsibility charts to depict project reporting structures and levels of authority and responsibility and the like were identified as a useful tool to communicate effectively the project objectives to all necessary project personnel.

The benefits that might be obtained from the adoption of performance analysis techniques and management cost and control systems (MCCS) to integrate all parameters within a project, and in particular, time and cost concluded the chapter.

Chapter 5 looked at project management planning and control software and identified how it might be used to aid greatly in determining optimal solutions to scheduling problems and in the tracking of project status once in progress.

This background material led to the formulisation of four hypotheses; however before looking briefly at each in turn it is worthwhile looking at a summary of the results with respect to project planning and control which are shown in Table 11.2. This table essentially identifies the areas of similarities and the differences in approaches between private and public sector contractors with regard to project planning and control.

Table 11.2 : Project Planning And Control Survey Results

Difference in approach between private and public sector construction contractors ?	***YES***	***NO***
Reasons considered most important for planning		•
Forms of risk analysis considered	•	
Planning techniques utilised	•	
The effect of the number of activities on the choice of planning technique	•	
Adoption of work breakdown structures	•	
Utilisation of linear responsibility charts	•	
Factors taken into account in the formulation of a time based plan for a project		•
Use of resource optimisation techniques		•
Techniques always or sometimes used to monitor time/cost/resources	•	
Elements of costs/resources monitored		•
Method of carrying out costing on projects		•
Opinions on whether costing should be integrated with the planning and control function		•
Use of performance analysis techniques	•	
Assessing how much work has been carried out		•
Use of a computerised approach to project planning and control	•	
Benefits from project management planning and control software	•	
Areas which current planning and control systems identify		•
Planning and control of multiple projects		•

Both private and public sector construction contractors believed in the principles of planning for the same reasons, namely, as a means of improving operational efficiency and of providing a basis for monitoring and controlling future work.

However, there were a number of differences in the techniques used for planning by the two sectors in practice. These included that the private sector frequently adopted network analysis or linked barchart methods rather than purely the basic barchart favoured in the public sector. Similarly, there was some use of work breakdown structures and linear responsibility charts to breakdown and organise work which was not 'mirrored' in the public sector. Furthermore, the use of performance analysis and extensive use of computerised methods for project planning and control were identified in the private sector.

In the planning process, there were also a number of areas where similarities existed in the approaches between private and public sector construction contractors. Both took into account a number of factors in the formulation of a time based plan for a project. However, very little refinement of such time based plans was carried out by subsequent resource optimisation techniques. The principal method for assessing the amount of work carried out by both sectors was the percentage complete, despite its limitations. Costing was predominantly carried out outwith the planning and control process, although there was a common wish by both private and public sector construction contractors to have cost integrated into the planning and control function. This was considered essential if accurate project performance monitoring was to be achieved.

In the project execution phase the private sector exercised much more control in terms of planning 'follow through' than in the public sector, in the manner that they monitored and controlled time, cost and resources. In fact, virtually no monitoring/control was carried out in the public sector.

Of those who used a computerised approach to project planning and control the private sector considered that significant advantages might be gained over manual methods. However, in the public sector, where their use was very limited, much less of a vote of confidence was given to computerised methods.

It was identified that there were two areas where project management planning and control software did not assist the project manager to any appreciable extent. These were in determining the corrective action to be taken to resolve a particular problem (which had arisen from the planning and scheduling process) and in the multi-project scheduling of time, resources and costs across a number of different projects.

11.3.2 Planning and Control : Contribution And Implication Of Findings

Project Planning Methods

The first hypotheses (P_1) suggested that private sector construction contractors operate more sophisticated project planning and control methods than public sector construction contractors.
In the main private sector construction contractors were seen to operate project planning procedures more frequently than the private sector and they also used a much wider range of techniques available. These included the use of 'what if' analysis, more extensive use of network procedures, work breakdown status, linear responsibility charts, performance analysis techniques and a computerised approach to project planning and control.

Where such techniques were operated a number of benefits might be gleaned. These include the opportunity of predicting more accurately the outcome of various project scenarios when using computerised methods and improved project communications when adopting work breakdown structures and linear responsibility charts. This ties in closely with the philosophy put forward by Baker, Murphy and Fisher (1988) who identified many areas where public opinion of contractors operating in the private sector was considered to be much higher than for those in the public sector. In particular public sector construction contractors were perceived as being inefficient, behind schedule, over budget and poorly planned.

In all instances it has to be said that the better the 'baseline' planning, the more likely is the chance for improved efficiency and a firm foundation for control in the subsequent execution phase. In this respect, private sector construction contractors currently have a distinct advantage over the public sector.

In the public sector there was a limited use of such project planning procedures, partly attributable to the lack of awareness or knowledge of the availability and assistance that they might provide in the management of projects. The excuse frequently put forward (that their projects were relatively straightforward and did not merit to any great extent the use of planning and control methods), was a very weak one. It is not possible to exercise effective control without a defined set of parameters to monitor progress against, be it, time, cost, quality or whatever.

The limited front-end planning in the public sector was not, in the main, followed through to the control phase and hence any value from the 'baseline' planning was essentially lost.

Indeed, where many smaller projects were being undertaken simultaneously, as was common in public sector construction contractors, it might be argued that it was even more critical to have proper control over all resources - otherwise a series of small recurring inefficiencies might lead to a major problem.

Clearly, it would be prudent of those public sector construction contractors intending to succeed competitively against the private sector that they look at, consider and implement some of the project planning procedures available, particularly in the area of multi-project control. The private sector too, cannot become complacent on their utilisation of available planning techniques.

Project Costing

The second hypothesis (P_2) postulated that costing on projects is carried out independently of the planning and control process by private and public sector construction contractors.

It is most important to consider time and cost together to assess a true picture of a project's progress at a particular moment in time. However, universally, contractors in both sectors were carrying out costing independently of planning and control. Performance can only be judged if time and cost are looked at in tandem, otherwise, misrepresentations of true project status may be experienced.

In essence private and public sector construction contractors were operating dual monitoring and reporting systems, neither of which independently, would give a project manager an accurate 'snapshot' view of a project's performance. Cost information is always retrospective with respect to time so that, if parallel systems are in process, inaccurate status reporting is likely. Furthermore there was unanimity in both sectors that they were having to operate parallel systems against their own beliefs.

This is against the principles put forward by many including Stevens (1986), Barnes (1988), Kerzner (1992) and Oberlender (1993) who all identified and expressed the importance for cost and time to be considered together and commented on the problems that might be encountered if they are not.

One of the main reasons for the problems encountered in the analysis of the time and cost interface was the type of project management planning and control software systems currently available on the market. Their apparent lack of flexibility and restricted 'back-up' from vendors has resulted in many contractors not developing the database facilities available, to take in the costing function. Similarly, the complex methods, involved in many instances, also deterred implementation. Further developments are required in project planning and control systems and management cost and control systems to allow cost and time to be integrated in a 'realtime' information system. (ie : up to date and not updated weekly, or monthly etc)

Computerised Approach To Project Planning And Control

The third hypotheses *(P_3)* put forward that the adoption of a computerised approach to project planning and control provides advantages over manual methods.

Private sector construction contractors considered that computerised methods offered advantages over manual methods; however, the limited use of such methods in the public sector did not attract such strong support. This was against the views of Abang and Beasley (1986), Naylor (1987) and Kerzner (1992) who all commented on the advantages of adopting computerised methods for project planning and control.

The ease in formulating 'baseline' plans, assessing different 'what-if' scenarios and monitoring of progress on projects were considered to be the main advantages of adopting a computerised approach. Without computerised project planning and control it is not possible to update, monitor and control all but the simplest plans accurately, or timeously, or to consider various 'what-if' scenarios.

However, despite the advantages that a computerised approach was thought to offer, especially in the private sector, there were two important areas where their performance appeared to be judged with some indifference. Firstly, such systems did not identify the corrective action to 'solve' a project's problems (which might have been identified by the system) nor did it put forward possible solutions to problems. In such cases the project manager must exercise his planning and organisational skills in tandem with his human resource management experience to assess and determine the optimum solution from the information available within the planning and control software. Secondly, existing computerised planning and control software did not appear to be used by construction contractors in the management of a number of simultaneous projects. Many planning and control systems, although claiming to be able to model similar project scheduling of time, resources and costs did not in reality live up to their expectations. The majority were geared for the single one off project.

Project Monitoring And Control

The fourth hypothesis (P_4) put forward that planning is not considered to the same degree in the control phase as it is during the formulation of a 'baseline' schedule for a project.

It was shown when considering hypothesis (O_2) that there was a 'tiered' approach to the adoption of various project management procedures with the management of time and then cost being the two factors considered most often by both private and public sector construction contractors. Likewise there was a tiered approach to the two phases of planning, that is 'baseline' pre-execution planning and planning in the control, or execution phase of a project.

Both private and public sector construction contractors carried out 'baseline' planning involving establishing a project's time, cost and sometime resource schedules. The private sector, in this respect, modelled a single activity duration, relationships, method of work and holidays into the planning process. Likewise, the public sector carried out a similar process, but with less emphasis placed on the overall modelling process.

When it came to the subsequent project execution phase the 'baseline' project plan was the basic mechanism of monitoring and controlling a project to previously determined objectives. It was at this stage that there was a great divergence in the approach between the private and public sectors. The private sector, unlike public sector construction contractors 'followed-through' the initial planning to the monitoring and control phase, using bar-charts, cost and time schedules and performance analysis to monitor project status. The public sector were clearly not following the kind of advice put forward by many, including Clough and Sears (1979), Harrison (1985) and Reiss (1992) who all emphasised the importance of the the need for monitoring and control once initial plans have been formulated.

Graphical reporting by use of barchart was the most common form of update method, the visual impact being more preferable to cost or time schedule listings. Only a few private sector construction contractors adopted performance analysis methods which gave a better indication of a project's status in terms of time and cost together in an integrated manner.

The public sector did not carry out planning procedures in the monitoring and control phase of projects. This essentially resulted in any limited 'baseline' planning actually carried out being rendered ineffective.

11.3.3 Planning and control : Recommendations

(1) Public sector construction contractors must use more sophisticated planning techniques in the 'baseline' planning of their projects.

(2) Public sector construction contractors must adopt, and private sector construction contractors must further develop, the use of work breakdown structures and linear responsibility charts to sub-divide a project into manageable packages with clearly defined responsibilities.

(3) Both private and public sector construction contractors should consider greater use of resource optimisation techniques in the management of their projects.

(4) In the monitoring and control phase of projects, public sector construction contractors must initiate 'follow through' procedures and monitor progress against the 'baseline' plan and private sector construction contractors must further develop their use of similar methods.

(5) Public sector construction contractors should consider cash flow in the management of their projects.

(6) Both private and public sector construction contractors require costing, which is carried out separately, to be an integral element of their planning and control systems.

(7) Attention should be paid by both private and public sector construction contractors in refining their methods of assessing how much work has been carried out on projects to enable more accurate status reporting to be undertaken.

(8) Public sector construction contractors should investigate more carefully the use of a computerised approach in the planning, monitoring and controlling of their projects.

(9) Existing project management planning and control software needs to be developed to give predictions of 'action to be taken' to solve problems which have been identified by such systems.

11.4 QUALITY MANAGEMENT

11.4.1 Quality management : Summary of background theory and research findings

Chapter 6 considered the background theory of how private and public sector construction contractors managed quality in their projects. The importance of quality over and above time and cost objectives was looked at and the various elements of quality control and quality assurance were judged on the effect that they might have in reducing overall project costs.

This led to a review of various quality management theories and of how formal quality standards have developed over time to the present version of the British, European and International Standard for quality, BS 5750/EN 29

001/ISO 9001.

The adoption of quality management systems since the 1987 version of BS 5750 has been on the ascendancy. Attention was therefore paid to the planning and implementation of such systems into construction contractor organisations. This involved a detailed look at quality system documentation including the role of the quality policy, quality manual, quality procedures and records, quality plans and works instructions in the overall quality process. This set the scene for how such systems might be introduced 'live' into organisations which, in many instances, (it has been put forward), required a change of culture in the manner that a company goes about its business.

Various methods of providing quality assurance were analysed, in particular third party quality assurance, which appeared to be rapidly becoming the norm in both private and public construction contractors alike. The procedures to be followed prior to and subsequent to a formal third party assessment led the way to showing how an organisation might achieve third party quality assurance accreditation status.

This background review led to the formulisation of three hypotheses with respect to quality management. However before looking at each in turn it is helpful to compile a summary of the main results with respect to quality management which are shown in Table 11.3. This table essentially identifies the areas of similarities and the differences in approaches between private and public sector contractors with regard to quality management.

Table 11.3 : Quality Management Survey Results

Difference in approach between private and public sector construction contractors ?	***YES***	***NO***
Commitment to quality		•
Factors relating to quality which may increase or decrease project costs		•
Forms of quality assurance adopted	•	
Areas of work registered in third party quality assurance systems	•	
Reasons for the adoption for third party accreditation of quality assurance systems	•	
Number of staff employed purely on quality assurance	•	
Employment of quality managers or quality auditors		•
Number of pages in quality system documentation	•	

Both private and public sector construction contractors had a similar commitment to quality and had written statements of their desire to ensure their quality was treated as an important organisational objective. These 'quality policy' statements were used to convey the quality message to all employees within an organisation. They were also frequently used as a marketing tool along with glossy company brochures to prospective clients and customers.

The effects of quality control and quality assurance on overall project costs were viewed similarly by the private and public sectors. There was unanimity that effective quality assurance might serve to enhance the possibility of reducing overall project costs to a much greater degree than merely quality control measures.

Various methods of providing quality assurance were looked at, ranging from internally monitored (termed first party quality systems), to formal independently assessed (termed third party quality systems) quality management systems. Many private sector construction contractors tended to operate more established quality management systems which had been developed over a period of time, whereas contractors in the public sector, who had only entered the quality arena as a result of recent central government initiatives had systems which were not yet mature in nature. With respect to third party quality management systems it was discovered that there was a definite trend for all contractors moving towards this method of providing quality assurance. This was undoubtedly as a result of the increasing publicity associated with BS 5750 and, in particular, the kudos and marketing potential which arises from third party accreditation.

There was, however, a distinct difference in the areas of business to which quality management systems were applied. It was commonly believed that companies who operated quality management systems necessarily applied them to all areas of their business. This was found not to apply universally (and in particular in public sector organisations who in the main tended to operate quality management systems only for a very small proportion of the works that they undertook). Private sector construction contractors for the most part did apply their quality management systems to all areas of their business.

It was evident that the reasons for the adoption of quality management systems in private and public sector construction contractors were different. Private companies adopted such systems to improve efficiency or to improve their competitive or marketing advantage. In stark contrast, the public sector universally adopted quality management systems as a direct result of a client or contractual obligation to do so.

Not surprisingly the private sector employed more staff who worked purely on quality assurance. Typically, they had larger turnovers and operated their quality management systems in more areas of their business than the public sector. Furthermore, their staff tended to be 'dedicated' to providing a 'central support' quality function rather than being staff who were key members of personnel, undertaking quality responsibilities over and above their normal role as was commonplace in the public sector.

The management of quality systems normally involved companies in appointing quality managers for implementing the overall policy desires with respect to quality and quality auditors to ensure that the written down procedures were being followed in practice. An important role of both was to make sure that the system was 'dynamic' in nature by looking at potential refinements and improvements on a continual basis

In the main, as previously outlined, the private sector operated more comprehensive quality management systems than their public sector counterparts. Such systems were applied to all areas of their business and as a consequence there tended to be more documentation in terms of the number of pages than in the public sector. Many private sector construction contractors operated a modular approach to the implementation of quality management systems with certain core modules applying to all projects (eg. contract review) being supplemented by specialised core modules (eg. reinforced concrete structures) depending on the nature of the project being undertaken.

11.4.2 Quality Management : Contribution And Implications of Findings

<u>Reasons For Implementing Quality Management Systems</u>

The first hypothesis *(Q_1)* put forward the idea that private and public sector construction contractors adopt and implement third party quality management systems for different reasons.

Both the private and public sectors had a strong commitment to quality and also believed that effective quality assurance procedures might aid reduction of overall project costs. However, withstanding these common features, the two sectors adopted and implemented third party quality management systems for completely different reasons.

The private sector believed that such systems would help improve overall efficiency of the organisation in terms of achieving quality first time with a corresponding optimum cost level. This is in agreement with the view put forward by Ashford (1990) who reckoned that companies adopting quality management systems for improving their own efficiency would gain most benefit from such systems.

On the other hand, the public sector seem to have entered the quality management arena only as a direct result of client, or contractual, requirements. This confirmed the views of McLellan (1993), who emphasised that the public sector had only introduced quality management systems as a means of satisfying client or contractual obligations.

The private sector also used third party quality assurance accreditation as a marketing tool and use the associated logos on their company letters, compliment slips, annual reports and literature brochures. The public sector, being restricted to very limited markets, did not derive any real marketing benefit from attaining third party accreditation and this was a further reason why adoption has not been through a process of self-initiation. Furthermore, public sector construction contractors were normally included as a matter of course on their local authority standing list of contractors and did not have to put forward a case for inclusion. It should be noted that currently in the UK that almost all tenders were assessed on cost alone and that therefore, once a contractor is on a tender list, there is virtually no commercial, or marketing benefit gained by public sector construction contractors from having quality assurance accreditation.

Clearly, if quality management systems are not adopted for the correct reasons, that is to improve operational efficiency and hence aid in reducing overall project costs, then the harmony or culture within such organisations will not be all that it should be.

A point of topical interest is the indifferent publicity that BS 5750 has frequently attracted in the press and technical journals. Many sources have stressed, quite correctly, that BS 5750 does *not* guarantee, or assure quality in any shape or form. Such systems simply comprise of procedures which 'bring in' specifications to be applied in a project and it is, in fact, the adequacy of these specifications that govern the degree of quality that can be expected in the final product. In short, if contractual specifications are not correct, then a product will be constructed to the wrong specification which may have an adverse effect on quality.

Methods Of Providing Quality Assurance

The second hypothesis (Q_2) commented that there are different methods of providing quality assurance operated by private and public sector construction contractors.

Private sector construction contractors provided quality assurance via a number of different methods, unlike contractors in the public sector. They operated internal and third party, externally assessed, quality management systems, in addition to any second party quality monitoring that their clients might initiate. The provision of these different forms of quality assurance were directly as a result of working in different markets.

Consideration of quality in private sector construction contractors appeared to have always been of prime importance; continuity of work and future work opportunities were seen as being strongly related to satisfactory completion of quality projects. This has continued into the present day situation where third party quality assurance accreditation to BS 5750 appeared to be becoming the norm in most circumstances. In this respect, the private sector have addressed this change by developing third party quality systems to BS 5750 and using the kudos associated with them as an important marketing tool.

Public sector construction contractors only operated a single form of quality assurance, namely third party, and this had been initiated more as a direct result of imposed legislation rather than from any underlying wishes of the organisation.

Although there is currently a difference in the forms of quality management systems operated, there is a move towards implementing third party systems within the private sector. In time, this is likely to replace all other forms of providing quality assurance.

Third Party Quality Management Systems

The third hypothesis *(Q3)* commented that private sector construction contractors have more comprehensive third party quality management systems than public sector construction contractors.

Private sector construction contractors generally applied quality management systems to all areas of their business and not just limited specific areas as was normally the case in the public sector.

Consequently, their quality system documentation was, in most instances, more comprehensive. However, the use of a 'modular' approach to the management of quality has in many instances kept these larger quality management systems manageable. Where quality system accreditation applies to all business areas, a client will have the confidence of knowing that an independent third party has assessed their quality management system against a pre-determined standard, normally BS 5750. It must be mentioned that the specification 'brought in' to a project by the implementation of a quality management system will be the main factor which ultimately determines overall project quality.

Clearly, when clients engage construction contractors to carry out projects it is important that they are assured that that the *whole* project will be 'quality assured' and not merely part(s) of it. Many public sector construction contractors have third party accreditation for *very* limited areas of work, which means that they can effectively only offer quality assurance for parts of a project.

Efforts should be made to regularise the use of third party quality management systems. Specifically, the scope of accreditation (by way of example, project design and construction) for a system should be clearly displayed on all company literature, when the BS 5750 logo is used. This will keep all concerned better informed as to the areas in which companies are actually 'quality assured'.

11.4.3 Quality management : Recommendations

(1) Organisations should consider the appointment of third party accreditation bodies in a business like manner and not purely on the kudos still associated with using BSI - Quality Assurance

(2) Public sector construction contractors should extend the application of their quality systems to cover all areas of their business

(3) The culture within public sector construction contractors needs to be influenced by 'retraining' as to the proper reasons for the adoption of quality systems to ensure maximum effectiveness of such systems

11.5 MANAGEMENT OF HUMAN RESOURCES

11.5.1 Human resource management : Summary of background theory and research findings

Chapter 7 considered the background theory of how private and public sector construction contractors consider the management of human resources in their projects.

It was initially identified that many organisations were at an early stage of development with respect to human resource management. The Chapter attempted to concentrate on some of the 'core' principles surrounding human resource management. These included looking at management theories, motivation theories and the roles of teams and leadership in the project environment.

Managerial theories were considered ranging from a scientific approach to management to more modern day approaches.

Motivational issues were considered in detail in view of their importance in influencing people to perform at an optimum performance. This involved looking at motivation on a need, incentive and expectancy basis, analysing and comparing the various theorist approaches. Considerable research has been carried out into motivation within the construction industry and several areas were investigated, including, the use of financial incentives, problems affecting tradesmen's productivity, motivators and demotivators on construction projects and aspects causing job satisfaction and dissatisfaction in the construction industry, from a project manager's viewpoint.

The role of teams in projects was considered to emphasise the importance of people working together as effective groups in the management of projects. Factors which assisted and hindered the performance of teams were considered prior to looking at the likely characteristics of effective and ineffective project teams. The functions of different members of teams operating in different roles was analysed with a view to ascertaining the principles involved in 'designing' a team.

The chapter concluded by looking at leadership in the project environment including leadership styles, approaches to leadership and problems which can arise with leadership.

This background theory led to the formulation of three hypotheses with respect to human resource management. However before looking at each in turn it is again worthwhile to look at a summary of the results with respect to human resource management which are shown in Table 11.4.

Table 11.4 : Management Of Human Resources Survey Results

Difference In approach between private and public sector construction contractors ?	***YES***	***NO***
General management principles considered most important at project manager level	•	
Lowest level of manager considered		•
Aspects of projects associated with job satisfaction		•
Aspects of projects associated with job dissatisfaction	•	
Factors affecting tradesmen's productivity		•
Task related qualities		•
People related qualities		•
Aspects Of projects associated as being good motivators		•
Personal characteristics of a project manager		•

General management principles considered most important, from a project manager's viewpoint, differed at the project manager level. In private sector construction contractors project managers considered organisation to be most important, in the public sector, forecasting and planning was considered likewise.

General foremen were recognised as being 'managers' in the project environment by both sectors and in private sector construction contractors, section foremen and gangers were viewed similarly.

Project managers in both private and public sector construction contractors perceived making a profit as the most likely aspect to cause them satisfaction. They perceived site supervisors, or agents as gaining satisfaction from completion on schedule and foremen from a combination of high standard of workmanship and completion on schedule.

With respect to job dissatisfaction project managers considered company or their own personal mistakes or inability to maintain schedule as being main factors. In private sector construction contractors, project managers perceived site supervisors or agents as being dissatisfied at not keeping to schedule, whereas in the public sector, project managers looked upon company or their own personal mistakes and poor workmanship as the main dissatisfiers.

In the private sector, project managers perceived foremen to be dissatisfied if workmanship was poor, or if workmen were uncooperative, in the public sector, uncooperative workmen and a lack of incentives were the main controlling factors with respect to job dissatisfaction.

Both private and public sector construction contractors believed that material or plant availability were the main factors affecting tradesmen's productivity on construction projects. However, in public sector construction contractors, absenteeism was also recognised as being a particular problem area.

Good communication skills and 'being committed to a project' were considered the most important people and task related skills required of project managers in private and public sector construction contractors alike.

Employer's attitude, achievement, recognition and responsibility were identified as being major motivators of people in the management of projects. Money, although seen as a motivator, was not considered nearly as important as any of these.

The personal characteristics of an effective project manager considered by both private and public sector construction contractors were communications, team building and leadership skills. Only a handful of contractors commented that technological skills were very important.

11.5.2 Human Resource Management : Contribution And Implication of Findings

<u>Human Resource Management</u>

The first hypothesis (H_1) put forward that human resource management is not considered to the same extent as other important project management procedures, including time, cost and quality.

Private sector construction contractors did not give weight to the management of human resources to the same degree as the management of time, cost or quality. Whereas three out of four construction contractors always planned with respect to time, only a mere quarter always looked at projects adopting a systematic approach to human resource management. Unfortunately, it appeared that there was little effort to control what on most projects is a very important resource, that is, the human element. This was in accord with the views put forward by Tyson and Fell (1986), Saha (1990) and Fabi and Petterson (1993) who all commented that knowledge of human resource management was still at an early stage in many organisations. Furthermore, it was evident that construction contractors assumed that the human element would take care of itself, a view expressed by Mansfield and Odeh (1991).

In contrast, public sector construction contractors did not consider the use of any project management procedures to any great extent. No preference was therefore given to the adoption of a particular procedure and all could be described as under utilised.

Effort must be made to promote the importance of human resource management in the management of projects and to consider the considerable benefits that may be achieved by the presence of highly motivated, well informed staff, improved communications and better team relationships in the project environment.

Motivational Issues Relating To Job Satisfaction Or Job Dissatisfaction

The second hypothesis (H_2) related to views put forward on issues with respect job satisfaction and job dissatisfaction by project managers in both private and public sector construction contractors.

Job satisfaction was viewed differently by various levels of management in both private and public sector construction contractors. Project managers looked upon making a profit as the most satisfying element of a project, which is not surprising in view of the fact that their performance is usually primarily judged on this issue. Site supervisors or agents were predominantly satisfied with completing projects on schedule and foremen from achieving a high standard of workmanship.

Clearly, personnel at different managerial levels must be suited to the characteristics which will provide job satisfaction. This will assist in properly motivating staff and improved job performance.

Project managers in both private and public sector construction contractors viewed company, or their own personal mistakes as causing job dissatisfaction. However, in the private sector alone, site supervisors or agents were dissatisfied not by keeping to schedule, but by company or their own personal mistakes in the public sector. Foremen in the private sector were dissatisfied by poor workmanship, but by lack of incentives or uncooperative workmen in the public sector.

It is important, where possible, for a project manager to be aware of and to control the factors which are likely to cause job dissatisfaction at different levels of management in the project environment.

The views of the various managerial levels within private and public sector construction contractors were consistent with those put forward by Borcherding and Oglesby (1974, 1975) who found that issues which caused job satisfaction and dissatisfaction were stratified depending on the managerial level involved.

Project manager performance

The third hypothesis *(H_3)* put forward that project manager performance is normally assessed on their human resource management skills.

It was evident that project managers were not judged on their human resource management skills, but purely on their ability to make a profit. This clearly, would not seem to be the best approach to the management of projects which are invariably strongly dependent on the level of effort put in by human resources.

This was further compounded by the fact that both private and public sector construction contractors did recognise the need for, and the importance of, human skills such as communication, motivation and leadership. Posner (1987) and Oberlender (1993) amongst others, commented on the importance of human resource characteristics. However, both sectors chose to ignore these important factors in the assessment of the performance of their project managers and merely consider profit.

11.5.3 Human resource management : Recommendations

(1) Both private and public sector construction contractors should move away from assessing project managers, purely on their ability to make a profit on projects.

(2) Public sector construction contractors should give consideration to informing their personnel more adequately, especially foremen, as to the principles behind the operation of bonus incentive schemes.

(3) Public sector construction contractors must further address the over generous conditions of employment that they offer their employees, especially manual workers, in view of the underlying absenteeism problem being experienced.

11.6 CONCLUDING REMARKS

It is important to recall that the main objective of this research was to establish the approaches that both private and public sector construction contractors adopted with respect to the use of project management procedures in the management of their projects, and to identify and explain the differences between them.

A number of hypotheses were formulated in Chapter Eight from the preceding literature review and these put forward various assertions on the use of project management procedures in the areas of organisation profile, planning and control, quality management and the management of human resources.

These were examined through a structured mail questionnaire, the survey data being analysed with the aid of a computer, and by means of semi-structured personal interviews in order to make decisions on their validity.

The research has been 'wide ranging' in nature in view of the extent of project management procedures investigated. However, throughout the thesis the following argument has been held to apply, irrespective of the type of procedure under consideration :

' <u>where project management procedures are adopted in the management of projects, a project manager will have the potential to better manage the project, than would otherwise be the case</u> '

This chapter has attempted to summarise the research by making a comparison of the background theory, outlined in the literature review, with the empirical work of the author obtained by the surveys. The implications of the findings have been discussed in relation to various views put forward by writers under the literature review for each of the four areas of the study, to illustrate where there is agreement, divergence or a more progressive approach existing on the adoption of project management procedures.

Summary Tables of the main findings arising from the study are now given in Tables 11.5 and 11.6.

Table 11.5 : Summary Of Main Findings Of Study

	SUMMARY OF MAIN FINDINGS OF STUDY
Turnover/Project size	Private sector construction contractors had larger turnovers, carried out larger, more complex projects than those in the public sector. In the main this was as a result of the private sector's ability to work in a free market environment.
Staffing Of Projects	Private sector construction contractors employed more salaried staff and made extensive use of sub-contractors when undertaking projects, unlike in the public sector; however, the number of manual staff employed in both sectors was similar.
Project Objectives	Private sector construction contractors considered satisfaction of the client, quality, completion on time and making a profit equally, whereas public sector construction contractors viewed profit singularly as the most important project objective. Here compulsory competitive tendering (CCT) appears to have stamped a negative 'be and end all' attitude with respect to profit in the public sector.
Use Of Project Management Procedures	Project management procedures with respect to time, cost, quality and human resources were not considered to any significant extent by either private or public sector construction contractors. However, the private sector did utilise such methods to a greater extent than was evident in the public sector.
Human Resource Management	Both private and public sector construction contractors viewed human resource management skills for project managers to be much more relevant than technical knowledge. However, the performance of project managers was judged primarily on their ability to make a profit on a particular project.
Reasons For Planning	Private and public sector construction contractors believed that the most important reasons for planning were to improve operational efficiency and to facilitate monitoring and controlling work once construction work had commenced.
Planning Techniques	The use of barcharts, by far, was the most popular planning technique for both private and public sector construction contractors, although the private sector used networks and linked barcharts on many of their projects. The choice of planning technique was related to the size and complexity of the project.
Division Of Work And Allocation Of Responsibilities	Private sector construction contractors adopted the principles of work breakdown structures and the use of linear responsibility charts to divide work and allocate responsibilities to a far greater degree than contractors in the public sector.
'Baseline' Planning	Both private and public sector construction contractors considered similar factors such as time durations, method of work and linking of activities in the 'baseline' planning of their projects; however, little attention was paid with respect to the availability of resources or the use of resource optimisation techniques.
Project Monitoring And Control	Private sector construction contractors, unlike those in the public sector, controlled and adjusted their project plans during the execution phase, including the constant monitoring of cash flow. One draw back was that both the private and public sectors tended to only adopt the percentage complete method as the means of assessing how much work had been carried out since the last update period.
Project Costing	Against their wishes, both private and public sector construction contractors carried out costing independently of the planning and control process, essentially using a subsidiary 'cost accounting' system.
Performance Monitoring	Although private sector construction contractors made some use of 'earned value analysis' techniques, these effective performance monitoring techniques which can consider the integrated effects of time and progress were seldom used by construction contractors.
Computerised Approach To Project Planning And Control	Public sector construction contractors used computerised methods for project planning and control to a far lesser degree than contractors in the private sector, despite the fact that its use can offer significant advantages over manual planning and control methods.
Commitment To Quality	Both private and public sector construction contractors were committed to providing quality projects, having written quality policy statements and a common belief that quality management could reduce overall project costs.
Forms of Quality Assurance	Because of the wider client base in the private sector more forms of providing quality assurance were prevalent than in the public sector arena, who only operated independently assessed, or third party quality management systems.

Source : Survey Results (Chapters Ten and Eleven)

Table 11.6 : Summary Of Main Findings Of Study (contd)

Areas Of Business For Quality Assurance	Private sector construction contractors frequently operated more comprehensive quality systems than those prevalent in the public sector. They were also applied to much wider areas of their business, in effect, covering the complete construction process. (and sometimes design, also)
Reasons For Adopting Quality Assurance	Construction contractors in the private sector believed strongly that operating quality management systems would lead to improved efficiency and improve competitive, or marketing advantage. Primarily, public sector construction contractors had responded to providing quality by purely client, or contractual motives.
Quality Assurance Staffing	Dedicated Quality Assurance staffing appeared to be the norm in private sector construction contractors for roles such as those of quality assurance manager and quality auditor. Within public sector construction contractors personnel undertook particular Quality assurance responsibilities in tandem with other duties.
Levels Of Management	Foremen were universally considered to be 'managers' in carrying out their role in the project environment.
Job Dissatisfaction	In the public sector alone foremen were perceived as being dissatisfied by lack of incentives. Generally poor workmanship and uncooperative workmen contributed to job dissatisfaction at this level of management. Site supervisors or agents looked upon company, or personal mistakes, not keeping to schedule and poor workmanship similarly. In a similar light, Project managers, likewise, viewed company, or personal mistakes or inability to maintain schedule as being major dissatisfiers.
Job Satisfaction	Similar factors, including making a profit, completion on schedule and a high standard of workmanship were the main factors at project manager, site supervisor or agent and foremen level, associated with job satisfaction in both private and public sector construction contractors.
Tradesmen's Productivity	Lack of availability of materials or plant contributed greatly to a reduction in tradesmen's productivity.
Human Attributes	Communications, teambuilding and leadership skills were viewed as being important personal characteristics of an effective project manager by private and public sector construction contractors alike.

Source : Survey Results (Chapters Ten and Eleven)

The main recommendations of the study are also shown in a similar fashion in Table 11.7.

Table 11.7 : Summary Of Main Recommendations Arising From Study

	SUMMARY OF MAIN RECOMMENDATIONS
Organisational Structure	Both private and public sector construction contractors should adopt a 'project' oriented approach to their works in order to clearly focus and define the 'role' of a particular project with respect to an organisation's overall strategy. Much more consideration must be given to the organisational form adopted in the execution of projects by both sectors with a view to achieving a structure for maximising operational performance.
Use Of Project Management Procedures	Many benefits could be gained by project managers in the management of projects if a more widespread use of project management procedures was adopted by both private and public sector construction contractors.
Project Staffing	With a view to maximising the use of available resources public sector construction contractors must utilise both their own personnel and sub-contractors, as appropriate in order to maintain a competitive edge in many areas of their works.
'Baseline' Planning	Existing 'baseline' planning techniques should be supplemented to a much wider extent by the use of work breakdown structures or linear responsibility charts to allow more comprehensive modelling of work and facilitate improved communications in the project environment. Furthermore, resource optimisation techniques should be much more widely utilised. In particular, public sector construction contractors should pay much greater attention to detail in the 'baseline' planning of their projects, which is currently limited in nature.
Project Monitoring And Control	Much greater emphasis should be placed on monitoring and controlling a project's status in terms of time and cost against a 'baseline' plan previously formulated in both sectors, but much more so in the public sector. Other methods of assessing the amount of work carried out between update periods, over and above the extensively utilised 'percentage complete' method, should also be investigated.
Project Costing	Costing, in accordance with the desire of almost all construction contractors must be integrated into the overall planning and control process to allow a meaningful interpretation of project status in terms of time and cost.
Computerised Methods	Public sector construction contractors must carefully investigate the possibilities of adopting computerised methods for project planning and control to a far greater extent than is the norm at present to facilitate effective project monitoring and control.
3rd Party Accreditation	Third party Quality Assurance accreditation is rapidly becoming the norm for organisations wishing to operate quality management systems; however, both private and public sector construction contractors must promote such quality initiatives to their employees as a means of providing improved efficiency with ultimately reduced costs, and not purely for reasons of kudos, or as a marketing tool
Areas Of Business Covered By QA	Within public sector construction contractors, if QA systems are to be operated, they should be logically extended to cover all areas of their business, as is the norm within private sector construction contractors.
Culture For QA In The Public Sector	The culture within public sector construction contractors needs to be influenced by re-emphasising the reasons why quality systems have been adopted (ie away from client, or contractual requirements) to improve effective operation of existing quality management systems.
Assessment Of Project Manager Performance	Both private and public sector construction contractors should move away from judging their project managers purely on their ability to make profit on projects. Human considerations such as communication, teambuilding and leadership skills must also be taken into account as these elements form a large part of a project manager's responsibilities.
Working Conditions In The Public Sector	Public sector construction contractors must examine the 'generous' conditions that they offer their employees, including flexi-time, paid sick leave (with bonus) and the like in order for them to remain competitive in the market place. Absenteeism is a knock-on result of the favourable conditions and measures must be taken to reduce 'downtime' for unnecessary absences, for example, by introducing sickness absence management schemes.

Source : Survey Results (Chapter Eleven)

The main contribution of this study has been to identify specific areas, as outlined in the above summary tables, where improvements may be made with respect to the adoption of project management procedures for both private and public sector construction contractors. Also put forward are recommendations which, if adopted, should lead to improved performance in the manner that private and public sector construction contractors go about their business in the second half of the nineties.

11.7 CRITIQUE

One criticism which may be made of this research is its wide ranging approach. However, this could also be argued to be its strongest point in that many areas in the use of project management procedures have been studied using the same sampling frame within one research project.

The study has looked into four major areas where project management procedures might be used in order to improve management of projects, itself a wide ranging topic. This has inevitably led to a reduced or limited coverage of certain subject areas, both in the literature review and in the subsequent surveys carried out. This, of necessity, has had to be a balance between 'depth' of subject area studied versus 'breadth' of subject area covered, although each sub area chosen has been received considerable enquiry.

A further criticism of the research might be that it has not concentrated on a single area of the industry, but has allowed construction contractors from a large number of sectors of the civil engineering construction industry (except housing), to form part of the survey sample. However, this is not considered to be a disadvantage in view of the fact that the study has concentrated on managerial issues in relation to the use of project management procedures which were reckoned to be similar, irrespective of the particular sector in which work is carried out.

A point of caution related to future research is put forward on the survey response rate that might be anticipated. Despite the reasonable response rate (32%) and usable replies (20%), which are considered to be comparable with other similar studies, a note of concern must be given regarding the attitudes of many construction companies in their possible lack of response to any future research proposals. Specifically there appears to be, in many companies, a reluctance to respond to questionnaires, or the like, when they do not offer a short term 'direct' commercial advantage. This is perhaps understandable in view of the sheer number of enquiries that many of them claim to be constantly receiving, but it is none the less regrettable because 'advances in the industry' can really only be made through such meaningful and serious enquiry.

11.8 RECOMMENDATIONS FOR FURTHER RESEARCH

The general nature of the research has resulted in recommendations being put forward with respect to the use and adoption of project management procedures. A number of areas have therefore been identified where future research might be carried out. These are now outlined.

Firstly, the project research lends itself to be repeated at a future date (probably 5 years) in view of the continuing changes in CCT legislation which continuously affects the distribution of both private sector construction contractors' output. Comparison at such a time might also specifically analyse how far the recommendations put forward in this study have been implemented by construction contractors.

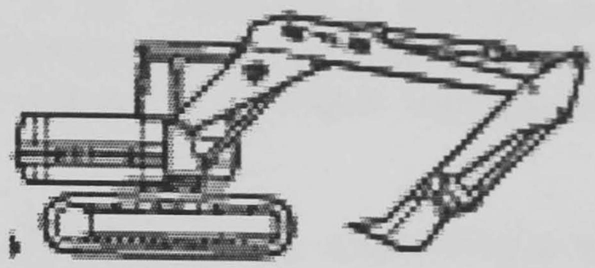
Secondly, each of the four areas which have been identified in this study might be singularly analysed to a greater extent through further research. However, the benefits that have come from analysing (under one umbrella) a number of different project management procedures within the same organisations would be lost in such instances.

Thirdly, a further area of research might be a comparison of private and public sector organisations in the professional services area, for example, design consultancy services. CCT is not due to be introduced in this respect until 1996/97 which points to the possibility of a before-and-after investigation being carried out.

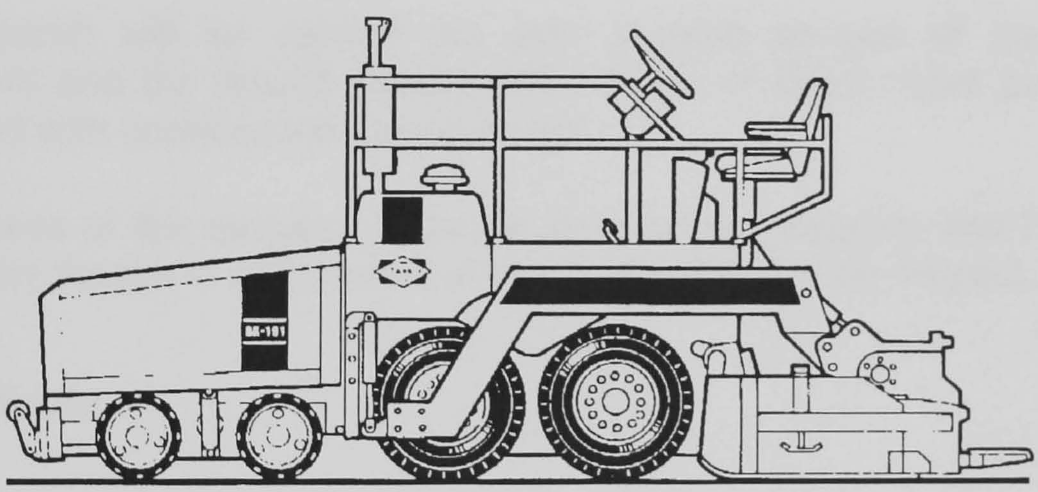
The data from this research has been collated in a manner to facilitate further research, especially with respect to any repeat study. For future research enquiries, the author would be pleased to be of assistance.

APPENDIX A

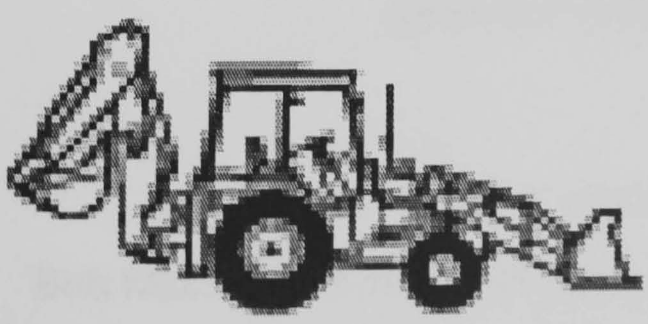
MAIL QUESTIONNAIRE

THE USE OF PROJECT MANAGEMENT PROCEDURES BY CONSTRUCTION CONTRACTORS



Bob McLellan
Construction Management Division
University of Strathclyde




THE USE OF PROJECT MANAGEMENT PROCEDURES BY CONSTRUCTION CONTRACTORS

I am a postgraduate doctorate student in the Construction Management Division of the Department of Civil Engineering at Strathclyde University, Glasgow and am undertaking research on the use of project management techniques by construction contractors.

I shall be very grateful if you will assist in the research by responding to the attached questionnaire at your earliest convenience.

The questionnaire has been designed around four central areas dealing with organisation profile, planning and control, quality and human resources. The majority of questions require only a 'tick' in the appropriate box or the deletion of inapplicable options.

Your response will be treated in confidence and neither you nor your organisation will be identified.

I do, however, undertake to deliver a summary of the findings of the research to yourself on conclusion of the research.

The research will be carried out over a wide sample of construction contractors and the results should prove to be of direct value to all those concerned with construction management.

The success of this research depends on your co-operation and I therefore express my thanks in anticipation of your assistance in this respect.

Yours faithfully

Bob McLellan

Please note that a donation will be made by the researcher to the British Heart Foundation for each fully completed questionnaire received.

••• Please return the completed questionnaire to •••

Bob McLellan, 'Kalong' 51 Castle Walk, PORT SETON EH32 0ER

PROJECT MANAGEMENT SURVEY

THE USE OF PROJECT MANAGEMENT PROCEDURES BY CONSTRUCTION CONTRACTORS

Introduction: ***This questionnaire is divided into FIVE sections as follows:***

SECTION 1 **Organisation profile.**

SECTION 2 **Planning and control.**

SECTION 3 **Quality management.**

SECTION 4 **Management of human resources.**

SECTION 5 **Attitude scales on the use of project management techniques.**

There are a number of questions contained within each section. Please attempt to complete fully all questions. To assist you in completing the questionnaire the majority of questions have been set out so that they can be answered by simply placing a 'tick' in the appropriate response box or by deleting those options which are inapplicable.

SECTION 1 - ORGANISATION PROFILE

Name of Organisation - ______________________

Head office address - ______________________

Contact name - ______________________

Job Title/Position - ______________________

Contact telephone number - ______________________

***Q1** Please indicate your turnover (construction) in the last two years (1990 and 1991), your pre-tax profit during the same period and the approximate percentage of your turnover carried out by sub-contractors.*

Year	Construction Turnover (£M)	Construction Pre-Tax Profit (£M)	% Of Construction Turnover Carried Out By Sub-contractors
1990			
1991			

***Q2** Please indicate your average employee numbers over the last two years in terms of staff (salaried) and manual workers.* (Please tick one box only in each category).

STAFF

- less than 10 [ ]
- 10 - 50 [ ]
- 51 - 100 [ ]
- 101 - 250 [ ]
- greater than 250 - ____________ (please state)

MANUAL

- less than 50 [ ]
- 50 - 150 [ ]
- 151 - 300 [ ]
- 301 - 500 [ ]
- greater than 500 - ____________ (please state)

***Q3** What is the approximate average value of construction contract carried out by your organisation?*

Please state - £ ______________________

Q4 ***On what value of contract do you normally have a single representative (usually termed project manager) responsible for the contract's cost, time and quality objectives?***

Value of contract does not influence decision	[ ]
less than £25,	[ ]
£25,001 - £75,000	[ ]
£75,001 - £250,000	[ ]
£250,001 - £500,000	[ ]
£500,001 - £1,000,000	[ ]
greater than £1,000,000	[ ]

Q5 ***What objective(s) does your organisation consider most important in the execution of projects (mark 1, 2, 3, 4 etc)?*** *NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1=, 1=, 3, 4).*

Satisfaction of client	[ ]
Achieving completion of project on time	[ ]
Meeting project quality requirements	[ ]
Achieving completion within budgeted costs and making a profit	[ ]

Q6 ***Which of the following skills do you deem to be most appropriate for project managers for effective project management performance (mark 1, 2, 3, 4 etc)?*** *NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1=, 1=, 3, 4).*

Technical expertise	[ ]
Team building/management of human resource skills	[ ]
Planning and organisational skills	[ ]
Entrepreneurial skills	[ ]
Expertise in project performance monitoring	[ ]

Please state any other skills that you deem to be appropriate - ____________________

____

____

Q7 ***Do you operate procedures relative to project planning and control, quality management and the management of human resources in the management of your projects in the construction phase?***

PROCEDURE	ALWAYS USED	SOMETIMES USED	NEVER USED
	tick any number of boxes	tick any number of boxes	tick any number of boxes
Planning to give baseline schedule of time for all project activities	[ ]	[ ]	[ ]
Planning to give baseline schedule of costs for all project activities	[ ]	[ ]	[ ]
Quality planning procedures (eg BS 5750) to ensure that project's quality objectives can be met	[ ]	[ ]	[ ]
Setting of performance measurement standards to be used for the control of time and cost	[ ]	[ ]	[ ]
Human resource management to ensure that such aspects as motivation of all staff, levels of authority/ responsibility, team development and leadership have been considered	[ ]	[ ]	[ ]
Other important procedures used in the management of your projects (please state)			

***Q8** Do you consider that the procedures used by your Company (as detailed by your response to the previous question) are adequate, inadequate or could be improved with respect to satisfying project cost, time, quality and human resource management objectives?*

PROCEDURE	ADEQUATE	INADEQUATE	COULD BE IMPROVED
	tick any number of boxes	tick any number of boxes	tick any number of boxes
Time objectives ie projects completed within contract programme or within agreed extension	[ ]	[ ]	[ ]
Cost objectives ie projects completed within project budget and completed at a profit	[ ]	[ ]	[ ]
Quality objectives ie little or no remedial work having to be carried out and complete satisfaction of finished product by client	[ ]	[ ]	[ ]
Human resource management objectives ie using available resources effectively and efficiently in a "team" like manner	[ ]	[ ]	[ ]

***Q9** What factors do you consider most important when assessing the performance of a project manager in terms of success of leading a project towards pre-established objectives (mark 1, 2, 3, 4 etc)? NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1= ,1= ,3 ,4 etc)*

Meeting target costs [ ]

Meeting key milestone dates [ ]

Making a profit [ ]

High quality of finished product [ ]

Technical accomplishment of project [ ]

Market considerations: eg following-on contracts, new business [ ]

Other (please state) - ____________________________

Q10 ***What form of organisational structure do you adopt for your projects?***

ORGANISATIONAL TYPE	MOST FREQUENTLY	SOMETIMES USED	NEVER USED
	(tick one box only)	tick any number of boxes	tick any number of boxes
FUNCTIONAL OR TRADITIONAL (ie pyramid style line of responsibility/authority/ communication)	[ ]	[ ]	[ ]
PROJECT (ie all project staff work directly to the project manager)	[ ]	[ ]	[ ]
MATRIX (OR FORM OF MATRIX) (ie project manager maintains a control over over project whereas functional elements exist in their own right with primary responsibility for supporting the project)	[ ]	[ ]	[ ]
Organisational structure is set up as required for each individual project with no standard form or type favoured	[ ]	[ ]	[ ]
Other (please state)			

Q11 ***Do you consider the following British Standards relevant to the Works carried out by your organisation and do you adopt the principles contained in them in the management of your projects?***

	STANDARD RELEVANT TO THE WORK OF YOUR ORGANISATION?	PRACTICE THE PRINCIPLES CONTAINED IN THIS STANDARD?
BRITISH STANDARD	tick any number of boxes	tick any number of boxes
BS 6046 : Part 1 : 1984 - Use of Network Techniques in Project Management - Guide to the use of management, planning, and reporting procedures	[ ]	[ ]
BS 6046 : Part 2 : 1981 - Use of Network Techniques in Project Management - Guide to the use of graphical and estimating techniques	[ ]	[ ]
BS 6046 : Part 3 : 1992 - Use of Network Techniques in Project Management - Guide to the use of computers	[ ]	[ ]
BS 6046 : Part 4 : 1981 - Use of Network Techniques in Project Management - Guide to resource analysis and cost control	[ ]	[ ]
BS 5750 : Quality Systems : Part 1 : 1987 Specification for the design/development, production, installation and servicing	[ ]	[ ]
BS 5750 : Quality Systems : Part 2 : 1987 Specification for the production and installation	[ ]	[ ]
BS 5750 : Quality Systems : Part 3 : 1987 Specification for the final inspection and test	[ ]	[ ]

SECTION 2 - PLANNING & CONTROL

Q1 Which of the following reasons do you consider to be the most important with respect to the functions of Project Planning in the construction phase (mark 1, 2, 3, 4 etc)? NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1= ,1= ,3 ,4 etc).

To eliminate or reduce uncertainty	[ ]
To improve operational efficiency	[ ]
To obtain a better understanding of the project's objectives	[ ]
To provide a basis for monitoring and controlling the work	[ ]

Q2 Do you carry out any form of risk analysis in the planning of your projects and if so, which of the following techniques do you utilise?

FORM OF RISK ANALYSIS CONSIDERED IN PROJECT PLANNING	tick any number of boxes
None	[ ]
PERT	[ ]
"What - If" Analysis	[ ]
Monte Carlo Simulation Method	[ ]
Decision Tree Analysis	[ ]
Other - Please state -	

Q3 Which of the following planning techniques do you most frequently utilise in planning for projects and which other techniques do you use?

PROJECT MANAGEMENT PLANNING TECHNIQUES	FREQUENTLY USED tick one box only	SOMETIMES USED tick any number of boxes	NEVER USED tick any number of boxes
Network Analysis	[ ]	[ ]	[ ]
Line Of Balance	[ ]	[ ]	[ ]
Bar Chart	[ ]	[ ]	[ ]
Linked Bar Chart	[ ]	[ ]	[ ]
Linear Programming	[ ]	[ ]	[ ]
Other-please state			

If you use Network Analysis in the modelling of your projects please state which method you adopt eg PERT, Precedence, Activity on Arrow, Activity on Node etc)

____

Q4 What is the average number of activities usually modelled within your projects - ______________

Does the number of activities within a project affect the choice of planning technique? YES/NO

Please comment - ______________________________

Q5 Do you make use of the principles of work breakdown structures in the planning and control of your projects? YES/NO

If 'Yes' how many levels do you normally use - ______________

Please comment on the category of levels used

- ______________________________

Q6 Do you use the PRINCE (Projects In Controlled Environment) Methodology in the management of your projects? ALWAYS/ SOMETIMES/ NEVER

Please comment - ______________________________

Q7 Do you utilise Linear Responsibility Charts (LRCs) or Matrices in the management of your Projects? YES/NO

If you use Linear Responsibility Charts or matrices please indicate why. Please tick all boxes that apply.

To depict general management responsibility [ ]

To depict specialised responsibility [ ]

To specify who must be consulted [ ]

To specify who may be consulted [ ]

To specify who must be notified [ ]

To specify who must approve [ ]

Other - please state - ______________________________

Q8 ***In the formulation of a 'baseline' time-based plan for your projects which of the following do you take account of in the modelling process?*** *Please tick any number of boxes.*

FACTORS TAKEN INTO ACCOUNT WITH RESPECT TO TIME	*ALWAYS*	*SOMETIMES*	*NEVER*
Single duration estimate for an activity	[ ]	[ ]	[ ]
Multiple duration estimate for an activity	[ ]	[ ]	[ ]
Activity relationships eg finish to start, lead/lag times etc	[ ]	[ ]	[ ]
Method of work	[ ]	[ ]	[ ]
Holidays	[ ]	[ ]	[ ]
Allowance for poor weather	[ ]	[ ]	[ ]
Allowance for variable productivity on site	[ ]	[ ]	[ ]

Other - please state - ______________________________

Q9 ***Do you allocate resources to activities after the formulation of a 'baseline' time-based plan for your projects using Serial Scheduling, Parallel Scheduling or some other method?***

Serial Scheduling is defined as ranking project activities in priority once only at the start using least value of total float or such like. The activities are then scheduled one at a time as soon as all of their predecessors are scheduled (not necessarily completed)? Activity will tend to be scheduled sequentially along each path in a network.

Parallel Scheduling is defined as scheduling activities one day at a time working from the first to the last day of the project. Each day activities that are ready to start (with all predecessors complete) are ordered in a list of some priority eg least total float first. This process is carried out on a daily basis to schedule as many activities as possible. Activities will tend to be scheduled back and forth among the paths in a network.

Use Serial Scheduling : FREQUENTLY/ SOMETIMES/ NEVER

Use Parallel Scheduling : FREQUENTLY/ SOMETIMES/ NEVER

Use some other method - please state - ______________________________

Q10 ***What resource scheduling heuristics (eg minimum late start time - order by increasing latest start time) do you use in the resource modelling/allocation to your projects?***

Please comment - ______________________________

Q11 ***Which of the following resource optimisation techniques do you utilise to optimise resource allocations?***

RESOURCE OPTIMISATION TECHNIQUE	*FREQUENTLY USED* *tick any number of boxes*	*SOMETIMES USED* *tick any number of boxes*	*NEVER USED* *tick any number of boxes*
None			
Resource Aggregation (the summation of the requirements for each resource for each time period)	[ ]	[ ]	[ ]
Resource Smoothing (the scheduling of activities) within float available to smooth out fluctuations in in individual resource demands)	[ ]	[ ]	[ ]
Resource Levelling (the production of a resource schedule reducing the variation between max and min level of resource requirements)	[ ]	[ ]	[ ]
Resource Limited Scheduling (the scheduling of activities so that pre-determined resource levels are never exceeded) Nb : min overall project duration may be exceeded	[ ]	[ ]	[ ]
Time Limited Scheduling (the scheduling of resources so that the project duration is not exceeded. Nb the envisaged resource levels may be exceeded	[ ]	[ ]	[ ]
Resource Splitting on certain allowable activities	[ ]	[ ]	[ ]

Other - please state - ______________________________

***Q12* Which of the following techniques do you use in the monitoring and control of time, resources and costs in your Projects?** *Please tick all boxes that apply.*

MONITORING/CONTROL METHOD USED	*ALWAYS USED*	*SOMETIMES USED*	*NEVER USED*
Gantt/bar charts planned vs actual	[ ]	[ ]	[ ]
Network diagrams planned vs actual	[ ]	[ ]	[ ]
Time schedules planned vs actual	[ ]	[ ]	[ ]
Resource schedules planned vs actual	[ ]	[ ]	[ ]
Cost schedules planned vs actual	[ ]	[ ]	[ ]
Cumulative "s" diagrams	[ ]	[ ]	[ ]
"Earned value diagrams"	[ ]	[ ]	[ ]
WBS cost schedules	[ ]	[ ]	[ ]

Other - please state - ______________________________

***Q13* In the monitoring of resources and costs in the construction phase of your projects which of the following do you monitor?** *Please tick all boxes that apply.*

ELEMENT OF RESOURCES/COSTS WHICH ARE MONITORED	*MONITORED/ CONTROLLED FOR ALL ACTIVITIES*	*MONITORED/ CONTROLLED FOR ONLY KEY ACTIVITIES*	*NOT MONITORED/ CONTROLLED FOR ANY ACTIVITIES*
"planned vs actual" resource utilisation	[ ]	[ ]	[ ]
Cash flow	[ ]	[ ]	[ ]
Labour costs	[ ]	[ ]	[ ]
Productivity	[ ]	[ ]	[ ]
Plant costs	[ ]	[ ]	[ ]
Sub-contractors	[ ]	[ ]	[ ]

Other - please state - ______________________________

Q14 ***How do you carry out costing on your projects?***

COSTING METHOD USED	*MOST FREQUENTLY tick one box only*	*SOMETIMES USED tick any number of boxes*	*NEVER USED tick any number of boxes*
Resource driven costing	[ ]	[ ]	[ ]
Activity driven costing	[ ]	[ ]	[ ]
WBS driven costing	[ ]	[ ]	[ ]
Costing is carried out separately from the planning/control process	[ ]	[ ]	[ ]

Other - please state - ______________________________

Q15 ***If costing is carried out separately would you rather it was integrated within procedures for planning and control?***

YES/NO

Q16 ***Do you use performance analysis such as C/SCSC (cost schedule control system criteria) in the management of your projects?***

YES/NO

If so, which of the following do you use in the monitoring/control of performance of your projects? *Please tick all boxes that apply.*

MONITORING/CONTROL OF PERFORMANCE	*ALWAYS USED*	*SOMETIMES USED*	*NEVER USED*
Budget costs for work scheduled (BCWS)	[ ]	[ ]	[ ]
Budget costs for work performed (BCWP)	[ ]	[ ]	[ ]
Actual costs for work performed (ACWP)	[ ]	[ ]	[ ]
Estimation of costs to completion (ETC)	[ ]	[ ]	[ ]
Schedule variance	[ ]	[ ]	[ ]
Cost variance	[ ]	[ ]	[ ]
Cost performance index	[ ]	[ ]	[ ]
Schedule performance index	[ ]	[ ]	[ ]

Other - please state - ______________________________

Do you think that the UK should have a system such as the C/SCSC criteria as an industry standard?

YES/NO

Please comment - ______________________________

Q17 ***In the tracking/monitoring of progress how do you assess how much work on an activity has been accomplished since the previous update period?***

METHOD USED	FREQUENTLY USED tick one box only	SOMETIMES USED tick any number of boxes	NEVER USED tick any number of boxes
Percentage complete	[ ]	[ ]	[ ]
Value earned (BCWP)	[ ]	[ ]	[ ]
Balance to earn	[ ]	[ ]	[ ]
Remaining time required to complete activity	[ ]	[ ]	[ ]

Other - please state - ____

Q18 ***Please state the percentage of your projects upon which you carry out planning/control using a computerised approach?*** [ ]

If applicable please state which computerised planning/control software package you use

\- ____

Note: If software has been designed "in-house" or by a consultant and is not a commercially available package please tick. [ ]

Does this package contribute significantly to improved planning of projects over manual methods?

YES/NO/NO DIFFERENCE

Please comment - ____

What improvements, if any, would you like to see in computerised planning/control software?

Please comment - ____

____

Q19 ***Does your current system for planning and control identify any of the following?***

Problems which are causing variances on a project. YES/NO

Impact of problems on time, cost and performance parameters. YES/NO

Impact of problems on other project activities or other projects. YES/NO

What corrective action should be taken to resolve problem. YES/NO

What are expected results of corrective action to be taken. YES/NO

***Q20** Which of the following techniques do you use in the planning, monitoring and control of a multiple number of projects?*

Multi-project scheduling of time across activities on all projects	*YES/NO*
Multi-project scheduling of resources across activities on all projects	*YES/NO*
Multi-project scheduling of costs across activities on all projects	*YES/NO*

SECTION 3 - QUALITY MANAGEMENT

***Q1** Does your Company have a written policy with regard to a commitment of quality? YES/NO*

NB: If 'YES', please attach a copy of your written quality policy if this is possible.

***Q2** Which of the following factors do you believe have an effect on quality standards achieved in the management of your projects in the construction phase?* *Please tick all boxes that apply.*

FACTOR	ALWAYS HAS AN EFFECT	SOMETIMES HAS AN EFFECT	NEVER HAS AN EFFECT
Poor judgement by project personnel	[ ]	[ ]	[ ]
Poor attitudes by project personnel	[ ]	[ ]	[ ]
Poor communications between project personnel	[ ]	[ ]	[ ]
Carelessness by project personnel	[ ]	[ ]	[ ]
Incompetence of project personnel	[ ]	[ ]	[ ]
Poor organisational procedures within project structures	[ ]	[ ]	[ ]
Lack of adequate training of project personnel	[ ]	[ ]	[ ]
Insufficient time given to set up project team as desired	[ ]	[ ]	[ ]

Other - Please state - ____

____

***Q3** Which of the following do you believe may have the effect of increasing or decreasing costs of your project?* *Please tick all boxes that apply.*

FACTOR	MAY INCREASE COSTS	NO EFFECT ON COSTS	MAY DECREASE COSTS
Internal failure costs (costs incurred by unacceptable work having to be done)	[ ]	[ ]	[ ]
External failure costs (costs incurred when remedial works have to be carried out on work which has been handed over to a customer)	[ ]	[ ]	[ ]
Appraisal costs (costs related to keeping failure costs down eg QA)	[ ]	[ ]	[ ]

Q4 ***Do you operate any of the following forms of quality assessment within your Company?***

Quality Assurance	*YES/NO*
Quality Control	*YES/NO*
Quality Improvement	*YES/NO*

Other - Please state - ______________________

If you operate a Quality Assurance System is it

First *Party*	*ie monitored internally only*	*YES/NO*
Second *Party*	*ie monitored by your Client/s*	*YES/NO*
Third *Party*	*ie monitored by a Certification Body such as BSI QA, SGS Yarsley or Lloyds*	*YES/NO*

If you operate a Third Party System, which Accreditation Body/ies monitor its application?

BSI Quality Assurance	[ ]
SGS Yarsley Quality Assured Firms Ltd	[ ]
Lloyds Register	[ ]
NAMAS	[ ]

Other - Please state - ______________________

Q5 ***If your Company is registered to BS 5750 please give the following information.***

Area/s of work - ______________________

Date of registration? - ______________________

Reason/s for registration - ______________________

____

Q6 Does your Company intend to become registered to BS 5750 in any (other) areas of work? YES/NO

If 'YES' please give the following information.

Area/s of work - ______________________

When do you intend to seek registration?

- ______________________

Reason/s for registration - ______________________

- ______________________

Q7 How many staff does your Company employ whose duties are purely associated with Quality Assurance Procedures? [ ]

Do you have a Quality Assurance Manager? YES/NO

Do you have a Quality Auditor? YES/NO

Are there any other staff who have a substantial proportion of their time devoted to Quality Assurance?

Please give details

- ______________________

- ______________________

Q8 How many pages are there in your Quality System Documentation? [ ]

SECTION 4 - MANAGEMENT OF HUMAN RESOURCES

***Q1* From a Project Manager's viewpoint, which elements of general management principles for Project Managers, site supervisors and foremen do you consider to be most important in the project environment (mark 1, 2, 3, 4 etc)?** *NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1= ,1= ,3 ,4 etc).*

ELEMENTS OF GENERAL MANAGEMENT PRINCIPLES	***PROJECT MANAGER***	***SITE SUPERVISOR***	***FOREMAN***
Supervision	[ ]	[ ]	[ ]
Forecasting and planning	[ ]	[ ]	[ ]
Organisation	[ ]	[ ]	[ ]
Method of work	[ ]	[ ]	[ ]
Command	[ ]	[ ]	[ ]
Control	[ ]	[ ]	[ ]
Coordination	[ ]	[ ]	[ ]
Motivation	[ ]	[ ]	[ ]

***Q2* From a Project Manager's viewpoint what do you consider to be the lowest level of manager in your projects?** *Please tick one box only.*

General Foreman [ ]

Site Agent [ ]

Contracts Manager [ ]

Other - please state - ______________________

Q3 From a Project Manager's viewpoint what aspects of a project are associated with job satisfaction at Project Manager, Supervisor and Foreman Level (mark 1, 2, 3, 4 etc)? *NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1= ,1= ,3 ,4 etc).*

ASPECTS OF PROJECT ASSOCIATED WITH JOB SATISFACTION	***PROJECT MANAGER***	***SITE SUPERVISOR***	***FOREMAN***
Job making a profit	[ ]	[ ]	[ ]
Client satisfaction	[ ]	[ ]	[ ]
Job completed on schedule	[ ]	[ ]	[ ]
High standard of workmanship	[ ]	[ ]	[ ]
Harmonious working environment	[ ]	[ ]	[ ]
Meeting challenging work	[ ]	[ ]	[ ]

Q4 From a Project Manager's viewpoint what aspects of the Project are associated with job dissatisfaction at Project Manager, Supervisor and Foreman level (mark 1, 2, 3, 4 etc)? *NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1= ,1= ,3 ,4 etc).*

ASPECTS OF PROJECT ASSOCIATED WITH JOB DISSATISFACTION	***PROJECT MANAGER***	***SITE SUPERVISOR***	***FOREMAN***
Personal or company mistakes	[ ]	[ ]	[ ]
Inability to maintain schedule	[ ]	[ ]	[ ]
Poor standard of workmanship	[ ]	[ ]	[ ]
Lack of incentives available	[ ]	[ ]	[ ]
Lack of information	[ ]	[ ]	[ ]
Inadequate site supervision	[ ]	[ ]	[ ]
Uncooperative workmen	[ ]	[ ]	[ ]

Q5 ***From a Project Manager's viewpoint which of the following factors do you consider to be most relevant with respect to tradesmen productivity on a construction project (mark 1, 2, 3, 4 etc)?*** *NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1= ,1= ,3 ,4 etc).*

Materials/plant availability	[ ]
Instructional time delay	[ ]
Inspection delay	[ ]
Tradesmen turnover	[ ]
Absenteeism	[ ]
Foreman delays	[ ]
Foreman incompetence	[ ]
Poor working environment	[ ]

Q6 ***In building a team for a particular project what task/activity and people related qualities do you consider as a Project Manager most important within the team (mark 1, 2, 3, 4 etc)?*** *NOTE: If more than one of the listed objectives is considered equally important please mark accordingly (eg 1= ,1= ,3 ,4 etc).*

TASK RELATED

Committed to Project	[ ]
Capacity to solve conflict	[ ]
Innovative and creativity	[ ]
Willingness to change	[ ]
Concern for quality	[ ]
Ability to predict trends	[ ]

PEOPLE RELATED

High work energy	[ ]
High need for achievement	[ ]
Good team	[ ]
Mutual trust	[ ]

***Q7* From a Project Manager's viewpoint what do you consider to be the best motivators of project team personnel in the execution of your projects?** *Please tick all boxes that apply.*

	WILL ALWAYS HELP IMPROVE MOTIVATION OF PROJECT STAFF	*MAY HELP IMPROVE MOTIVATION OF PROJECT STAFF*	*WILL NOT HELP IMPROVE MOTIVATION OF PROJECT STAFF*
Employers attitude	[ ]	[ ]	[ ]
Achievement	[ ]	[ ]	[ ]
Recognition	[ ]	[ ]	[ ]
Responsibility	[ ]	[ ]	[ ]
Money	[ ]	[ ]	[ ]
Advancement	[ ]	[ ]	[ ]
Participation	[ ]	[ ]	[ ]
Competition	[ ]	[ ]	[ ]
Social Relationships	[ ]	[ ]	[ ]

***Q8* Does your Company have management training in the following areas?**

Project management YES/NO

Planning and control YES/NO

Quality management YES/NO

Human resource management YES/NO

Performance management

Q9 ***What factors or variables are most likely to cause problems in the management of your projects?***

FACTOR OR VARIABLE	*WILL CAUSE PROBLEMS*	*MAY CAUSE PROBLEMS*	*WILL NOT CAUSE PROBLEMS*
Inadequate resources	[ ]	[ ]	[ ]
Meeting unrealistic deadlines	[ ]	[ ]	[ ]
Unclear goals	[ ]	[ ]	[ ]
Uncommitted team members	[ ]	[ ]	[ ]
Insufficient planning	[ ]	[ ]	[ ]
Breakdown in communications	[ ]	[ ]	[ ]
Changes in project goals and hence resources	[ ]	[ ]	[ ]
Conflict between functions	[ ]	[ ]	[ ]

Q10 ***What personal characteristics or skills to you believe necessary in a good, effective Project Manager?***

	ESSENTIAL	*DESIRABLE*	*NOT NECESSARY*
Technological skills	[ ]	[ ]	[ ]
Communications	[ ]	[ ]	[ ]
Team building	[ ]	[ ]	[ ]
Leadership	[ ]	[ ]	[ ]
Management skills	[ ]	[ ]	[ ]
Coping skills	[ ]	[ ]	[ ]

Other - Please state - ______________________________

SECTION 5 : ATTITUDE SCALES ON THE USE OF PROJECT MANAGEMENT TECHNIQUES

This section has a number of statements with a corresponding 'attitude scale' with values ranging from 1 to 5 which corresponds to strongly agreeing with the statement (1) to strongly disagreeing with the statement (5).

Please circle the number that most closely reflects your attitude.

Statement	STRONGLY AGREE		NEUTRAL		STRONGLY DISAGREE
1 The management of budgets, costs and profit are the most important activities carried out by a project manager in the construction phase.	1	2	3	4	5
2 The management of time and project schedules is not considered as important as meeting budget, cost and profitability objectives in the construction phase.	1	2	3	4	5
3 The management of quality is not considered as important as meeting budget, cost, profitability, time and schedule objectives in the construction phase.	1	2	3	4	5

4 The benefits that may be achieved by improved human resource management are not considered or quantified to the same degree as time, cost or quality objectives in the construction phase.	STRONGLY AGREE 1 2 NEUTRAL 3 4 5 STRONGLY DISAGREE
5 Performance analysis as a project management technique, where time and cost are considered in an integrated manner has not to date become widely accepted and therefore used in the construction industry.	STRONGLY AGREE 1 2 NEUTRAL 3 4 5 STRONGLY DISAGREE
6 Organisations would benefit greatly in terms of improved project performance if personnel were trained in the various aspects of human relation management such as motivation, communication, teamwork etc.	STRONGLY AGREE 1 2 NEUTRAL 3 4 5 STRONGLY DISAGREE
7 Project Management 'Knowledge Based Systems' should be developed to integrate the management of time, cost, quality and people in the construction phase of projects.	STRONGLY AGREE 1 2 NEUTRAL 3 4 5 STRONGLY DISAGREE
8 The use of 'Knowledge Based Systems' to model project management techniques will contribute greatly to overcome the dissatisfaction of many project managers who utilise existing computer software packages.	STRONGLY AGREE 1 2 NEUTRAL 3 4 5 STRONGLY DISAGREE

9 Resource planning and scheduling facilities within different planning and control software packages do not model resources identically and great care must be taken when analysing any output data from such packages.	*STRONGLY AGREE* 1 — 2 — *NEUTRAL* 3 — 4 — 5 *STRONGLY DISAGREE*
10 Quality management is not adopted by many organisations of their own free will because of the initial 'set-up' costs and 'maintenance' costs of such systems.	*STRONGLY AGREE* 1 — 2 — *NEUTRAL* 3 — 4 — 5 *STRONGLY DISAGREE*
11 A national standard (eg British Standard) should be developed to encourage a consistent approach to project planning, monitoring, controlling and performance measurement.	*STRONGLY AGREE* 1 — 2 — *NEUTRAL* 3 — 4 — 5 *STRONGLY DISAGREE*

Thank you very much for completing this survey. Please return it to :

BOB McLELLAN
'KALONG'
51 CASTLE WALK
PORT SETON
EAST LOTHIAN
EH32 0ER

APPENDIX B

OUTLINE 'QUESTIONNAIRE' FOR PERSONAL INTERVIEW SURVEYS

PERSONAL INTERVIEW - QUESTIONNAIRE OUTLINE

Name & Organisation

Annual turnover and nature of works undertaken

Type, or range of project types to which this questionnaire on the use of project management procedures applies?

Other relevant details

Organisation Profile

Q1. How are your staffing levels determined (salaried and manual) for the projects that you undertake in terms of annual turnover and for individual projects?

Q2. For what reasons do you utilise sub-contractors projects within your organisation?

Q3. What role do sub-contractors play with respect to staffing levels?

Q4. Does project size, or complexity influence your decision to use sub-contractors? If so, why?

Q5. What is the average value of a single project within your organisation?

Q6. What was the smallest and largest project that you undertook in 1992?

Q7. What is the average number of activities modelled in your projects? Please comment.

Q8. In what way, if any, is project size related to the number of activities that you model within your projects?

Q9. What relationship, if any, is there between the use of sub-contractors and project size?

Q10. What do you consider to be the most important short and long term project objectives when carrying out projects?

Q11. In what manner, if any, are short or long term project objectives related to the size of a project?

Q12. What project management procedures do you adopt with respect to planning of time? Why these?

Q13. What project management procedures do you adopt with respect to planning of cost? Why these?

Q14. What project management procedures do you adopt with respect to planning of quality? Why these?

Q15. What project management procedures do you adopt with respect to human resource management? Why these?

Q16. How are the different project management procedures, which are operated, integrated together in the project environment?

Q17. Is particular emphasis placed on any of the project management procedures that you operate?

Q18. How frequently do you adopt the use of project management procedures in the management of your projects? {never / 0-33% / 34-66% / 67-100%} Please explain your reasons for the frequency stated.

Q19. Is the use of project management procedures in the management of your projects related to project size, or complexity? If so, in what way?

Project Planning And Control

Q20. What planning technique(s) do you most frequently use in the planning of your projects?

Q21. In what way does the size, or complexity of a project affect the use, or choice of planning technique?

Q22. What form(s) of network analysis do you use? Any particular reasons why?

Q23. In what manner do you plan resources in the management of your projects?

Q24. Do you consider time limited or resource limited scheduling of resources to be most appropriate for the projects that you undertake? Why?

Q25. What techniques do you use for the 'tracking' of projects?

Q26. How frequently do you monitor project progress and in what manner?
{never / 0-33% / 34-66% / 67-100%} Please explain your reasons for the frequency stated.

Q27. How do you monitor cash flow in the management of your projects?

Q28. How are the effects of time and cost together considered from the initial planning phase through to control on site in the execution phase?

Q29. How do you assess the amount of work that has been carried out between monitoring periods?

Q30. Do you adopt the principles of a WBS in the planning of your projects? Please comment on their appropriateness.

Q31. Do you adopt the principles of linear responsibility charts in the planning of your projects? If so, please comment on how they are used.

Q32. In what way does project size, or complexity affect the use of either a WBS or linear responsibility charts? Please comment.

Q33. Under what circumstances would you consider adopting the use of performance analysis techniques? Please comment.

Q34. How often do you use performance analysis techniques and are they related to the size, or complexity of a project? Please comment.

Q35. How often do you adopt a computerised approach to project planning and control? {never / 0-33% / 34-66% / 67-100%} Please explain why.

Q36. In what areas of planning, monitoring and control do you adopt a computerised approach?

Q37. In what way is project size or complexity related to the adoption of a computerised approach to project planning and control?

Q38. What benefits have you gained from adopting a computerised approach to project planning and control?

Q39. What deficiencies, if any, do you believe are present in the current planning and control systems that you operate? (either manual or computerised)

Q40. How and where can modifications be made to rectify problems in current planning and control systems that you operate?

Management Of Quality

Q41. What forms of Quality assurance do you operate?

Q42. For what reason(s) do you operate the forms of Quality assurance stated above?

Q43. In what way did client/contractual considerations influence the adoption of quality management procedures within your organisation?

Q44. How has Quality Assurance affected customer satisfaction?

Q45. What effect has Quality Assurance had on the quality of the finished product, or service that your organisation offers?

Q46. How have you used Quality Assurance as a marketing tool? Has this led to securing more work/business?

Q47. How many pages does your Quality Assurance system have? Please comment.

Q48. What areas of your business does your Quality Management system apply to? Please comment.

Q49. If you adopt a 'modular' approach to the use of your quality system, please comment further.

Management Of Human Resources

Q50. What part does job satisfaction have to play in the management of projects? (for each of the following job roles : project manager/agent/foreman, all from a project manager's viewpoint)

Q51. What factors influence job dissatisfaction in the management of projects? (for each of the following job roles : project manager/agent/foreman, all from a project manager's viewpoint)

Q52. Do you believe that incentives being applied (either financial, or otherwise) are adequate for all project personnel in your projects? Please comment.
(for each of the following job roles : project manager/agent/foreman, all from a project manager's viewpoint)

Q53. Do you consider Human Resource Considerations to the same extent as Time, Cost or Quality? Please comment.

Q54. What improvements could you make to improve human resource management in your projects? (for each of the following job roles : project manager/agent/ foreman, all from a project manager's viewpoint)

General

Q55. What percentage of project costs do you consider would be saved if proper Planning, Cost, Quality and Human Resource aspects were applied to your projects?

Project Management Procedure	***Potential Overall Project Saving (expressed as a percentage)***
Management of time	0-5 5-10 10-15 15-20 20-25 25-30 30-35 35-40 other____
Management of cost	0-5 5-10 10-15 15-20 20-25 25-30 30-35 35-40 other____
Management of quality	0-5 5-10 10-15 15-20 20-25 25-30 30-35 35-40 other____
Management of human resources	0-5 5-10 10-15 15-20 20-25 25-30 30-35 35-40 other____
other (s)...please state	

Q56. What improvements to project management procedures do you consider could be made in your organisation with respect to Time, Cost, Quality or Human Resource Management?

APPENDIX C

SURVEY RESULTS

Size Of Private And Public Sector Construction Contractors

Table 1A : Size Of Responding Private Sector Construction Contractors

Annual Construction Turnover (£M)	***No***	***%***
0 - 10 : small	14	22.2
11 - 100 : average	30	47.6
101 - 400 : above average	14	22.2
401 - 800 : large	1	1.6
greater than 800 : very large	4	6.3

Table 1B : Size Of Responding Public Sector Construction Contractors

Annual Construction Turnover (£M)	***No***	***%***
0 - 10 : small	5	29.4
11 - 100 : average	12	70.6
101 - 400 : above average	0	0.0
401 - 800 : large	0	0.0
greater than 800 : very large	0	0.0

Table 1C : Comparison Of Size Of Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the size of respondent organisations between the private and public sectors.
Alternative Hypothesis : H_1 the private and public sectors.	That there is a difference in the size of respondent organisations between
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the size of organisation between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**6.76 (Significant at Alpha = 0.05)**

Table 1D : Comparison Of Size Of Private And Public Sector Construction Contractors With Turnovers Less Than £100M

Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.016 (Not Significant at Alpha = 0.1)**

Number Of Salaried Staff Employed

Table 2A : Number Of Salaried Staff Employed - Private Sector Construction Contractors

Number Of Salaried Staff	No	%
less than 10	4	6.3
10 - 50	14	22.2
51 - 100	7	11.1
101 - 250	22	34.9
greater than 250	16	25.4

Table 2B : Number Of Salaried Staff Employed - Public Sector Construction Contractors

Number Of Salaried Staff	No	%
less than 10	1	5.9
10 - 50	10	58.8
51 - 100	3	17.6
101 - 250	3	17.6
greater than 250	0	0.0

Table 2C : Comparison Of Number Of Salaried Staff Employed By Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the number of salaried employees between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the number of salaried employees between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the size of organisation between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**10.03 (Significant at Alpha = 0.01)**

Table 2D : Comparison Of Number Of Salaried Staff Of Private And Public Sector Construction Contractors With Turnovers Less Than £100M And Comparison In The Private Sector For < £100M And > £100M

Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**1.121 (Not Significant at Alpha = 0.1) (Pri < £100M vs Pub < £100M)**
Actual Value Of Chi-square	**1.373 (Not Significant at Alpha = 0.1) (Pri < £100M vs Pri > £100M)**

Number Of Manual Staff Employed

Table 3A: Number Of Manual Staff Employed - Private Sector Construction Contractors

Number Of Manual Staff	No	%
less than 50	9	14.3
50 - 150	16	25.4
151 - 300	14	22.2
301 - 500	9	14.3
greater than 500	15	23.8

Table 3B : Number Of Manual Staff Employed - Public Sector Construction Contractors

Number Of Manual Staff	No	%
less than 50	1	5.9
50 - 150	3	17.6
151 - 300	4	23.5
301 - 500	7	41.2
greater than 500	2	11.8

Table 3C : Comparison Of Number Of Manual Staff Employed Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the number of manual employees between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the number of manual employees between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the number of manual employees between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.=2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**1.69 (Not Significant at Alpha = 0.1)**

Table 3D : Comparison Of Number Of Manual Staff Of Private And Public Sector Construction Contractors With Turnovers Less Than £100M And Comparison In The Private Sector For < £100M And > £100M

Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.016 (Not Significant at Alpha = 0.1) (Pri < £100M vs Pub < £100M)**
Actual Value Of Chi-square	**4.92 (Significant at Alpha = 0.05) (Pri < £100M vs Pri > £100M)**

Percentage Use Of Sub-Contractors

Table 4A : Percentage Use Of Sub-contractors Engaged - Private Sector Construction Contractors

Percentage Use Of Sub - Contractors	No	%
did not state	9	14.3
0 - 20	11	17.5
21 - 40	16	25.4
41 - 60	8	12.7
61 - 80	12	19.1
81 - 100	7	27.0

Table 4B : Percentage Use Of Sub-contractors Engaged - Public Sector Construction Contractors

Percentage Use Of Sub - Contractors	No	%
did not state	3	17.6
0 - 20	13	76.5
21 - 40	1	5.9
41 - 60	0	0.0
61 - 80	0	0.0
81 - 100	0	0.0

Table 4C : Comparison Of Percentage Use Of Sub-Contractors Engaged By Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the percentage use of sub-contractors engaged between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the percentage use of sub-contractors engaged between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the percentage use of sub-contractors engaged between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.=2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**11.46 (Significant at Alpha = 0.01)**

Table 4D : Comparison On The Use Of Sub-Contractors Between Private And Public Sector Construction Contractors With Turnovers Less Than £100M And Comparison In The Private Sector For < £100M And > £100M

Critical Value Of Chi-Square	2.71 (1 d.f.)
Fishers Exact Test	**0.00002 (Significant at Alpha = 0.1) {Pri < £100M vs Pub < £100M}**
Actual Value Of Chi-square	**0.007 (Not Significant at Alpha = 0.1) {Pri < £100M vs Pri > £100M}**

Average Value Of Single Project

Table 5A : Average Value Of A Single Project Carried Out By Private Sector Construction Contractors

Average Value Of Single Contract	***No***	***%***
up to £250 000	13	20.6
£250 001 - £500 000	8	12.7
£500 001 - £750 000	7	11.1
£750 001 - £1 000 000	5	7.9
£1 000 001 - £3 000 000	21	33.3
£3 000 001 - £5 000 000	6	9.5
greater than £5 000 000	3	4.8

Table 5B : Average Value Of A Single Project Carried Out - Public Sector Construction Contractors

Average Value Of Single Contract	***No***	***%***
up to £250 000	16	94.1
£250 001 - £500 000	1	5.9
£500 001 - £750 000	0	0.0
£750 001 - £1 000 000	0	0.0
£1 000 001 - £3 000 000	0	0.0
£3 000 001 - £5 000 000	0	0.0
greater than £5 000 000	0	0.0

Table 5C : Comparison Of The Average Value Of A Single Project Between Private And Public Sector Construction Contractors

Null Hypothesis : H_o	That there is no difference in the average value of a single contract between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the average value of a single contract between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_o	Since H_1 simply predicts a difference in the average value of a single contract between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**31.0 (Significant at Alpha = 0.001)**

Average Number Of Activities Modelled Within Projects

Table 6A : Average Number Of Activities Modelled Within Projects - Private Sector

Average Number Of Activities Modelled Within Projects	No.	%
Varies too much to be specific	5	7.9
0 -10	6	10.3
11-20	15	25.9
21-50	13	22.4
51-100`	12	20.7
101-200	3	5.2
201-500	5	8.6
Greater Than 500	4	6.9

Table 6B : Average Number Of Activities Modelled Within Projects - Public Sector

Average Number Of Activities Modelled Within Projects	No.	%
0 -10	5	29.4
11-20	10	58.8
21-50	2	22.2
51-100`	0	0.0
101-200	0	0.0
201-500	0	0.0
Greater Than 500	0	0.0

Table 6C : Comparison Of The Average Number Of Activities Modelled Within Projects Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the average number of activities modelled within projects between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the average number of activities modelled within projects between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the average number of activities modelled within projects between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**14.39 (Significant at Alpha = 0.001)**

Table 6D : Comparison On The Average Number Of Activities Modelled Between Private And Public Sector Construction Contractors With Turnovers Less Than £100M And Comparison In The Private Sector For < £100M And > £100M

Critical Value Of Chi-Square	2.71 (1 d.f.)
Fishers Exact Test	**0.014 (Significant at Alpha = 0.1) (Pri < £100M vs Pub < £100M)**
Fishers Exact Test	**0.018 (Significant at Alpha = 0.1) (Pri < £100M vs Pri > £100M)**

Most Important Project Objective

Table 7A : Most Important Project Objective - Private Sector

What objective(s) does your organisation consider most important ?	No.	%
Satisfaction Of Client (1)	11	17.5
Achieving Completion Of Project On Time (2)	1	1.6
Meeting Project Quality Requirements (3)	3	4.8
Achieving Completion Within Budgeted Costs And Making A Profit (4)	15	23.8
(1) And (4)	11	17.5
(1), (2), (3) And (4)	16	25.4
Other combination(s)	6	9.5

Table 7B : Most Important Project Objective - Public Sector

What objective(s) does your organisation consider most important ?	No.	%
Satisfaction Of Client (1)	1	5.9
Achieving Completion Of Project On Time (2)	0	0.0
Meeting Project Quality Requirements (3)	1	5.9
Achieving Completion Within Budgeted Costs And Making A Profit (4)	10	58.8
(1) And (4)	0	0.0
(1), (2), (3) And (4)	2	11.0
Other combination(s)	3	17.6

Table 7C : Comparison Of The Most Important Objective Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the most important project objective between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the most important project objective between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the most important project objective between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**7.68 (Significant at Alpha = 0.05)**

Table 7D : Comparison On The Most Important Projective Between Private And Public Sector Construction Contractors With Turnovers Less Than £100M And Comparison In The Private Sector For < £100M And > £100M

Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**3.91 (Significant at Alpha = 0.1) {Pri < £100M vs Pub < £100M}**
Actual Value Of Chi-square	**0.081 (Not Significant at Alpha = 0.1) {Pri < £100M vs Pri > £100M}**

Most Appropriate Skills For Project Managers

Table 8A : Most Appropriate Skills For Project Managers - Private Sector Construction Contractors

Which Of The Following Skills Are Most Appropriate For Project Managers ?	***No.***	***%***
Technical Expertise	5	7.9
Team Building / Management Of Human Resource Skills	27	42.8
Planning And Organisational Skills	24	38.0
Entrepreneurial Skills	2	3.2
Expertise In Project Performance Monitoring	5	7.9

Table 8B : Most Appropriate Skills For Project Managers - Public Sector Construction Contractors

Which Of The Following Skills Are Most Appropriate For Project Managers ?	***No.***	***%***
Technical Expertise	1	5.9
Team Building / Management Of Human Resource Skills	6	35.3
Planning And Organisational Skills	8	47.1
Entrepreneurial Skills	1	5.9
Expertise In Project Performance Monitoring	1	5.9

Table 8C : Comparison Of The Most Appropriate Skills For Project Managers Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the most appropriate skills for project managers between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the most appropriate skills for project managers between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the most appropriate skills for project managers between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**0.47 (Not Significant at Alpha = 0.1)**

Procedures operated With Respect To Project Planning & Control, Quality And The Management Of Human Resources

Table 9A : Project Management Procedures Operated - Private Sector

Project Management Procedures Operated In The Management Of Projects	***Always***		***Sometimes***		***Never***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Planning With Respect To Time	53	84.1	8	12.7	2	3.2
Planning With Respect To Cost	40	63.5	23	36.5	0	0.0
Quality Planning Procedures	30	47.6	27	42.9	6	9.5
Performance Measurement Standards	28	44.4	32	50.8	3	4.8
Human Resource Management	15	23.8	34	54.0	14	22.2

Table 9B : Project Management Procedures Operated - Public Sector

Project Management Procedures Operated In The Management Of Projects	***Always***		***Sometimes***		***Never***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Planning With Respect To Time	7	41.2	10	58.8	0	0.0
Planning With Respect To Cost	4	23.3	11	64.7	2	11.8
Quality Planning Procedures	0	0.0	10	58.8	7	41.2
Performance Measurement Standards	4	23.5	8	47.1	5	29.4
Human Resource Management	5	29.4	5	29.4	7	41.2

Table 9C : Comparison Of Project Management Procedures Operated Between The Private And Public Sectors

Null Hypothesis : Ho	That there is no difference in the procedures always operated with respect to project planning and control, quality and the management of human resources between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the procedures always operated with respect to project planning and control, quality and the management of human resources between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 4 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the use of procedures always operated with respect to project planning and control, quality and the management of human resources between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 4 obtained from statistical tables.
Critical Value Of Chi-Square	7.78 (4 d.f.)
Actual Value Of Chi-square	**8.12 (Significant at Alpha = 0.1)**

Table 9D : Comparison On The Most Important Projective Between Private And Public Sector Construction Contractors With Turnovers Less Than £100M And Comparison In The Private Sector For < £100M And > £100M

Critical Value Of Chi-Square	6.25 (3 d.f.)
Actual Value Of Chi-square	**6.39 (Significant at Alpha = 0.1) (Pri < £100M vs Pub < £100M)**
Actual Value Of Chi-square	**0.80 (Not Significant at Alpha = 0.1) (Pri < £100M vs Pri > £100M)**

Are Procedures Operated With Respect To Project Planning & Control, Quality And The Management Of Human Resources Adequate?

Table 10A : Are Procedures Operated Adequate? - Private Sector

Project Management Procedures - Are They Adequate, Inadequate Or Could They Be Improved ?	***Adequate***		***Inadequate***		***Improved***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Time Objectives	44	69.8	0	0.0	19	30.2
Cost Objectives	28	44.4	3	4.8	32	50.8
Quality Objectives	21	33.3	2	3.2	40	63.5
Human Resource Management Objectives	19	30.2	6	9.5	38	60.3

Table 10B : Are Procedures Operated Adequate? - Public Sector

Project Management Procedures - Are They Adequate, Inadequate Or Could They Be Improved ?	***Adequate***		***Inadequate***		***Improved***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Time Objectives	6	35.3	2	11.8	9	52.9
Cost Objectives	2	11.8	2	11.8	13	76.5
Quality Objectives	2	11.8	3	17.6	12	70.6
Human Resource Management Objectives	5	29.4	5	29.4	7	41.2

Table 10C : Comparison Of The Adequacy of Procedures Operated Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the adequacy of procedures operated with respect to project planning and control, quality and the management of human resources between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the adequacy of procedures operated with respect to project planning and control, quality and the management of human resources between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 3 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the adequacy of procedures operated with respect to project planning and control, quality and the management of human resources between private and public sector construction contractors the region of rejection consisting of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 3 obtained from statistical tables.
Critical Value Of Chi-Square	6.25 (3 d.f.)
Actual Value Of Chi-square	**Adequate - 2.85 (Not Significant at Alpha = 0.05)**
Actual Value Of Chi-square	**Could be Improved - 3.38 (Not Significant at Alpha = 0.05)**

Most Important Factor In assessing Project Manager Performance

Table 11A : Most Important Factor In Assessing Project Manager Performance - Private Sector Construction Contractors

Factors Considered Important In Assessing Project Manager Performance	***No.***	***%***
Meeting Target Costs	10	13.8
Meeting Key Milestone Dates	6	8.3
Making A Profit	44	61.1
High Quality Of Finished Product	7	9.7
Technical Accomplishment Of Project	3	4.2
Market Considerations - eg Follow - On Contracts etc	2	2.8

Table 11B : Most Important Factor In assessing Project Manager Performance - Public Sector Construction Contractors

Factors Considered Important In Assessing Project Manager Performance	***No.***	***%***
Meeting Target Costs	6	35.3
Meeting Key Milestone Dates	1	5.9
Making A Profit	8	47.1
High Quality Of Finished Product	2	11.8
Technical Accomplishment Of Project	0	0.0
Market Considerations - eg Follow - On Contracts etc	0	0.0

Table 11C: Comparison Of The Most Important Factor Considered In Assessing Project Manager Performance Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the most important factor considered in assessing project manager performance between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the most important factor considered in assessing project manager performance between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the most important factor considered in assessing project manager performance between private and public sector construction contractors the region of rejection consists of those values o Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**2.94 (Not Significant at Alpha = 0.1)**

Form Of Organisational Structure Adopted For Projects

Table 12A : Form Of Organisational Structure Adopted for Projects - Private Sector Construction Contractors

Form Of Organisational Structure Adopted For Projects	Always		Sometimes		Never	
	No.	%	No.	%	No.	%
Functional Or Traditional	33	52.4	22	34.9	8	12.7
Project	10	15.9	39	61.9	14	22.2
Matrix	8	12.7	20	31.7	35	55.6
Structure Set up as Required For Each Project	11	17.5	17	27.0	35	55.6

Table 12B : Form Of Organisational Structure Adopted for Projects - Public Sector Construction Contractors

Form Of Organisational Structure Adopted For Projects	Always		Sometimes		Never	
	No.	%	No.	%	No.	%
Functional Or Traditional	9	52.9	5	29.4	3	17.6
Project	3	17.6	5	29.4	9	52.9
Matrix	0	0.0	6	35.3	11	64.7
Structure Set up as Required For Each Project	3	17.6	8	47.1	6	35.3

Table 12C : Comparison Of The Form Of Organisational Structure Adopted For Projects Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the form of organisational structure adopted for projects between the private and public sectors.
Alternative Hypothesis : H_1	That there is no difference in the form of organisational structure adopted for projects between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the form of organisational structure adopted for projects between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.034 (Not Significant at Alpha = 0.1)**

Relevance And Adoption Of BS 6046 And BS 5750 In The Management Of Projects

Table 13A : Relevance And Adoption Of BS 6046 And BS 5750 In The Management Of Projects - Private Sector Construction Contractors

Relevance and Adoption of BS 6046 and BS 5750	Relevant		Practice	
	No.	%	No.	%
BS 6046 : Parts 1, 2, 3 And 4	18	28.6	15	23.8
BS 5750 : Part 1 : 1987	26	41.3	22	34.9
BS 5750 : Part 2 : 1987	53	84.1	41	65.1

Table 13B : Relevance And Adoption Of BS 6046 And BS 5750 In The Management Of Projects - Public Sector Construction Contractors

Relevance and Adoption of BS 6046 and BS 5750	Relevant		Practice	
	No.	%	No.	%
BS 6046 : Parts 1, 2, 3 And 4	3	17.6	0	0.0
BS 5750 : Part 1 : 1987	0	0.0	0	0.0
BS 5750 : Part 2 : 1987	17	100.0	12	70.6

Table 13C : Comparison Of The Relevance And Adoption Of BS 6046 And BS 5750 In The Management Of Projects Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in attitudes to the relevance and adoption of BS 5750 : Part 2 in the management of projects between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in attitudes to the relevance and adoption of BS 5750 : Part 2 in the management of projects between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in attitudes to the relevance and adoption of BS5750 : Part 2 in the management of projects between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.045 (Not Significant at Alpha = 0.1)**

Reasons Considered Most Important for Planning In the Construction Phase

Table 14A : Reasons Considered Most Important For Planning In The Construction Phase -Private Sector Construction Contractors

Reasons Considered Most Important For Planning In The Construction Phase	No.	%
To Eliminate Or Reduce Uncertainty	6	9.5
To Improve Operational Efficiency	26	41.3
To Obtain A Better Understanding Of The Project's Objectives	5	7.9
To Provide A Basis For Monitoring And Controlling The Work	26	41.3

Table 14B : Reasons Considered Most Important For Planning In The Construction Phase - Public Sector Construction Contractors

Reasons Considered Most Important For Planning In The Construction Phase	No.	%
To Eliminate Or Reduce Uncertainty	3	17.6
To Improve Operational Efficiency	9	52.9
To Obtain A Better Understanding Of The Project's Objectives	1	5.9
To Provide A Basis For Monitoring And Controlling The Work	4	23.5

Table 14C : Comparison Of The Most Important Reason Considered For Planning In The Construction Phase Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the most important reason considered for planning in the construction phase between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the most important reason considered for planning in the construction phase between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the most important reasons considered for planning in the construction phase between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**3.79 (Not Significant at Alpha = 0.1)**

Forms Of Risk Analysis Considered In The Planning Of Projects

Table 15A : Forms Of Risk Analysis Considered In The Planning Of Projects - Private Sector Construction Contractors

Form Of Risk Analysis Considered In Project Planning	*No.*	*%*
None	26	41.3
PERT	18	28.6
' What - if ' Analysis	28	44.4
Monte Carlo Simulation Method	0	0.0
Sensitivity Analysis	9	14.3
Decision Tree Analysis	3	4.4

Table 15B : Forms Of Risk Analysis Considered In The Planning Of Projects - Public Sector Construction Contractors

Form Of Risk Analysis Considered In Project Planning	*No.*	*%*
None	12	70.6
PERT	2	11.8
' What - if ' Analysis	3	17.6
Monte Carlo Simulation Method	0	0.0
Sensitivity Analysis	0	0.0
Decision Tree Analysis	0	0.0

Table 15C : Comparison Of Forms Of Risk Analysis Considered In The Planning Of Projects Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the forms of risk analysis considered between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the forms of risk analysis considered between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the forms of risk analysis considered between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**3.61 (Significant at Alpha = 0.1)**

Planning Techniques Utilised In Planning For Projects

Table 16A : Planning Techniques Utilised In Planning For Projects - Private Sector Construction Contractors

Planning Techniques Utilised In Planning For Projects	Frequently		Sometimes		Never	
	No.	%	No.	%	No.	%
Network Analysis	21	33.3	27	42.9	15	23.8
Line Of Balance	0	0.0	17	27.0	46	73.0
Bar Chart	47	74.6	16	25.4	0	0.0
Linked Bar Chart	29	46.0	23	36.5	11	17.5
Linear Programming	1	1.6	21	33.3	41	65.1

Table 16B : Planning Techniques Utilised In Planning For Projects - Public Sector Construction Contractors

Planning Techniques Utilised In Planning For Projects	Frequently		Sometimes		Never	
	No.	%	No.	%	No.	%
Network Analysis	0	0.0	9	52.9	8	47.1
Line Of Balance	0	0.0	0	0.0	17	100.0
Bar Chart	16	94.1	0	0.0	1	5.9
Linked Bar Chart	0	0.0	12	70.6	5	29.4
Linear Programming	0	0.0	6	35.3	11	64.7

Table 16C : Comparison Of Barchart And Network Techniques Frequently Utilised Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in planning techniques utilised between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in planning techniques utilised between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the planning techniques utilised between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**6.97 (Significant at Alpha = 0.01)**

Forms Of Network Analysis Adopted

Table 17A : Forms Of Network Analysis Adopted - Private Sector Construction Contractors

Form Of Network Analysis Adopted	*No.*	*%*
Precedence	35	72.9
Activity On Arrow	7	14.6
Activity On Node	2	4.2
PERT	4	8.3

Table 17B : Forms Of Network Analysis Adopted - Public Sector Construction Contractors

Form Of Network Analysis Adopted	*No.*	*%*
Precedence	2	22.2
Activity On Arrow	4	44.4
Activity On Node	0	0.0
PERT	3	33.3

Table 17C: Comparison Of The Forms Of Network Analysis Adopted Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the forms of network analysis adopted between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the forms of network analysis adopted between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0 critical statistical	Since H_1 simply predicts a difference in the forms of network analysis adopted between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the value of the Chi-square distribution for d.f.= 1 obtained from tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**8.55 (Significant at Alpha = 0.01)**

Effect Of Number Of Activities On Choice Of Planning Technique

Table 18A : Effect Of Number Of Activities On Choice Of Planning Technique - Private Sector Construction Contractors

Does The Number Of Activities Within A Project Affect The Choice Of Planning Technique ?	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Affects Choice Of Planning Technique	41	65.1	22	34.9

Table 18B : Effect Of Number Of Activities On Choice Of Planning Technique - Public Sector Construction Contractors

Does The Number Of Activities Within A Project Affect The Choice Of Planning Technique ?	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Affects Choice Of Planning Technique	7	41.2	10	58.8

Table 18C : Comparison Of The Effect Of Number Of Activities On Choice Of Planning Techniques Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the effect of the number of activities on the choice of planning technique between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the effect of the number of activities on the choice of planning technique between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the effect of the number of activities on the choice of planning technique between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**3.18 (Significant at Alpha = 0.1)**

Adoption Of Principles Of Work Breakdown Structures

Table 19A : Adoption Of Principles Of Work Breakdown Structures - Private Sector Construction Contractors

Adoption Of Work Breakdown Structures In The Planning And Control Of Projects	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Adopt Principles Of Work Breakdown Structures	26	41.3	37	58.7

Table 19B : Adoption Of Principles Of Work Breakdown Structures - Public Sector Construction Contractors

Adoption Of Work Breakdown Structures In The Planning And Control Of Projects	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Adopt Principles Of Work Breakdown Structures	1	5.9	16	94.1

Table 19C : Comparison On The Adoption Of Work Breakdown Structures Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the adoption of the principles of work breakdown structures between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the adoption of the principles of work breakdown structures between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the adoption of the principles of work breakdown structures between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**7.49 (Significant at Alpha = 0.01)**

Utilisation Of Linear Responsibility Charts

Table 20A : Utilisation Of Linear Responsibility Charts - Private Sector Construction Contractors

Utilisation Of Linear Responsibility Charts (LRCs)	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Use Linear Responsibility Charts	15	23.8	48	76.2

Table 20B : Utilisation Of Linear Responsibility Charts - Public Sector Construction Contractors

Utilisation Of Linear Responsibility Charts (LRCs)	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Use Linear Responsibility Charts	0	0.0	17	100.0

Table 20C : Comparison On The Utilisation Of Linear Responsibility Charts Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the utilisation of linear responsibility charts between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the utilisation of linear responsibility charts between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the utilisation of linear responsibility charts between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**4.98 (Significant at Alpha = 0.05)**

Factors Taken Into Account In The Formulation Of A Time Base Plan For Projects

Table 21A : Formulation Of A Time Based Plan For Projects - Private Sector

Factors Taken Into Account In The Formulation Of A Time Based Plan For Projects	Always		Sometimes		Never	
	No.	%	No.	%	No.	%
Single Duration Estimate For An Activity	43	68.3	18	28.6	2	3.2
Multiple Duration Estimate For An Activity	8	12.7	37	58.7	18	28.6
Activity Relationships : eg finish to start, lead/lag times	43	68.3	13	20.6	7	11.1
Method Of Work	44	69.8	18	28.6	1	1.6
Holidays	48	76.2	9	14.3	6	9.5
Allowance For Poor Weather	20	31.7	33	52.4	10	15.9
Allowance for Variable Productivity On Site	8	12.7	37	58.7	18	28.6

Table 21B : Formulation Of A Time Based Plan For Projects - Public Sector

Factors Taken Into Account In The Formulation Of A Time Based Plan For Projects	Always		Sometimes		Never	
	No.	%	No.	%	No.	%
Single Duration Estimate For An Activity	10	58.8	4	23.5	3	17.6
Multiple Duration Estimate For An Activity	0	0.0	7	41.2	10	58.8
Activity Relationships : eg finish to start, lead/lag times	3	17.6	6	35.3	8	47.1
Method Of Work	7	41.2	5	29.4	5	29.4
Holidays	4	23.5	8	47.1	5	29.4
Allowance For Poor Weather	2	11.8	9	52.9	6	35.3
Allowance for Variable Productivity On Site	2	11.8	7	41.2	8	47.1

Table 21C : Comparison Between Private And Public Sectors

Null Hypothesis : Ho	That there is no difference in the factors taken into account in the formulation of a time based plan for projects between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the factors taken into account in the formulation of a time based plan for projects between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 4 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the factors taken into account in the formulation of a time based plan for projects between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 4 obtained from statistical tables.
Critical Value Of Chi-Square	7.78 (4 d.f.)
Actual Value Of Chi-square	**5.00 (Not Significant at Alpha = 0.1)**

Resource Optimisation Techniques

Table 22A : Resource Optimisation Techniques - Private Sector

Resource Optimisation Techniques Used To Optimise Resource Allocations	***Frequently***		***Sometimes***		***Never***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Resource Aggregation	16	25.4	23	36.5	24	38.1
Resource Smoothing	19	30.2	26	41.3	18	28.6
Resource Levelling	14	22.2	28	44.4	21	33.3
Resource Limited Scheduling	5	7.9	25	39.7	33	52.4
Time Limited Scheduling	20	31.7	18	28.6	25	39.7
Resource Splitting	10	15.9	22	34.9	31	49.2
No Techniques Are Used					11	17.5

Table 22B : Resource Optimisation Techniques - Public Sector

Resource Optimisation Techniques Used To Optimise Resource Allocations	***Frequently***		***Sometimes***		***Never***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Resource Aggregation	1	5.9	5	29.4	11	64.7
Resource Smoothing	3	17.6	5	29.4	9	52.9
Resource Levelling	0	0.0	3	17.6	14	82.2
Resource Limited Scheduling	1	5.9	1	5.9	15	88.2
Time Limited Scheduling	0	0.0	6	35.3	11	64.7
Resource Splitting	1	5.9	4	23.5	12	70.6
No Techniques Are Used					2	11.8

Table 22C : Comparison Of Resource Optimisation Techniques Utilised Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the use of resource optimisation techniques utilised between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the use of resource optimisation techniques utilised between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 5 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the use of resource optimisation techniques utilised between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 5 obtained from statistical tables.
Critical Value Of Chi-Square	9.24 (5 d.f.)
Actual Value Of Chi-square	**2.95 (Not Significant at Alpha = 0.1)**

Techniques Used In Monitoring Time, Resources and Costs

Table 23A : Techniques Used - Private Sector Construction Contractors

Methods Of Monitoring And Controlling Time, Resources And Costs In The Management Of Projects	Always		Sometimes		Never	
	No.	%	No.	%	No.	%
Gantt/Bar Charts : Planned Versus Actual	38	60.3	18	28.6	7	11.1
Network Diagrams : Planned Versus Actual	4	6.3	36	57.1	23	36.5
Time Schedules : Planned Versus Actual	9	14.3	35	55.6	19	30.2
Resource Schedules : Planned Versus Actual	10	15.9	37	58.7	26	41.3
Cost Schedules : Planned Versus Actual	22	34.9	34	54.0	7	11.1
Cumulative 's' Diagrams	6	9.5	24	38.1	33	52.4
'Earned Value' Diagrams	3	4.8	9	14.3	51	81.0
WBS Cost Schedules	3	4.8	6	9.5	54	85.7

Table 23B : Techniques Used - Public Sector Construction Contractors

Methods Of Monitoring And Controlling Time, Resources And Costs In The Management Of Projects	Always		Sometimes		Never	
	No.	%	No.	%	No.	%
Gantt/Bar Charts : Planned Versus Actual	0	0.0	10	58.8	7	41.2
Network Diagrams : Planned Versus Actual	0	0.0	6	35.3	11	64.7
Time Schedules : Planned Versus Actual	0	0.0	8	47.1	9	52.9
Resource Schedules : Planned Versus Actual	0	0.0	8	47.1	9	52.9
Cost Schedules : Planned Versus Actual	0	0.0	7	41.2	10	58.8
Cumulative 's' Diagrams	0	0.0	0	0.0	17	100.0
'Earned Value' Diagrams	0	0.0	0	0.0	0	100.0
WBS Cost Schedules	0	0.0	0	0.0	0	100.0

Table 23C : Comparison Between Private And Public Sectors

Null Hypothesis : Ho	That there is no difference in techniques used for monitoring time, resources and costs between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in techniques used for monitoring time, resources and costs between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 5 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the techniques used for monitoring time, resources and costs between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 5 obtained from statistical tables.
Critical Value Of Chi-Square	9.24 (5 d.f.)
Actual Value Of Chi-square	**8.73 (Not Significant at Alpha = 0.1)**

Elements Of Costs/Resources Monitored

Table 24A : Elements Of Costs/Resources Monitored - Private Sector Construction Contractors

Monitoring Of Resources And Costs On All/Some/No Activities	All		Some		None	
	No.	%	No.	%	No.	%
' Planned Versus Actual ' Resource Utilisation	19	30.2	38	60.3	6	9.5
Cash Flow	41	65.1	8	12.7	14	22.2
Labour Costs	41	65.1	8	12.7	14	22.2
Productivity	27	42.9	23	36.5	13	20.6
Plant Costs	32	50.8	17	27.0	14	22.2
Sub-Contractor Costs	43	68.2	6	9.5	14	22.2

Table 24B : Elements Of Costs/Resources Monitored - Public Sector Construction Contractors

Monitoring Of Resources And Costs On All/Some/No Activities	All		Some		None	
	No.	%	No.	%	No.	%
' Planned Versus Actual ' Resource Utilisation	4	23.5	9	52.9	4	23.5
Cash Flow	1	5.9	2	11.8	14	82.4
Labour Costs	10	58.8*	6	35.3	1	5.9
Productivity	7	41.2	7	41.2	3	17.6
Plant Costs	10	58.8*	6	35.3	1	5.9
Sub-Contractor Costs	10	58.8*	5	29.4	2	11.8

Table 24C : Comparison Of Elements Of Costs/Resources Monitored Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the elements of costs/resources monitored between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the elements of costs/resources monitored between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 5 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the elements of costs/resources monitored between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 5 obtained from statistical tables.
Critical Value Of Chi-Square	9.24 (5 d.f.)
Actual Value Of Chi-square	**8.37 (Not Significant at Alpha = 0.1)**

Methods Of Carrying Out Costing On Projects

Table 25A : Methods Of Carrying Out Costing On Projects - Private Sector Construction Contractors

Method Of Carrying Out Costing On Projects	*Frequently*		*Sometimes*		*Never*	
	No.	*%*	*No.*	*%*	*No.*	*%*
Resource Driven Costing	10	15.9	20	31.7	33	52.4
Activity Driven Costing	11	17.5	23	36.5	29	46.0
WBS Driven Costing	1	1.6	6	9.5	56	88.9
Costing Is Carried Out Separately From Planning/Control	42	66.7	7	11.1	14	22.2

Table 25B : Methods Of Carrying Out Costing On Projects - Public Sector Construction Contractors

Method Of Carrying Out Costing On Projects	*Frequently*		*Sometimes*		*Never*	
	No.	*%*	*No.*	*%*	*No.*	*%*
Resource Driven Costing	3	17.6	3	17.6	11	64.7
Activity Driven Costing	3	17.6	4	23.5	10	58.8
WBS Driven Costing	0	0.0	0	0.0	17	100.0
Costing Is Carried Out Separately From Planning/Control	10	58.8	1	5.9	6	35.3

Table 25C : Comparison Of Methods Of Carrying Out Costing On Projects Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the methods of carrying out costing on projects between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the methods of carrying out costing on projects between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the methods of carrying out costing on projects between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.05 (Not Significant at Alpha = 0.1)**

Integration Of Costing With Planning/Control Methods

Table 26A : Integration Of Costing With Planning/Control Methods - Private Sector Construction Contractors

Costing Is Carried Out Separately But Would Prefer It To Be Integrated Within Planning / Control Procedures	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Costing Should Be Integrated Within Planning / Control System	37	75.5	12	24.5

Table 26B : Integration Of Costing With Planning/Control Methods - Public Sector Construction Contractors

Costing Is Carried Out Separately But Would Prefer It To Be Integrated Within Planning / Control Procedures	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Costing Should Be Integrated Within Planning / Control System	10	90.9	1	9.1

Table 26C : Comparison Of Integration Of Costing With Planning/Control Methods Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the integration of costing with planning/control methods between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the integration of costing with planning/control methods between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the integration of costing with planning/control methods between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.=1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**1.25 (Not Significant at Alpha = 0.05)**

Use Of Performance Analysis Techniques

Table 27A : Use Of Performance Analysis Techniques - Private Sector Construction Contractors

Use Of Performance Analysis In The Management Of Projects	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Adopt Performance Analysis Procedures	13	20.6	50	79.4

Table 27B : Use Of Performance Analysis Techniques - Public Sector Construction Contractors

Use Of Performance Analysis In The Management Of Projects	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Adopt Performance Analysis Procedures	0	0.0	17	100.0

Table 27C : Comparison On The Use Of Performance Analysis Techniques Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the use of performance analysis techniques between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the use of performance analysis techniques between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the use of performance techniques between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**4.18 (Significant at Alpha = 0.05)**

Methods Of Assessing How Much Work Has Been Carried Out

Table 28A : Methods Of Assessing How Much Work Has Been Carried Out - Private Sector Construction Contractors

Method Of Assessing How Much Work Has Been Carried Out On An activity Since The Previous Update Period	***Frequently***		***Sometimes***		***Never***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Percentage Complete	54	85.7	6	9.5	3	4.8
Value Earned (BCWP)	4	6.3	20	31.7	39	61.9
Balance To Earn	0	0.0	19	30.2	44	69.8
Remaining Time To Complete Activity	5	7.9	39	61.9	19	30.2

Table 28B : Methods Of Assessing How Much Work Has Been Carried Out - Public Sector Construction Contractors

Method Of Assessing How Much Work Has Been Carried Out On An activity Since The Previous Update Period	***Frequently***		***Sometimes***		***Never***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Percentage Complete	15	88.2	1	5.9	1	5.9
Value Earned (BCWP)	1	5.9	4	23.5	12	70.6
Balance To Earn	1	5.9	0	0.0	16	94.1
Remaining Time To Complete Activity	0	0.0	8	47.1	9	52.9

Table 28C : Comparison On The Methods Of Assessing How Much Work Has Been Carried Out Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in assessing how much work has been carried out between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in assessing how much work has been carried out between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in assessing how much work has been carried out between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (1 d.f.)
Actual Value Of Chi-square	**0.07 (Not Significant at Alpha = 0.1)**

Computerised Approach To Project Planning And Control

Table 29A : Computerised Approach To Project Planning And Control - Private Sector Construction Contractors

Percentage Of Projects Using A Computerised Approach For Planning / Control	No.	%
Nil	14	22.2
0 - 10	4	6.3
11 - 20	5	7.9
21 - 40	6	9.5
41 - 60	3	4.8
61 - 80	11	17.5
81 - 100	20	31.7

Table 29B : Computerised Approach To Project Planning And Control - Public Sector Construction Contractors

Percentage Of Projects Using A Computerised Approach For Planning / Control	No.	%
Nil	11	64.7
0 - 10	4	23.5
11 - 20	1	5.9
21 - 40	1	5.9
41 - 60	0	0.0
61 - 80	0	0.0
81 - 100	0	0.0

Table 29C : Comparison On A Computerised Approach To Project Planning And Control Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the adoption of a computerised approach to project planning and control between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the adoption of a computerised approach to project planning and control between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the adoption of a computerised approach to project planning and control between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**17.57 (Significant at Alpha = 0.001)**

Table 29D : Comparison On The Use Of A Computerised Approach Between Private And Public Sector Construction Contractors With Turnovers Less Than £100M And Comparison In The Private Sector For < £100M And > £100M

Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**13.08 (Significant at Alpha = 0.1) (Pri < £100M vs Pub < £100M)**
Actual Value Of Chi-square	**0.0009 (Not Significant at Alpha = 0.1) (Pri < £100M vs Pri > £100M)**

Project Management Planning And Control Software Used

Table 30A : Project Management Planning And Control Software Used - Private Sector Construction Contractors

Name Of Project Management Planning And Control Software Used	No.	%
'In - House ' Developed Software	7	14.3
Pertmaster	10	20.4
Power - Project	12	24.3
Hornet	11	22.4
Plantrac	6	12.2
Baronet	1	2.0
Openplan	6	12.2
Microplanner	3	6.1
Superproject	3	6.1
Manifest	1	2.0
Artemis	2	4.1
Microsoft Project	1	2.0

Table 30B : Project Management Planning And Control Software Used - Public Sector Construction Contractors

Name Of Project Management Planning And Control Software Used	No.	%
'In - House ' Developed Software	1	16.7
Pertmaster	3	50.0
Power - Project	0	0.0
Hornet	0	0.0
Plantrac	0	0.0
Baronet	0	0.0
Openplan	0	0.0
Microplanner	0	0.0
Superproject	1	16.7
Manifest	0	0.0
Artemis	0	0.0
Microsoft Project	1	16.7

Does Planning And Control Software Contribute Significantly Over Manual Methods?

Table 31A : Does Planning And Control Software Contribute Significantly Over Manual Methods? - Private Sector Construction Contractors

Planning and Control Software Contribute Significantly To Improved Planning Over Manual Methods	Yes		No		No Difference	
	No.	%	No.	%	No.	%
Significantly Improves Project Planning And Control	42	85.7	2	4.1	5	10.2

Table 31B : Does Planning And Control Software Contribute Significantly Over Manual Methods? - Public Sector Construction Contractors

Planning and Control Software Contribute Significantly To Improved Planning Over Manual Methods	Yes		No		No Difference	
	No.	%	No.	%	No.	%
Significantly Improves Project Planning And Control	3	50.0	2	33.3	1	16.7

Table 31C : Comparison On Whether Planning And Control Software Contributes Significantly Over Manual Methods Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the adoption of a computerised approach to project planning and control between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the adoption of a computerised approach to project planning and control between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the adoption of a computerised approach to project planning and control between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**4.58 (Significant at Alpha = 0.05)**

Areas Which Current Planning and Control Systems Identify

Table 32A : Areas Which Current Planning and Control Systems Identify - Private Sector Construction Contractors

Areas Which Current Panning And Control System Identify	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Problems Which Are Causing Variances On A Project	46	73.0	17	27.0
Impact Of Problems On Time, Cost, And Performance Parameters	47	74.6	16	25.4
Impact Of Problems On Other Project Activities Or Other Projects	30	47.6	33	52.4
What Corrective Action Should Be Taken To Resolve Problem	17	27.0	46	73.0
What Are Expected Results Of Corrective Action To Be Taken	29	46.0	34	54.0

Table 32B : Areas Which Current Planning and Control Systems Identify - Public Sector Construction Contractors

Areas Which Current Panning And Control System Identify	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Problems Which Are Causing Variances On A Project	8	47.1	9	52.9
Impact Of Problems On Time, Cost, And Performance Parameters	8	47.1	9	52.9
Impact Of Problems On Other Project Activities Or Other Projects	6	35.3	11	64.7
What Corrective Action Should Be Taken To Resolve Problem	1	5.9	16	94.1
What Are Expected Results Of Corrective Action To Be Taken	2	11.8	15	88.2

Table 32C : Comparison On Areas Which Current Planning and Control Systems Identify Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the areas which current planning and control systems identify between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the areas which current planning and control systems identify between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 4 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the areas which current planning and control systems identify between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 4 obtained from statistical tables.
Critical Value Of Chi-Square	7.78 (4 d.f.)
Actual Value Of Chi-square	**2.78 (Not significant at Alpha = 0.05)**

Planning And Control Of Multiple Projects

Table 33A : Planning And Control Of Multiple Projects - Private Sector Construction Contractors

Techniques Used In The Planning And Control Of A Multiple Number Of Projects	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Multi - Project Scheduling Of Time Across Activities On All Projects	17	27.0	46	73.0
Multi - Project Scheduling Of Resources Across Activities On All Projects	13	20.6	50	79.4
Multi - Project Scheduling Of Costs Across Activities On All Projects	13	20.6	50	79.4

Table 33B : Planning And Control Of Multiple Projects - Public Sector Construction Contractors

Techniques Used In The Planning And Control Of A Multiple Number Of Projects	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Multi - Project Scheduling Of Time Across Activities On All Projects	4	23.5	11	64.7
Multi - Project Scheduling Of Resources Across Activities On All Projects	2	11.8	15	88.2
Multi - Project Scheduling Of Costs Across Activities On All Projects	2	11.8	15	88.2

Table 33C : Comparison On The Planning And Control Of Multiple Project Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the planning and control of multiple projects between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the planning and control of multiple projects between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the planning and control of multiple projects between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.30 (Not Significant at Alpha = 0.1)**

Commitment To Quality

Table 34A : Written Policy Stating A Commitment To Quality - Private Sector Construction Contractors

Does Company Have A Written Policy With Regard To A Commitment Of Quality	Yes		No	
	No.	%	No.	%
Written Policy To A Commitment Of Quality	53	84.1	10	15.9

Table 34B : Written Policy Stating A Commitment To Quality - Public Sector Construction Contractors

Does Company Have A Written Policy With Regard To A Commitment Of Quality	Yes		No	
	No.	%	No.	%
Written Policy To A Commitment Of Quality	13	76.5	4	23.5

Table 34C : Comparison Of Private And Public Sector Construction Contractors Commitment To Quality

Null Hypothesis : H_0	That there is no difference in a commitment to quality between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in a commitment to quality between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the commitment to quality between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.14 (Not Significant at Alpha = 0.1)**

Factors Relating To Quality Which May Increase Or Decrease Project Costs

Table 35A : Factors Which May Increase Or Decrease Project Costs - Private Sector Construction Contractors

Factors Which May Increase Or Decrease Project Costs	May Increase		No Effect		May Decrease	
	No.	%	No.	%	No.	%
Internal Failure Costs	61	96.8	2	3.2	0	0.0
External Failure Costs	59	93.6	4	6.3	0	0.0
Appraisal Costs	22	34.9	18	28.6	23	36.5
Prevention Costs	17	27.0	7	11.1	39	61.9

Table 35B : Factors Which May Increase Or Decrease Project Costs - Public Sector Construction Contractors

Factors Which May Increase Or Decrease Project Costs	May Increase		No Effect		May Decrease	
	No.	%	No.	%	No.	%
Internal Failure Costs	17	100.0	0	0.0	0	0.0
External Failure Costs	17	100.0	0	0.0	0	0.0
Appraisal Costs	8	47.1	6	35.3	3	17.6
Prevention Costs	5	29.4	1	5.9	11	64.7

Table 35C : Comparison Of Private And Public Sector Construction Contractors On Factors Relating To Quality Which May Increase Or Decrease Project Costs

Null Hypothesis : H_0	That there is no difference in factors relating to quality which may increase or decrease project costs between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in factors relating to quality which may increase or decrease project costs between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 3 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the factors relating to quality which may increase or decrease project costs between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 3 obtained from statistical tables.
Critical Value Of Chi-Square	6.25 (3 d.f.)
Actual Value Of Chi-square	**0.31 (Not Significant at Alpha = 0.1)**

Forms Of Quality Assessment Adopted

Table 36A : Forms Of Quality Assessment Adopted - Private Sector Construction Contractors

Forms Of Quality Assessment Adopted	Yes		No	
	No.	%	No.	%
Quality Assurance	53	84.1	10	15.9
Quality Control	55	87.3	8	12.7
Quality Improvement	30	47.6	33	52.4

Table 36B : Forms Of Quality Assessment Adopted - Public Sector Construction Contractors

Forms Of Quality Assessment Adopted	Yes		No	
	No.	%	No.	%
Quality Assurance	15	88.2	2	11.8
Quality Control	4	23.5	13	76.5
Quality Improvement	0	0.0	17	100.0

Table 36C : Comparison On The Forms Of Quality Assessment Adopted Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the forms of quality assessment adopted between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the forms of quality assessment adopted between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the forms of quality assessment adopted between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**12.04 (Significant at Alpha = 0.001)**

Forms Of Quality Assurance Adopted

Table 37A : Forms Of Quality Assurance Adopted - Private Sector Construction Contractors

Forms Of Quality Assurance Adopted	***No.***	***%***
First Party - monitored Internally Only	28	44.4
Second Party - Monitored By Clients	19	30.2
Third Party - Monitored By A Certification Body	25	39.7
Third Party - Awaiting Third Party Accreditation	21	33.3

Table 37B : Forms Of Quality Assurance Adopted - Public Sector Construction Contractors

Forms Of Quality Assurance Adopted	***No.***	***%***
First Party - monitored Internally Only	0	0.0
Second Party - Monitored By Clients	0	0.0
Third Party - Monitored By A Certification Body	11	64.7
Third Party - Awaiting Third Party Accreditation	6	35.3

Table 37C : Comparison On The Forms Of Quality Assurance Adopted Between Private And Public Sector Construction Contractors

Null Hypothesis : Ho	That there is no difference in the forms of quality assurance adopted between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the forms of quality assurance adopted between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the forms of quality assurance adopted between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**15.82 (Significant at Alpha = 0.001)**

Accreditation Bodies Used

Table 38A : Accreditation Bodies Used - Private Sector Construction Contractors

Accreditation Body Who Monitors Third Party Quality Assurance System	No.	%
BSI - Quality Assurance	18	72.0
SGS Yarsley Quality Assured Firms Ltd	2	8.0
Lloyds Register	3	12.0
NAMAS	0	0.0
BUQI	1	4.0
CQA	1	4.0

Table 38B : Accreditation Bodies Used - Public Sector Construction Contractors

Accreditation Body Who Monitors Third Party Quality Assurance System	No.	%
BSI - Quality Assurance	9	81.8
SGS Yarsley Quality Assured Firms Ltd	2	18.2
Lloyds Register	0	0.0
NAMAS	0	0.0
BUQI	0	0.0
CQA	0	0.0

Areas Of Work Registered

Table 39A : Areas Of Work Registered - Private Sector Construction Contractors

Third Party Accreditation - Areas Of Work Registered	***No.***	***%***
Civil Engineering Construction	8	32.0
All Areas Of Business	6	24.0
General Construction	2	8.0
Design & Build, Civil Engineering And Building Construction	5	20.0
Building and Civil Engineering Construction	3	12.0
Design, Construction And Management	1	4.0

Table 39B : Areas Of Work Registered - Public Sector Construction Contractors

Third Party Accreditation - Areas Of Work Registered	***No.***	***%***
Safety Fencing	10	58.8
Surface Dressing	2	11.8
Traffic Signs	3	17.6
Road Markings	1	5.9
Gully Emptying/ Ground Maintenance	1	5.9

Table 39C : Comparison On The Areas Of Work Registered Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the areas of work registered between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the areas of work registered between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the areas of work registered between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Fishers Exact Test	**Probability of a distribution as extreme as this = 3.93**

Reasons For Third Party Accreditation

Table 40A : Reasons For Third Party Accreditation - Private Sector Construction Contractors

Third Party Accreditation - Reason For Registration / Application For Registration	***No.***	***%***
To Meet Client /Contractual Requirements	8	17.4
To Improve Quality / Efficiency	15	32.6
To Improve Competitive Advantage / Marketing Advantage	21	45.6
To Improve Customer Satisfaction	2	4.3

Table 40B : Reasons For Third Party Accreditation - Public Sector Construction Contractors

Third Party Accreditation - Reason For Registration / Application For Registration	***No.***	***%***
To Meet Client / Contractual Requirements	14	82.3
To Improve Quality / Efficiency	1	5.9
To Improve Competitive Advantage / Marketing Advantage	2	11.8

Table 40C : Comparison On The Reasons For Third Party Accreditation Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the reasons for third party accreditation between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the reasons for third party accreditation between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the reasons for third party accreditation between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**23.06 (Significant at Alpha = 0.001)**

Staff Employed Purely On Quality Assurance

Table 41A : Staff Employed Purely On Quality Assurance - Private Sector Construction Contractors

Staff Employed Purely associated with Quality Assurance	*No.*	*%*
Nil	6	11.1
1	19	35.2
2 - 3	10	18.5
4 - 5	6	11.1
6 - 10	12	22.2
11 - 20	1	1.9
greater than 20	0	0.0

Table 41B : Staff Employed Purely On Quality Assurance - Public Sector Construction Contractors

Staff Employed Purely associated with Quality Assurance	*No.*	*%*
Nil	6	40.0
1	5	33.3
2 - 3	3	20.1
4 - 5	1	6.6
6 - 10	0	0.0
11 - 20	0	0.0
greater than 20	0	0.0

Table 41C : Comparison On The Number Of Staff Employed Purely On Quality Assurance Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the number of staff employed purely on quality assurance between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the number of staff employed purely on quality assurance between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the number of staff employed purely on quality assurance between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**4.6 (Significant at Alpha = 0.05)**

Quality Assurance Manager/Quality Auditors

Table 42A : Quality Assurance Manager/Quality Auditor - Private Sector Construction Contractors

Does The Company employ a Quality Assurance Manager Or A Quality Auditor	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Quality Assurance Manager	49	90.7	5	9.3
Quality Auditor	42	77.8	12	22.2

Table 42B: Quality Assurance Manager/Quality Auditor - Public Sector Construction Contractors

Does The Company employ a Quality Assurance Manager Or A Quality Auditor	***Yes***		***No***	
	No.	***%***	***No.***	***%***
Quality Assurance Manager	16	94.1	1	5.9
Quality Auditor	15	88.2	2	11.8

Table 42C : Comparison On The Employment Of Quality Assurance Manager(s)/ Quality Auditor(s) Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the employment of quality assurance managers or quality auditors between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the employment of quality assurance managers or quality auditors between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the employment of quality assurance managers and quality auditors between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.05 (Not Significant at Alpha = 0.1)**

Number Of Pages In Quality System Documentation

Table 43A : Quality System Documentation - Private Sector

Number Of Pages In Quality System Documentation	No.	%
not stated	11	20.3
varies dependant on type of project	5	9.2
0 - 20	1	2.8
21 - 40	3	8.3
41 - 80	7	19.4
81 - 120	6	16.7
121 - 200	7	19.4
201 - 400	9	25.0
401 - 600	1	2.8
greater than 600	4	11.1

Table 43B : Quality System Documentation - Public Sector

Number Of Pages In Quality System Documentation	No.	%
not stated	6	35.3
0 - 20	0	0.0
21 - 40	1	9.1
41 - 80	3	27.3
81 - 120	6	54.5
121 - 200	1	9.1
201 - 400	0	0.0
401 - 600	0	0.0
greater than 600	0	0.0

Table 43C : Comparison On The Number Of Pages

Null Hypothesis : H_o	That there is no difference in the number of pages in quality system documentation between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the number of pages in quality system documentation between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_o	Since H_1 simply predicts a difference in the number of pages in quality system documentation between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**6.58 (Significant at Alpha = 0.01)**

General Management Principles Considered Most Important

Table 44A : General Management Principles - Private Sector

General Management Principles Considered Most Important From A Project Manager's Viewpoint	Project Man.		Supervisor		Foreman	
	No.	%	No.	%	No.	%
Supervision	1	1.6	31	49.2	22	34.9
Forecasting And Planning	13	20.6	3	4.8	1	1.6
Organisation	28	44.4	14	22.2	8	12.7
Method Of Work	1	1.6	8	12.7	9	14.3
Command	9	14.3	3	4.8	9	14.3
Control	4	6.3	4	6.3	5	7.9
Coordination	1	1.6	1	1.6	0	0.0
Motivation	13	20.6	8	12.7	15	23.8

Table 44B : General Management Principles - Public Sector

General Management Principles Considered Most Important From A Project Manager's Viewpoint	Project Man.		Supervisor		Foreman	
	No.	%	No.	%	No.	%
Supervision	0	0.0	9	52.9	7	41.2
Forecasting And Planning	10	58.8	2	11.8	0	0.0
Organisation	2	11.8	4	23.5	2	11.8
Method Of Work	0	0.0	0	0.0	3	17.6
Command	0	0.0	0	0.0	1	5.9
Control	0	0.0	0	0.0	0	0.0
Coordination	3	17.6	0	0.0	0	0.0
Motivation	2	11.8	2	11.8	4	23.5

Table 44C: Comparison On The General Management Principles Considered

Null Hypothesis : H_0	That there is no difference in the general management principles considered most important between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the general management principles considered most important between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the general management principles considered most important Accreditation Bodies used between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**9.83 (Significant at Alpha = 0.05) Project Manager**
Actual Value Of Chi-square	**0.06 (Not Significant at Alpha = 0.1) Site Supervisor**
Actual Value Of Chi-square	**0.40 (Not Significant at Alpha = 0.1) Foreman**

Levels Of Management In Projects

Table 45A : Levels Of Management In Projects - Private Sector Construction Contractors

Lowest Level Of Manager In Projects From A Project Manager's Viewpoint	***No.***	***%***
Section foreman / Chargehand	12	19.0
General Foreman	46	73.0
Site Agent / Supervisor	3	4.8
Contracts Manager	2	3.2

Table 45B : Levels Of Management In Projects - Public Sector Construction Contractors

Lowest Level Of Manager In Projects From A Project Manager's Viewpoint	***No.***	***%***
Section foreman / Chargehand	0	0.0
General Foreman	12	70.6
Site Agent / Supervisor	4	23.5
Contracts Manager	1	5.9

Table 45C : Comparison On The Levels Of Management In Projects Between Private And Public Sector Construction Contractors

Null Hypothesis : H_o	That there is no difference in the lowest level of manager considered between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the lowest level of manager considered between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_o.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 1 d.f.
Region Of Rejection of H_o	Since H_1 simply predicts a difference in the lowest level of manager considered between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 1 obtained from statistical tables.
Critical Value Of Chi-Square	2.71 (1 d.f.)
Actual Value Of Chi-square	**0.04 (Not Significant at Alpha = 0.1)**

Aspects Of Projects Associated With Job Satisfaction

Table 46A : Aspects Of Projects Associated With Job Satisfaction - Private Sector

Aspects Of Projects Associated With Job Satisfaction From A Project Manager's Viewpoint	***Project Man.***		***Supervisor***		***Foreman***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Job Making A Profit	44	69.8	11	17.5	0	14.3
Client Satisfaction	16	25.4	12	19.0	5	7.9
Job Completed on Schedule	11	17.5	33	52.4	21	33.3
High Standard Of workmanship	0	0.0	12	19.0	19	30.2
Harmonious working Environment	1	1.6	6	9.5	12	19.0
Meeting Challenging Work	8	12.7	3	4.8	3	4.8

Table 46B : Aspects Of Projects Associated With Job Satisfaction - Public Sector

Aspects Of Projects Associated With Job Satisfaction From A Project Manager's Viewpoint	***Project Man.***		***Supervisor***		***Foreman***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Job Making A Profit	9	52.9	6	35.3	2	11.8
Client Satisfaction	5	29.4	1	5.9	0	0.0
Job Completed on Schedule	0	0.0	6	35.3	3	17.6
High Standard Of workmanship	0	0.0	2	11.8	7	41.2
Harmonious working Environment	0	0.0	1	5.9	4	23.5
Meeting Challenging Work	3	17.6	1	5.9	1	5.9

Table 46C : Comparison On The Aspects Of Projects Associated With Job Satisfaction Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the aspects of projects associated with job satisfaction between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the aspects of projects associated with job satisfaction between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the aspects of projects associated with job satisfaction between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**0.90 (Not Significant at Alpha = 0.1)** Project Manager
Actual Value Of Chi-square	**4.48 (Not Significant at Alpha = 0.1)** Site Supervisor
Actual Value Of Chi-square	**1.89 (Not Significant at Alpha = 0.1)** Foreman

Aspects Of Projects Associated With Job Dissatisfaction

Table 47A : Job Dissatisfaction - Private Sector Construction Contractors

Aspects Of Projects Associated With Job Dissatisfaction From A Project Manager's Viewpoint	***Project Man.***		***Supervisor***		***Foreman***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Company Or Personal Mistakes	20	31.7	7	11.1	6	9.5
Inability To Maintain Schedule	21	33.3	19	30.2	7	11.1
Poor Standard Of Workmanship	5	7.9	9	14.3	16	25.4
Lack Of Incentives Available	1	1.6	3	4.8	9	14.3
Lack Of Information	14	22.2	11	17.5	7	11.1
Inadequate Site supervision	2	3.2	7	11.1	3	4.8
Uncooperative workmen	3	4.8	10	15.9	21	33.3

Table 47B : Job Dissatisfaction - Public Sector Construction Contractors

Aspects Of Projects Associated With Job Dissatisfaction From A Project Manager's Viewpoint	***Project Man.***		***Supervisor***		***Foreman***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Company Or Personal Mistakes	9	52.9	6	35.3	2	11.8
Inability To Maintain Schedule	5	29.4	1	5.9	0	0.0
Poor Standard Of Workmanship	0	0.0	6	35.3	3	17.6
Lack Of Incentives Available	0	0.0	2	11.8	7	41.2
Lack Of Information	0	0.0	1	5.9	4	23.5
Inadequate Site supervision	0	0.0	1	5.9	1	5.9
Uncooperative workmen	2	11.8	1	5.9	6	35.3

Table 47C : Comparison Between Private And Public Sectors

Null Hypothesis : H_0	That there is no difference in the aspects of projects associated with job dissatisfaction between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the aspects of projects associated with job dissatisfaction between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the aspects of projects associated with job dissatisfaction between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**4.97 (Significant at Alpha = 0.1)** Project Manager
Actual Value Of Chi-square	**4.03 (Not Significant at Alpha = 0.1) Site Supervisor**
Actual Value Of Chi-square	**2.19 (Not Significant at Alpha = 0.1) Foreman**

Factors Affecting Tradesmen's Productivity

Table 48A : Factors Affecting Tradesmen's Productivity - Private Sector

Factors Affecting Tradesmen Productivity From a Project Manager's Viewpoint	No.	%
Materials / Plant Availability	42	66.7
Instructional Time Delay	4	6.3
Inspection Delay	0	0.0
Tradesmen Turnover	3	4.8
Absenteeism	2	3.2
Foreman Delays	0	0.0
Foreman Incompetence	8	12.7
Poor Working Environment	9	14.3

Table 48B : Factors Affecting Tradesmen's Productivity - Public Sector

Factors Affecting Tradesmen Productivity From a Project Manager's Viewpoint	No.	%
Materials / Plant Availability	10	58.8
Instructional Time Delay	0	0.0
Inspection Delay	1	5.9
Tradesmen Turnover	0	0.0
Absenteeism	4	23.5
Foreman Delays	0	0.0
Foreman Incompetence	0	0.0
Poor Working Environment	2	11.8

Table 48C : Comparison Of Factors Affecting Tradesmen's Productivity Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the factors affecting tradesmen's productivity between the private and public sectors.
Alternative Hypothesis : H_1 between the	That there is a difference in the factors affecting tradesmen's productivity private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	α= 0.1
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the factors affecting tradesmen's productivity between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**0.05 (Not Significant at Alpha = 0.1)**

Task Related Qualities Considered Most Important From A Project Manager's Viewpoint

Table 49A : Task Related Qualities Considered Most Important From A Project Managers Viewpoint - Private Sector Construction Contractors

Task Related Qualities Considered Most Important From A Project Manager's Viewpoint	*No.*	*%*
Committed To Project	47	74.6
Result Orientated Attitude	11	17.5
Innovative And Creative	6	9.5
Willingness To Change	1	1.6
Concern For Quality	3	4.8
Ability To Predict Trends	0	0.0

Table 49B : Task Related Qualities Considered Most Important From A Project Managers Viewpoint - Public Sector Construction Contractors

Task Related Qualities Considered Most Important From A Project Manager's Viewpoint	*No.*	*%*
Committed To Project	11	64.7
Result Orientated Attitude	1	5.9
Innovative And Creative	3	17.6
Willingness To Change	0	0.0
Concern For Quality	2	11.8
Ability To Predict Trends	0	0.0

Table 49C : Comparison Of Task Related Qualities Between Private And Public Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in task related qualities considered most important from a project manager's viewpoint between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in task related qualities considered most important from a project manager's viewpoint between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in task related qualities considered most important from a project manager's viewpoint between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**2.93 (Not Significant at Alpha = 0.1)**

People Related Qualities Considered Most Important From A Project Manager's Viewpoint

Table 50A : People Related Qualities Considered Most Important From A Project Managers Viewpoint - Private Sector Construction Contractors

People Related Qualities Considered Most Important From A Proj Manager's Viewpoint	No.	%
High Work Energy	12	19.0
Capacity to Solve Conflict	3	4.8
Good Communication	30	47.6
High Need For Achievement	11	17.5
Good Team Spirit	12	19.0
Mutual Trust	4	6.3

Table 50B : People Related Qualities Considered Most Important From A Project Managers Viewpoint - Public Sector Construction Contractors

People Related Qualities Considered Most Important From A Proj Manager's Viewpoint	No.	%
High Work Energy	3	17.6
Capacity to Solve Conflict	0	0.0
Good Communication	9	52.9
High Need For Achievement	4	23.5
Good Team Spirit	1	5.9
Mutual Trust	0	0.0

Aspects Of Projects Associated As Being Good Motivators From A Project Manager's Viewpoint

Table 51A : Motivation - Private Sector Construction Contractors

Aspects Associated As Being Best Motivators From A Project Manager's Viewpoint	***Always Helps***		***May Help***		***Will Not Help***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Employers Attitude	44	69.8	19	30.2	0	0.0
Achievement	40	63.5	23	36.5	0	0.0
Recognition	47	74.6	16	25.4	0	0.0
Responsibility	26	41.3	35	55.6	2	3.2
Money	20	31.7	38	60.3	5	7.9
Advancement	12	19.0	51	80.9	0	0.0
Participation	28	44.4	32	50.8	3	4.8
Competition	4	6.3	52	82.5	7	11.1
Social Relationships	6	9.5	43	68.2	14	22.2

Table 51B : Motivation - Public Sector Construction Contractors

Aspects Associated As Being Best Motivators From A Project Manager's Viewpoint	***Always Helps***		***May Help***		***Will Not Help***	
	No.	***%***	***No.***	***%***	***No.***	***%***
Employers Attitude	11	64.7	6	35.3	0	0.0
Achievement	12	70.6	5	29.4	0	0.0
Recognition	13	76.5	4	23.5	0	0.0
Responsibility	11	64.7	6	35.3	0	0.0
Money	7	41.2	9	52.9	1	5.9
Advancement	6	35.3	10	58.8	1	5.9
Participation	9	52.9	7	41.2	1	5.9
Competition	3	17.6	14	82.4	0	0.0
Social Relationships	4	23.5	9	52.9	4	23.5

Table 51C : Comparison Between Private And Public Sectors

Null Hypothesis : H_0	That there is no difference in the aspects of projects associated as being good motivators from a project manager's viewpoint between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the aspects of projects associated as being good motivators from a project manager's viewpoint between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 4 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the aspects of projects associated as being good motivators from a project manager's viewpoint between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	7.78 (4 d.f.)
Actual Value Of Chi-square	**3.08 (Not Significant at Alpha = 0.1)**

Management Training

Table 52A : Management Training - Private Sector Construction Contractors

Management Training	*Yes*		*No*	
	No.	*%*	*No.*	*%*
Project Management	40	63.4	23	36.6
Planning And Control	45	71.4	18	28.6
Quality Management	52	82.5	11	17.5
Human Resource Management	27	42.8	36	57.2
Performance Management	30	47.6	33	52.4

Table 52B : Management Training - Public Sector Construction Contractors

Management Training	*Yes*		*No*	
	No.	*%*	*No.*	*%*
Project Management	7	41.2	10	58.8
Planning And Control	7	41.2	10	58.8
Quality Management	12	70.6	5	29.4
Human Resource Management	9	52.9	8	47.1
Performance Management	4	23.5	13	76.5

Personal Characteristics Of An Effective Of An Effective Project Manager

Table 53A : Personal Characteristics Of An Effective Project Manager - Private

Personal Characteristics Of An Effective Project Manager	Essential		Desirable		Not Necessary	
	No.	%	No.	%	No.	%
Technological Skills	7	11.1	52	82.5	4	6.3
Communications	56	88.9	6	9.5	1	1.6
Team Building	44	69.8	19	30.2	0	0.0
Leadership	56	88.9	7	11.1	0	0.0
Management Skills : eg planning	33	52.3	30	47.6	0	0.0
Coping Skills	29	46.0	34	53.9	0	0.0

Table 53B : Personal Characteristics Of An Effective Project Manager - Public

Personal Characteristics Of An Effective Project Manager	Essential		Desirable		Not Necessary	
	No.	%	No.	%	No.	%
Technological Skills	1	5.9	13	76.5	3	17.6
Communications	16	94.1	1	5.9	0	0.0
Team Building	11	64.7	6	35.3	0	0.0
Leadership	15	88.2	2	11.8	0	0.0
Management Skills : eg planning	11	64.7	6	35.3	0	0.0
Coping Skills	9	52.9	8	47.1	0	0.0

Table 53C : Comparison Of Personal Characteristics Of An Effective Project Manager Between Private And Sector Construction Contractors

Null Hypothesis : H_0	That there is no difference in the personal characteristics of an effective project manager between the private and public sectors.
Alternative Hypothesis : H_1	That there is a difference in the personal characteristics of an effective project manager between the private and public sectors.
Statistical Test	The reported information is categorical in nature and the groups are mutually exclusive and exhaustive. The Chi-square test for independent groups is appropriate to test H_0.
Significance Level	$\alpha = 0.1$
Sampling Distribution	The sampling distribution of chi-squared is approximated with 2 d.f.
Region Of Rejection of H_0	Since H_1 simply predicts a difference in the personal characteristics of an effective project manager between private and public sector construction contractors the region of rejection consists of those values of Chi-square that exceed the critical value of the Chi-square distribution for d.f.= 2 obtained from statistical tables.
Critical Value Of Chi-Square	4.60 (2 d.f.)
Actual Value Of Chi-square	**0.88 (Not Significant at Alpha = 0.1)**

Table 54A : Attitude Scales On The Use Of Project Management Procedures - Private Sector Construction Contractors

Attitude Scales On The Use Of Project Management Procedures	***1***	***2***	***3***	***4***	***5***
	%	%	%	%	%
Budgets, Costs And Profit Are Most Important Activities	17.6	47.1	23.5	11.8	0.0
Time And Schedules Are Not As Important as Budgets,Costs,Profit etc	5.9	17.6	23.5	47.1	5.9
Quality Is Not As Important As Budgets, Costs, Profit, Time etc	0.0	41.2	5.9	41.2	11.8
H.R.M. Benefits Are Not Assessed To Same Degree As Costs, Time	17.6	47.1	17.6	17.6	0.0
Performance Analysis Is Not Widely Used In THe Construction Ind.	23.5	29.4	41.2	0.0	5.9
Personnel Be Trained In Teamwork, Motivation, Communications etc	35.3	47.1	17.6	0.0	0.0
Knowledge Based Systems Should Be Developed	11.8	23.5	64.7	0.0	0.0
Knowledge Based Systems Will Overcome Existing Software Probs.	5.9	11.8	76.5	5.9	0.0
Different Planning/Control Software Gives Different Resource Results	17.6	11.8	64.7	5.9	0.0
Quality Assurance Is Not Adopted - Initial Set-Up & Running Costs	47.1	29.4	11.8	11.8	0.0
A National Standard For Planning, Control, etc Should Be Developed	5.9	23.5	41.2	23.5	5.9

Table 54B : Attitude Scales On The Use Of Project Management Procedures - Public Sector Construction Contractors

Attitude Scales On The Use Of Project Management Procedures	***1***	***2***	***3***	***4***	***5***
	%	%	%	%	%
Budgets, Costs And Profit Are Most Important Activities	20.6	46.0	17.5	12.7	3.2
Time And Schedules Are Not As Important as Budgets,Costs,Profit etc	3.2	36.5	12.7	38.1	9.5
Quality Is Not As Important As Budgets, Costs, Profit, Time etc	3.2	30.2	15.9	30.2	20.6
H.R.M. Benefits Are Not Assessed To Same Degree As Costs, Time	15.9	47.6	19.0	15.9	1.6
Performance Analysis Is Not Widely Used In THe Construction Ind.	20.6	39.7	33.3	4.8	1.6
Personnel Be Trained In Teamwork, Motivation, Communications etc	30.2	50.8	12.7	4.8	1.6
Knowledge Based Systems Should Be Developed	9.5	28.6	55.6	3.2	3.2
Knowledge Based Systems Will Overcome Existing Software Probs.	1.6	15.9	69.8	9.5	3.2
Different Planning/Control Software Gives Different Resource Results	22.2	38.1	36.5	3.2	0.0
Quality Assurance Is Not Adopted - Initial Set-Up & Running Costs	34.9	47.6	11.1	6.3	0.0
A National Standard For Planning, Control, etc Should Be Developed	6.3	19.0	34.9	20.6	19.0

'attitude scale' : values range from 1 to 5 which correspond to strongly agreeing with the statement (1) to strongly disagreeing with the statement (5).

STRONGLY AGREE — ***STRONGLY DISAGREE***

1 2 3 4 5

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