University of Strathclyde
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Site Management Teams and Project Performance in the UK Construction Industry

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DECLARATION

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ABSTRACT

Genuine team working is inextricability associated with good performance. Within the United Kingdom construction industry the need for team working is extensive. A proper understanding of teams and the advancement of construction team management capacity would have far-reaching benefits for the sector. The research programme investigates the empirical relationship between construction site management team efficiency and project performance.

The adopted case study methodology employs various data gathering techniques. The team variable ratings are evaluated using an attitude statement questionnaire. The team member questionnaire addresses seven key variables identified from the team literature review as a precondition for enhanced team performance. The responses are collated, analysed and presented collectively as a team percentage rating. Project performance is evaluated using seven key performance indicators. The KPI's have been carefully selected to align with four business perspectives derived from Kaplan and Norton's Balanced Scorecard concept. The resultant customised balanced scorecard provides a holistic measure of project well-being. The responses are collated, analysed and presented collectively as a project percentage score. Various statistical techniques test the strength of relationship between the site team and project performance within a construction site setting.

The research findings authenticate the team-performance relationship and demonstrate the potential significance of a diagnostic toolkit designed to assess the 'health' of the site team dynamic. The innovative performance management model provides a roadmap for positive team management intervention and subsequent employment of tailor-made team building programmes. The concept is transferable. Opportunities exist to develop the initiative not only within the confines of construction team management but also beyond industry boundaries. For example, project performance scorecards, reward management and team performance pay.

Keywords: Teams, Projects, Performance Management, Construction Management.

PUBLICATIONS ARISING

1. TENNANT, S. AND LANGFORD, D. (2005a), Teams & Project Performance in the UK Construction Industry, CIB W99 4th. Triennial International Conference, Port Elizabeth, South Africa, May 17th. – 20th. Vol. 1. pp. 200-210.

2. TENNANT, S. AND LANGFORD, D. (2005b), Team 'Working' & Project Performance in the UK Construction Industry, 11th. Joint CIB International Symposium, Helsinki, Finland, June 13th. – 16th. Vol. 7(4), pp. 237-249.

3. TENNANT, S. AND LANGFORD, D. (2005c), Construction Management Teams & Project Performance, ARCOM 2005 - Twenty First Annual Conference, SOAS, London, UK, September 7th. – 9th. Vol. 2. pp. 939-948.

4. TENNANT, S. AND LANGFORD, D. (2006), Team Performance Measurement – Let's Reward Teamwork, ARCOM 2006 - Twenty Second Annual Conference, UCE, Birmingham, UK, September 4th. – 6th. Vol. 1. pp. 189-197.

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CHAPTER 1: INTRODUCTION

1.1 TEAM WORKING

"The difference between teams that perform and other groups that don't is a subject to which most of us pay far too little attention" (Katzenbach and Smith, 1993a). For the United Kingdom construction industry the statement has a particular significance. Construction is commonly perceived to be a team-based business, (Moore and Dainty, 1999). Enhancement of team management capacity by means of innovative team performance measurement may have far-reaching consequences for a sector that has been "widely criticised for...its failure to form effective teams" (Baiden *et al*, 2006).

1.2 THE UNITED KINGDOM CONSTRUCTION INDUSTRY

The construction industry is one of the most influential business sectors in the United Kingdom (UK) (Dti, 2005). The latest industry figures suggest that for the fiscal period of the study (2004) the UK construction turnover exceeded the one billion pound barrier for the first time. The UK construction output is the second largest in the European Union and its industry significance for the national economy should not be under estimated. "Construction is hugely important to the economy (accounting in 2002 for 8.2% of both Gross Value Added and Gross Domestic Product with output at £102.4 billion in 2004 current prices)" (Dti, 2005).

Construction is an industry with many unique characteristics. "The industry is generally driven by single and unique projects, each creating and disbanding project teams made up of varying combinations of large and small firms" (Pathirage *et al*, 2005). An official definition of the construction 'industry' is set by UK Standard Industrial Classification of Economic Activities 2003 (SIC). The expression construction "includes general construction and special trade construction for buildings and civil engineering, building installation and building completion. It includes new work, repair, additions and alterations, the erection of prefabricated buildings or structures on the site and also constructions of a temporary nature." It is an overly generic classification that would appear to focus on the product of construction activities at the exclusion of many key players involved in construction process. The Department of Trade and Industry (Dti) definition of the construction sector better articulates the eclectic composition of the various participants involved in the delivery, "the sector is defined as one which embraces the construction materials and products; suppliers and producers; building services manufactures, providers and installers; contractors and sub-contractors, professionals, advisors and construction clients and those organisations that are relevant to the design, build, operation and refurbishment of buildings" (Dti, 2006). To sum up the process of construction as both a product and a service the construction industry may be succinctly defined as "all those firms involved directly in the design and construction of buildings" (Morton, 2002). The construction industry "is characterised by a large number of relatively small firms, a large number of relatively small construction projects and low barriers to entry, particularly in the (small) contracting sub-sector" (Dti, 2002). A facet often typified by their frequently antagonist yet wholly inter-dependent working relationships. Current industry figures indicate that the sector has over 250 000 construction related firms operating of which the majority of companies are small, medium enterprises (SME's). In terms of employment it is estimated that "2.2 million people work in Britain's Construction Industry" (HSE, 2004).

The statistics highlight the significant contribution and considerable impact that the construction industry has not only in economic terms but on society in general. Its size both in term of turnover and employment positions the construction industry as a strategic barometer of economic and domestic well-being. A fact commonly acknowledged by the UK Government, stating that "the sector has a profound influence over our quality of life at home and at work" (Dti, 2002). Government recognise construction industry performance as a key sector for the realisation of sustainable socio-economic improvement.

That said, "the UK has a long history of reports bemoaning the performance level of the construction industry" (Leiringer *et al*, 2005). In particular the last decade has been witness to many reports written about the extensive dissatisfaction among stakeholders and the apparent endemic under-achievement of a construction industry when addressing issues such as business acumen, health and safety, recruitment, career opportunities, marketing, public relations and education. In terms of overall performance "it is universally recognised that the industry must improve" (Dti, 2002). Many reasons have been given for poor levels of attainment in efficiency and quality. One notable attribute frequently cited, (Latham 1994, Egan, 1998) of the industry is the disjointed disposition of a diverse cross section of industry practitioners and stakeholders. Other reasons include a highly competitive industry with relatively few barriers to entry, procurement practices that promote adversarial relationships compounded by an industry framework that is disjointed, highly fragmented and predominately inward looking. It is not all pessimistic news the construction industry does have its successes, "UK construction at its best is excellent" (Egan, 1998). However because of the indigenous culture of a traditionalist industry driven by risk aversion and the familiar, examples of world class construction represent a one-off achievement rather than a continual learning experience that can be assimilated in to everyday construction practice. This was highlighted by CIRIA in their report 'Guide to developing effective learning networks in construction', stating that "most players in the UK industry tend to focus on winning new projects and completing them in a predictable way." They find or make little opportunity for experimentation or learning, or for finding out what others are doing. "Although there are indeed many examples of excellent practice in flagship construction projects, often these remain isolated and few industry practitioners take up the technologies and techniques used" (Holti and Whittle, 1999).

The UK Government's interest in the welfare of the construction industry symbolises the wide reaching significance of the sector. "The past decade has seen several governmental initiatives in the UK aimed at improving the performance of the construction sector" (Leiringer *et al*, 2005). Government sponsored reports that include Latham 1994, Egan 1998, and Accelerating Change 2002 have addressed many of the core issues. These industry reviews have identified barriers to enhanced performance and recommended management drivers for change. One of the foremost recommendations from the 'Rethinking Construction Report' by Sir John Egan, published in 1998 was to eliminate 'repeated processes'. In production terms this equated to a more systematic and integrated construction process, utilising modern technologies and a standardisation of construction component. The cultural shift in 'manufacturing processes' can only be realised if supported by the construction team. Egan (1998) noted that "manufacturing has achieved performance improvements by integrating the process and team around the product." This contrasts dramatically with traditional construction industry practice where "the repeated selection of new teams...inhibits learning, innovation and the development of skilled and experienced team" (Egan, 1998). As a consequence team working has been identified as a fundamental tenet of the construction industry operating and competing in the twenty first century. This raises the question; does the team perform for the mutual benefit of the United Kingdom construction industry and the wider economy?

1.3 AIMS AND OBJECTIVES

At the heart of the research strategy is the concept of an innovative team performance diagnostic toolkit, designed to investigate team working from first principles and analytically determine which facet of the team dynamic if any, would benefit from the boundless array of team training initiatives available. Much has been deliberated upon about teams and team working. The volume of team related literature, number of team related courses and the everyday management rhetoric to 'work as a team' is testimony to the ever popular allure of team values. There in lies the problem. With a plethora of 'so called' team solutions readily available how do construction teams and their companies identify which course of team training action is best suited to their unique team situation?

1.3.1 AIM

The ambition of this team orientated research programme is probably best stated in terms of what it is not. It is not a remedy for team ailments. It is not another team building exercise that offers a quick-fix answer to achieving enhanced team working. The aim is to create a practical team measurement model that is founded upon first principles and reflects contemporary team working philosophies applicable to the UK construction environment. It will identify both the strength and weakness of the team dynamic. The research ambition will present a major investigative challenge. According to Roger Leveson, (2000), head of Human Resources for Pearce Retail the evaluation of "team effectiveness is one of the last measurement frontiers." To achieve the aim of developing an empirically founded team performance diagnostic toolkit the various research objectives need to be clearly stated.

1.3.2 OBJECTIVES

In order to accomplish the aim ten primary research objectives have been set. The objectives will also provide direction for research structure and development.

1/ Establish a benchmark of current understanding of team working philosophies. This will involve a comprehensive literature review of team working publications both in a theoretical and practical setting.

2/ Establish a benchmark of current understanding of performance management and measurement. This will include an overview performance management theory as well as specific performance management and measurement systems / techniques applied to teams and team working.

3/ Create an investigative framework that satisfies established protocols for demonstrating appropriate levels of academic rigour and promoting confidence in the research outcomes.

4/ Develop an assessment criterion for the evaluation of construction site management team working.

5/ Develop an assessment criterion for the evaluation of project performance.

6/ Review research protocol for the suitable selection, application and evaluation of multiple project investigation techniques.

7/ Select appropriate investigative techniques for statistical inquiry.

8/ Organise the data analysis into a coherent and presentable format. Communicate the outcomes in a clear, concise and meaningful manner. Free from ambiguity and potential misinterpretation.

9/ Discuss the results of the research.

10/ Predict the prospective implications of the study and present recommendations for future research.

1.4 HYPOTHESIS

The hypothesis presented in this thesis is based on an original statement made by Katzenbach and Smith (1993a) published in their seminal team article "The Discipline of Teams." The authors make the sweeping proclamation that "teams and good performance are inseparable; you cannot have one without the other." This comment suggests that, regardless of the human, organisational and environmental backdrop the ultimate definition of a team is best articulated in terms of performance outcomes. Only working collaborations that can demonstrate satisfactory levels of project performance may be described as 'real' teams. Whereas collaborative efforts that fail to demonstrate acceptable levels of performance may be more appropriately labelled 'groups'. The adopted research hypothesis reverses and contextualises the original declaration by Katzenbach and Smith and is tailored specifically for a construction industry audience. The research hypothesis states that 'construction site management teams and good project performance are unrelated; you can have one without the other.'

1.5 SCOPE AND LIMITATIONS

It is important at the outset to determine the scope and limitations of the research programme. Defining the scope and limitations of inquiry helps establish a benchmark for research boundaries, third party participation, target audience, interpretation and understanding.

1.5.1 SCOPE

The scope of the report in its initial stages assumes a broad analysis of the relevant topic areas, reviewing both teams and performance in an everyday management context. The appraisal of these two management themes progress to a more exacting investigation, by explicitly defining the boundaries of both participation and relevance.

Participation is restricted to a specific 'unit of analysis' that has organisational and team leader parameters. All team participants must be employed by the same 'principal' contractor and carry out a management function under the direct leadership of the site / project manager. Typically this construction site team would comprise a project manager, one or more site managers, assistant site managers, site engineers, quantity surveyors, services co-ordinators and planners. All participants must be permanently site based.

Research relevance relates to the dimension of investigation and may be expressed in terms of a relevance hierarchy. The primary relevance category is associated with the construction site based team. A secondary relevance category may adopt a wider appeal but is still restricted specifically to construction industry interests. Such as integrated project teams, partnering and other forms of industry alliance. A tertiary category exports the unique findings of a highly contextualised research methodology in to the business environment in general. Presenting the research in universal expressions of understanding and demonstrating potential opportunities for other sectors to explore, adopt and/or adapt aspects of the original research concepts.

1.5.2 LIMITATIONS

In this particular study, limitations refer to the degree of control and resultant level of confidence associated with the final research outcomes. For the research to be manageable it is necessary at the outset to accept that limitations will apply. Some will be logistic in nature such as timescales, resources, access to data sources and third party co-operation. Other constraints will be more abstract. The statement "all research is interpretive" (Gummesson, 2003), typifies the dilemma. Regardless of the research logistics, policy, procedure and systems prepared and practiced in an effort to achieve uniformity and objectivity of outcome, the results will ultimately need to be decoded. This act of communication by its very nature is dependent on personal understanding and experience and therefore places interpretative limitations on the study. Other theoretical issues abound. For example, project participants may be inhibited in providing their true response due to organisational or group pressures, personal reasons or simply because they are being observed for the purpose of a study. The 'unit of analysis' for multiple project investigation, the measurement of scale for qualitative data and the application of parametric data techniques for non-parametric data sources will all contribute to the architecture of the research. At this point is timely and heartening to comment that the objective of research is not to be perfect. Limitations whether they are logistical or theoretical are an inevitable feature of conducting research. The crux of the dilemma is that the limitations should not detract from the supreme fact that the research has something interesting to say.

1.6 OVERVIEW OF THESIS STRUCTURE

The purpose of this section is to provide an overview for each of the eight chapters of the thesis.

1.6.1 CHAPTER 1 – INTRODUCTION

Chapter 1 is the introductory chapter; its purpose is to acquaint the reader with the research rationale. This is achieved by firstly introducing the construction industry within which the research is conducted. Outlining some facts and figures associated with the construction industry in the UK and commenting on some of the issues and challenges that face sector stakeholders in the twenty first century. Secondly the hypothesis to be tested is stated. The commonly held assertion that teams and good performance are indivisible is investigated within the specific context of construction site management teams and their corresponding construction project performance. Furthermore the aims and objectives, scope and limitations of the thesis are also outlined and established. Chapter 1 sets out the research topography in preparation for a more detailed 'ground' analysis.

1.6.2 CHAPTER 2 – TEAMS AND TEAM WORKING

Chapter 2 begins with a brief historical overview of teams and team working in an organisational environment. A definition of the team is examined along with the notion of group to team evolution. The discussion develops into team identification, team fit and team diversity, citing examples of current team inventories used to ascertain personal preferences within a balanced team environment. The chapter concludes by developing a team literature matrix that illuminates seven key team variables arranged under three contextual headings. All the key team variables make an important contribution to the collective synergy of the team.

1.6.3 CHAPTER 3 – PERFORMANCE MANAGEMENT

Chapter 3 examines the concept and development of performance management and measurement within the business community. Initial analysis is somewhat abstract in that the idea of 'learning to perform' and 'learning organisations' potential to perform is outlined as a precursor to a definition of performance. Organisational performance management ideals and the increasing recognition of performance management and measurement as a key managerial function are reviewed. This is exemplified by the introduction of key performance indicators (KPI's) and the transition away from the customary monetary outlook in favour of a holistic understanding of organisational performance credentials. Performance management of teams receives special consideration. This sub-chapter highlights the frequent contradiction in organisational behaviour where on the one hand team working is strongly advocated but on the other hand team performance is rarely acknowledged, seldom measured and only on occasion rewarded. The chapter concludes with a review of performance management and measurement attitudes within in the UK construction industry, outlining some of the challenges facing stakeholders working in the built environment.

1.6.4 CHAPTER 4 – RESEARCH METHODOLOGY

Chapter 4 outlines the research framework, research rationale and key research questions. A review of research ideology has been undertaken to determine the most appropriate research strategy to adopt allied with the correct research tactics to apply. The research methodology also reflects on the question of ethics and addresses the personal objective to be a 'considerate researcher'. The construction of a research model brings in to focus the principal elements of the programme and illustrates the interdependencies between the key stages. Subsequent discussion concentrates on the techniques adopted for the measurement of both team and project performance. An attitude statement questionnaire is designed to capture team member perceptions of team working. Individual member responses can be scored, aggregated, presented and expressed as a team percentage 'rating'. The measurement of project performance exploits existing key performance indicators (KPI's) developed by Constructing Excellence in the Built Environment purposely for the construction industry. The carefully selected KPI's are incorporated within a balanced scorecard framework to create a customised holistic project performance measurement model. To test the research reliability, validity, adaptability and reproducibility a pilot study is carried out and an archetypal report presented.

1.6.5 CHAPTER 5 – CASE STUDY AND RESULTS SUMMARY

Chapter 5 continues with the ideals of the adopted research strategy and reviews the principles and practicalities associated with the adopted case study methodology. The discussion concentrates on the virtues of the case study approach, culminating in the construction of a case study design that is appropriate to the aims and objectives of the wider research programme. Issues of case study type, unit of analysis, lateral, longitudinal and hierarchical analysis in conjunction with protocol are discussed and presented. Chapter 5 concludes with a summary of the case study results. Case study data and information is pooled together under their corresponding company profile. Four major UK construction contractors participated in the research, Company A for the pilot study (see Chapter 4) and Company B, C and D for the main study. A detailed breakdown of the thirteen participating case studies can be found in Appendix G: Project Case Study Reports.

1.6.6 CHAPTER 6 – DATA ANALYSIS

Chapter 6 presents a detailed data analysis of the case study findings. A number of parametric and non-parametric testing techniques are employed in an endeavour to provide statistically founded judgement on the relationship between construction site team 'rating' and project performance 'score'. Analysis of the data has three distinct formats. Initially the individual case study data is analysed within company boundaries, secondly corporate team project data are combined, compared and contrasted. Finally all thirteen case studies are aggregated and examined as a representative snapshot of the UK construction industry. The data analysis summary highlights some of the main research findings.

1.6.7 CHAPTER 7 – DISCUSSION

Chapter 7 discusses two different research perspectives. The first section 'Strengths & Weaknesses' reflect on the practical merits of the research in relation to the initial aims and objectives. The section concludes with the embryonic concept of a 'Team

Training Matrix'. Using the team performance diagnostic toolkit it would be possible to identify already existing and widely accepted team building initiatives that would best suit the needs of the team under examination. The second section 'Opportunities and Threats' takes a theoretical look at the potential implications of future research within the field of team studies. Issues reviewed include theory to practice and critical management theory. This section also identifies a number of team issues that may be further developed using the findings of this research study as a starting point. Suggestions include team performance rewards, HRM and organisational fit as well as research applicability beyond the boundaries of the UK construction industry.

1.6.8 CHAPTER 8 – CONCLUSIONS AND RECOMENDATIONS

The concluding comments in chapter 8 reflect on the endeavour, originality and achievement of the research programme as a whole. It provides both a personal and pragmatic insight in to the many trials and uncertainties associated with undertaking research. The chapter concludes by making a statement on the rightness of Katzenbach and Smith's original hypothesis, "teams and good performance are inseparable; you cannot have one without the other." Comment is made on the complexity of behavioural studies in a team setting, the ever-present risk of research contamination from the simple act of being observed (the Hawthorne effect) and the provisional characteristic of the construction site team. Future research directions are reviewed with consideration given to integrated project team configurations and extending the research premise beyond construction industry boundaries. Final comments reflect on the notable research achievement.

1.7 SUMMARY

Chapter 1 has introduced the research rationale and provided a synopsis of the research programme in terms of research ambition. The primary management themes are also introduced, namely; construction site management teams and construction project performance. The structure of the thesis has also been explained accompanied by a précis of contents for each of the chapters.

CHAPTER 2: TEAMS AND TEAM WORKING

2.1 INTRODUCTION

Team theory is a resilient management theme; the notion of team working has a long history. In the second half of the twentieth century its theoretical and practical contribution to work-place engineering and re-design has been extensively reviewed and comprehensively documented. The quantity of readily available team management literature, team-building seminars and conferences is a tangible testimony to the enduring appeal of team working philosophies. In an era of ever changing management trends, corporate interest in the team working ideal has remained steadfast. In the present day global economy the utilisation of team working is proclaimed to be an essential management tool, fundamental to corporate well-being where "properly functioning teams are now central to many organisations' health" (Fisher *et al*, 1998). For ambitious, competitive and highly motivated organisations, "teams are considered to be on the leading edge of management and human resource development" (Harris and Harris, 1996).

2.1.1 BACKGROUND

The arrangement of collective human behaviour within a cooperative and collaborative socialisation framework can be traced back to the origins of civilisation; for example in the search for something to eat "the hunting party was a group with a very important common goal – to obtain food to survive" (Cornick and Mather, 1999). Within an industrial context the investigation and subsequent recognition of workplace behaviour and worker well-being originate from the Industrial Revolution of the early nineteenth century. Robert Owen (1771 – 1858), a British utopian socialist experimented with more humane and progressive employment regimes. As manager of the New Lanark cotton mills in Scotland from 1800 to 1825, he endorsed an ethos of management responsibility for the employees that extended beyond the factory environment and included the employees' families and the wider community. Robert Owen believed that a cared-for workforce would be more motivated and committed to the company. As a result New Lanark gained international fame when Owen's programme for enhancing his workers' environment resulted in increased productivity and profit.

The formal study of workplace behavioural science began in earnest during the 1920's and 30's with the development of a research and learning science commonly referred to as the Human Relations School. The Human Relations perspective on corporate efficiency has its own origins rooted within Frederick Taylor's Scientific Management model of the early twentieth century, but believed that focusing on the effectiveness and efficiency of a production process at the detriment of the individual had the potential to de-humanise the workplace at the expense of maximum efficiency. It may be contended that the Human Relations School advances Fredrick Taylor's Scientific Management principles, believing that better understanding of the formal and informal dynamics that motivate human activity can, in confluence with improved technical processes, achieve greater efficiencies for the organisation whilst enhancing the well-being and self-actualisation of the individual. The human relationship approach to management science, with particular reference to the renowned Hawthorne Studies (1924 – 1927), clearly demonstrated the significance of group dynamics in the workplace. The report concluded that a "wage incentive plan was less important in determining an individual worker's output than was group acceptance and security" (Donnelly *et al*, 1998).

In post-Second World War Britain, the practice of functioning and in this particular case, dysfunctional team working was initially acknowledged by the Tavistock Institute of Human Relations in London. Their studies concentrated on the coal-mining and textile industries of the 1950's. Trist and Bamforth's report, 'Some Social and Psychological Consequences of the Longwall Method of Coal Getting' published in 1951, demonstrated the disastrous consequences of introducing technological change without taking into consideration the unique social interplay that augments the productivity of the work group. Their recognition of the 'socio-technical' component of group unity has since become a benchmark for future team studies in the United Kingdom. Their study highlighted the social and psychological consequences that may accompany organisational change in the workplace and the need for managers to reflect on the informal as well as the formal social hierarchies. Management concepts have continued to evolve; adopting and adapting knowledge from other scientific sources such as sociology, psychology and other behavioural science hybrids to develop models for organisational design and re-design. Examples include Quality of Working Life (QWL), Business Process Re-engineering (BPR) and more recently team-based working models that include self-managing teams (SMT) and high performance teams (HPT).

"Developments in modern manufacturing methods and service excellence have put greater emphasis on team working" (Open University, 2001b). Today, global industries ranging from aerospace and car-manufacturing to financial services as well as the public sector have embraced team philosophies in striving for improved efficiency coupled with increased productivity. There exists a discreet difference from the team philosophies of previous years. The traditional team work research perspective of the founding behavioural scientists was, in essence, benevolent in its concern, "the principal managerial and social science concerns have been with morale" (Buchanan, 2000). Modern team management theories focus primarily on the needs of the business leading Cully *et al* (1998) to observe that "considerations of performance have obviously contributed to the growth in importance of team working during the 1990's." Johnston *et al*, (2000) was more explicit in their observations "they want people who will make them profitable and ... profit-generation is increasingly in the hands of teams." This viewpoint is further endorsed by Marchington, (2000), commenting that "more recently, there have been few doubts that the attractiveness of the team concept has rather more to do with gaining competitive advantage through advances in productivity and quality – which may be enhanced by teams, than with any altruistic motive." After all, "the whole point of teamwork is that the performance of the group as a whole is better than would be the normal sum of the performances of the individuals comprising the group" (Gabriel, 1991).

The business perspective for capturing team synergy would appear to be allied directly with increased corporate competitiveness and subsequent profit-generation. A new wave of management thinking has shifted the typical team paradigm. From a primarily tactical approach used, predominately by manufacturing industries to improve, in a concurrent fashion, productivity and operative morale towards a contemporary prospective that views the application of team working as a wide-ranging corporate intent that touches all aspects of business performance. The team working concept is equally applicable to most business operations, ranging across manufacturing and service organisations that include Government and the public sector. Team working as a management concern is presently driven by a corporate desire to compete via the effective employment of human resources. Or put more succinctly, "The objectives... are strategic rather than operational" (Procter and Mueller, 2000).

2.2 DEFINITION OF TEAMS

'Team' is a common, everyday expression yet an exact definition remains elusive. The New Oxford Dictionary of English, (1998) defines a team as "two or more people working together" and the Chambers English Dictionary (1990) states that a team is "a set of persons working or playing in combinations." These dictionary descriptions communicate a casual application of the team ideal, free of context and over-simplifying two fundamental concepts. First, the collective nature of the grouping and secondly the collaborative dimension of 'working together' or playing 'in combinations'. Management interpretation of team virtues supplements this basic definition by acknowledging group activity but introduces the necessity for a commonly shared objective. Harris and Harris (1996) define a team as "a work group or unit with a common purpose through which members develop mutual relationships for the achievement of goals / tasks." Francis and Young's (1979) team definition is, "an energetic group of people who are committed to achieving common objectives, who work well together and enjoy doing so, and who produce high quality results." Katzenbach and Smith in their book "The Wisdom of Teams", (1993b), suggest that the team definition would be better articulated as an "essential discipline that real teams share," stating that "a team is a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable." These statements compare with Harris and Harris in meaning but elaborate on the strength of social interdependency, a quintessential team competence: a quality "increasingly being promoted as being necessary for successful team work" (Tarricone and Luca, 2002). The liberal use of team vocabulary may support a communal and corporate need for structure and a formal, readily identifiable expression of social cooperative activity. Unfortunately the everyday management rhetoric may dilute the true collective nature of team-oriented operations and therefore "carries with it the danger that team working will lose all meaning" (Procter and Mueller, 2000). Vague team interpretations will only support 'lazy' management in the creation of 'name-only' teams. An indefinable meaning may lessen the importance of the term but "as terminological precision is so elusive, it is perhaps more appropriate to focus attention on how aspects of organisational context influence the different forms of team working adopted" (Buchanan, 2000). Accepting a generic understanding of the term 'team', accommodates the diversity and vitality of the team concept within corporate and sector environments. Teams are similar yet different; it's the depth of analysis that differentiates the description giving rise to the notion that a definition may be better accommodated within the team taxonomy. In non-specific terms the management team definition is a simple tripartite relationship that encompasses collective, collaborative activity with a common objective as initially stated by Harris and Harris. Within a context-specific organisational situation teams become complex, multifaceted, dynamic but always provisional, in that "teams are transient" (Gabriel, 1991). Team ideals, compositions and corporate systems are inherently time-dependant and as such the working definition needs to be malleable enough to reflect an ever-changing contextual attribute.

What is the role of organisational context within the definition of team-based collaborations? Failure to recognise organisational limitations may inhibit team performance. Examples of unsuccessful team working have highlighted the role organisations play in the formation and support of collaborative effort, "the most fundamental problem that teams confront is our existing work structure" (Conti and Kleiner, 1997). Jasmine Tata (2000) commented on the cultural and structural constraints of team working by stating that "lack of significant success is often not a failure of the team concept, but as a result of insufficient attention being paid to the organisational context of team systems." She expanded on the significance of organisational limitations by declaring that, "work teams do not exist in a vacuum, but are part of a larger organisational system with distinct cultural and structural characteristics." As a consequence the introduction of contemporary team philosophies may contradict existing organisational norms. Companies should endeavour to establish degrees of compatibility between existing working practices and those associated with a team orientation prior to the implementation phase. Organisational context will shape the adaptation of team based philosophies and as such will redefine the generic meaning of team within an organisational-specific setting. Supporting the suggestion and addressing the objective that team structure reflects company procedures and values.

The organisational constraints of team definition may be expanded beyond the traditional boundaries of management structure. The industry environment may also shape the exactness of team meaning although this facet appears to be overlooked in much of the team management literature. In many cases the team structure, although transitory in nature, is conceived and based at predetermined, permanent locations and for the most part associated with a manufacturing or service industry. The workplace environment in this case may be classed as constant, whereas in construction the opposite is generally true. The construction industry is a project-based industry, focusing on bespoke complex operations that promote cross-functional collaborative working within a nomadic, highly competitive, client-interfacing environment. Fluctuating sector parameters such as project availability, procurement and building type combined with transient people - project combinations undoubtedly influence the team definition, composition and corporate customs. It may be reasoned that the construction environment supports an atypical team configuration. This may be interpreted as an inter-developing, intra-dependent relationship. Any modification to accepted industry norms may influence company perceptions, practice, culture and ultimately team definition. Distinct cultural identity, as a consequence of sector and corporate idiosyncrasies may also contribute to team interpretation. People groupings based on functional and character diversity will create unique combinations that will symbolise the traditions of the sector, company, professions, trades and skills. Within the construction industry the cultural identity of the various professions is deep-rooted and habitually antagonistic, with the potential to impede the formation of truly integrated, shared-focus, project teams. Within a contextual framework, the precision of a meaningful team definition takes time and "managers may be well advised to use the label 'groups' on all occasions in the first instance" (Fisher *et al*, 1997), particularly in the construction sector.

2.3 GROUP - TO - TEAMS

The prospective benefits of team working are well documented, Colenso (1997), stated that "the primary and overwhelming organisational motive behind the use of teams is performance enhancement." Adair (1986) made similar remarks with regard to organisational output, stating that team working "increased productivity, efficiency and also the increased motivation of the members of a team." Undoubtedly, the underlying principle associated with the notion of team working is to "improve the organisations competitive position through the effective utilisation of human resources", (Morley and Heraty, 1995). These statements endorse the virtue of collaborative-based work design but it is necessary at the outset to distinguish the difference between a group and a team. Within the rhetoric of management jargon the term group and team are often used synonymously, with many authors using the terms interchangeably, drawing little or no distinction between the two, (Dainty, 2002) and supported by Dr. M. Belbin's (1997) observation that the expression "team is often used benignly for a group". Fisher *et al*, (1997) in their study 'Team or Group? Managers perceptions of the differences' acknowledge the common ambiguity associated with the terms, "the conclusion is difficult to avoid: in the literature many authors continually refer to teams as groups and groups as teams, neither perceiving nor implying any distinction between them."

Conversely, many management commentators argue that the 'nouns', team and group, are distinguishable, whilst supporting the idea that the team expression is in essence a derivative of group work design. As stated earlier, a definitive definition of the term team remains problematic but "it is a mistake to think that any group of people acting together constitute a team" (Colenso, 1997). "The team is far from a loose-knit group of workers linked together by proximity or even similarity of tasks. On the contrary, the team is defined by a small number of individuals with complementary skills holding themselves mutually accountable for a commitment to quality, customer service and productivity", (Natale *et al*, 1998). The original interpretation requires further clarification in order that individuals may be identified as clearly belonging to a group or a team. Luck and Newcombe (1996) succinctly state that "a group is less formal than a team," this explanation introduces the concept of structure but requires further clarification with regard to direction and ambition. Woodcock and Francis (1995) portray a team as "a group of people who must directly relate together to achieve shared objectives." This implies a degree of interdependency while focusing on the need for a mutual goal. Therefore, "the two factors which help distinguish teams from groups are: 1/ the level of dependency and 2/ the degree of commonality" (Williams, 1996). A group may be viewed as a disparate collection of individuals with little shared purpose. Whereas the essence of a team is that the individuals share a common purpose and where the action of one member directly influences the chances of success for other individuals and the team as a whole. Team performance is dependent on collective effort.

The commonly held notion that team compositions cultivate from group origins is widely respected within team management theory. First published in 1965, Tuckman's universal sequential 'group-to-team' transition model of 'forming, storming, norming and performing', later revised to include 'adjourning' (Tuckman and Jensen, 1977), is an important point of reference for contemporary group studies. Alternative group-to-team transition models have been proposed. In Connie J. G. Gersick's study, 'Time and Transition in Work Teams: Toward a New Model of Group Development (1988)', she re-examines the pattern of group-to-team conversion. Accepting the initial premise that group-to-team is an evolutionary process she challenges Tuckman's synthesised group model, proposing "a new model of group development that encompasses the timing and mechanisms of change as well as groups' dynamic relations with their context". The model provides fresh impetus to group metamorphosis, introducing time as measure with which the group can calibrate their performance. The article suggests that the half-way point in particular, acts as a catalyst, where the group transfer their attention away from 'how much time has passed – to how much time is left'. This heightens the challenge, focuses resolve and acts as a stimulus for group motivation and performance standard. The recognition of the contextual element is noteworthy. The comment is congruent with the lack of team definition. As stated earlier, team definition may be more accurately expressed and better understood within its context-specific framework, believing that team functioning may be unique to the contingent environment in which it operates. Group-to-team development may also be perceived as part of that equation.

A contained theme running through team management literature is the need for trust. Trust development is often implied but as a 'sociological inquiry' associated with group-to-team transition it is rarely exposed as a 'mechanism of change'. Many commentators identify trust as an 'ingredient' for successful team working, "teams demand strong group culture, which is based on empowerment, shared vision, creativity, participation, learning ability, trust and shared consensus" (Castka *et al*, 2001). Johnston *et al* (2000), suggests that well-structured successful teams will possess "trust-building" skills, "Trust and honesty are essential to the success of the team" (Tarricone and Luca, 2002). Trust as an expression has many similarities with team. It lacks a definitive definition, it takes time, it's chronological in its development and engendered trust becomes a consequence of shared experience, like teams it has a relationship characteristic. The resultant level of trust and intrapersonal confidence of the initially disparate individuals may ultimately define the parameters of conduct for the group / team activity and creativity; it can permeate the inter-social relationships, promoting an interdependency of practice that can outperform traditional group endeavours. "The fundamental basis of this distinction is the belief that interpersonal relations allow for the creation of trust" (Weber and Carter, 1998), and "trust is a critical component of the entire team concept" (Natale *et al*, 1998).

The process of group to teams requires management effort and time, "the conventional wisdom is that teams take at least six months to create" (Gray and Suchocki, 1996). Within the construction industry many barriers exist which inhibit the promotion of constructive team formation and team building. Issues such as fluctuations in workload, availability of personnel and the temporary nature of a project-based environment all contribute to a belief that effective team selection and team-building may be too difficult and short lived for the attainment of any real benefits. It has been acknowledged that "the endemic characteristics of construction projects make the formation of a project team difficult" (Luck and Newcombe, 1996). "It is self evident that teams that only construct one project learn on the job at the client's expense and hence will never be as efficient, safe, productive or profitable as those that work repeatedly on similar projects" (Egan, 2002).

2.4 TEAMS IN THE WORKPLACE

Team type in the workplace is fashioned by the environment in which the team operates and "in many ways, the team represents a miniature version of the organisation which sponsors it" (Harris and Harris, 1996). The resultant team composition and characterisations subsequently reflect the various contextual parameters associated with the wider business environment, for example; industry sector, organisational structure and membership diversity. An assortment of team titles exemplify the range of team types commonly formed within organisations. Terminology such as department teams, quality circles, cross-functional teams, self-managing teams and high performance teams, to name a representative few have become everyday expressions in companies worldwide. All of these team types will posses strategic features that are indigenous to their organisational context; in particular, membership discretion, i.e. the level of autonomy delegated by the organisation to the team. In general terms, department teams have a traditional role within organisations, focusing on group cohesion between members with similar backgrounds. Quality circles, as the name suggests, are a product of company quality initiatives and can be constructive in the dissemination of business improvement practices. These teams are normally formed in a problem-solving capacity and have the lowest levels of team autonomy. A contradictory corporate requirement for process differentiation whilst facilitating integration supports the creation of an organisational cross-functional or matrix team formation. Cross-functional teams by their nature have more autonomy than departmental teams although senior management generally retain control of membership selection, reward distribution and project strategy. This type of multi-disciplinary task-force is representative of project management teams in the construction industry. Self-managing teams (SMT) may also be referred to as high performance teams (HPT) but a review of the available literature illustrates that although enhanced performance may be the central aim of the self-managing team concept, increased performance is not necessarily guaranteed. In essence self-managing teams and high performance teams have a significant level of industrial democracy, delegated via a management-initiated system of employee participation for aspects of production and decision-making that under traditional departmentalised team structures would have been viewed as a management function. Self-management team members are encouraged to embrace task ownership and with it an increased sense of responsibility for their work. For that reason self-managing teams have the highest levels of autonomy, empowered by their self-determination; whereas departmental team formations have the lowest levels of organisational independence.

2.5 TEAM BUILDING

"Team working is a strategy that has the potential to improve the performance of individuals and organizations, but it needs to be nurtured over time" (Ingram, 1996). This introduces the concept of team building. Team building is perhaps the most difficult and yet most promoted aspect of human relations in organisations, (Cornick and Mather, 1999). The idea is straightforward, the application is more challenging. "The purpose of teambuilding interventions is to enhance performance by improving the processes that characterize the work of the group" (Kipp and Kipp, 2000). The problem is choosing an appropriate team improvement initiative from the overwhelming array of options available. Team training can be presented in many guises such as lectures, case study, group discussion and workshops, to name a few but they will in all probability only deal with one specific aspect of a multifaceted team environment.

2.5.1 THE TEAM ENVIRONMENT

The team environment has three clearly identifiable points of reference and two key relationships. "These dimensions are related to: the organisational dimension; the team dimension; the individual dimension" (Castka *et al*, 2002). The relationship are between the individual and the team and may be referred to as the 'team balance' and the team and the organisation and may be referred to as the 'team fit', see figure 2.5.1., team relationships.

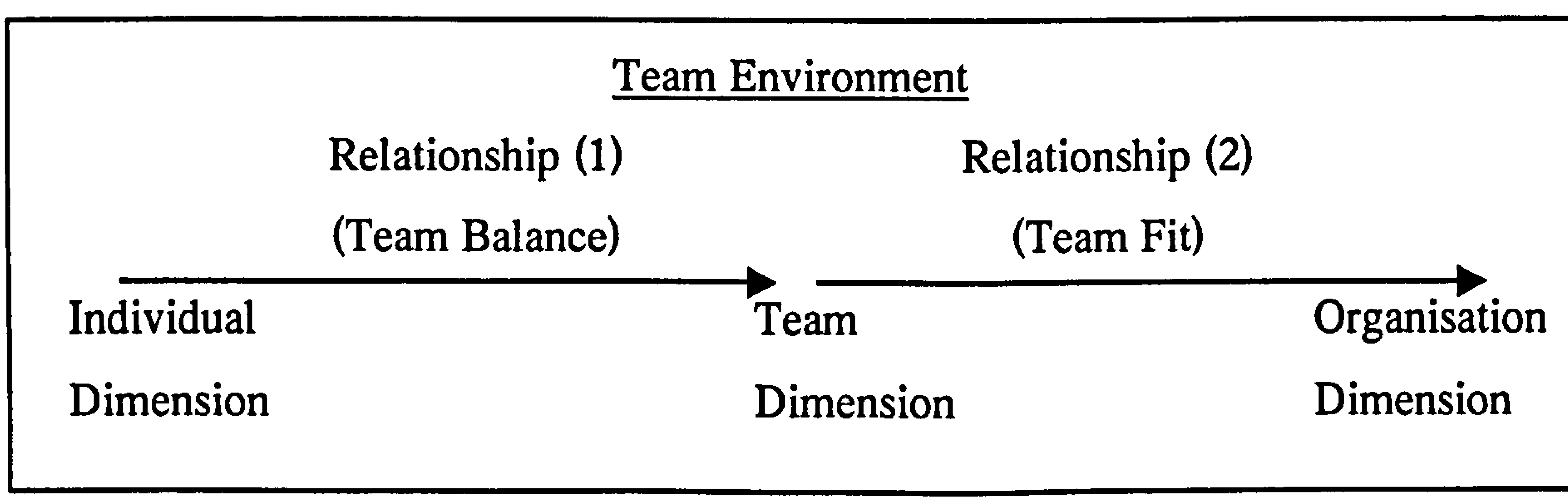


Figure 2.5.1 Team Relationships

The notion of 'Team Fit' is the inter-relationship between team members as a collective unit and the wider organisational framework. It is a management tenet that organisational structure will follow strategy. Therefore, endorsing a team working philosophy as a strategic intent for improved performance may challenge existing company structures. This differs from 'Team Balance' where the focus is on membership diversity, member characteristics and the resultant interplay between individual participants.

2.5.2 TEAM FIT

A basic requirement of the multiplicity of organisational context is that it re-defines the developing collaborative culture by complementing evolving team structures with organisational endorsement. Company policy should endeavour to facilitate the requirements of team working. One of the long-established barriers to fully embracing a collective approach to organisational social re-design is the continuing reward of the individual regardless of the team contribution. The implementation of a reward structure that supports collectivism as opposed to individualism is central to the effective management of collaborative working practices. Therefore, "companies implementing teamwork approaches must design plans that reward employees and encourage workers to participate enthusiastically in team projects" (Natale *et al*, 1998). Incentives that reward teamwork underpin the evolving cooperative ethos of the employees. This reinforces the belief that without the various, co-ordinated, individual contributions to the collective effort, task accomplishment would not have been realised. To ascertain the most appropriate fit between organisation and team type it may be advisable to audit existing corporate structures, systems and customs. A disparity between organisational frameworks and team structures is likely to lead to unsuccessful team working, "it is not easy to implement autonomous work teams in an organisational culture that emphasises retaining power in managerial hands" (Tata, 2000). A well-designed team in the workplace may be assessed against two broad achievement ratings; a contextual evaluation - relating to the quality of 'match' between the team formation and the wider management community and effective functioning - based on an evaluation of interpersonal processes, with specific emphasis on team 'balance'.

2.5.3 TEAM BALANCE

Team balance is often cited as an important facet of the overall team design and relates to the diversity of individual traits represented within the team composition. Traditionally the composition of teams in the workplace has been determined through either functional or status considerations in order to ensure the right level of expertise and experience. This approach does not take into account the implications of individual personalities and behaviours in the team process. In particular, "it ignores the likelihood that team members will have individual preferences for the roles they adopt in a team situation" (Partington and Harris, 1999). Team balance represents the necessity for a suitable 'mix' of team players. A blend of team membership that can provide competent functional representation alongside behavioural roles that encourages collaborative, harmonious, productive working. "The compatibility of the members of the team is of vital importance" (Gabriel, 1991). A great deal of research has been carried out within this field of psychology, developing hypothessi on personality combinations that have the potential to enhance team performance. Conscious of the fluid nature of socio-technical team dynamics, a number of these studies have promoted the development of predictive diagnostic and psychometric models. The models afford management with a suggestive insight in to the personality dynamics of existing or proposed team formation. The findings can be benchmarked against a predetermined 'ideal-team' blend in an attempt to evaluate the potential team synergy levels. Two of the most commonly cited personality inventories employed in the investigation, identification and selection of team membership personality characteristics are: Belbin's Team Role Self Perception Inventory (BTRSPI) and The Myers-Briggs Type Indicator (MBTI).

2.5.4 BELBIN'S TEAM ROLE THEORY

Dr. R. Meredith Belbin is one of the world's leading authorities on the formation and performance of teams and has conducted extensive research in to management teams and why they succeed or fail. Dr. R.M. Belbin's concept of Team Role Theory published in his book, 'Management Teams: Why they succeed or fail' (1981), was the result of nine years research carried out at Henley Management College, England. By utilising a number of psychometric tests it became possible to accurately predict levels of team performance. Repeated experimentation disclosed that various combinations of personnel would result in varying degrees of success. Belbin argued that a balanced team, representing a spread of personal characteristics would have a greater chance of outperforming a team that did not exhibit a cross-section of individual behaviour preferences. As the research progressed patterns emerged that could be identified and more importantly related to the typical contributions that individuals brought to a team. After extensive research Dr. R.M. Belbin identified nine distinct Team Role categories as worthwhile to have in most team formations. They were labelled as follows:

Plant, Resource Investigator, Co-ordinator, Shaper, Monitor Evaluator, Team Worker, Implementer, Completer and The Specialist (added in 1993).

Each label or category incorporates formulaic behavioural patterns that carry strengths in addition to weaknesses (acceptable and unacceptable). The application of Team Role Theory therefore offers an insight in to team dynamics, providing a framework for team selection and a prediction on the likely level of team synergy to be attained. Since the introduction of the BTRSPI in 1981 (modified in 1993), the application of Belbin's team role theory has established a prominent position within the commercial and industrial sectors of the United Kingdom. "The best-known model of individual differences in the team context" (Hardingham, 1997) and, "Belbin's Team-Role Theory is extensively used as a counselling and team development tool by organisations and management consultancies in the UK" (Prichard and Stanton, 1999).

2.5.5 THE MYERS-BRIGGS TYPE INDICATOR

The Myers-Briggs Type Indicator is a personality assessment tool based on the original work of Swiss psychologist Carl Jung (1875 – 1961) and further developed by two American women, Katherine Cook Briggs (1875 – 1968) and her daughter, Isabel Briggs Myers (1897 – 1980). The Myers-Briggs Type Indicator is used for the measurement of an individual's personality preference, using four basic scales of extreme bi-polar emotions. The four dimensions are as follows:

1/ extraversion / introversion, 2/ sensate / intuitive,
3/ thinking / feeling and, 4/ judging / perceiving.

Various combinations of these four basic characterisations result in sixteen permutations relating to discrete personality profiles. The Consulting Psychologists Press (CPP), which owns the copyright to the MBTI, claim that the MBTI is the most widely used personality inventory with approximately two million people a year taking the questionnaire (2003). Within a team context, CPP proclaim that the MBTI can help elucidate differences in personal preferences, work styles and interpersonal dynamics, helping teams understand how to make the most of the inherent capabilities different people bring to their shared task. This viewpoint is supported by Culp and Smith, (2001) in their research publication "Understanding Psychological Type to Improve Project Team Performance" in which they studied various group type MBTI configurations, concluding that "project teams can increase their chances of success by understanding and capitalising on different behavioural styles related to psychological type."

2.5.6 TEAM CULTURE

Team culture is a term used to describe team behaviour that engenders group norms, practice and customs. It is a product of the team environment over time.

2.5.7 GROUPTHINK

The expression "groupthink describes those shared values and opinions that can be a source of innovation or may act as a barrier to organizational change" (Ingram, 1996). Groupthink is founded on cohesion, "for example the greater the attraction within the group, the more likely it is that membership adheres closely to a group norm" (Donnelly *et al*, 1998). A management concern for groupthink behaviour is a potential inability to critically evaluate the decision making process. This is often referred to as the 'groupthink phenomenon'. Group cohesion overrides rational thought which can lead to irrational decisions accepted by all group members. In order to avoid dysfunctional group cohesion it is important that the decision making process is continually contested inside as well as tested outside the team environment.

2.6 TEAMS IN THE UK CONSTRUCTION INDUSTRY

The application of team concepts and team working within the construction sector is extensive, where "construction is arguably the largely collectivist activity" (Moore and Dainty, 1999). Over the past decade, construction company awareness of team working practices has reflected the growing corporate management interest in team related theory. In keeping with the contemporary team paradigm, the appeal of enhanced team-based alliances would appear to be, for the most part, commercially motivated. In Tim Cornick and James Mather's book publication 'Construction project teams – making them work profitably' (1999), they identify the monetary dimension as a critical criteria, "the pay-off must be financial in the first instance and will only come when team working results in each business firm represented receiving the profit it expected."

Common everyday construction language is interspersed with collective expressions. Phrases such as the 'Design Team', 'Construction Team' and 'Project Team' epitomise the perception that collaborative effort and team working is intrinsic to the success of many building operations. Expressions of the team ideal are not the sole preserve of the construction professional. Employees at operative level are also engaged in cooperative activities. Terms such as squads, gangs and crew highlight the need for collaborative effort in order that the multiplicity of task that epitomise construction activity is carried out efficiently and productively. Although the professional and operative groupings may share similar contextual factors such as industry and possibly organisational backgrounds the team compositions do have discernible differences. The operative team may be aligned with a traditional departmental orientation, where autonomy is routinely low and management direction and authority is high. The team members generally have a similar skills-base linked to a trade, experience or both. Skilled 'groupings' have a narrow task definition, such as bricklaying, plastering or joinery work and operate within long-standing demarcation parameters. The professional teams require a multi-functional, inter-disciplinary representation, engaging a cross-section of construction professionals responsible for carrying out duties particular to their specialist education and training. This team-type configuration is descriptive of a cross-functional or matrix team. Autonomy is likely to be project-specific with senior management intervention confined to decision-making that interfaces project execution with the wider business performance. The professional cross-functional team can occur at two notable project levels, the site management team and the project team. For example, the site management team will comprise of various professionals, directly employed by the principal contractor and creating in all probability a unique people combination brought together for one project. The project team will again comprise of various professionals, including the client, designer, contractor and specialist representatives, but for every team member there may be a different employer. Interestingly, membership is unlikely to be exclusive to one team or the other but loyalty may be, "every individual has a vested interest in their own 'firm' winning – which may or may not be the same as the project team 'winning" (Cornick. and Mather, 1999). A contextual simulation to the concept of 'individualism / collectivism' may be made, where the 'individualism' of the company prevails against the collectivism of project interests. Integration is crucial but more problematic because of entrenched cultural practices and the increased likelihood of contradictory agendas. "This in turn often results in blame culture whereby the various team members seek to minimise their level of exposure to poor performance, rather than working together in a spirit of trust, cooperation and collaboration" (Baiden *et al*, 2006). For the cross-functional construction team, the formation of a project alliance or task-force at the expense of team working may directly influence performance.

2.6.1 GOVERNMENT INITIATIVES

The United Kingdom Government has a history of construction related intervention. Since the Second World War Government initiatives have periodically sought to address construction related themes in an attempt to modify the practice and representation of the sector. In the early nineteen-nineties against a backdrop of economic recession and a growing public scepticism of the sector, the Government commissioned another review of industry practice in an attempt to appease criticism and assist construction clients, including local and national government in achieving better value for money. In 1994 Sir Michael Latham published his government-sponsored report 'Constructing the Team'. The recommendations focused primarily on issues relating to contractual arrangements but Latham documented the requirement for an improved team oriented attitude. Recognising that integral to any business process improvement was the necessity for a more harmonious, trusting working relationship. Latham (1994) stated that under current industry circumstances, effective team working was not a company priority, "it is not easy to create teamwork in construction when everyone is struggling to avoid losses". This watershed publication acted as a catalyst for initiating industry change. The construction sector was challenged explore innovative ways in which to carry out its business for the mutual benefit of all the principal stakeholders. The Latham report put the customer at the core of the strategy, believing that the consumer drives change and that a collaborative, collective working party, including professional consultants, specialist contractors, building contractors and auxiliary companies involved in the supply chain could focus on the project processes and the end value it delivers to the client.

Subsequent to the publication of the Latham Report, the promotion of teams and the concept of team-building became a key feature of the Construction Industry Board's (CIB) 'Constructing Success - the Construction Strategy Code of Practice, 1997'. The team-working theme was again identified as a key stimulus for change in Sir John Egan's construction review paper, Rethinking Construction, published in 1998. The 'Egan' report resulted in construction companies becoming more proactive in their attempts to widen their business portfolio to incorporate an element of alternative procurement contracts, such as joint ventures, consortia and project partnering, "The industry must replace competitive tendering with long-term relationships" (Egan, 1998). In 2000, the government continued its campaign for more co-operative working practices and reiterated the need for effective team working across the construction sector through the DETR initiative, Movement for Innovation (m4i). In the summer of 2002, as an extension to the Government's ongoing commitment to the Rethinking Construction programme, 'Accelerating

Change' was published. In an introductory statement Sir John Egan, (2002) acting as chairman of the Strategic Forum for Construction, emphasised the pivotal role team-based working would play in creating an industry that could deliver value for its clients and compete within a global community, "Integrated team working is key. Integrated teams deliver greater process efficiency and by working together over time can help drive out the old style adversarial culture, and provide safer projects using a qualified, trained workforce. I want to see expert teams coming together to deliver world-class products, based on an understanding of client needs."

The need for higher performance team working within the construction industry was beginning to be viewed as a foundation for 'building' project success, "sound teamwork is now widely regarded as crucial for the achievement of increasingly complex and interrelated social and economic goals" (Fryer, 1997) and "effective teamwork leads to better results for the client and all in the supply chain" (Dti, 1997). Since the publication of the Latham Report in 1994, team 'thinking' has permeated the majority of government sponsored initiatives. As previously stated, Sir John Egan identified team working as a key component for the future competitiveness and success of the UK Construction Sector. The impact has been perceptible, in the current climate of joint ventures, consortia and project partnering, team working has become something of an industry buzzword. Although the term is often used when group might be more accurate. It is important to recognise that team working will not miraculously occur unless mechanisms are established that will nurture and enhance the socio-technical dynamics. For construction managers with the responsibility for the selection and formation of 'site management teams' the necessity to affect the contextual framework bearing on the grouping is paramount. In the pursuit for higher performing teams, team organisational factors such as unity of objective, leadership style, reward structure, 'balance' and level of autonomy ought to be re-evaluated. The importance of a 'best-fit-suitably-balanced' team composition between function and personality is well documented, "the members of a team must be carefully selected.... no matter how competent an individual is, little will be achieved if that person cannot function as part of a team" (Lavender, 1996). From much of the available literature teams are often cited as panacea. Notwithstanding the rare occasion, better performance team working within the construction environment is not a naturally occurring phenomenon it requires effort, time and above all good management.

2.7 TEAM MATRIX - IDENTIFYING THE KEY VARIABLES

The organisation and social interaction of group working has been extensively researched since the establishment of the Human Relations School of Management thinking in the late 1920's, early 1930's. There have been numerous perspectives on group thinking since the renowned Hawthorne Studies carried out by Elton Mayo. In general terms most group research has focused on the dynamic of 'natural' work groups, believing that the "commonalities are more important than the differences when striving for team performance" (Katzenbach and Smith, 1993b). It is unexpected to conclude that the potential contribution of team working philosophy out with 'natural' work groups has rarely been scientifically investigated. In particular, "the cross-functional team has not been the focus of much empirical research" (Proehl, 1997). Proctor and Mueller (2000), also commented on the apparent scarcity of team working analysis associated with particular types of production groupings, stating that "an association between team working and continuous production is better documented," although, "other production types offer greater possibilities for team working. This would appear to be the case in the one-off nature of job production, but research evidence here is lacking." The cross-functional team is the mainstay of the typical construction organisation. Advancing managerial insight on the working team dynamic may assist a construction company in realising the strategic goal of corporate competitive advantage in an aggressive, economically and politically changeable environment. Better understanding of cross-functional construction team synergy may have an influential outcome for an industry profoundly reliant on all-inclusive integrative working relationships.

The present-day team literature viewpoint has re-aligned the group emphasis away from intra-team definition and investigation. Contemporary team analysis embraces a broader approach that includes team functioning within an organisational specific contextual framework. This suggests that the support mechanisms for successful group / team cohesion are inextricably related to corporate identity, custom and industry culture that co-exists alongside membership compatibility and diversity. "The literature on cross-functional teams, places more evidence on the need for management support, establishing team authority and accountability, carefully selecting the members and leaders, and communicating effectively with external stakeholders" (Proehl, 1997). This statement is endorsed by Charles Manz, in a discussion with Allan Church and transcribed for the article 'from both sides now: the power of teamwork – fact or fiction' (Church, 1998). He remarked that "evidence is now starting to identify the organisational conditions that must be in place for a team to have a real chance of effectiveness, and these conditions have much to do with structural and contextual features that cannot be implemented through mere exhortation." A better understanding of balanced membership roles, coupled with the contextual constraints to enhanced team performance may improve management perception of cross-functional team working. Addressing these issues may facilitate the notion of better performance – faster.

Recent Public and Private sector disillusionment with the construction industry tends to imply that contractors and their construction site management teams are not fulfilling their potential. Construction companies often stand accused of failing to meet completion dates, failing to adequately control budgets and failing to build defect free buildings, delivered right first time. Responding to the criticism by adopting superficial management rhetoric and bringing together a disparate group of construction professionals and calling them a team, as a 'quick-fix' endeavour to instil 'corporate collectivism' is unlikely to succeed. Cross-functional teams have tremendous potential due to their inherent diversity of composition. The in-built multiplicity and vitality of membership requires to be augmented with organisational mechanisms that strengthen the project team mind-set. Implementation of contemporary team related Human Resource Management practice augmented with tailored education and training programmes may well dissolve barriers to unproductive collaborative working and dilute the prejudices of an industry immersed in cultural and 'tribal' practices. Modern-day management thinking presents construction companies with the opportunity to differentiate their operational philosophies from their competitors to create and 'coach' High Performance Cross-functional Teams (HPX_fT) with the skill, balance, integrity, creativity and emotional awareness to satisfy the modern day demands of Government and private industry clients.

The research needs of High Performance Cross-functional Teams (HPX_fT) in the management of construction site operations have three broad categories of trans-boundary team interaction. The three categories incorporate seven key team variables identified from the literature review, as a prerequisite in the attainment of team working within the workplace. Some of the variables identified are frequent points of reference whilst others receive little direct attention yet are often omnipresent within the subtext. This may insinuate a credible contribution out with the recognised boundaries of established team thought, for example the significance of industry culture and tradition on the attitude of team participants. Within this report, seven key team variables have been acknowledged and are summarised within their appropriate category. The relationship between category, variable and author has been collated in a 'Team Literature Summary Matrix'. (see Table 2.7.1)

TEAM LITERATURE SUMMARY – CATEGORY / VARIABLE & AUTHOR MATRIX							
Category	**Group Compatibility & Diversity**				**Organisational Context**		**Industry Context**
Key Variable / **Author**	Inter-dependency	Membership Diversity	Team Dynamic	Trust	Corporate Intent incl. Performance	Systems - Procedures & Customs	Culture
Adair, J.					☑		
Belbin, M.	☑	☑					
Buchanan, D.						☑	
Castka, P. *et al.*				☑			
Colenso, M.	☑				☑		
Conti, B. and Kleiner, B. H						☑	
Cornick, T. and Mather, J.					☑		
Culp, G. and Smith, A.		☑					
Fisher, S. *et al.*					☑		
Gabriel, E.		☑					
Harris, P. R. and Harris, G. K.						☑	
Johnson, P. R. *et al.*				☑			
Katzenbach, J. and Smith, D.			☑		☑		
Lavender, S.		☑					
Manz, C.		☑				☑	
Moore, D. R. and Dainty, A. R. J.	☑						
Morley, M. and Heraty, N.					☑		
Natale, S. M. *et al.*	☑		☑			☑	
Partington, D. and Harris, H.		☑					
Proehl, R. A.							☑
Tarricone, P. and Luca, J.	☑			☑		☑	
Tata, J.						☑	
Woodcock, M. and Francis, D.	☑						

2.7.1 GROUP COMPATIBILITY AND DIVERSITY

Key Variables:

Interdependency, Membership Diversity, Team Dynamic and Trust

The first category relates to four critical facets of socioemotional logic that shape group compatibility and diversity. Management awareness and application of personality inventories developed to assemble 'complimentary' individuals would facilitate the group in both a professional and behavioural role. Working within the restrictive parameters of the construction industry, managers may ascertain the most appropriate, suitably balanced team formation from the existing organisational labour pool. This may promote a more efficient and effective deployment of staff, matching project placement with the necessary experience, skills and personalities. Discerning employee 'preferred role' using a personality identification inventory has made a limited impact on the selection and formation of construction teams. "From a review of construction team literature it is surprising to conclude that the criterion for team selection remains deficient in its formal appraisal of humanistic skills" (Tennant, 2001). "Industries, other than construction, for example, petro-chemical, pharmaceuticals, have long undertaken psychometric testing of team members in order to establish, and build upon, the particular strengths of the individuals" (Sommerville and Dalzeil, 1998).

Summary of Key Variables within this Category:

✓ Interdependence: A common theme, placing emphasis on the need for managed integration and a mutually supportive team environment.

✓ Membership Diversity: A reoccurring topic for many authors, citing the widely held belief that diversity of team membership was fundamental in the selection and formulation of successful teams.

✓ Team Dynamic: A few authors within the literature review identified team size as a topic worth considering. The authors implied that the efficiency of team working may be related to the number present within the team structure.

Team formations of between eight and twelve members were seen as most efficient. Large teams were more likely to fragment and behave as disparate groups as opposed to a unified team.

✓ Trust: The subject of trust within team formations received reasonable attention. Focusing on the intra-group / team dynamics, trust was acknowledged as a key factor in the transition of a group to a team. Trust between team members was reviewed as essential if a heightened state of group cohesion was going to be achieved.

2.7.2 ORGANISATIONAL CONTEXT

Key Variables:

Corporate Intent, Systems - Procedures & Customs

The second category relates to the organisational context, the corporate structures, systems and customs that may influence team cohesion and commitment. Within the construction company environment the contextual framework may be more complex than other industry sectors. Entrenched professional stereotypes coupled with traditional, individualistic management structures conspire to undermine group cohesion, trust, commitment and ultimately performance. Organisations, in general, are more comfortable with an individual orientated style of Human Resource Management. Conti and Kleiner (1997) state that "the most fundamental problem that teams confront is our existing work culture," that it "is orientated toward individual and standardisation of work activity" (Castka *et al*, 2001). Culturally and historically an individualistic ideology connects effortlessly with the wants of the individual and their own agenda but may counteract against the team ethos. The motivation maxim of 'what gets rewarded, gets done' if addressed on a personal basis may prompt team members to satisfy their own needs thus blurring the interdependency of their efforts, whereas, "rewarding teamwork will support a paradigm of collaboration, enabling full utilisation of people's talents" (Logan, 1995).

Summary of Key Variables within this Category:

- ✓ Corporate Intent (including performance): The changing corporate ethos, from an initial benevolent standpoint to one of corporate objective and competitive advantage. The utilisation of teams as a strategic management decision in the quest for improved company performance.

- ✓ Systems, Procedures & Customs: The most common key variable identified within the literature search. The consensus revolved around the concept that teams may identify themselves as micro-organisations and as such exhibit characteristics representative of the 'parent' organisation. Addressing the systems, procedures and customs of the parent group may reduce the risk of organisational disparity between the company and its teams.

2.7.3 INDUSTRY CONTEXT

Key Variable:

Culture

The third category relates to the industrial context that reinforces established convention and behaviour, functional and dysfunctional, within the construction sector. "This fragmented approach to project procurement and product delivery processes frequently lead to project team being characterised by adversarial relationships, a lack of transparency and mistrust" (Baiden *et al*, 2006). Confronting unconstructive industry characteristics such as conflict, fluctuating workloads and barely sustainable profit margins requires individual and organisational learning about new or improved ways of carrying out construction management practice.

Summary of Key Variables within this Category:

- ✓ Culture: The influence of organisational culture on the likelihood of successful team working within the workplace. This variable explored the broader social dynamics that exist within specific industries and the possible consequences if ignored. Culture, as a variable was infrequent, particularly in an industry context. Due to the significance of culture within construction and the general acceptance that construction is a 'team game', construction industry culture may be noteworthy (key) within the context of the subject matter.

2.8 CONCLUSION

This chapter identifies a number of strengths and weaknesses within the subject matter of team study. From the literature review, micro-analysis of the team composition and the resultant dynamics associated with altering various facets of the internal team structure, via selection and / or training appear to predominate across the field of team research. Key variables, such as membership diversity, interdependency, team dynamic and trust emerge as the most common themes and are often cited as fundamental in the search for team cohesion, inter-personal harmony and effectiveness. Although the micro-analysis of team 'disposition' remains prevalent the role of organisations and their impact on team 'success' was a notable and frequent theme. Consequently, recent team research trends are developing a more 'outward' looking perspective, proactively assessing the environmental dynamic that may facilitate the 'inward' psychoanalysis of membership diversity, interdependency and trustworthiness. A broader, macro-analysis of team issues adopting contemporary management perspectives of contingency and agility are raising organisational consciousness in the quest for improved team creativity and innovation. For example, the strength of relationship between team working as a traditional 'human relations' concept allied with a contemporary perspective of competitive advantage is extensively studied and generally endorsed within an increasingly unpredictable and turbulent global marketplace. Interestingly, this approach contextualises the issue of team work and enhances management awareness that teams are not created within a vacuum.

External demands undoubtedly have an impact, not only for the team structure and the participants involved but also those directly responsible for the selection and management of team working environments. Investigation within an organisational context highlights possible dysfunctional conflicts with conventional organisational systems and procedures, such as; team type, staff appraisal, level of autonomy, reward, employee recognition and local customs. Organisational structures that are traditionally 'individualistic' in concept are paradoxically opposite to the core beliefs of team working and the 'collectiveness' associated with team philosophy. Culture within an organisational context was given limited prominence by a few authors but appeared to be completely overlook when its boundaries were extended to include the industry or sector environment. Considering the pervasiveness of tradition and culture within various sectors of the UK economy it was unexpected to remark on the apparent absence of information relating to possible 'interdependencies' between industry practice, shaped by cultural constraints and team performance. At present, there is only limited research relating to the UK construction industry perspective and the performance of construction site management teams.

The team literature review has highlighted aspects of applied team research that could be of value to the construction industry although, the information available is in some measure 'out of context' and as such requires to be customised to suit the needs of the UK construction industry. Drawing together the various sub-topics (acknowledging both the strengths and weaknesses of current team research) it becomes clear that the research direction should adopt aspects of the known and well documented studies and adapt these findings to suit the complexities and idiosyncrasies of the UK construction industry. The concept of investigating team performance within a UK construction industry context requires the application of generic team concepts within a specific sector environment and "focusing on performance – not chemistry or togetherness or good communications or good feelings – shapes teams more than anything else" (Katzenbach and Smith, 1993b).

CHAPTER 3: PERFORMANCE MANAGEMENT

3.1 INTRODUCTION

For Katzenbach and Smith (1993a) the definitive characteristic that distinguished a group, taskforce, alliance (or any other socially inclusive working party from a team) is performance. The New Oxford Dictionary of English (1998) defines performance as "an action, task or operation, seen in terms of how successfully it was performed." The Collins English Dictionary (1991) is more concise in its meaning, defining performance as simply the "manner or quality of functioning." As an expression of 'action', 'achieving' or 'functioning', the term performance gives the impression of being vague in its meaning and of limited significance in its evaluation. The lexicon definitions offer a simple, generic explanation at the expense of exactness. A more considered interpretation of the stated definitions and in particular, reflecting on the phrase "in terms of how successfully it was performed," suggests that for performance to be unambiguous it requires to be measured against a previous standard and/or expected quality. This would demonstrate the measure of success attained, providing observers with a quantifiable dimension of performance benchmarked against an expected criterion. For example an outcome may be judged to be 'below average', 'average' or 'above average'. The Penguin Dictionary of Psychology (1990) introduces behaviour into the definition, stating, "in its broadest sense, performance can be equated with behaviour." In this explanation there is a definitive, albeit contradictory, distinction between human performance and human learning. Human performance relates to the overt, observable behaviour where action and objective criteria can be established and validated whereas learning relates to the covert, unobservable behaviour and generally remains hypothesised i.e. latent functioning.

3.1.1 LEARNING TO PERFORM

The inclusion of learning (individual and company) in a performance related context is supported by a number of literature sources. Endorsing the notion that organisational learning allied with knowledge management can promote performance management processes, “the learning organisation is an important ingredient of any ‘rounded’ knowledge management programme” (Skyrme and Amidon, 2002). Figure 3.1.1 illustrates a simple sequential dependency between knowledge (know-what), learning (know-how) and performance (action and reaction).

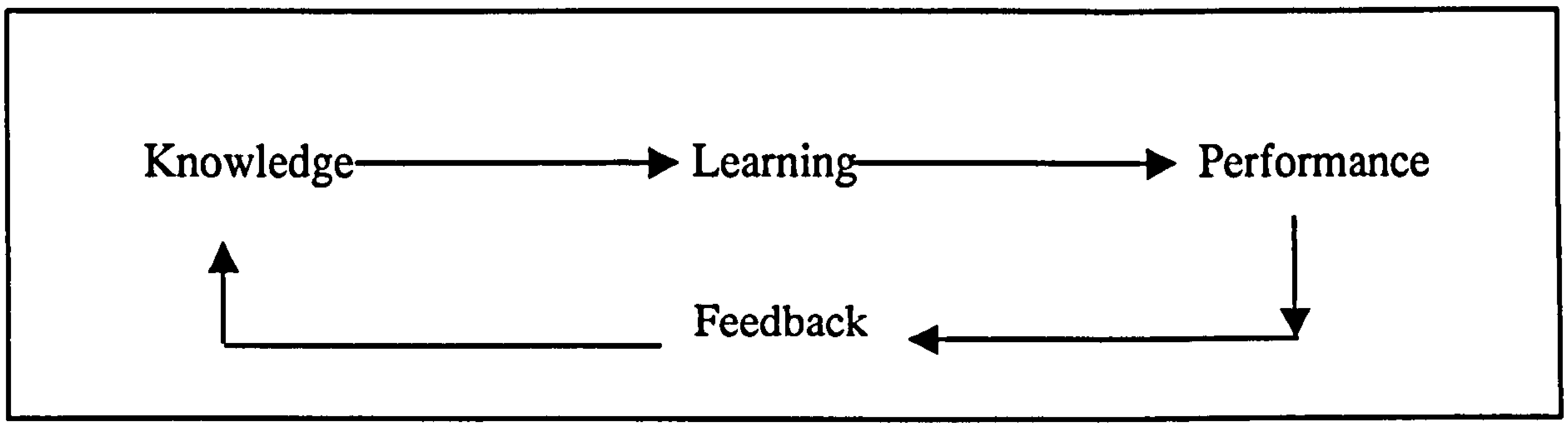


Figure 3.1.1 Knowledge-Learning-Performance Model

The management of knowledge and the increased ability to synthesis and communicate knowledge in to learning will undoubtedly impact on an organisations ability to function, particularly relevant in terms of creativity, innovation and speed of application. In a business environment that is placing increased emphasis on intellectual property as opposed to financial actuality, performance management needs to recognise and better understand the contribution individual learning, corporate learning and the management of organisational knowledge can make to corporate performance. Cultivating organisational learning may be viewed as necessary to ensure corporate longevity. “All firms are in essence knowledge organisations. Their ability to outperform the marketplace rests on the continuous generation and synthesis of collective organisational knowledge” (Brown and Duguid, 2002). Within this focused definition, performance may be viewed as an abstract philosophy until it is unlocked from its behavioural perspective and quantified in criteria and outcomes. In other words, performance is characterised as human behaviour expressed as action. Ingram and McDonnell (1996) in their paper ‘Effective performance management – the teamwork approach considered’, contextualise performance within a business environment, stating “performance is the result of achieving organisational objectives,” associating performance with an explicit expression of business success. Therefore, within a competitive commercial meaning, company performance could be expressed as an outcome(s) of collective behaviour(s). Bounded by a business framework, company performance may have two contextual meanings, 1/ 'action' which are internal to the organisation and 2/ 'reaction' which are external to the organisation.

3.1.2 INTERNAL CONTEXT

Within an internal corporate context, performance relates to business operations and production management. The main constituents underpinning internal performance are economy and efficiency. The economy of manufacture and service focus primarily on cost production such as 'economy of scale', whereas efficiency is concerned with level of productivity and the transformation relationship between output and inputs.

3.1.3 EXTERNAL CONTEXT

Out with the immediate company environment, performance as perceived by the consumer and/or customer is also pertinent. This may be referred to as the external contextual meaning of performance. Within this definition aspects such as effectiveness and ethics can be considered. Effectiveness relates to the matching of product / service with customer / consumer expectancy. Business ethics correspond with an organisation's impact on the corporate social responsibility to the community and the wider environment.

3.1.4 ORGANISATIONAL LEARNING

The receptiveness of a firm's ability to adapt and culturally evolve may be expressed as 'organisational learning'. "Organisations can improve their effectiveness by developing competences and skills and by learning how to change attitudes and practices" (Kyro, 2003). As a consequence organisational frameworks that can efficiently capture explicit and tacit knowledge (knowledge management) should benefit organisational learning. In theory the development of knowledge management systems should produce enhanced corporate performance. Figure 3.1.2 illustrates managerial dependency between knowledge management (know-what), organisational learning (know-how) and enhanced performance (action and reaction).

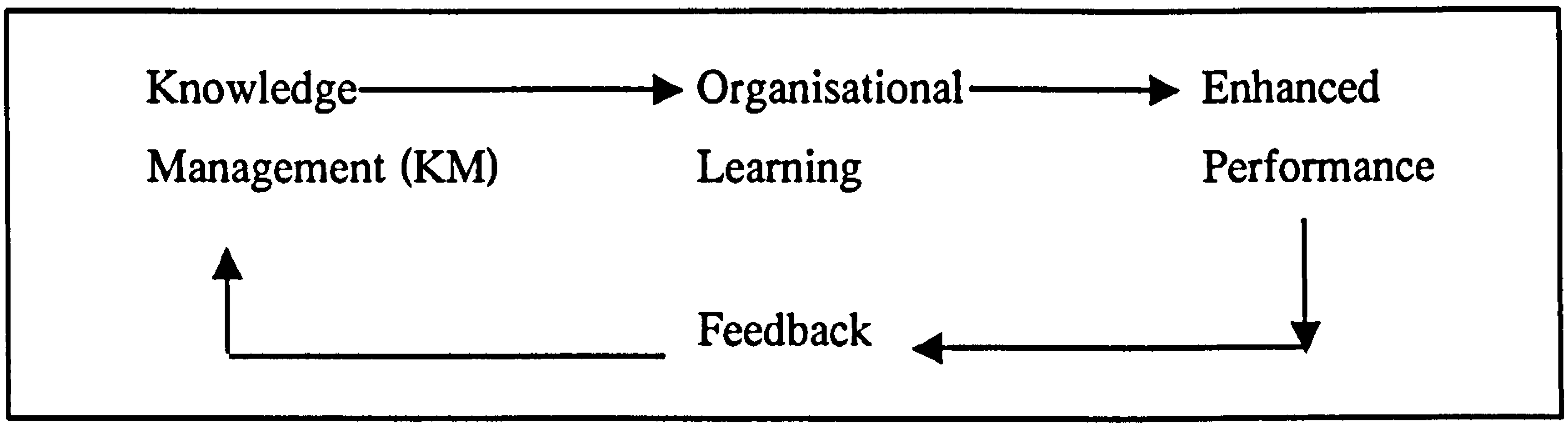


Figure 3.1.2 'Organisational' Knowledge-Learning-Performance Model

3.1.5 PERFORMANCE DEFINITION

A precise definition of performance is contingent upon the contextual constraints of a particular situation. Performance is essentially outcome dependant and can be interpreted differently from many viewpoints implying that "project success means different things to different people" (Chan and Chan, 2004). Having identified that company performance is contingent upon behavioural action and reaction, internally and externally, the questions that organisations need to address are 'what key measures best represent corporate functioning?' Conscious of the contextual dimensions, the continuous measurement of corporate competence and achievement levels is essential for the sustained well-being of the organisation as "it is of direct and immediate importance to the business community, as the very survival of a business depends on its ability to evaluate performance" (Crowther, 1996). Organisational performance is only one component part of a cybernetic loop. Evaluation of likely future performance achievement requires detailed information on previous performance measures and informed feedback. The closed feedback link is necessary to enable a comparison with previous efforts and as a possible standard against other comparable 'third party' achievements. For the majority of businesses the traditional measure of performance analysis have been monetary, "financial measures have been the most widely used performance measure in the past" (Gautreau and Kleiner, 2001). In cost-analysis terms, financial performance would include accounting standards relating to profitability, solvency, gearing and investment opportunities with auxiliary measures relating to time and quality. Cost, time and quality (specification) have been the traditional measures used in the UK construction sector, "they are identified and discussed in almost every article on project success" (Chan and Chan, 2004). Within this framework, performance information can be assessed by comparing planned outcomes against actual outcomes and quantifying the difference. Contemporary management thinking interprets performance as an all-inclusive, balanced concept, amalgamating the traditional 'hard – financial / productivity' quantitative measures alongside 'softer – creativity / customer satisfaction' qualitative facets. "Hard measures are those which are quantifiable, such as profit and market share, while soft measures include innovation and flexibility" (Ingram, 1996). This emergent ideology concerned with the definition, formulation, implementation and evaluation of performance, incorporating broader, less tangible attributes has resulted in the growth of business acumen analysis. Contemporary performance management concepts continue to build from the management accountancy models of yesteryear.

3.2 PERFORMANCE MANAGEMENT

In an unpredictable business environment "the success and continuity of an organisation depends on its performance" (Flapper *et al*, 1996). Over the past decade management interest in performance management has evolved from what was essentially an accounting system of performance measurement in to a heterogeneous range of performance statistics each specifically intended to assess various performance attributes of the organisation.

3.2.1 INTRODUCTION TO PERFORMANCE MANAGEMENT

Historically, organisational performance criterion has focused first and foremost on the financial aspects of business achievement. As quoted upon by many commentators, including Crowther (1996), "evaluation of the techniques used for measuring performance has largely concentrated on accounting techniques."

Evidence of double entry book keeping can be traced back to the fifteenth century. The emergent industrial society of the nineteenth century witnessed the increasing standardisation of financial accounting procedure, driven by growing Government Taxation, corporate liability and other stakeholder bodies. Over the coming decades a sophisticated system of accounting protocol developed in an effort to regulate procedure and coordinate the manner in which financial information was disseminated. This approach to performance measurement was satisfactory whilst corporate trading remained straightforward. By the 1950's changes in manufacturing and increased competition from overseas started to create different demands on organisations and these impacted on their corporate interests.

One of the main catalysts for change was the emerging Japanese economy underpinned and driven by quality management ideals. The principal player was W. E. Deming. Deming, an American statistician taught quality improvement methods to Japanese engineers in the aftermath of the Second World War. In support of the 'statistical process control' techniques, Deming developed a model for continuous quality improvement, the PDSA cycle. It comprised of four logical management steps that would be repeated; Plan, Do, Study, Act. The quality principles instilled by W. E. Deming have continued to evolved and have become more commonly known as Total Quality Management. It would be another three decades before the quality movement began to make an impact on Western performance management values.

A key development in the management of performance was the concept of Management by Objectives (MBO). MBO was first introduced by Peter Drucker in 1954 in his book 'The Practice of Management'. The MBO concept focused on strategic positioning and goal setting as a technique to enhance future organisational performance. MBO principles symbolised a shift away from the scientific management values of F. W. Taylor (1856 – 1915) and the early 20^{th}. Century industrial period. MBO incorporated an evolving Human Relations model where worker collaboration and industrial democracy was encouraged. Interestingly, this coincided with developments in team studies and the work of the Tavistock Institute of Human Relations in the UK. In this respect "MBO could be viewed as a first attempt to merge two contrasting paradigms (the rational goal model and the human relations model)" (Dinesh and Palmer, 1998). Business recognition of Drucker's 'Management by Objective' philosophy became widespread in the 1960's and 1970's and the establishment of a 'step by step' method of implementation augmented its adoption.

By the 1970's and 1980's the ever-changing business environment increased competition and the rapid development of information communication and technology (ICT) strategies meant that the traditional financial measures, still heavily relied upon within a MBO approach, contributed less and less to a modern day business operation. By the 1980's, early 1990's the introduction and increased uptake of quality standards revitalised business policies. Milestones in the development of quality standards include the Quality Assurance systems, BS 5750, ISO 9000 and in 2000 the BS EN ISO 9001 standard was issued. The need to manage quality led to the development of quality management systems and the encapsulating philosophy of Total Quality Management (TQM). TQM represented "the most positive step taken to date in broadening the basis of business performance measurement" (Eccles, 1991). "Companies in Europe and North America, as a result of the success of Japanese companies, have begun to take a wider view of performance measurement, with various quality awards and theories being introduced during the 1980's" (Beatham *et al*, 2004). Some thirty years after the inauguration of the 'Deming Prize' by the Union of Japanese Scientists and Engineers (JUSE). "The concept of TQM...embraces the philosophy, principles, processes, practices and procedures of management to provide customer satisfaction in the goods and services provided by all parts of the organisation" (Hellard, 1995). Central to the philosophy is empowerment and collective practices, "TQM...relies heavily on team working" (Thorpe and Sumner, 2004). By the mid-nineteen nineties quality management systems (QMS) and TQM had evolved as strategic corporate frameworks to be utilized in an increasingly competitive global market. "The performance improvement culture of today largely stems from the quality movement" (Welch and Mann, 2001). Teams have also become integrated within the quality movement as a main component of company success. "Teamwork has been shown to be a key element for improving business process performance and, as a consequence, organisational performance" (Telleria *et al*, 2002").

3.2.2 CONTEMPORARY PERFORMANCE MANAGEMENT

Over the years, a number of criticisms have been levied at the cost-accounting approach to performance measurement. Firstly, financial data records operational competence, "emphasising economy and efficiency and neglecting measures of customer satisfaction and quality" (Open University, 2001d). This fulfils manufacture accountability (economy and efficiency) but is of little consequence for the external consumer / customer, (effectiveness and ethics). Secondly, "financial figures are better at measuring the consequences of yesterday's decisions than they are at indicating tomorrow's performance" (Eccles, 1991). This statement is supported by Kaplan and Norton (1993), who have written extensively on the shortcomings of traditional financial accounting systems. They clearly believed that "traditional financial measures report on what happened last period without indicating how managers can improve performance in the next." In the early 1990's senior managers began to realise that the effects of globalisation and increased competitiveness of the marketplace required distinctive strategies from those of yesteryear. Modern-day assessment of performance including the adoption of a systematic approach to managing performance had begun to broaden the focus of performance measurement techniques to include non-traditional performance dimensions. At the basis of the new corporate thinking was the "shift from treating financial figures as the foundation for performance measurement to treating them as one among a broader set of measures" (Eccles, 1991).

In 1992, The Harvard Business Review published an influential article by Kaplan and Norton, entitled 'The Balanced Scorecard – Measures That Drive Performance'. The business perspective presented by the Balanced Scorecard appeared to articulate the thoughts of many executives, who at that time were being confronted with the corporate dilemma of managing greater organisational diversity, business complexity and increased stakeholder accountability. Kaplan and Norton endorsed the utilisation of the 'Balanced Scorecard' concept by stating that "the traditional financial performance measures worked well for the industrial era, but are out of step with the skills and competencies companies are trying to master today." As a consequence of Kaplan and Norton's innovative approach to 'encompass broader' corporate performance measures, there was widespread management acceptance that "the traditional financial Performance Indicators (PI's) alone no longer suffice to determine the company's health, and that other types of indicator are needed as well" (Flapper *et al.* 1996).

In the USA 'corporate America' was advocating Kaplan and Norton's balanced scorecard framework for the management of performance objectives. At a similar time The European Foundation for Quality Management (EFQM) excellence model was being introduced, initially to a European business audience. The EFQM business excellence model is a non-prescriptive framework specifically designed to help companies' measure performance, identify performance gaps and encourage solutions for achieving excellence. It is essentially a management tool designed to help define and assess continuous improvement of an organisation, and is built on eight fundamental concepts of excellence, (Beatham *et al*, 2004). The EFQM model recognises that the attainment of excellence is likely to be achieved by using various approaches to business improvement. "The content of the model focused on the philosophy and practice of Total Quality Management. The 1990s witnessed a shift in focus towards innovation and creativity, and the growing importance of partnerships and knowledge management. In April 1999, the model was revised to reflect these changes, and was renamed the EFQM European Excellence Model" (Chartered Institute of Management, 2004). The EFQM Excellence Model has been attributed with encouraging companies to take "a broader view of performance than they might normally have taken. In particular, they chose to focus on people and customer components of the model" (Open University, 2001c).

3.2.3 PERFORMANCE MANAGEMENT SYSTEMS (PMS)

Today's perception of Performance Management may be expressed as a holistic concept, incorporating a broad cross-section of behaviourally 'anchored' organisational cause and effect. The outcomes are communicated to corporate stakeholders as well as suppliers and customers, mapping progress against previously determined results. Comparing outcomes with company predictions and developing future targets in concordance with corporate strategy. For example, performance management acknowledges that decisions taken today, based on past outcomes may positively influence the outcomes of tomorrow. In essence, the organisational responsibility of Performance Management is to provide helpful professional judgement by taking in to account a wide range of performance measures and stakeholders. It is important to recognise that the needs of the stakeholders require to be balanced against each other, albeit disproportionately, depending on management interpretation and priority setting. In order that the Performance Management concept is applied in a concurrent, consistent and integrative manner, organisational protocol requires to be ascertained, taking in to account the strategic fit of a proposed Performance Management System (PMS) and existing organisational practice. A Performance Management System requires built-in mechanisms to translate corporate strategy in to specific measurable achievements, after all, "what you measure is what you get" (Kaplan and Norton, 1992). Management protocols bound the concept within corporate and industry 'standards', offering a unique opportunity to benchmark internal and external 'efficiency and effectiveness' on a comparable status with previous results and where possible, offer a 'like-for-like' comparison with industry-wide performance. A fundamental part of the formulation of a Performance Management System is to establish company measures that are critical to future performance and corporate survival namely, key performance indicators (KPI's) and benchmarking procedures.

3.3 PERFORMANCE MANAGEMENT TERMINOLOGY

The terms performance measure and performance indicator are often used synonymously and refers to the measurement of an activity that is critical to the success of an organisation. Some commentators find it useful to draw a distinction between the two terms in order to better delineate the contribution they make to the data gathering process of a performance management system. Performance measure may be viewed as retrospective in that it provides 'hard', quantifiable data after the event. Performance indicators, on the other hand, relate to data collection than relies primarily on 'soft' qualitative data and is prospective in nature, "in that they (indicators) point the way to aspects of performance that will need to be observed" (Armstrong and Baron, 1998). Regardless of semantics, both performance measures and indicators can be applied for benchmarking purposes and are key components of any organisation's desire to move towards realising 'the best in industry' performance levels.

3.3.1 PERFORMANCE MEASUREMENT

"Over the last ten years business excellence, performance measurement and benchmarking have all become important to those organisations pursuing performance improvement" (Welch and Mann, 2001). It is noteworthy to comment that many companies have a large number of key performance measures of which only a few – and sometimes none – are actually adopted by management to measure performance. "It is not the number and reach of the measures that is most important. It is the relevance." (Roest,1997). The establishment of key measures within a performance management system may help create a partnership between staff, including team formations and managers in the achievement of business goals. This notion is comparable with Peter Drucker's MBO philosophy and aligns with current management thinking in that contemporary 'team working' practice facilitates 'performance'. A performance management system enables an organisation to quantify the benefits of a team oriented workplace design in terms of its predetermined key performance indicators, (KPI's). A performance indicator may be defined as "a measure of a factor critical to success" (Constructing Excellence, 2004). It is important to note that the use of KPI's for team performance measures is likely to differ in structure and application although the underlying principle remains unchanged. The formulation and implementation of a performance management system is recognised by many management commentators as an increasingly challenging, albeit necessary, activity. "Firms need to find the right balance between productivity and people, using indicators which reconcile 'hard' and 'soft' components" (Ingram and McDonnell, 1996).

The establishment of performance measures challenges managers to link operational, tactical and financial performance outcomes to key strategic performance indicators. The level of aggregation is likely to be significant, creating a hierarchy of performance indicators (PI's) that link 'partial' i.e. operational, tactical and financial, performance indicators to overall i.e. strategic performance indicators (PI's) in a manner that is explicit, coherent and organisationally transparent. The scope of mutually-supportive PI's is crucial to the successful implementation of a 'performing', performance management system. An advantage of sub-dividing 'overall' PI's into 'partial' PI's permits microanalysis of organisational functioning and better identifies and evaluates discrete component parts of organisational performance. It may be suggested that the overall effectiveness of a Performance Management System is inherent within the level of correspondence between the various measures. For example operational statistics should correlate with tactical measures that may in turn be expressed, albeit partly, in financial terms. It is also important to note that "performance measurement systems are intended to monitor and control the activities of organisations" (Roberts, 1994).

The role and position of PI's within the system may be provisional, contingent upon the many variables related to organisational input / output and industry custom. PI's should be periodically reviewed with regard to deleting existing PI's or adding additional PI's, as appropriate to the situation. A necessity of performance management is the requirement to be both dynamic and relevant, reflecting the ever-changing company and industry parameters whilst remaining consistent in its objective – to facilitate corporate advantage. Performance management systems can be company-specific and will be invariably characterised by the PI's adopted. It is essential that KPI's make a contribution to managements' assessment of corporate economy and efficiency along with effectiveness and ethics. In short, performance management must make a contribution and 'account for something'.

3.3.2 KEY PERFORMANCE INDICATORS (KPI's)

Measurement is a cornerstone of performance management philosophy. "It is the basis for providing and generating feedback, it identifies where things are going well to provide foundations for building further success, and it indicates where things are not going well, so that corrective action can be taken" (Armstrong and Baron, 1998). Performance measurement can act as a driver for corporate strategy presenting the necessary evidence that an organisation is moving in the intended direction. In short, measurement links business strategy with commercial reality. It is imperative that what is being measured is meaningful and directly corresponds to organisational performance and is not dictated by the ease of which information may be gathered. There may be a tendency to collect and interpret data that is easily quantifiable at the expense of data gathering that is problematic, difficult to assess, subtle in its meaning but yet significant in its contribution to the understanding of organisational effectiveness and efficiency. Performance measures should endeavour to be relevant, significant, comprehensive and used intelligently. Historically, financial accounting procedures have formed the basis of most performance measurement systems. The accountancy-focused performance view of the firm has a well-established 'set of rules' for information gathering, presentation and dissemination. Developed over many decades, companies have relied heavily on financial information as the principal indicator of corporate health, but in complex markets and information rich societies, financial well-being is now only part of an organisations performance appraisal.

An accurate evaluation of corporate performance requires company strategy to be integrated with performance measures, if not then it is likely that a disparity will exist between forecasted outcomes and actual results. The measures should reflect a cross-section of operational aspects relating to the business, including the already well-established financial information systems. Identifying key indicators can communicate senior management goals with desired employee behaviour and provide informed, continuous feedback on their actions thus cultivating a culture of continuous improvement. It is fundamental to performance management principles that the range of measures developed can individually assess specific-operational activity whilst seamlessly interrelated with other criterion to provide an all-embracing representation of company performance. Developing a perceptive, coherent, company wide hierarchy of measures is vital if the results are to provide a set of best value indicators. "Placing these new measures on an equal footing with financial data takes significant resources" (Eccles, 1991). Not only in terms of cost, time and labour but also in management style and mind-set.

3.3.3 BENCHMARKING

Central to the measurement and subsequent evaluation of performance is the concept of a benchmark. The EFQM definition, as cited by Cain (2004) is "a measured, 'best-in-class' achievement; a reference of measurement standard for comparison; this performance level is recognised as the standard of excellence for a specific business process." A 'point of reference' for the appraisal of company attainment, for example a firm's Key Performance Indicator used for comparison with an established company or industry standard.

Benchmarking is the application of the benchmark concept. "Benchmarking can be described as the process of identifying, understanding and adapting exemplar practices from within the same organisation or from other organisations to help improve performance" (Open University, 2001a). Benchmarking is a 'source of reference' for the evaluation of company performance in comparison with an already established company or industry standard. The application of benchmarking can take different forms. A common application is internal benchmarking where one aspect of the company is compared against another. Other categories include; competitive benchmarking that refers to company comparison with competitors in the same industry. Functional benchmarking draws comparison with organisational processes and procedures from other sectors. Finally, generic benchmarking is an attempt to learn from innovative practice regardless of industrial or organisational setting. For example best health and safety practice in offshore oil exploration being adopted on construction sites. The underlying concept of benchmarking may also be expressed within an organisational learning context, see figure 3.3.1. "Benchmarking, benchlearning and benchaction are not a one-time project. It is a continuous improvement strategy and a change management process. Thus benchmarking is a part of the total quality management (TQM) system, and it relates well to other TQM initiatives" (Freytag and Hollensen, 2001). Figure 3.3.1 illustrates the concept of benchmarking within an organisational knowledge-learning-performance model.

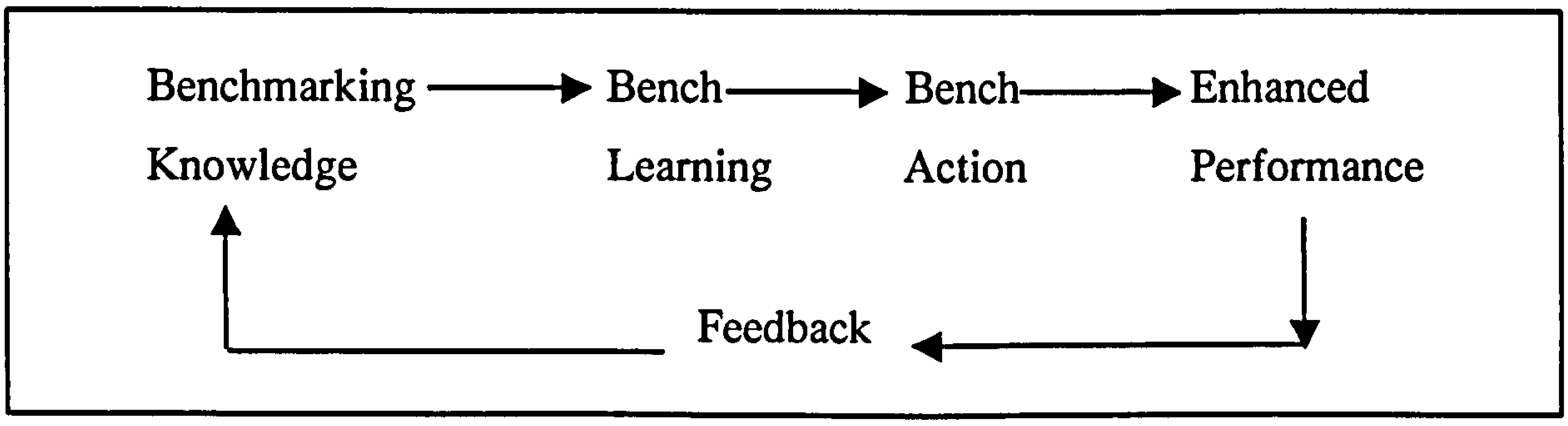


Figure 3.3.1 Benchmarking-Benchlearning-Benchaction Model

3.4 HOLISTIC PERFORMANCE MANAGEMENT MODELS

A holistic approach to performance management assumes that multiple stakeholders must be satisfied simultaneously, (Open University, 2001c). Two of the best known holistic performance management frameworks are the EFQM Excellence Model and Kaplan and Norton's Balanced Scorecard. The underlying philosophy of both models is very similar; "each consists of a non-prescriptive template offering managers a relatively small number of categories of key performance metrics to focus on" (Wongrassamee *et al*, 2003).

3.4.1 THE EFQM EXCELLENCE MODEL

The first European quality model was created in 1988 and first launched in 1991. Developed by fourteen leading European companies the objective was to promote corporate excellence as a response to the increasing competitive pressures of a global market place. Its popularity has continued to grow and "by January 2003, EFQM membership had grown to around 800 organisations from most European countries and most sectors of activity" (EFQM, 2002). "The European Foundation for Quality Management's business excellence model emphasises a holistic approach to performance improvement" (Open University, 2001c). The model is based upon eight fundamental concepts of sustainable excellence.

They are:

1/ Results Orientation;

2/ Customer Focus;

3/ Leadership and Constancy of Purpose;

4/ Management by Processes and Facts;

5/ People Development and Involvement;

6/ Continuous Learning, Innovation and Improvement;

7/ Partnership Development; and

8/ Corporate Social Responsibility.

EFQM suggest that the "Excellence Model is a practical tool that can be used in a number of different ways:

- ✓ As a tool for Self-Assessment
- ✓ As a way to Benchmark with other organisations
- ✓ As a guide to identify areas for Improvement
- ✓ As the basis for a common Vocabulary and a way of thinking
- ✓ As a Structure for the organisation's management system" (EFQM, 2006).

The model has nine criteria, broken down in to five enabling activities (leadership, people management, policy and strategy, partnership and resources and finally processes) which drive four areas of results (people results, customer results, society results and key performance results). The model also has feedback in the form of innovation and learning which stimulates leadership and the other four enablers which in turn drive results, producing more feedback, completing the continuous improvement loop. The EFQM Excellence Model is a 'live' framework where EFQM continually update the model to reflect changing business needs and current management thinking.

3.4.2 THE BALANCED SCORECARD

As a result of the outdated nature of transactional cost systems, "distorted cost information is the result of sensible accounting choices made decades ago" (Cooper and Kaplan, 1988) and in recognition of contemporary commercial needs business executives sought innovative ways to articulate corporate well-being. In response to this challenge Robert S. Kaplan and David P. Norton (1992) devised the 'Balanced Scorecard'. The assertion of the Balanced Scorecard was to construct a set of four interrelated measures that give senior managers a fast and comprehensive information model that is representative of corporate strategy, objectives and competitive demands. Financial information on its own is backward looking, commenting on previous performance without predicting future achievements. The balance scorecard supplements the financial viewpoint with three other business perspectives, namely; customer perspective, internal business perspective and an innovation and learning perspective. The four perspectives create a more 'rounded' approach to performance assessment, acknowledging the importance of the various stakeholders, including the customer / consumer. Kaplan and Norton (1992), stress that the balanced scorecard presents a cross-functional shortlist of key indicators for present and future performance. The Balanced Scorecard "provides answers to four basic questions:

- ✓ How do customers see us? (customer perspective)
- ✓ What must we excel at? (internal perspective)

✓ Can we continue to improve and create value? (innovation and learning perspective)

✓ How do we look to shareholders (financial perspective)."

Even though the four business perspectives are established, the actual content of the balanced scorecard is indeterminate. "The balanced scorecard is not a template that can be applied to businesses in general or even industry-wide. Different market situations, product strategies, and competitive environments require different scorecards" (Kaplan and Norton, 1993). Companies are required to customise the scorecard to best represent their specific corporate desires in terms of vision, structure, technology and culture. Nor is the balanced scorecard a measurement tool used solely to monitor and control employee behaviour. An underlying rationale of the balanced scorecard is to communicate strategic performance, permeating the various layers of administration in a manner that is comprehensible and constructive to those involved in the tactics of operational performance. The provision of meaningful feedback on previous outcomes should provide the motivation and direction for better performance - faster. There is a strong human relations aspect to the successful implementation of the scorecard. Notably, this facet concurs with recent developments in the organisation and structure of the workplace ecology and in particular the increased adoption of team-based working. The balanced scorecard "approach to performance measurement is consistent with initiatives under way in many companies: cross-functional integration, customer-supplier partnerships, global scale, continuous improvement and team rather than individual accountability" (Kaplan and Norton, 1992).

3.4.3 KEY PERFORMANCE INDICATORS & THE CONSTRUCTION INDUSTRY

The construction industry has been beset by a number of high profile project setbacks fuelling claims by construction clients that they were not getting value for money, often "accused of being, at worst, wasteful, inefficient and ineffective" (Beatham *et al*, 2004). In response to the increased criticism the UK Government set up a

'Construction Task Force' to investigate and report on the efficiency and quality of UK construction from a client's perspective. In 1998 Sir John Egan published his findings, entitled 'Rethinking Construction' which announced many recommendations for improving industry performance. One of the central themes was the need to set targets for improvement, "to drive dramatic performance improvement the Task Force believes that the construction industry should set itself clear measurable objectives, and then give them focus by adopting quantified targets, milestones and performance indicators" (Egan, 1998). To support the development of 'company scorecards' and sponsor continuous improvement and benchmarking initiatives that are industry-wide, the Government set up 'The Key Performance Indicator (KPI) Project Management Group'. This specialised group, representing a cross-section of industry stakeholders merged with the Construction Best Practice Programme (CBPP) to launch Constructing Excellence and more recently became Constructing Excellence in the Built Environment. Over the past seven years these government sponsored forums have developed a comprehensive hierarchy of Key Performance Indicators particular to the UK construction industry.

The KPI's (first published in 1999) are a 'live, year-on-year' commentary of industry performance. They continue to be developed and refined as more companies adopt the values and provide the necessary feedback against which industry-wide benchmarks can be established and reported. As stated in the Construction Industry KPI Handbook (2002), "KPI's provide a simple means of assessing performance against the range of performance currently being achieved in the UK construction industry. They provide basic 'health checks' to establish areas of strength that need to be maintained, and areas of weakness that need to be improved." Construction industry KPI's shift performance emphasis away from an internal accountability towards a more outward looking, customer-orientated focus. Each Headline Performance Indicator is sub-divided in to two main classifications (project performance & company performance) combined they support a suite of ten KPI's. For example the 'UK Economic KPI's – All Construction' wall-chart has ten individual KPI's categorised and identified as follows, see table 3.4.1.

Table 3.4.1 **Economic - All Construction Key Performance Indicators**

Project Performance:	
1/ Client satisfaction – product	2/ Predictability – cost
3/ Construction cost	4/ Client satisfaction - Service
5/ Predictability – time	6/ Construction time
7/ Defects	
Company Performance:	
8/ Profitability	9/ Productivity
10/ Safety	

3.4.4 KEY PERFORMANCE INDICATORS & BENCHMARKING INDUSTRY PERFORMANCE

Precise guidance is provided by the Government sponsored KPI Project management Group, regarding data gathering and calculation in an endeavour to promote uniformity of statistical information across the construction sector. The KPI templates can combine both 'hard' and 'soft' measures of performance as required. To assist companies in their acceptance of the performance management system, exemplars for data gathering surveys, data analysis and data calculation are available with further support accessible via regional workshops and the Government sponsored, Construction Best Practice Programme (CBPP). After data analysis and calculation, the KPI's are translated in to a performance measure expressed in terms of a percentage score (%) and plotted on a radar chart for ease of interpretation and comparison with industry best practice. The radar chart provides a comprehensive pictorial representation of company performance, readily identifying areas of strength as well as weakness. In addition to developing and initiating a new performance management framework for the construction sector the Government has also incorporated the setting-up of benchmarking clubs as local forums for industry practitioners. Membership of a benchmarking club allows the organisation to compare their performance with those of comparable organisations. It also establishes and promotes the notion of best practice, acting as a medium for construction companies to share their experiences within a forum isolated from the competitive environment of the marketplace. The benchmarking clubs have a pivotal role to play in the dissemination of best practice and the promotion of continuous improvement programmes in that "competitors are more likely to supply information to a neutral party (which can disguise it and make it available to all its members or customers) than to one another" (Eccles, 1991). As part of the evolution of industry KPI's, discrete sectors within the industry, such as 'Housing', 'Consultants' and 'Materials' as well as 'Social' (Respect for people) and 'Environmental' themes are having KPI's developed as part of the overall hierarchy of construction industry key performance indicators. Latterly, in response to feedback from KPI users, additional KPI's have been developed to supplement existing measures where companies feel it is appropriate to their needs. Overall, the existing suite of KPI's offer construction "organisations with a framework to benchmark activities both at a broad level, and at a level much closer to the 'coal face'- such as rectifying defects and meeting clients' expectations" (Raynsford, 2000).

3.5 PERFORMANCE MANAGEMENT OF TEAMS

"Team working is a long-established practice," and "has risen in popularity of late as a response to changes in organisations" (Staniforth, 1996). As a consequence, company perception of team working as a tactical measure associated with the improvement of productivity has been 'promoted' to a strategic intent impacting on an array of corporate processes. The paradigm shift in corporate interpretation of team working has unquestionably tied business interests to the performance of teams. Within this context, to purport that the measurement of company performance is fundamental to the well-being of the organisation is to imply that corporate interests are progressively more in the hands of teams. The increasing adoption of team working philosophies within the working environment also raises the question of evaluating team performance. This poses a number of basic questions such as, how is 'team' performance to be defined and what should (and can) be measured? It has been widely cited that the effective and efficient channelling of group effort in a coherent and functional fashion often outperforms the efforts of individuals or other types of working group. "Employee work teams, when thoughtfully designed and implemented, can deliver many important benefits such as waste reduction, increased productivity, increased product quality and increased employee commitment and flexibility" (Natale *et al*, 1995). As Wageman (1997), succinctly stated, "organisations need teams to compete." Generating evidence of tangible competitive gains necessitates a company performance management system to take cognises of the working arrangements adopted. "If organisations want teams to make an important contribution towards the achievement of corporate goals, when measuring team performance companies need to ensure that these measures are consistent with organisational goals" (Telleria *et al*, 2002). In terms of performance management and measurement, benchmarking team performance would be a logical starting point for establishing new knowledge, (Love and Holt, 2000).

3.5.1 BENCHMARKING TEAMS

There is little documentary evidence for the systematic evaluation and benchmarking of team performance. Considering the recognised importance of the team formation and team building in contributing to the overall success of the organisation, it is somewhat surprising to conclude that team effectiveness is not measured in any structured way, (Raiden *et al*, 2004). Companies appear to be more comfortable with conventional benchmarking procedures that consider processes and outcomes. To omit team performance displays a management disregard for the role teams and team working play in everyday organisational practice. The contradiction in management rhetoric may be indicative of an underlying cultural conflict between attitudes and behaviours of the individual and the collective societies of the organisation.

3.5.2 INDIVIDUALISM VERSUS COLLECTIVISM

Research suggests that although performance management is widely acknowledged as a prerequisite for competent corporate management, little has been done to assimilate and customise 'individualistic' performance management principles within a team orientated 'collectivism' environment. "One of the interesting findings of our research was that, although everyone we contacted talked about organisational and individual performance, relatively few organisations made specific arrangements for team performance management" (Armstrong and Baron, 1998). This viewpoint concurs with Staniforth's (1996) observations relating to staff appraisal policy, where he states that "there is little evidence to suggest that anything other than 'individual appraisal' is done," and puts forward the question, "do we really appraise team work, or just individuals who work in teams." Staniforth concludes by observing that "many UK organisations do not yet appear to have broken the shackles of an individualistic approach to work."

In line with conventional organisational policy, team working should be part of the monitor / control management structure and as such incorporate mechanisms that support and facilitate, in a predetermined fashion, team performance. Business operations would appear to be more comfortable with an individualistic approach to employee management where "a kind of 'rugged individualism' and independence has been traditionally rewarded and has been the model of success" (Natale *et al*, 1995). An important characteristic of a 'true' team formation is the notion that an individual's performance is wholly dependent on the performance of others. Therefore, a traditionally-rooted individualistic approach to performance management contradicts team working philosophies and may act as a constraint on potentially higher performing teams due to the level of individual membership compromise. Personal agenda's may predominate over the team agenda if the nature of performance rewards favours the individual. Company formulation of a performance management system should be mindful of the team working style and adopt practices that reflect and reward the collective / collaborative characteristics of the workplace.

All performance management systems require an input from human resource management. In a team oriented workplace supplementary human resource involvement may be required in an attempt to create an accommodating organisational climate, addressing issues such as; remuneration, reward, appraisal, continued professional development and in particular teamwork training. Failure to design a contingent human resource outlook may inhibit performance and further contradict team principles. Quantifiable performance measurement of team functioning will most likely be modified for specific situations. That said the basic framework for performance calibration is expected to be comparable with other types of working arrangement. In addition to existing key standardised performance indicators, consideration may be given to specific characteristics typical of team working, for example relationships, social interaction, purposive and culture, (Ingram, 1996). In this respect a 'Team Climate Inventory (TCI)' has been pioneered by Anderson and West (1994) as a viable model for evaluating team performance. The TCI research focused on innovation as the synthesis of underling team processes and could be correlated with positive team behaviour(s) and outcome(s). The resultant TCI scores can then be translated as a measure of team 'collectiveness' and interpreted in conjunction with more traditional performance indicators.

3.6 PERFORMANCE MANAGEMENT IN CONSTRUCTION

Over the past decade, condemnation of the construction industry has focused on two key concerns. First, a growing client dissatisfaction in both the private and public sector and second, increasing disquiet at the management of people and the working conditions endured by those involved in the wider construction environment. The principle driving force for the recent demands for improvement in the performance of construction has come from the former. Construction clients have been disheartened with the continuing disregard for overall customer satisfaction. "Construction too often fails to meet the needs of modern businesses that must be competitive in international markets, and rarely provides best value for clients and taxpayers" (Egan, 1998). Over the years a developing culture of ever lower tender prices (compounded by misinformed / naive clients), crisis management and short term business projections have tainted existing organisational practices, leaving the client frustrated with repeated under-performance of the construction industry and increasingly distrustful of the people involved. Disillusionment within the construction industry is not solely confined to client bodies, professionals within the industry also expressed growing scepticism when assessing the future prospects for the UK construction industry. The following comments were published in Sir John Egan's Government sponsored report, 'Rethinking Construction' in 1998. With regards to company return on investment (ROI) the report stated that construction "has a low and unreliable rate of profitability...too low for the industry to sustain healthy development." On innovation and process improvement it stated that construction "invests little in research and development and in capital," and finally on personal development the report concluded that "there is a crisis in training...too few people are being trained to replace the ageing skilled workforce...construction also lacks a proper career structure to develop supervisory and management grades." In short the construction industry was in decline with a growing public image of mediocrity. As a result the sector struggles to recruit the quality and quantity of personnel required to help raise industry standards and overall performance.

3.6.1 CONSTRUCTION PERCEPTION OF PERFORMANCE

Performance in construction not only needs to improve but management approach to the measurement of effectiveness and efficiency also requires to be examined. Traditionally, performance measures within the construction sector have been based primarily on project cost, project time and specification (quality). These three variables could be significantly influenced depending on the procurement route selected by the client. For example a 'traditional' procurement route can offer an element of certainty with regard to cost and specification but project time may be less easy to predict. Whereas, design and build can offer advantages with regard to cost and time but at the expense of quality. Within these 'long-established' construction performance management criteria, it could be noted that contradiction and dilemma have been perceived as an uncontrollable consequence of the building process and as such were accepted as inevitable. For the client, the dominant criterion for selecting a contractor was nearly always the lowest cost, often at the detriment of project time and / or specification. Amendments to the building design and construction would predictably impact on the quality of the building provision but at the forfeit of rising costs and ongoing extensions of time. Undiscriminating clients' preoccupation with reducing costs, coupled with an unrealistic expectation with regards to project value compounded the problems already facing a highly competitive, economically dependant and fragmented UK construction industry. Tender prices were pushed down to levels that were only sustainable in the short term by exploiting sub-standard resources and as a consequence promoted client dissatisfaction with the service / product and disillusionment within the industry. The current 'traditional' performance measures fail to encapsulate the needs of the construction participants, often encouraging client and contractor to engage in a cycle of compromise (trade-off) that all too frequently would lead to conflict borne out of frustration / misunderstanding / suspicion and restrictive performance parameters. The construction industry needs to modernise and undertake extensive changes to the way it conducts business (inside and out) if companies wish to remain competitive and provide sustainable working procedures that promote best working practice and a 'healthy' respect for the people involved in the construction environment.

3.7 RESEARCH DIRECTION – TEAM PERFORMANCE WITHIN A CONSTRUCTION INDUSTRY SETTING

This research concentrates on the belief that cross-functional team performance, via a customised management selection and performance criterion, may be utilised to organise 'best-fit, suitably balanced' construction teams within an environment that supports, measures and rewards team endeavour. The construction site management team require a balance of technical knowledge, business acumen, organisational attributes and humanistic skills to facilitate knowledge transfer, communication and co-operative working to a point where it becomes habitual within the total construction process. The benefits associated with this level of human collaboration are frequently cited, "Innovation within the construction process has been shown to be related to the level of integration achieved" (Moore and Dainty, 2001). The selection and formation of teams and team working may have experienced a revival over the past ten years but the temporary nature and ever present workload fluctuations of a project-based industry raise many obstacles to the effective selection of suitable people combinations, "the selection of team members is critical to the success of the business and the project but, particularly in the case of the project, it is often outside the control of the manager" (Newcombe *et al*, 1990). The commercial pressures of a highly competitive industry appear to create an environment that, at present, leaves little scope for formal diagnostic team selection. The continuing adoption of partnering ideals is likely to redesign the traditional workplace conduct from a confrontational win or lose approach, to a contemporary win - win model of collaboration, interpersonal understanding and team efficacy. It will not necessarily work; unless the environment is complementary to the needs of the individual, the team and the organisation (see Figure. 3.7.1).

3.7.1 THE PERFORMANCE CHALLENGE

The continuous measurement and benchmarking of team performance is integral to the success of establishing and maintaining high-performance cross-functional team working in a construction environment. The challenge for organisations is to introduce a team performance criterion that is informative, manageable, meaningful and consistent within a modernised, multi-dimensional, performance management structure. At present there is limited research literature on team performance management (Armstrong and Baron, 1998; Staniforth, 1996; Telleria *et al,* 2002). This may suggest that the resurgence in team theory and its application within the workplace has accelerated whilst management support mechanisms that assist decision-making policy such as a performance management system have become organisationally challenged and obsolete. Within construction their now exists an opportunity to adopt contemporary team ideals coupled with a modern performance management philosophy. The utilisation of thoughtfully managed high-performance cross-functional construction site management teams within a customised performance management structure is feasible. In addition the team performance management system would align with the values of the Government sponsored best practice programme. Key Performance Indicators for Teams (KPI for Teams) would allow construction managers to appraise team performance based on predetermined criteria that could also support team appraisal, team development, levels of client satisfaction and benchmarking. Figure 3.7.1 illustrates multi-dimensional systems construct, exemplify the concurrent influence of industry, organisational and group framework that facilitates the accomplishment of High Performance Cross-Functional Teams.

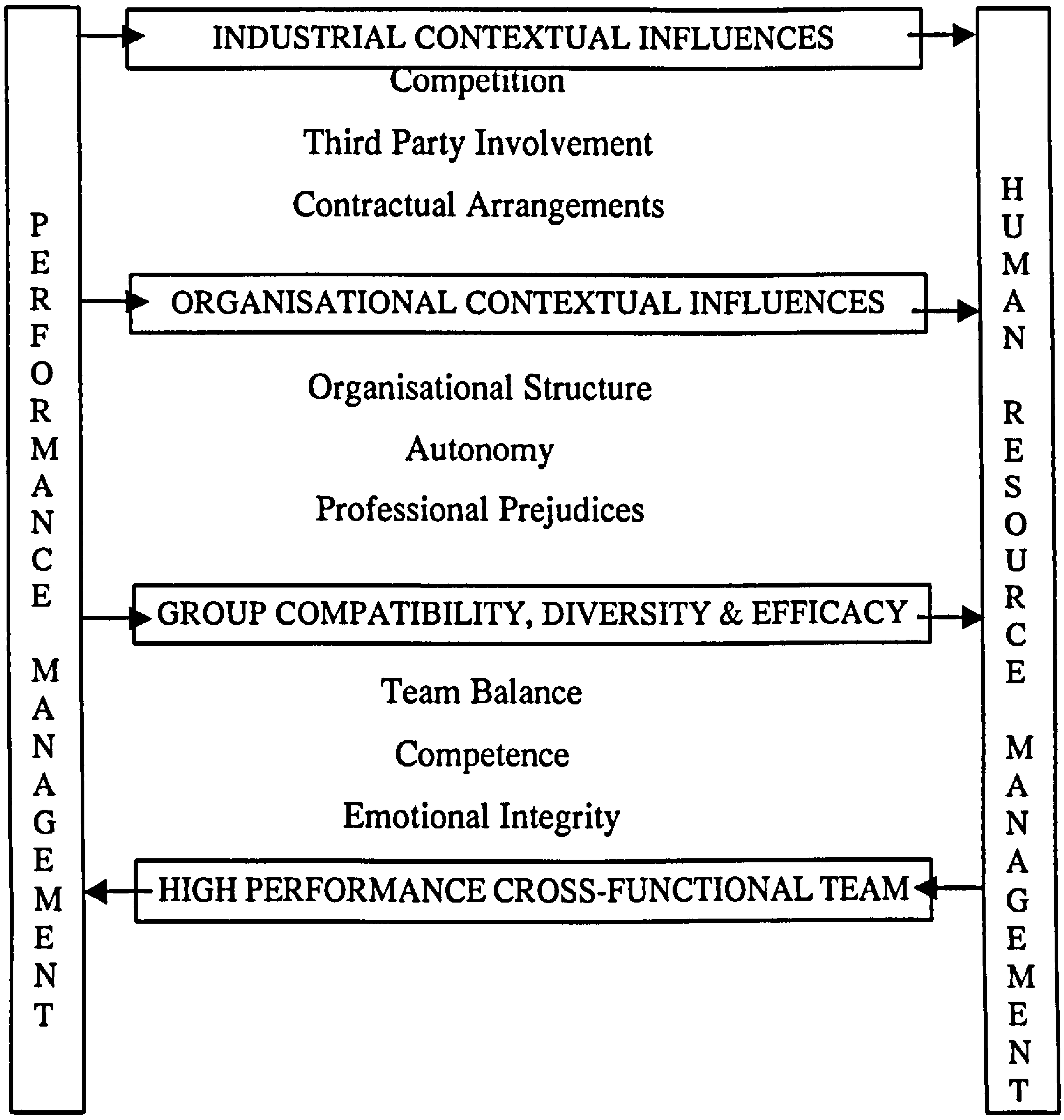


Figure 3.7.1 The Performance Challenge

3.8 CONCLUSION

The 'multi-dimensional construct', cross-functional team working will produce 'hard' and 'soft' measures of operation that can be developed to evaluate the success or failure of the team environment. It is essential that the design of a performance management system encapsulate not only the economy and efficiency of the group but also effectiveness and ethics of the organisation sponsoring the group work. The underlying ethos of the performance management system can be extended beyond the team to the wider but strategically important business environment. 'Team Performance within a Construction Industry Context' also requires integration within already established performance measurement systems such as the Government sponsored Key Performance Indicators (KPI's). Performance management assimilation with developing practices of this nature may encourage a more inclusive approach to the management of site construction teams, promoting adoption and adaptation of existing management tools to attain a holistic quantification of team functioning. The resultant measurement of performance will provide authenticity and facilitate meaningful interpretation to the formation, implementation and evaluation of cross-functional team working within the practice of construction site management. If there is any hope for team working to succeed as a management strategy for enhanced performance it must be studied in detail and correctly applied, (Natale *et al*, 1998).

CHAPTER 4: RESEARCH METHODOLOGY

4.1 INTRODUCTION

The success of a research programme is "dependent upon a valid choice of research methodology" (Walker, 1997a) which will dictate the direction of all subsequent chapters. The expression "research methodology refers to the principles and procedures of logical thought processes which are applied to a scientific investigation" (Fellows and Liu, 2003). A key determinant in the selection of an appropriate research methodology is the requirement to create a meaningful connection between current knowledge, research investigation and industry practice. Although it may be challenged that the agenda for those carrying out the research and are ostensibly 'outside' the industrial setting will differ from those working 'inside' the industrial environment. It is important that a common research denominator should be identified. This would facilitate future research findings to be received in a positive context and receive greater acceptance within mainstream working practices. In the past "insufficient attention is paid to the relationship between research and practice in construction. Those in industry...are often disappointed with the contribution of research, either because it is too theoretical or because the simple solutions suggested do not work" (Barrett and Barrett, 2003).

Research applications may not work for reasons other than an incompatibility between theory and practice. Other issues abound, "different methodologies accentuate different aspect of reality" (Green, 2002). This needs to be acknowledged at the outset as Remenyi and Money (1996) observed "there are many factors to be considered when choosing an appropriate research methodology." An awareness of industry background coupled with typical wants and desires in terms of research aptness and acceptability enables the research methodology to be crafted in such a way that it satisfies both academic inquiry and dovetails with industry practice. For some commentators pressure from industry opinion makers, especially when seeking financial funding for applied research is more than likely to impact on the adopted research methodologies and resultant outcomes. "In such situations, it is difficult to imagine how the results could do anything other than support the interests of the particular power group which commissioned the research" (Green, 1998). In such instances it can be seen that research on its own can have well defined boundaries, common interpretation between participants and a unity of objective.

The transition from theory to practice, even in an embryonic format such as pilot studies and subsequent case studies introduce potential research inhibitors. For example construction site disposition, social dynamics and organisational politics introduce a greater potential for misinterpretation. Interpretation is a key factor in all research regardless of the methodologies selected, "whether we use numbers (quantitative) or words (qualitative) in our research is unimportant per se...both numbers and words require interpretation" (Gummesson, 2003). To deal with interpretation it can be helpful to introduce the concept of hermeneutics. Interpretation and hermeneutic processes help encapsulate the many facets of intellectual capacity.

A research strategy needs to be developed that endeavours to promote consistency and coherence between existing knowledge and improved understanding. Adopting a hermeneutical outlook helps define the interpretative parameters of the researcher and promote results, analysis and 'interpretation' in context with the setting. Interpretation can also be constructively critical. Contemporary hermeneutics is a part of critical theory concepts and provides a balance to the interpretation of 'real-world' investigation. Recent articles within construction management literature have adopted 'critical' interpretations of industry practice in an effort to stimulate debate and offer different perspectives on traditional viewpoints. Recognising that "all research is interpretive" (Gummesson, 2003) reduces the pressure to pursue either a qualitative or quantitative methodology. "There is no uniquely best approach to research, either in the natural world or the built environment in particular, and the best that can be done is to describe the way in which the research is carried out in a variety of situations" (Amaratunga *et al*, 2002).

4.1.1 RESEARCH FRAMEWORK

The adopted research structure needs to address the basic supposition of the research question and translate cognitively with current comprehension. The selected methodology should also be sympathetic to the needs of the researcher in terms of accessible data and academic rigour whilst simultaneously satisfying industry requirements in terms of desire for applicability. "Those in industry appear to want guidance from research that clearly tells them what to do in order to achieve greater profitability, greater efficiency (doing things better) and, to some extent greater effectiveness (doing better things)" (Barrett and Barrett, 2003). The objective of the research methodology is to offer research solutions that synthesise with current thought and provide building blocks of knowledge that augment existing practice. Translating research theory to practice is fundamentally a communication exercise. There needs to be a meaningful link of understanding that can interact with the cognitive schemata of the practitioner. This will facilitate the comprehension of new knowledge (research needs) with existing practice (industry needs).

The researcher also has cognitive limitations. This implies that the researcher should be aware of personal strengths and weaknesses by selecting a methodology that is meticulousness in data gathering and appropriate for assessment within the context of the research question. To limit the potential for research complexities the exactness of the research question should be carefully reviewed, "setting priorities and focuses of attention, thus excluding a range of unstudied topics" (Wield, 2002). Identifying the outer boundaries of the investigation "enable the researchers to focus on just a few very specific aspects of the real world and make a definitive statement about these, which will be of general application" (Barrett and Barrett, 2003). The adopted research methodology should address the investigative motivation, the needs, the researcher, the functional needs of industry stakeholders and the end user. The transformation of research theory to practice is the premise of P. Barrett and L. Barrett's research paper entitled 'Research as a kaleidoscope on practice,' (2003). The authors suggest the adoption of three distinct research perspectives coined as 'microscopic', 'telescopic,' and 'periscopic.' Research may commence with a closed research environment that may have limited industry involvement (microscopic) working through various epistemologies (positivism, critical realism and pragmatism) to culminate in an open system requiring illimitable interplay with industry practitioners (periscopic). The research composition is therefore being shaped from current understanding of the subject area. The research framework is underpinned with an extensive literature review of both team working and performance management and measurement appraisals. An aspect of present day practice is integrated in to the methodology by assimilating current industry standards and protocols for performance management and measurement. This is correlated with the data gathering of team performance.

4.1.2 RESEARCH RATIONALE

The original premise of the research programme is the assertion that team working will produce enhanced performance outcomes. Katzenbach and Smith (1993a) in their seminal article "The Discipline of Teams" stated that "teams and good performance are inseparable; you cannot have one without the other." Within a construction context anecdotal evidence is readily available professing the performance advantages associate with team working (Latham, 1994; Egan, 1998; Egan, 2002). However the author is unaware of empirical examples of enhanced construction site management performance outcomes that can be attributed directly to the efforts of a well-managed, multi-functional, mature and balanced group environment, i.e. team working. Evidence of project success being directly attributed to carefully constructed and disciplined team management and measurement techniques appear to be very rare.

4.1.3 KEY RESEARCH QUESTION

Predictably the fundamental research question defines the parameters of the research programme and "implicitly or explicitly represent a conceptual framework and a means of putting in to operation" (Weild, 2002). In this particular study research thinking is formed by the question, 'do better performing site management teams produce better performing construction projects?' If Katzenbach and Smith's statement is correct then better performing site management teams will produce better construction project outcomes. If the evidence suggests otherwise then the proclaimed benefits associated with improved teamwork within a construction site setting will be open to debate.

The theoretical conjecture adopted for this project concentrates on two distinct management variables, team working and performance. Hypothesis testing protocol advocates that the initial stance to be adopted is the null hypothesis (H_o), until proven otherwise. The null hypothesis suggests that the two variables act independently of one another and are not correlated. On the other hand, if the results indicate that there is a discernible association between the two principal variables then the null hypothesis is rejected in favour of the alternative hypothesis, (H_A). It is worth noting that the function of the hypothesis statement is to investigate the research question by methods of statistical inference. The statistical outcome offers an investigative insight (albeit tentatively) to the initial research question. The results and subsequent data analysis establish a basis upon which an empirical judgment can be made to discuss the research findings in relation to the underlying premise, 'do better performing site management teams produce better performing construction projects?'

4.1.4 EVALUATING THE RESEARCH STRATEGY

Developing an appropriate research methodology is a key phase for the successful execution of the research programme. There are various research strategies available, three of the accepted research strategies frequently refer to are: experiments, surveys and case study. Colin Robson (1993) in his book 'Real World Research' summarises their characteristics as follows:

1/ Experiment: measuring the effects of manipulating one variable on another variable.

2/ Survey: collection of information in standardised form from groups of people

3/ Case Study: development of detailed, intensive knowledge about a 'single' case, or of a small number of related 'cases'.

4.1.5 THE RESEARCH STRATEGY

The aim of this research is to test the hypothesis for an assertion that team and performance are independent of each other – you can have one without the other. Under theoretical conditions an 'experiment' is a feasible option, although the practicality of managing this type of approach is extremely limited. The key is 'control'. The researcher needs to be in a position of influence, capable of directing events that affect at least one of the variables under scrutiny. For this study the level of control is out with the remit of the researcher.

A 'survey' strategy alleviates the need for experimental control. For studies of this nature emphasis is placed on survey sampling techniques and the need for representative, random, non-biased data collection, (Robson, 1993). This would normally entail generating large sample sizes from a cross-section of industry stakeholders. This extends be beyond the scope of currently available research resources.

The case study offers a more flexible approach to investigative analysis. Control over events is unnecessary and sample sizes are restricted to one 'case' or a few 'cases'. The case study strategy also permits various methods of data collection to be employed in pursuit of better understanding a particular phenomenon – albeit within clearly defined contextual parameters.

Taking into careful consideration the research question, the research environment and the available resources the research strategy of choice is the case study.

4.1.6 THE RESEARCH METRIC

Much has been written about the merits of both qualitative and quantitative research traditions. "This debate has centred on the relative value of two fundamentally different and competing schools of thought or inquiry paradigms. Logical positivism uses quantitative and experimental methods to test hypothetical-deductive generalisations...Phenomenological (interpretive science) inquiry uses qualitative and naturalistic approaches to inductively and holistically understand human experience in context specific settings" (Amaratunga *et al*, 2002).

Table 4.1.1 Two Schools of Science source: Amaratunga *et al*, 2002.

Approach	Concept	Methods
Positivism	Social structure Social facts	Quantitative Hypothesis testing
Interpretive science (phenomenological)	Social construction Meanings	Qualitative Hypothesis generation

"It should be clear that the difference between qualitative and quantitative research is not one of 'better' or 'worse' but rather one of appropriateness to the question" (Bouma and Ling, 2004). Both research approaches are widely acknowledged in terms of their merits and suitability, "qualitative research is best suited for theory creation, whereas quantitative research is best suited for theory testing" (Kvale, 1996). The research hypothesis proclaiming, 'that construction site management teams and good project performance are unrelated; you can have one without the other' is a construction industry construal of an original statement made by Katzenbach and Smith (1993a). Therefore this research is 'theory testing'. "In quantitative studies, the research question seeks out a relationship between a small number of variables" (Stake, 1995). For this research enquiry there are two principal variables, site team working and project performance. Bearing in mind the stipulation to test a theory involving a limited number of variables, the research strategy of choice is quantitative.

4.1.7 QUANTITATIVE RESEARCH

The epitome of quantitative research methods is the measurement of data in an objective and rational manner. The data collection may utilise a number of recognised techniques. "In conducting quantitative research, three main approaches are employed: asking questions of respondents by questionnaires or interviews; carrying out experiments; and 'desk research' using data collected by others" (Fellows and Liu, 2003).

4.2 THE RESEARCH METHOD

As discussed earlier, "research methodology refers to the procedural framework within which research is conducted" (Remenyi *et al*, 1998). From a researchers perspective the primary objective of the research method is to provide a workable framework for the formulation, implementation and evaluation of research data that will facilitate a sound and just response to the research question. As stated earlier there are essentially two variables in the 'research equation', team working and project performance. For team working the literature search has shown that previous team based studies have primarily employed qualitative research methods such as questionnaire in their initial assessment of team qualities, (Belbin, 1982; Anderson and West, 1994; Borrelli *et al*, 1995). Numerical inferences such as 'values' and 'scores' have been added later to create a quasi-quantitative measure founded on the strength of the participants' response. The perception of 'team efficiency' may be assessed by asking team members to answer a series of 'behaviourally based' questions. For this research programme the questions all relate to the seven different team variables identified in the literature review, namely: (Group Compatibility and Diversity) interdependency, membership diversity, team dynamic and trust; (Organisational Context) corporate intent and systems-procedures & custom; (Industry Context) culture. The assessment of project performance is more straightforward in its selected methods. The construction industry currently employs performance management concepts such as key performance indicators and benchmarking procedures that can be adopted and adapted specifically for the measurement of a project's performance.

4.2.1 RESEARCH METHOD - FORMULATION

The research method has two key components, the measurement of team working and the measurement of project performance. This requires inputs from a number of different project sources. The team input can be obtained from participating construction site team members. The project performance data can be gathered from a cross-section of project stakeholders including team members, project leaders and client / client representatives.

4.2.2 RESEARCH METHOD - IMPLEMENTATION

The implementation of the research method draws upon two distinctive concepts of performance measurement. The input required from team members is a behaviourally anchored measurement of performance. The input required for a corresponding project measurement is predominately output driven. The measurement of team working is suited to an attitude questionnaire. Although qualitative in its conceptual origins a weighting can be given to the strength of opinion expressed by the participant.

The questionnaire is presented in seven distinct sections; each section addresses a particular team variable. The response options are placed on a continuum (completely true – never true) that can be interpreted on a Likert scale of 1 to 5. A team member's response can then be numerically evaluated and translates to an overall team mean rating. The overall measure of the team status is represented by the mean value of the seven team variable ratings.

Project performance can be broken down in to key project performance indicators. Each of these can be measured, combining elements of qualitative and quantitative data and individually benchmarked against current construction industry performance standards. In essence, the research output is not dissimilar to current industry performance models except it is specific to a construction project and their corresponding site management team.

4.2.3 RESEARCH METHOD - EVALUATION

The data generated for both the team-working rating and project performance benchmark score needs to be numerically compatible to permit detailed assessment of the associated outcomes. The team working evaluation can be expressed as a percentage 'rating', dividing the actual score by a maximum possible score and multiplying the result by one hundred. A rating value can be calculated for each of the seven discrete team variables, which can then be aggregated to produce a 'mean team rating'. The mean team rating is representative of an overall measure of 'teaminess'. The team measure epitomises the strength of team member perception in relation to general levels of site team synergy. The data can be illustrated using a radar chart, presenting each of the team variables on a separate axis exemplifying team strengths and weaknesses. 'Teaminess' is an expression used by Richard Guzzo, Professor of Psychology at the University of Maryland, USA, (Church, 1998).

Measurement of project performance will involve seven individual KPI's. Each of the KPI's are expressed as a percentage and divided to produce an overall mean project performance score. The mean project score is representative of an overall measure of project performance. The results can also be illustrated on a radar chart, with each axis presenting the various strengths and weaknesses associated with the corresponding KPI and the project score in general. The similarity between the values and presentation of the team working variable(s) and project performance variable(s) assist both visual interpretation of the results and investigative data analysis.

4.2.4 RESEARCH ETHICS

Ethics may be described as "a branch of philosophy...its object is the study of both moral and immoral behaviour in order to make well-founded judgements and to arrive at adequate recommendations" (Pratley, 1995). Research undertaken within the field of behavioural sciences will by definition involve a high degree of social interaction with a wide range of research stakeholders. This may involve asking questions, observing behaviour or accumulating other information about their private life and personal thoughts. In a wider research context corporate information gathered may be regarded as sensitive to industry competitors. Regardless of the research methodology selected "all our dealings with other people raise ethical issues" (Bouma and Ling, 2004). The conduct of the researcher and the ensuing management of data need to be reflected upon prior to any formal or informal research inquiry. This may be managed by following an ethical code that highlights the importance for 'respect for people, beneficence and justice'. "These principles are considered universal, transcending geographical, cultural, economic, legal and political boundaries" (Rivera *et al*, 2004). Other aspects of the research assignment also call for careful consideration. "Doing research is often a public act (PhD theses end up in the university's library for public use), and with that come responsibilities" (Voi and Potter, 2002) such as confidentiality, data protection, academic integrity, copyright as well as research ethics.

4.2.5 ETHICAL CONSIDERATIONS

One of the key personal objectives of the research programme was to be perceived as a considerate researcher. This would require a high degree of planning, organisation, empathy with the participants and a personal demeanour that would encourage participation without misplaced apprehension about how or where the information would be used. Participation would be voluntary and clearly left to the discretion of the individual team member. In such circumstances those that participate do so willingly and in a spirit of mutual understanding and cooperation. All participants need to be confident that any resultant communiqués or publications in terms of both company and individual identity would remain confidential. This would be easily achieved by simply classifying each participating company as 'Company A / B or C' and construction site case studies as 'Project 1 / 2 or 3'. This would facilitate future referencing by assigning each individual case study with a unique research reference number for example 'Company B, Project 3' could be simply referred to as 'B/3'.

4.3 RESEARCH HYPOTHESIS

To evaluate the relationship between the two principal variables, 1/ Site Management Teams and 2/ their corresponding Project Performance it is necessary to generate and quantify data from both sources (team members and their project). In an attempt to facilitate a comparison between the two research variables a methodology of data collection has been fashioned that culminates in the arrangement of a common medium of measurement and presentation. Site team outputs may be assessed via an attitude statement questionnaire. The team member questionnaire assesses the core construction site management team. For example, those directly employed by the principal contractor responsible for the project development. Their personal response to the behaviourally based questionnaire records their 'strength of opinion' on team dimensions directly related to the seven key variables identified from the team literature review. Responses to the prescribed statements may then be scored, assessed and benchmarked against a maximum possible score and presented as seven discrete team variable percentages. The percentage ratings can then be plotted and illustrated on a radar chart. In addition a mean rating is calculated giving a quantitative indication on the overall perceived level of project 'teaminess'.

Project Performance is a more tangible construct. The project performance criteria can be developed from existing construction key performance indicators (KPI's) and presented in a customised framework that supports and best represents project-based outputs. It is likely that some of the information sources already exist or existing 'hard' information may need to be 'repackaged' to suit the standard presentation of performance information as recommended by the Constructing Excellence in the Built Environment forum. Again the information can be translated into seven discrete performance related percentage scores and graphically illustrated on a radar chart. A mean performance measure can be calculated representing an overall assessment of the current project well-being. As an output, the data associated with both variables and their outcome(s) can be presented using the same medium thus creating a common denominator suitable for direct assessment; a percentage rating, seven discrete variables and presentation via a radar chart. A comparison can be made between the two principal variables and their corresponding 'performance' score's using statistical investigation techniques. These would include ANOVA's, student's t-test, various correlation techniques as well as mean and standard deviation. If the null hypothesis is accepted then an indeterminate relationship exists between the two sets of results. If the null hypothesis is rejected, a positive relationship exists, suggesting a significant degree of interdependency. For example, if evaluation of the mean team rating is high then it may be expected that the mean project performance score is also high or vice-versa. If the null hypothesis is upheld then there is insignificant data correlation between the two variables, suggesting that the influence of one (i.e. team variable) is independent of the other (i.e. project performance).

To assist with the development of the research question in to an appropriate research methodology a research model was developed. This outlines the hypothesised relationship between the two principal variables and helps define the research parameters. Arrows have also been added to provide 'direction' and indicate where the research methodology dissects to accommodate the conceptual and practical aspects of performance measurement and finally their correlation with each other. Progress is also mapped in terms of 'phases' namely, research question, stage, source, methodology, presentation, data collection, analysis and finally discussion.

A diagrammatical depiction of the research paradigm is illustrated in figure 4.3.1, The Research Model.

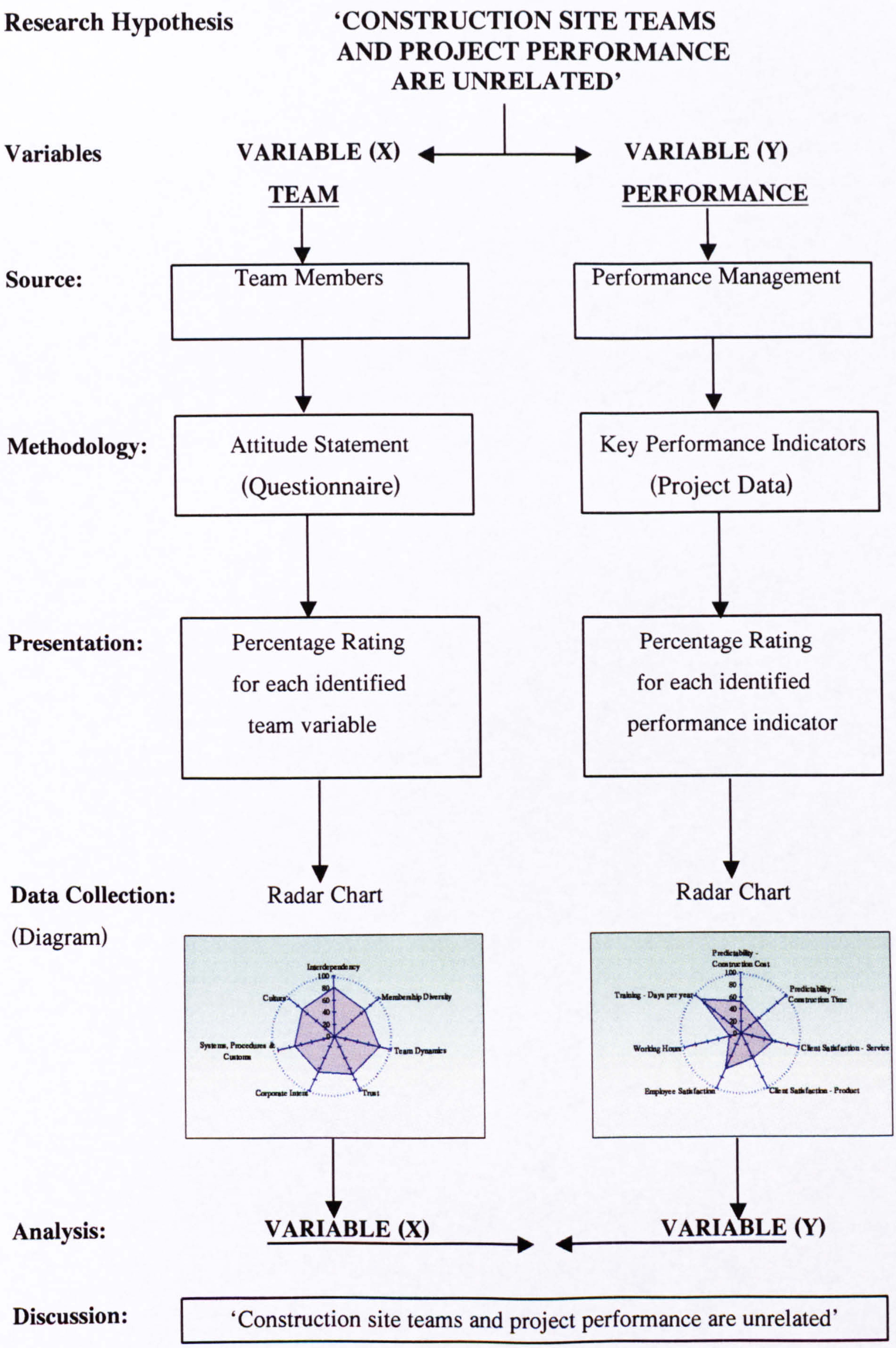


Figure 4.3.1 The Research Model

4.4 SELECTED RESEARCH METHOD

The research methodology has two distinct performance measurement frameworks and data collecting methods. The team performance rating is evaluated from an attitude questionnaire issued to all participating construction professionals working on site and employed by the principal contractor. The project performance is derived from seven carefully selected project key performance indicators. Calculated and benchmarked using the performance measurement criteria set out by the Constructing Excellence in the Built Environment (2004).

4.5 THE TEAM MEMBER QUESTIONNAIRE

4.5.1. RATIONALE

The rationale behind the team member questionnaire is to quantify aspects of team working in a manner that permits comparison with project performance. Following a team literature review seven team variables have been identified and labelled under three distinct headings: Category A, Group Compatibility & Diversity: Category B, Organisational Context and Category C, Industry Context. The team member questionnaire is used to assess an individual's perception of the team environment in which they work with specific regard to the variables identified for the evaluation of 'teaminess'. The resultant data is collated to provide management with team indicators that may be used to identify team strengths and weaknesses and permit judgment to be taken on unique aspects of team performance.

4.5.2 THE QUESTIONNAIRE

The questionnaire format is based upon the assessment and evaluation of carefully constructed attitude statements and the application of 'Likert Scales'. The 'Likert Scales' provide a quantifiable basis for attitude measurement founded upon an attitude ranking of strongly agree to strongly disagree and incorporating a ordinal value system of one (1) to five (5). Each increment on the scale is assumed to be equal. A score of 1 would represent one extreme of the continuum for example, strongly disagree and a score of 5 would represent strongly agree. The questionnaire adopts most of the fundamental Likert principles but has been slightly amended to provide compatibility with future data analysis and presentation. The attitude measurement criterion has been amended to response statements of, completely true, mostly true, partly true, slightly true and never true. It should be noted that attitude statements are techniques used to place an opinion on a continuum in relation to one another, in relative and not absolute terms.

The respondent to the team questionnaire receives an introduction to the research topic, an instruction sheet for the questionnaire, with an example and the questionnaire. The questionnaire has two sections. Section A/ asks background questions relating to the individual, their profession, company and project particulars. Section B/ contains the team attitude statements. Each of the seven variables under consideration has five associated statements. The respondent is invited to answer all questions by marking a cross (X) in the appropriate box. Research ethics is obviously an important issue at this stage and in an effort to engender trust and confidence in the research methodology, personal anonymity is assured.

Each questionnaire respondent receives an information sheet summarising the main points of the research. These include a research overview that introduce the participant to the research premise, a definition of the team parameters and guidance with an example on how to complete the questionnaire. Background information is also requested from the team member, details include: company employer, project, job title, length of service, gender and age bracket. Auxiliary research information such as researcher, contact address and sponsor organisations is also included.

4.5.3 ORDER OF STATEMENTS

Due to the well-defined classification of team variables no particular order is deemed necessary. In an effort to promote consistency, in relation to the research and previous team variable identification the sections have been identified as follows:

<u>Category 1 : Group Compatibility & Diversity</u>
Section B/1 - Interdependency
Section B/2 - Membership Diversity
Section B/3 - Team Dynamics
Section B/4 - Team Trust

<u>Category 2 : Organisational Context</u>
Section B/5 - Corporate Intent (incl. Performance)
Section B/6 - Systems / Procedures (incl. rewards) & Custom

<u>Category3 : Industry Context</u>
Section B/7 - Culture

4.5.4 TYPE OF STATEMENTS

The questionnaire is presented in the form of 'statements'. The respondent is invited to reply to these statements by selecting only one response out of a possible five responses. The type of reply ranges from 'Completely True' to 'Never True'. Prescribed responses have been selected in accordance with the principles associated with the 'Likert Scales'. There are five possible outcomes, see table 4.5.1.

Table 4.5.1 Questionnaire Responses

Completely True	Mostly True	Partly True	Slightly True	Never True

4.5.5 DATA PROCESSING

The prescribed statements are placed in succession of highest team order to lowest team order. Five points would be presented for a 'Completely True' response decreasing to one point for a 'Never True' response. Therefore a response of 'Mostly True' would be allocated a score of four points, 'Partly True' would equate to three points and a response of 'Slightly True' would receive two points. Each team variable would be measured via five question statements with a cumulative score obtained by adding the five individual respondent scores. An actual score, out of a possible score of twenty-five points can then be achieved for each team variable. A percentage score can be obtained by dividing the actual total score by the possible total score (25) and multiplying the answer by one hundred. The percentage obtained can then aggregated with corresponding team member ratings. The outcome can be easily transferred on to the appropriate axis of a radar chart. The radar chart can then provide a pictorial representation of the team variable questionnaire and represent the mean team 'rating' based on the cumulative attitude of all participating team members. An analysis can be made by calculating a mean team rating based on the individual team member responses to each of the seven variables. This may be compared against other construction site management teams as well as relating to project performance.

4.5.6 A CHECKLIST FOR QUESTIONNAIRE SUITABILITY

Table 4.5.2 Checklist for Questionnaire Suitability

Homogeneity	Linearity	Reliability	Validity (see Pilot Study)	Reproducibility
☑	☑	☑		☑

Working Definitions: (Oppenheim, 1982).

1/ Homogeneity	The scale adopted should focus on one aspect at a time.
2/ Linearity	Promotes a straight-line model using interchangeable units.
3/ Reliability	The need for consistency.
4/ Validity	Provide confidence that the performance measurement mechanisms collect appropriate units of data, (see Appendix F: Pilot Study Report).
5/ Reproducibility	Scoring style repeats the same measurement criteria.

4.6 THE QUESTIONNAIRE TOOLKIT

4.6.1 INTRODUCTION

This team questionnaire toolkit has been produced in an effort to establish a quantifiable measure of construction site management team working. The toolkit adopts a quantitative methodology to data collection, utilising attitude statements to evaluate respondents 'strength of opinion' on a number of team related issues. Its purpose is to measure the 'cohesive-working' intensity of a team-based environment using seven different team variables (indicators). The seven variables have been identified as critical success factors for modern-day team working and may be categorised under three separate headings. These are as follows:

A/	<u>Group Compatibility & Diversity</u>			<u>Abbreviation</u>
	The team variables:	1/	Interdependency	- (Id)
		2/	Membership Diversity	- (MD)
		3/	Team Dynamics	- (TD)
		4/	Trust	- (Tr)
B/	<u>Organisational Context</u>			<u>Abbreviation</u>
	The team variables: (incl. Performance)	5/	Corporate Intent	- (CI)
		6/	Systems / Procedures (incl. rewards) & Custom	- (SP&C)

C/	Industry Context			Abbreviation
	The team variable:	7/	Culture	- (CI)

4.6.2 TEAM VARIABLE DEFINITION

The team variable definitions are as follows:

1/ Interdependency: Definition – "The extent to which team members cooperate and work interactively to complete the task" (Stewart and Barrick, 2000). In a team situation this suggests that the success of the team objective is reliant on the cumulative effort of all the participants. A connected consistency and creation of a mutually supportive working environment.

2/ Membership Diversity: Definition – To award variety and assortment to personal traits within a common grouping. This variable refers to the balance and mix of team members in relation to professional and behavioural roles, respectively.

3/ Team Dynamics: Definition – Number of permanent core members working within the site management team environment and the extent of intrapersonal communication, formal and informal that takes place within the group, (Stewart and Barrick, 2000). Assessment based on team member perception.

4/ Trust: Definition – Perceived level of honesty, emotional integrity and confidence among team members. The level of intrapersonal worthiness engendered within the group setting combined with a firm belief in the expectation, commitment and confidence of others.

5/ Corporate Intent: Definition – The application of thought to a particular concept, diligently applied. In context, corporate intent should communicate a company strategy that combines team objectives with wider corporate community.

6/ Systems, Procedures & Custom: Definition – Workplace attributes that contribute to the organisational framework and effective administration of the team.

7/ Culture: Definition – The manifestation of human behaviour expressed in developed attitudes, values and a cognitive refinement in understanding. Including subjective characteristics such as manners, feelings and behaviour(s) that are deep-rooted in both time and tradition.

4.6.3 TEAM PARAMETERS

Within a construction environment company employees may find themselves members of numerous team formations. It is important that all participants base their questionnaire responses on one identified team formation. In this case the Construction Site Management Team parameters may be defined as: All permanently employed site based construction professionals, working for the same company, under the direct leadership of the Construction Project Manager (Team Leader).

The following figure (4.6.1) illustrates a typical construction site management team formation with the Project Manager as Project Leader.

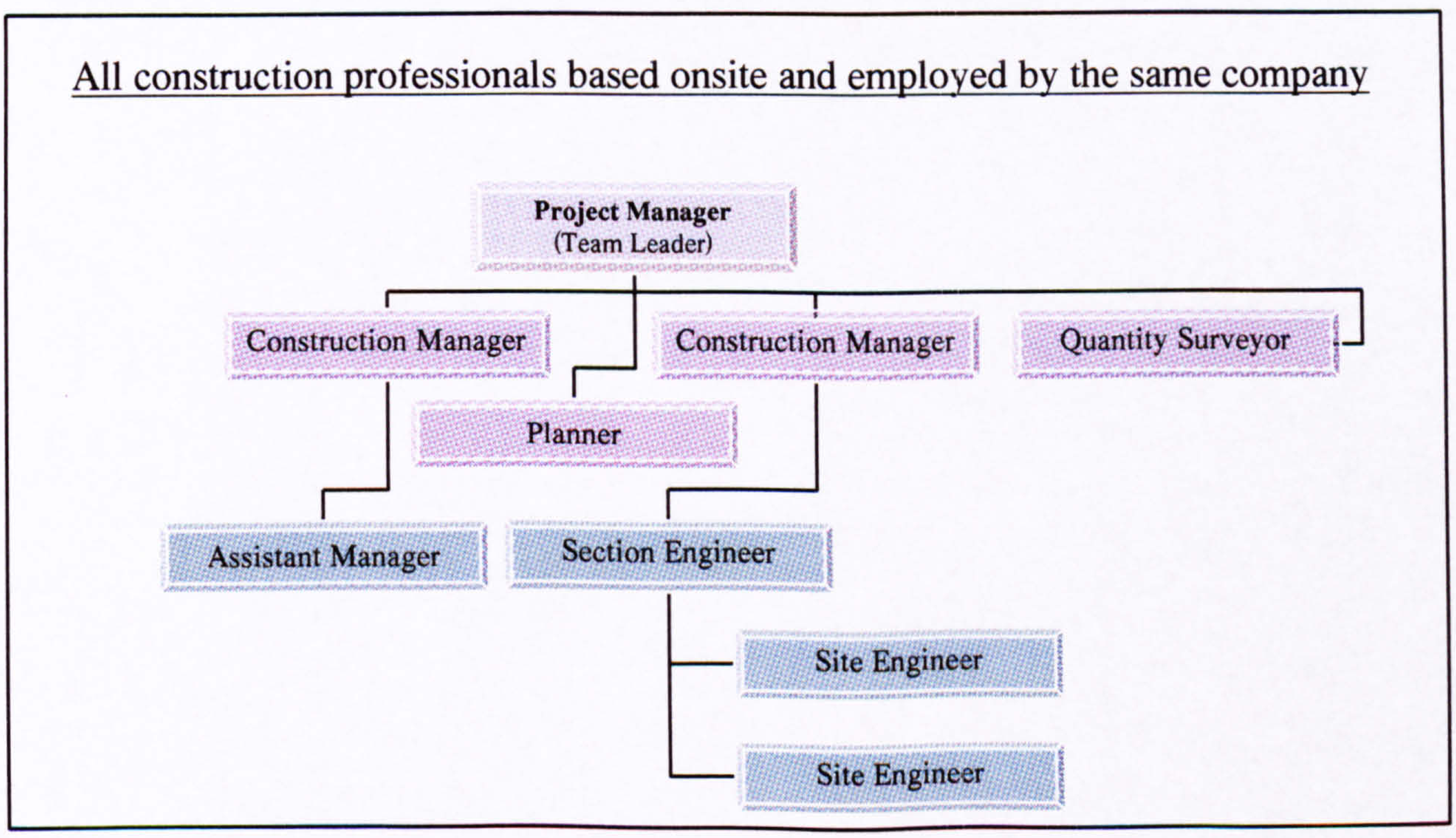


Figure 4.6.1 Site Team Participants

4.6.4 QUESTIONNAIRE VALIDITY

In an attempt to reduce the likelihood of error and evaluate the practicality of this research phase a questionnaire pilot study was undertaken. This would provide confidence that the questionnaire performance measurement mechanisms measured what was intended in a consistent and unambiguous manner.

4.6.5 QUESTIONNAIRE PILOT STUDY

The 'Team Member Questionnaire – Pilot Study' was conducted in an effort to generate feedback from participants and permit an internal research methodology evaluation prior to a full pilot study. For full details of the questionnaire pilot study see Appendix: A, the 'Team Member Questionnaire – Pilot Study' report. The initial design of the 'Team Member Questionnaire' raised a number of production issues. It was necessary to explore a range of options related to questionnaire architecture that would best evaluate the perceived intensity of team working. Most of the discussion centred on the questionnaire composition and layout. In essence the pilot study was undertaken to test the reliability, validity and reproducibility of the team questionnaire format. This would provide an opportunity for participant feedback and an internal evaluation of the proposed methodology. Information obtained at this stage of the questionnaire design would help facilitate the ongoing development of a research template that would be suitable for the collecting, collating, analysing and presentation of data.

As well as layout and clarity of questions there was also debate on the mechanism to be applied to measure team member 'strength of opinion'. Two techniques were tested. The first half of the questionnaire used a rating scale (Likert Scale) with respondents being asked to select only one reply out of a possible five responses. The prescribed options ranged from 'completely true, mostly true, partly true, slightly true and finally, never true'. The second section employed a thermometer arrangement. Respondents were presented with a 100mm straight line, representing a continuum with two possible polar responses, namely true or false located at opposite ends of the line. The participating team member would be asked to place a cross anywhere on the line at a position that best represented their 'strength of opinion' in reply to the questionnaire statement. This would then be translated in to a rating, ranging from somewhere between zero to one hundred. The measurement from zero to the cross could then be expressed as a percentage. An example of the thermometer arrangement is presented in Figure 4.6.2.

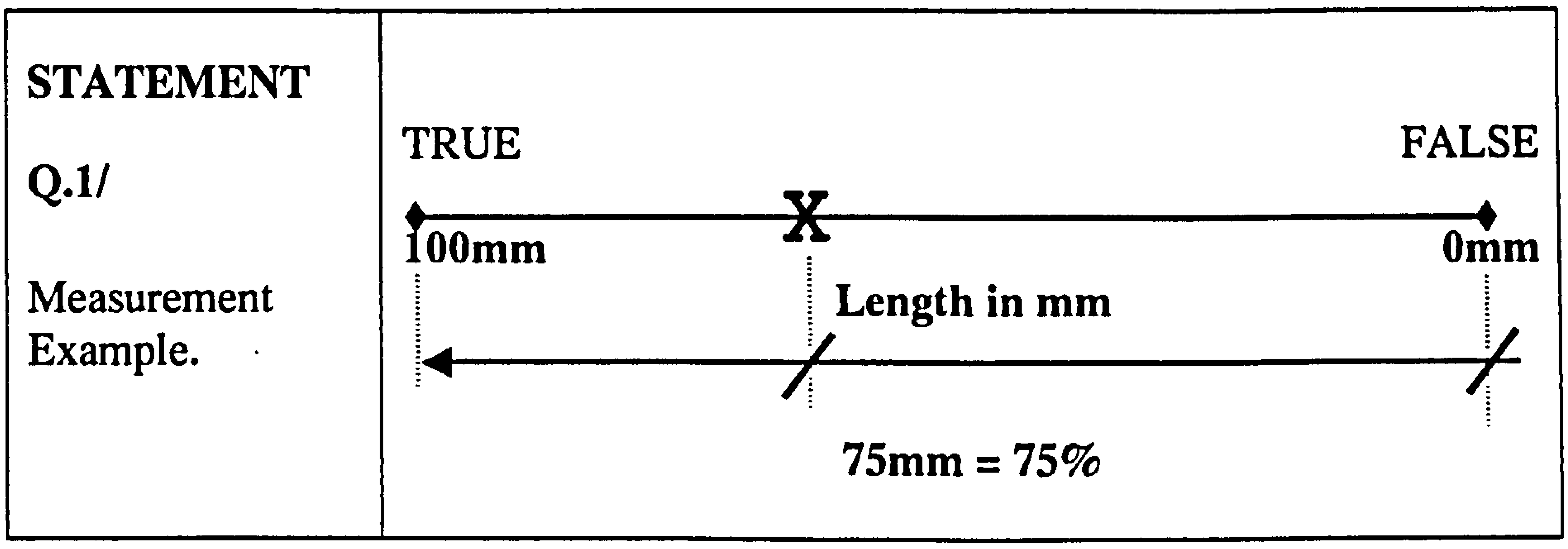


Figure 4.6.2 Thermometer Arrangement

Finally the team members were asked to select the style of response they preferred. Provision was also made available to provide feedback on other aspects of the questionnaire. Allowing participants to make comment on the appropriateness of the completed questionnaire as well as asking for suggestions for future improvements.

4.6.6 STUDY GROUPS

There were two study groups involved in the questionnaire pilot. Individual breakdowns of the pilot questionnaire results have been included in Appendix A: Team Member Questionnaire – Pilot Study.

4.6.7 COMMENTS

A number of comments were recorded and questionnaire adjustments made where appropriate. The respondents also stated that they preferred a questionnaire style that used the 'rating' arrangement as opposed to the 'thermometer' arrangement.

4.6.8 AMENDMENTS

Five statements have been amended as a result of the pilot study feedback.

Section B/1: Question 4 stated, "The team leader is very supportive, facilitating and nurturing in leadership style." The expression 'leadership' was omitted. On reflection the style is relative to the 'team leader', not necessarily a team leadership style.

Section B/1: Question 5 stated, "The success of your role / output is wholly reliant on the performance of others." The term 'output' has been omitted.

Section B/2: Question 1 stated, "Individual team members collectively represent a cross-section of the departments' skill base." The term individual conflicted with the term collectively. The statement was rephrased, "Team members collectively represent a cross-section of the construction professions."

Section B/3: Question 5 stated, "The team leader is more concerned with completing tasks than with managing people." The terms 'tasks' and 'people' have been swapped round. This aligns the scoring with the responses of the other statements, i.e. managing people (5 points, completely true) – to – completing tasks (1 point, never true). The amended statement reads "The team leader is more concerned with managing people than with completing tasks."

Section B/7: Question 4 stated, "Commitment and loyalty to the company from the employees is very high." The statement was amended to "Employee commitment and loyalty to the company is very high."

4.6.9 QUESTIONNAIRE CONCLUSION

The team pilot study proved to be a very useful exercise. In terms of the original remit the questionnaire proved to be well founded and balanced. The preferred style of presentation was resolved, with a 'rating' arrangement proving to be the most popular. Minor amendments were required to be made to various attitude statements. Forethought also needs to be taken at the outset to clearly identify the parameters of the team boundary under deliberation. The inclusion of a 'typical construction site team hierarchy' should help define the team parameters under consideration when completing the team questionnaire. Otherwise, the analyses of two comparable group structures within two very different working environments authenticate the questionnaire objectives. The similar groups' structures scored similar results whereas the environmental variables clearly demonstrated workplace differences that may have been predicted under the circumstances. Therefore the questionnaire format, phraseology and results exemplify a confidence in the validity of the variables being measured, reliability in the measurement criteria, a format that permits reproduction and clarity in the presentation of results.

4.7 THE PROJECT PERFORMANCE KPI's

4.7.1 RATIONALE

The rationale behind the project performance indicators is to evaluate aspects of project attainment in a manner that permits comparison with site related team-based working. Over the past seven years the Department of Trade and Industry (Dti) via the Construction Best Practice Programme (CBPP) have developed a number of Key Performance Indicators for specific application within the construction sector. At present the Construction Industry KPI's are still evolving and are being keenly advocated by the recently amalgamated 'Constructing Excellence in the Built Environment' organisation. Constructing Excellence now oversees and coordinates the previous work of the DTI and Rethinking Construction. "Evidence from nine Best Practice Companies, coupled with the experience Constructing Excellence has gained over several years, shows that the real benefit of performance measurement and benchmarking is in shining a spotlight on company performance and showing where action is needed to improve" (Dti, 2004). Over the past seven years, since their introduction, KPI's have been gaining in significance within the industry and a number of major UK contractors' now present KPI information within their corporate portfolio and financial statements. Using recognised, reputable and standardised data collection procedures, such as industry 'accredited' KPI's and relating the assembled information to project team working and performance gives the research a prevalence that may otherwise be difficult to establish or could be disregarded as inappropriate to industry and company needs.

4.7.2 KPI SELECTION CRITERIA

It is important that project performance measurement is holistic in its methodology. An arbitrary selection of industry KPI's would not necessarily provide a holistic measurement of performance, (Beatham *et al*, 2004). KPI selection requires an overarching Performance Management System (PMS) to shape the alignment criteria with an encapsulating measurement strategy. Two of the most prominent holistic performance management systems are Kaplan and Norton's Balanced Scorecard and the EFQM Excellence Model. The objective of the research performance measurement system is to isolate and evaluate project performance. At the heart of the EFQM business excellence model is the notion of self-assessment using questionnaires, self-audits and benchmarking. The EFQM Excellence Model involves the 'whole' company and would require extensive customisation to accommodate a project performance profile. Application of the model out with the prescribed assessment criteria could undermine the veracity of the performance outcomes. For this reason there would always be a degree of uncertainty and research risk associated with the adoption of the EFQM format. The balanced scorecard in its original format is ideally suited to the measurement of bespoke projects. The model (strategy) could remain intact with suitable KPI's carefully chosen to align with the ideals of a holistic performance management model. The underlying principles of the Balanced Scorecard could then be applied with confidence to the performance measurement of a construction project.

For the purpose of this research Kaplan and Norton's Balanced Scorecard was adopted as the framework for the selection of suitable Key Performance Indicators. Kaplan and Norton's Balanced Scorecard outlines a performance template that is structured around four different business perspectives, namely; financial, external, internal and innovation & learning. The financial perspective is traditionally viewed as a 'lagging' measure. Providing a snapshot of previous performance primarily founded on monetary data. The other three perspectives may be considered as 'leading' measures. The function of 'leading measures' is to provide a potential insight in to performance attributes that may significantly influence future performance. For the purpose of the project performance measurement seven individual Key Performance Indicators, four from the 'Economic - All Construction' KPI's and three from 'Respect for People' KPI's were then selected for inclusion within the balanced scorecard framework. The seven carefully selected KPI's used to measure project performance are as follows:

Category: Economic - All Construction KPI's:

1/ Predictability – Construction Cost

2/ Predictability – Construction Time

3/ Client Satisfaction – Service

4/ Client Satisfaction – Product / Facility

Category: Respect for People KPI's:

5/ Employee Satisfaction

6/ Working Hours (per week)

7/ Training (days per year)

In an effort to incorporate positive features of the EFQM Model, selection appraisal of the KPI's accommodate 'leading' as well as 'lagging' indicators in conjunction with objective and subjective measures of efficiency, see table 4.7.1.

Table 4.7.1 KPI Selection Appraisal

	'Lagging Indicators'	'Leading Indicators'
'Objective Measures'	Predictability: Construction Cost Predictability: Construction Time	Training (Days per year) Hours (worked per day)
'Subjective Measures'	Client Satisfaction: Product	Client Satisfaction: Service Employee Satisfaction

The resultant suite of seven indicators may be collectively referred to as Project Performance KPI's, (see Table 4.7.2). The project performance research selection model assimilates current Key Performance Indicators with Kaplan and Norton's Balanced Scorecard to produce a customised suite of 'Pan-Project' Performance Indicators.

4.7.3 KPI SELECTION MODEL

In an endeavour to map the various performance management concepts and techniques a research model was constructed. The model illustrates the use of existing industry KPI's being selected based upon Kaplan and Norton's Balanced Scorecard. The selections conform to a holistic criterion of business perspective, leading or lagging indicators and objective or subjective measures, see table 4.7.2.

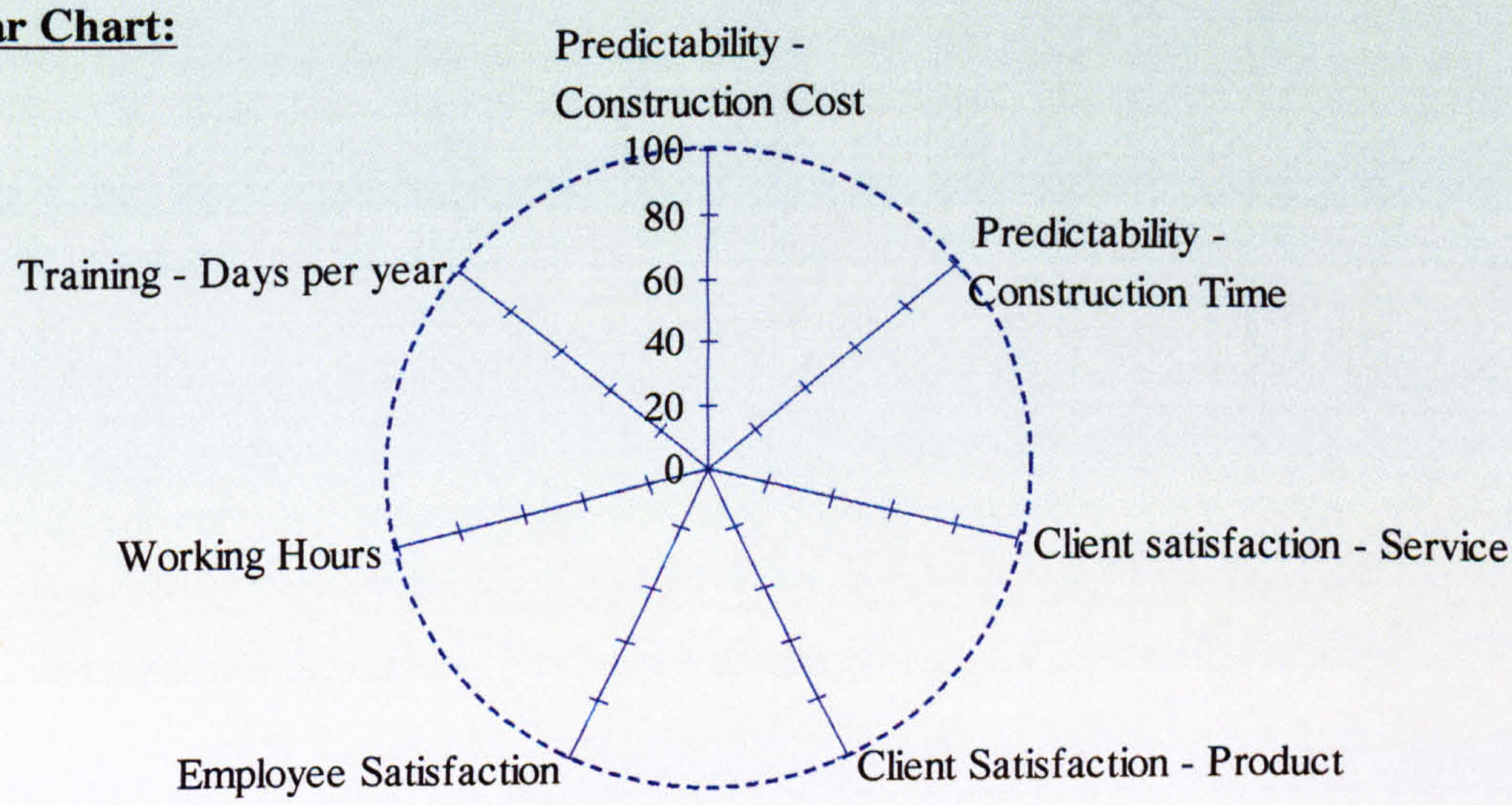
Table 4.7.2 The KPI Selection Model:

Balanced Scorecard Template and Key Project Performance Indicators

KPI's **KEY PERFORMANCE INDICATORS 'ECONOMIC'**	+	**KPI's** **KEY PERFORMANCE INDICATORS 'RESPECT FOR PEOPLE'**
Balanced Scorecard		Balanced Scorecard

Financial Perspective: Predictability: Construction Cost Predictability: Construction Time	**Innovation and Learning Perspective:** Training Days (per year)
Customer Perspective: Client Satisfaction : Service Client Satisfaction : Product / Facility	**Internal Perspective:** Employee Satisfaction Working Hours (per week)

Radar Chart:



A number of considerations were given to the selection of the KPI's to ascertain a 'best-fit' criterion with Kaplan and Norton's balanced scorecard framework.

- ✓ The four perspectives needed to be addressed.
- ✓ The indicators selected required a degree of adaptability to monitor project performance.
- ✓ The required information needed to be current.
- ✓ The information needed to be readily accessible.
- ✓ The selected indicators represent both 'leading' and 'lagging' measures.
- ✓ The selected indicators used both objective and subjective scales of measurement.

It is noteworthy to state that six of the ten 'Economic – All Construction' indicators are best suited to annual and / or end of project analysis and may be thought to have a more meaningful contribution towards a developed programme of continuous business improvement and year-on-year audits. For example, defects deal with the completed facility, profitability is based on annual accountancy figures and construction cost / time measures the year on year change. A safety KPI was an option. Health and safety is a key indicator for project well-being and work-related accident data would be recorded as part of the mandatory requirements under the 'Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR) legislation. After careful consideration the safety KPI was omitted. The decision was based on the possibility that construction companies may have been guarded about making available 'sensitive' information of this nature. As a result construction firms would be hesitant about participating in the research programme.

4.7.4 KPI OVERVIEW

Four KPI's are taken from the 'All Construction' suite of indicators. Predictability of both construction indicators cost and time endeavours to monitors ongoing changes in cost and time as the project progresses. The construction cost and time 'updates' can be interrelated with recent industry benchmarks and expressed as a percentage in terms of industry norms. Client satisfaction with regard to service and product takes into consideration the opinion of the consumer, i.e. external perspective. Often overlooked, the judgment of the client may be seen as crucial if the project is to be considered successful. Two client perceptions are evaluated:

1/ Service – this indicator acknowledges the working relationship between client and contractor as a significant facet in the overall construction process. The method of evaluation quantifies this aspect of client opinion that is qualitative in nature and therefore traditionally awkward to gauge and subsequently often ignored.

2/ Product / facility – addresses the more tangible dimension of construction, this indicator measures current levels of client satisfaction with the projects more physical features.

A further three KPI's are taken from the 'Respect for People' suite of indicators. Employee satisfaction is evaluated via a four statement questionnaire with the score averaged out to portray an indicative value representative of employee satisfaction. Cumulatively the 'score' may provide a crude representation of team employment satisfaction. Working hours provides another insight from the team members' perspective ensuring that overall performance takes in to account the level of effort required to achieve the outcomes. The outcome may be effective but is it efficient? The KPI, Training days best fits the perspective of Innovation and Learning. This indicator addresses a business perspective that examines performance beyond the traditional boundaries and embraces corporate intent with regard to 'position' and 'added value' concepts.

4.7.5 DATA GATHERING

Data collection for the study has three main sources:

1/ The Client

2/ The Team or Project Leader and

3/ The Team Member.

The Client: The client of the project being managed by the site construction team is given a questionnaire that asks 'How satisfied are you with.....a) Service and b) Product / Facility? They are invited to give one response to each question as: Very Satisfied, Satisfied, Neither Satisfied nor Dissatisfied, Dissatisfied or Very Dissatisfied, see Appendix D: Client / Client Representative Questionnaire.

The Team Leader: The team leader is asked two specific project related questions in an attempt to quantify aspects of project predictability, cost and time. They are asked to provide information on construction cost, the cost at commit to construct and the current projected cost of the completed project. They are also asked for information on time, the contract duration at commit to construct and the current projected duration for the completed project, see Appendix C: Team Leader Questionnaire.

The Team Member: All members of the construction site management team, including the team leader, are invited to provide additional information along with the team questionnaire. This includes an employee satisfaction questionnaire that asks 'How satisfied are you with.....a) Influence, b) Pay, c) Achievement and d) Respect? They are asked to give one response to each question, labelled as: Very Satisfied, Satisfied, Neither Satisfied nor Dissatisfied, Dissatisfied or Very Dissatisfied. The team members are also asked to provide information on their total employment hours over the past four weeks and total number of training days over the past year, see Appendix B: Team Member Questionnaire,

4.7.6 DATA PROCESSING

The collating and processing of data is carried out in accordance with the recommendations outlined in the Construction Industry Key Performance Indicators Handbook, (Dti, 2004).

4.7.7 A CHECKLIST FOR PERFORMANCE MEASUREMENT SUITABILITY

Table 4.7.3 Checklist for Performance Measurement Suitability

Holistic Measurement	KPI Adaptability	Data Source & Availability	Validity (see Appendix F: Pilot Study report)	Reproducibility
☑	☑	☑		☑

Working Definitions:

1/ Holistic Measurement - Promoting a contemporary approach to performance management and in particular project measurement taking in to consideration four discrete organisational perspectives.

2/ KPI Adaptability - The use of appropriate 'project' indicators that can be employed using current construction information prior to completion.

3/ Data Source & Availability - The identification and collection of readily available construction project information.

4/ Validity - Provide confidence that the indicators measure what it is suppose to measure. (see Appendix E: Project Performance Toolkit – Worked Example and Appendix F: Pilot Case study Report).

5/ Reproducibility - Scoring style represents the same measurement criteria replicated across numerous projects.

4.7.8 PROJECT PERFORMANCE SUMMARY

The essence of this research project is to determine if varying levels of team based working directly influences project performance. The project has two main variables, 1/ team working and 2/ project performance and therefore data needs to be collected and collated in a manner that facilitates comparison between these two variables. In this research a team questionnaire is to used to establish a measure of construction site management 'teaminess' and is presented as percentages on a seven-axis radar chart, each axis representing a team variable. The project performance data is a mix of tangible and intangible data collection and is also be presented on a seven-axis radar chart with each axis representing a project variable. By deriving a common denominator for information investigation it should be feasible to measure the strength of relationship between the two management themes. The resultant analysis between team working and project performance should provide evidence pertaining to the underlying research hypothesis, 'construction site teams and good project performance are unrelated; you can have one without the other'.

4.8 THE PROJECT PERFORMANCE TOOLKIT

4.8.1 PROJECT PERFORMANCE KPI'S

The measurement of project performance is fundamental to the assessment of team working efficiency and effectiveness. The current Construction Industry Key Performance Indicators advocated by Constructing Excellence in the built environment represent a cross-section of the sector requirements. The diversity of indicator type offers an assortment of performance indicators that may be adopted to match the discrete requirements of a project orientated organisation. In an effort to measure ongoing project performance a bespoke Project Performance Toolkit, containing seven Key Performance Indicators was developed. The unique Project Key Performance toolkit comprises of four KPI's from the All Construction suite of KPI's and three KPI's from the Respect for People suite of KPI's. KPI explanations of the measures adopted are outlined in tabular form, see Table 4.8.1 - Project Performance Toolkit – What it measures.

Table 4.8.1 Project Performance Toolkit - What it measures

PROJECT PERFORMANCE KPI's	WHAT IT MEASURES
1/ Predictability – Construction Cost	Measures current (up to date) construction cost estimates compared with original estimates.
2/ Predictability – Construction Duration	Measures how close the project is running on time compared with original estimates.
3/ Client Satisfaction – Service	Measures how satisfied the client is with the level of service received to date during the project.
4/ Client Satisfaction – Product	Measures how satisfied the client is with the product / facility to date.
5/ Employee Satisfaction	To measure the overall level of work satisfaction among the site management team
6/ Working Hours	To measure the average number of hours worked per site management team member per week.
7/ Training	To measure the level of training provided to all site management team members.

4.9 KEY PEFORMANCE INDICATORS – PROJECT DEFINITIONS

The working definition of the seven identified Key Performance Indicators and method of application suitable for performance measurement of project data are outlined. Description and methods of calculation have been taken from Construction Industry KPI Handbook, 2004 and Respect for People KPI Handbook 2004, both published by Constructing Excellence in the Built Environment. For an example see Appendix E: Project Performance Toolkit – Worked Example.

4.9.1 PREDICTABILITY – CONSTRUCTION COST

Objective – To measure the reliability of cost estimates as the project progresses from concept to completion.

Definition – Current estimated cost less the estimated costs at commit to construct, expressed as a percentage of the estimated costs at commit to construct.

Method: 1/ Identify the estimated cost at commit to construct and the projected actual cost based on current information.

2/ Calculate the percentage change between the later and the earlier cost.

3/ From the Predictability-cost KPI graph, measure the benchmark score.

4/ Transfer the 'snapshot' benchmark on to the Project Performance Radar Chart.

Formula:

Performance (%) predictability cost – construction =

$$\frac{\text{Current estimated construction cost at completion} - \text{Estimated construction cost at tender}}{\text{Estimated construction cost at tender}} \times 100$$

4.9.2 PREDICTABILITY – CONSTRUCTION TIME

Objective – To measure the reliability of construction time estimates.

Definition – Current estimated duration for completion less the estimated duration at Commit to Construct, expressed as a percentage of the estimated duration at Commit to Construct

Method: 1/ Identify the estimated duration at commit to construct and the projected actual duration based on current information.

2/ Calculate the percentage change between the later and the earlier time.

3/ From the Predictability-time KPI graph, measure the benchmark score.

4/ Transfer the 'snapshot' benchmark on to the Project performance Radar Chart.

Formula:

$$\frac{\text{Current estimated construction duration at completion} - \text{Estimated construction duration at tender}}{\text{Estimated construction duration at tender}} \times 100$$

4.9.3 CLIENT SATISFACTION - SERVICE

Objective – To determine the overall level of client satisfaction, to date, with the main contractor's site project team.

Definition – How satisfied the client is with the service of the main contractor, using a 1 to 10 scale, where:

10	=	Totally satisfied
5 / 6	=	Neither satisfied nor dissatisfied
1	=	Totally dissatisfied

Method: 1/ Carry out a survey with the client to determine how satisfied the client is with the current level of service from the main contractor using the 1 –10 rating scale.
2/ From the Client satisfaction - service KPI graph, measure the benchmark score.
3/ Transfer the 'snapshot' benchmark on to the Project Performance Radar Chart.

Formula: 1/ The performance score for Client satisfaction – service is the rating from the client's survey.

4.9.4 CLIENT SATISFACTION - PRODUCT

Objective – To determine the overall level of client satisfaction, to date, with the product / facility.

Definition – How satisfied the client is with the product / facility, using a 1 to 10 scale, where:

10	=	Totally satisfied

5 / 6	=	Neither satisfied nor dissatisfied
1	=	Totally dissatisfied

Method: 1/ Carry out a survey with the client to determine how satisfied the client is with the current quality of product / facility using the 1 – 10 rating scale.
2/ From the Client satisfaction – product KPI graph, measure the benchmark score.
3/ Transfer the 'snapshot' benchmark on to the Project Performance Radar Chart.

Formula: 1/ The performance score for Client satisfaction – product is the rating from the client's survey.

4.9.5 EMPLOYEE SATISFACTION

Objective – To measure site management teamwork satisfaction.

Definition – How satisfied site management team members are with:
the amount of influence they have over their jobs;
the amount of pay they receive;
the sense of achievement they get from their work;
the respect they get from line managers;
using the 1 to 10 scale where:

10	= very satisfied
8	= satisfied
5 / 6	= neither satisfied nor dissatisfied
3	= dissatisfied
1	= very dissatisfied

The performance rating is the average of the individual ratings for the four responses.

Method: 1/ Conduct a survey, in which all the site project team members answer the following questions relating to employee satisfaction using the 1 –10 scale.

a) How satisfied are you with the amount of influence you have over your job?

b) How satisfied are you with the amount of pay you receive?

c) How satisfied are you with the sense of achievement you get from your work?

d) How satisfied are you with the respect you get from your line manager?

2/ From the Employee satisfaction KPI graph, measure the benchmark score.

3/ Transfer the 'snapshot' benchmark on to the Project Performance Radar Chart.

Formula: Performance score (rating) = The average of the overall ratings for all site team members.

4.9.6 WORKING HOURS

Objective – To determine the average number of hours worked per week.

Definition – The number of usual hours worked per week per site management team member in their main job, (The total number of hours should include all overtime paid and unpaid).

Method: 1/ Conduct a survey in which all the project site management team members answer a question relating to the number of usual working hours each week over a period of at least four weeks.

2/ From the survey determine the total number of usual hours worked each week by all site management team members and the number of team members.

3/ Transfer the Benchmark score on to the Project Performance Radar Chart.

Formula:

$$\frac{\text{Total number of usual hours worked each week by all site management team members}}{\text{Total number of site management team members}}$$

4.9.7 TRAINING

Objective – To determine the level of training provided for the site project team members.

Definition – The number of training days (on and off the job) provided per site team member per year.

Method: 1/ Conduct a survey with all site project team members to determine the total number of company training days provided over the past twelve months.

2/ From the survey determine the performance score (days) and establish the KPI score.

3/ Transfer the benchmark score on to the Project Performance Radar Chart.

Formula:

$$\frac{\text{Total number of training days provided in the last year for site project team members}}{\text{Total number of site project team members}}$$

Note: See Appendix E: Project Performance Toolkit – Worked Example, for further explanation and an exemplar of the project performance data calculations.

4.10 PLOTTING & INTERPRETATION OF RESULTS

In order to visualise the results of the Project Key Performance Indicators, the percentage score is taken from the benchmark analysis sheet (research used 2004 benchmarking data) and transferred on to a radar chart along the appropriate axis. The radar chart has seven axes, each representing a project performance variable and is marked off in increments of twenty percent starting from zero, (the centre point) to one hundred, (the circumference point of the radar chart) see figure 4.10.1. Each variable result is plotted on the appropriate axis of the radar chart and a straight line is drawn between the identified points, creating a seven-sided shape. In general terms the radar chart paints a broad picture of project strengths and weaknesses. Points closest to the circumference indicate a strong affiliation with the designated variable; whereas points located nearer the centre point of the diagram suggests a project weakness with that particular variable.

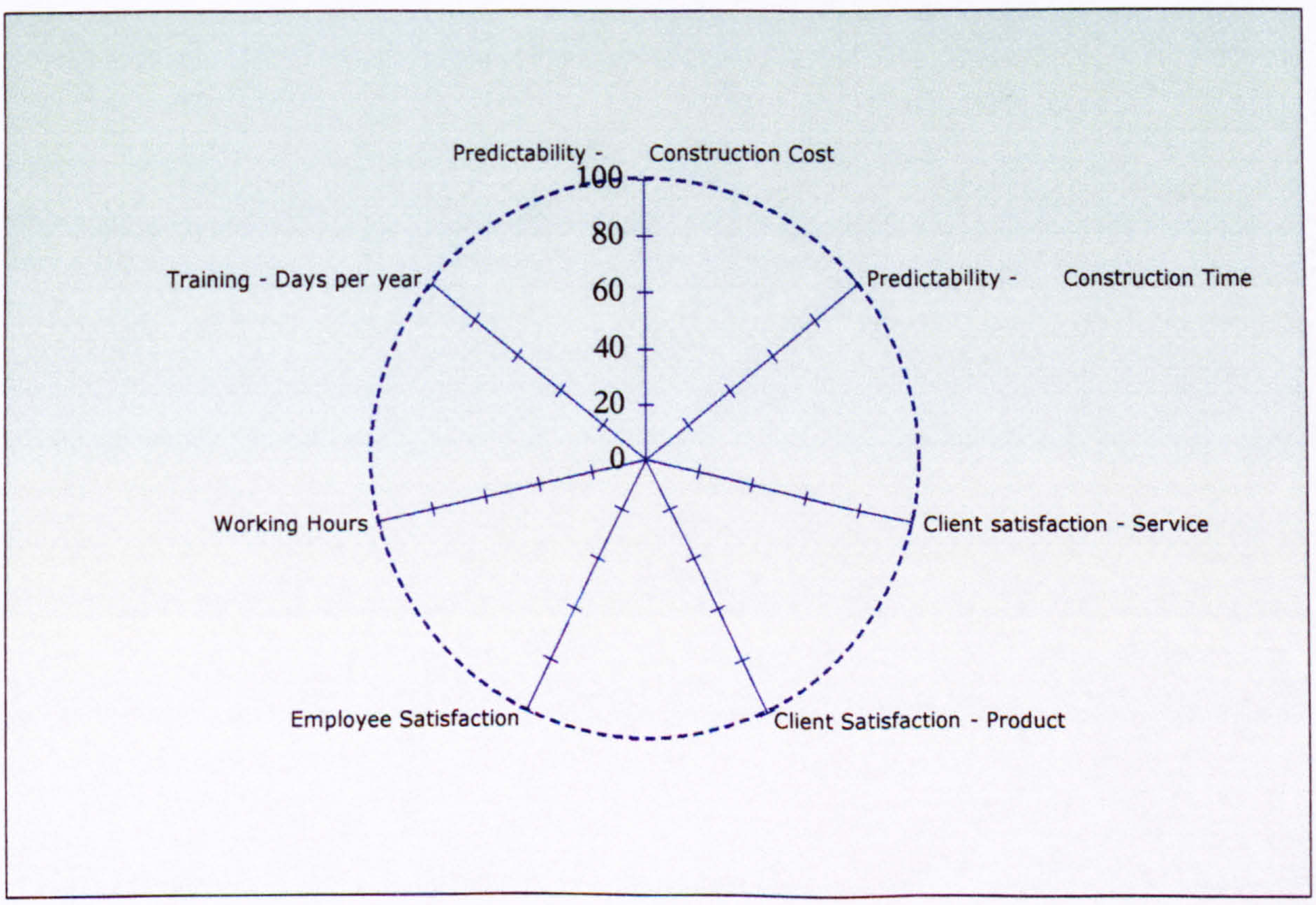


Figure 4.10.1 Typical Project Performance Radar Chart

4.10.1 PROJECT PERFORMANCE CALCULATION

An overall project performance can be calculated by averaging all seven KPI scores. This would provide a mean project 'benchmarked' score representing an overall project performance evaluation taking in to consideration both strengths and weaknesses associated with the project profile.

4.11 THE PILOT STUDY

To fully test the methodology in terms of feasibility, practicability, structure and report writing a pilot study carried out in June 2004, see Appendix F: Pilot Case Study Report. The study is part of a wider research programme investigating the relationship between the level of site team 'dynamics' and project performance. The research programme has two major components, 1/ the measurement of team efficiency and 2/ the measurement of project performance. The evaluation of 'teaminess' characteristics are determined by completing a team member attitude questionnaire. Project performance information is pooled from a number of different sources, including client information (Client), project information (Team Leader) as well as the team questionnaire (Team Member). Team qualities correspond to seven distinct variables with each variable identified as a key success factor for effective team working. Project performance is also illustrated using seven distinct variables and is based on the recognised industry standards used for expressing Key Performance Indicators (KPI's). It is important to note that 'overall' performance incorporates various dimensions of performance relating to financial, client (external), employee (internal) and innovation & training perspectives. Each of the variables is given an equal weighting. It is therefore more balanced in its performance appraisal. This contradicts the traditional performance indicators where financial measures were regarded to be more significant.

4.12 CONCLUSION

The pilot study was a success. The team member questionnaire fulfilled the precondition criteria of homogeneity, linearity, reliability, reproducibility and the case study experience satisfied the question of validity. The project measurement also fulfilled the prerequisite criteria. Project measurement proved to be satisfactory with regard to holistic measurement, KPI adaptability, data and source availability, reproducibility and finally validity. The mechanics of analysis and presentation of data conformed to the original aspirations of the prototype model. Overall the pilot study provided confidence that the proposed research methodology was both appropriate and robust.

CHAPTER 5: CASE STUDY & RESULTS SUMMARY

5.1 INTRODUCTION

A major contributing factor to the success of the research programme was the selection and subsequent management of the case study research methodology. Within the 'Human Relations' school of thought "case study research continues to be an essential form of social science inquiry" (Yin, 2003). A case study protocol was used to design, collect, collate and process team and performance data from thirteen unique construction sites. Case study as a research methodology presents the opportunity to carry out structured field study that depicts in-situation experience symbolic of the natural environment. A case study may be defined as "a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence" (Robson, 2000). Robert Yin, a researcher who has written many articles and promoted the case study as a legitimate, academically robust research methodology defined the case study "as an empirical inquiry that investigates a contemporary phenomenon within its real-life context especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2001). It is a fundamental concept that the selection and subsequent investigation of a case study is not founded upon a typical 'case' in point it "is not concerned with statistical generalisation but with analytic generalisation" (Robson, 2000). Put another way, "case studies produce findings generalisable to theoretical propositions" (Raiden *et al*, 2006). The "case study research is not sampling research; that is a fact asserted by all the major researchers in the field, including Yin, Stake, Feagin and others" (Tellis, 1997a). "At the heart of it is the idea that the case is studied in its own right, not as a sample from a population" (Robson, 2000). The case study approach is acknowledged as "a valuable method of research, with distinctive characteristics that make it ideal for many types of investigations" (Tellis, 1997a). The essence of a case study is to "emphasise detailed contextual analysis of a limited number of events or conditions and their relationships" (Soy, 1997).

5.1.1 THE MERITS OF A CASE STUDY

As with most research methodologies the case study has disadvantages as well as advantages. Critics of the case study as a research method tend to focus on conceptual reasoning such as representation, reliability and validity stating that "its dependence on a single case renders it incapable of providing a generalising conclusion" (Tellis,1997a). Case study critics also cite the role of the researcher and their interaction with the 'case-actors' as a source of research subjectivity and potential prejudice commenting that "intense exposure to study of the case biases the findings. Some dismiss case study research as useful only as an exploratory tool." (Soy, 1997). Robson (2000) states that case study may be perceived as a "kind of 'soft option', possibly admissible as a precursor to some hard-nosed experiment or survey." That said the popularity of the case study has increased in recent times. The acceptance of qualitative research techniques coupled with a growing maturity of the social sciences has to some extent strengthened the justification for employing case study methodology as a recognised and academically sound epistemology. By means of an improved understanding and better developed protocol the merits of case study have been acknowledged. "The advantages of the case study method are its applicability to real-life, contemporary, human situations and its public accessibility through written reports. Case study results relate directly to the common reader's everyday experience and facilitate an understanding of complex real-life situations." (Soy, 1997). A key feature of a successful case study is confidence in the framework, the design, the procedure and the processes used to encapsulate the 'case'. To achieve research assurance with regard to reliability and for this particular research programme replication, case study protocols need to be formulised and rigorously observed. "A case study protocol contains more than the survey instrument, it should also contain procedures and general rules that should be followed in using the instrument. It is to be created prior to the data collection phase. It is essential in a multiple-case study, and desirable in a single-case study" (Tellis, 1997a).

5.1.2 SELECTING A CASE STUDY RESEARCH STRATEGY

The selection of a case study methodology was obvious. "Case studies encourage in-depth investigation...(and) may be selected on the basis of their being representative with similar conditions to those used in statistical sampling to achieve a representative sample, to demonstrate particular facets of the topic" (Fellows and Lui, 2003). The use of case study provides a pragmatic approach to testing the assertion that varying levels of team work directly influence project performance. The contextual relevance of the research strategy combined with a lateral and hierarchical investigative viewpoint will shift the emphasis of inquiry from particularisation to generalisation. Capturing data in this manner from a cross-section of construction site management teams across different UK construction companies may facilitate an analysis of project, corporate and industry trends. To support the validity and reliability of the case study results and in an effort to minimise sources of error or 'contamination' the focus of assessment would be explicit, namely team working and project performance. Other variables are invariably present but for the purpose of the research and to promote the notion of systematic replication and empirical consistency the case study variables out with the defined research remit would be read as constant.

5.1.3 CASE STUDY TYPE

There are numerous classifications of case study; three of the most common types as identified by Yin (2003) are as follows:

i/ Descriptive case study where the objective is to record a observable fact.

ii/ Exploratory case study are theory led, where the objective is to focus the observations on processes or interactions identified in the initial research premise.

iii/ Explanatory case study suitable for casual investigations. "Explanatory research aims at hypothesis testing which usually has a casual explanatory character (based on probabilistic relation) allowing a conclusion to be logically inferred" (Fellows and Liu, 2003).

Based on the descriptions elicited the case study classification best suited for this particular research programme is the explanatory case study. For example testing the research null hypothesis that high levels of team working act independently from enhanced levels of project performance conforms to an explanatory case study classification.

5.1.4 THE CASE STUDY 'UNIT OF ANALYSIS'

It is important to define the research hierarchy and identify the specific 'unit of analysis'. "The unit of analysis is a critical factor in the case study. It is typically a system of action rather than an individual or group of individuals. Case studies tend to be selective, focusing on one or two issues that are fundamental to understanding the system being examined" (Tellis, 1997a). This viewpoint is endorsed by Westgren and Zering (1998) stating that "choosing the proper unit of analysis to study a single phenomenon or a set of phenomena is critical to explanatory power of the case research." Whilst the research parameters are authenticated by the scope of the research umbrella related to the case study, the selection and application of specific research 'tactics' provide appropriate research methodologies capable of generating suitable data sources. The case study refers to the contextual framework within which the data collection techniques are employed. "The unit of analysis defines what the case is. This could be groups, organisations or countries, but it is the primary unit of analysis" (Tellis, 1997a). "Case studies tend to be selective, focusing on one or two issues that are fundamental to understanding the system being examined" (Tellis, 1997b). For the 'team – performance' research programme the 'case' inferred to in the term 'case study' relates specifically to the construction site management team and associated project parameters. It is important not be confuse 'unit of analysis' with the 'unit of data collection'. Unit of data collection refers to the individual participants. The primary 'unit of analysis' relates to the individual site management team and their corresponding project performance. The use of several site management teams from different company backgrounds provides an additional opportunity for lateral and hierarchical inquiry. In relation to this particular research programme this may be referred to as the 'secondary' unit of analysis. In secondary units of analysis the case study is bounded by corporate affiliations such as Company B, Company C and Company D. This is in contrast to the primary unit of analysis which would identify projects as Company B, Project 1 (B/1), Company B, Project 2 (B/2), Company B, Project 3 (B/3) and so on.

5.1.5 THE CASE STUDY DESIGN

For this particular research programme the use of 'explanatory' case study would be best suited to a multiple 'case' design where the focal point of the investigation, i.e. teams and performance, is replicated across a number of cases (projects), i.e. the primary unit of analysis. Replication of the 'case' may equate to academic robustness when presenting the findings. "The richness of the interactions between the focal unit of analysis and other adjacent (lateral or hierarchical) units may be necessary to do a complete job of relating the phenomenon to the complex context in which it is observed." (Westgren and Zering, 1998). As always "the researcher strives to establish a chain of evidence forward and backward. External validity reflects whether or not findings are generalisable beyond the immediate case or cases; the more variations in places, people, and procedures a case study can withstand and still yield the same findings, the more external validity. Techniques such as cross-case examination and within-case examination along with literature review help ensure external validity. Reliability refers to the stability, accuracy, and precision of measurement." (Soy, 1997). The case study protocol will relate to the primary unit of analysis, this will support informational needs for both 'team' and 'company' investigation. The 'unit of analysis' is examined only once producing a snapshot of performance related data, facilitating a methodology of a lateral study as opposed to a longitudinal study. A longitudinal study would involve a prerequisite number of case visits at predetermined phases within the overall timescale of the project. The following figure 5.1.1 is a graphical representation of the adopted research case study design taking in to account the proposal for lateral (time dimension) as well as hierarchical points of investigative referencing.

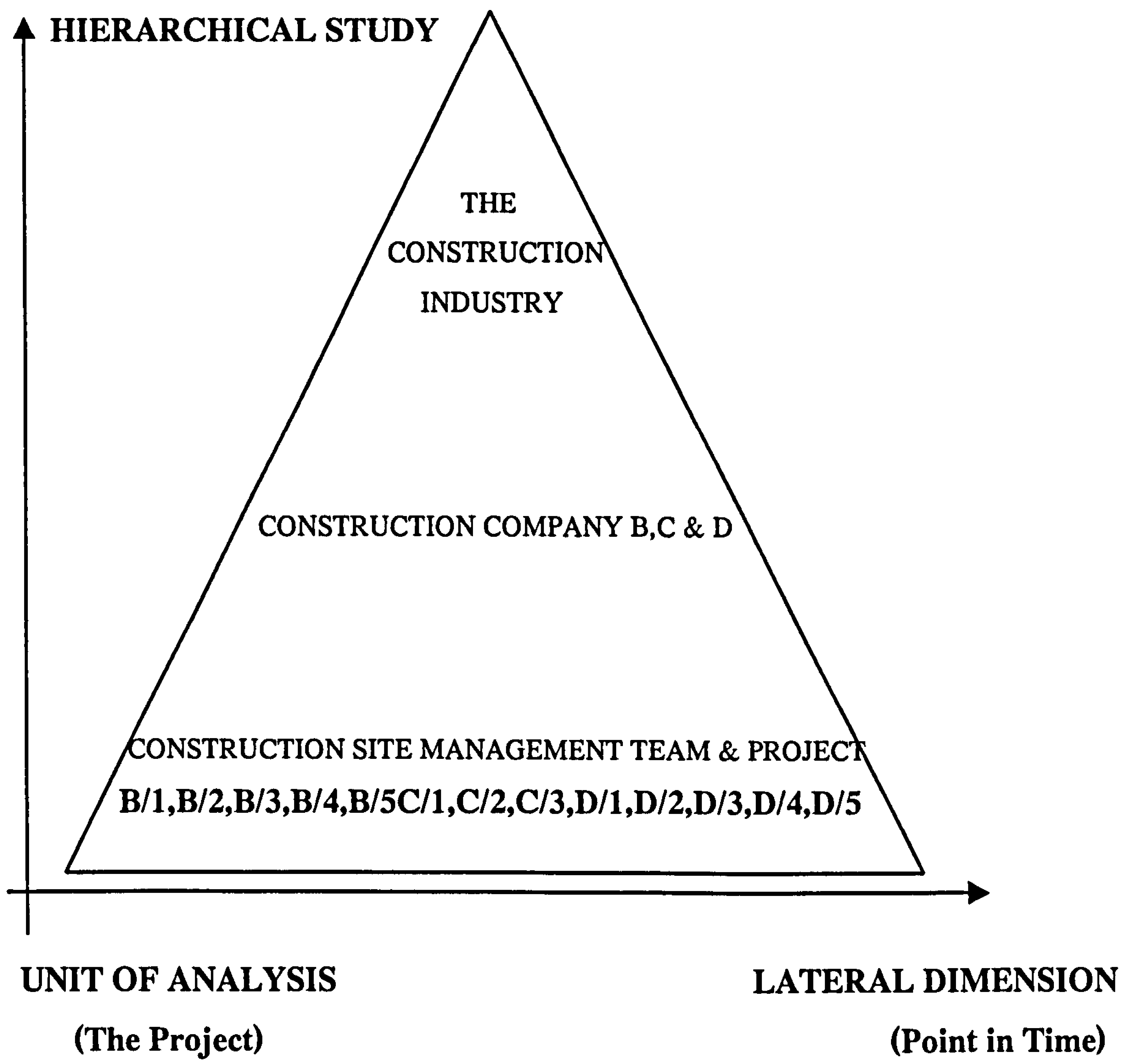


Figure 5.1.1 Case Study Design

5.1.6 CASE STUDY PROTOCOL

Case study protocol refers to the 'general rules' and 'procedures' to be followed. A number of research parameters and data collection instruments must be established prior to the data collection. The research parameters primarily relate to the type of 'case' to be studied and who qualifies to participate. The main criteria for project selection focused on two easily identifiable construction industry classifications. The first classification 'new build' or 'refurbishment' is a common expression. Nearly fifty percent of all construction work is classified as refurbishment therefore to select only one type or the other may unnecessarily prejudice participation levels. Many projects involve elements of both, refurbishment of existing buildings while building new extensions. Scenarios of this nature would compound the problem of selection criteria. Therefore selected case studies could be new build, refurbishment or a hybrid of both. The other everyday construction classification is contracting or house-building. There are significant differences in both construction management and construction technology. A point acknowledged by 'Constructing Excellence'. In recognition of domestic and non-domestic construction markets they produce different key performance indicator benchmarks specifically for contracting and house-building. Project performance data was central to the study. To ensure consistency of application and permit investigation across 'multi-case' case studies, research participation was restricted to contracting organisations. Another potential variable was the method of procurement and type of contractual agreement employed. Although recognised it was sidelined in favour of a clear focus on the construction site management team and the project performance.

Participation was another key issue. The construction industry relies heavily on sub-contractors and agency labour to meet business needs. To this end the team 'dimension' needed to be explicitly identifiable in terms of both team boundary and participants. The construction site management team was distinguished from other construction teams by identifying the project leader, company employment and managerial / supervisory responsibility as a prerequisite for membership. This team classification would exclude trade operatives. For example a site based project leader / manager for the main contractor and those working for the principal contractor and reporting directly to the project leader with managerial status would describe the construction site management team. Those working in the team reporting to the team leader but not directly employed by the same organisation would be excluded from participating. All participating companies were private UK contractors with a national portfolio of construction activity.

5.2 CASE STUDY DATA COLLECTION

Data generation is captured via team member questionnaires and project information questionnaires, (see Appendix B, Appendix C and Appendix D).

5.2.1 TEAM DATA COLLECTION

The replies from the 'Team Member Questionnaire' (Appendix B) are collated using standardised data collection sheets. This will organise questionnaire responses in to tabular framework ready to be scored and processed. This is undertaken initially from an individual stance (see table 5.2.1) and progresses towards a site management team (project team) representation (see table 5.2.2).

Table 5.2.1 Team Member 'Individual' Questionnaire Data Sheet

Company: A								
Project: 1		(Id)	(MD)	(TD)	(Tr)	(CI)	(SP&C)	(Cl)
Team Member 1 (TM/1)		Section B1	Section B2	Section B3	Section B4	Section B5	Section B6	Section B7
Question 1		'rating'						
Question 2		'rating'						
Question 3		'rating'						
Question 4		'rating'						
Question 5		'rating'						
Actual		'total'						
Possible		25	25	25	25	25	25	25
PERCENTAGE		TM%	TM%	TM%	TM%	TM%	TM%	TM%

Table 5.2.2 Team Member 'Project' Questionnaire Data Sheet

Company: A								
Project: 1 (A/1)		(Id)	(MD)	(TD)	(Tr)	(CI)	(SP&C)	(Cl)
Team Participants		Section B1	Section B2	Section B3	Section B4	Section B5	Section B6	Section B7
Member 1		TM %	TM %	TM %	TM %	TM %	TM %	TM %
Member 2								
Member 3								
Member 4								
Actual								
Possible(100xNo.)								
PERCENTAGE		%	%	%	%	%	%	%

5.2.2 PROJECT PERFORMANCE DATA COLLECTION

Project performance levels are recorded using a cross-section of data sources. Data for Construction Predictability – Cost and Time was received from the Project Leader, see 'Team Leader Questionnaire', (see Appendix C). Client Satisfaction – Service and Product was provided by the client via the 'Client / Client Representative Questionnaire', (see Appendix D). Data related to Employee Satisfaction, Hours Worked (per week) and Training Days (per year) was incorporated into the 'Team Member Questionnaire – Section B/8', (see Appendix B). The results were transferred in to industry benchmark scores using the appropriate 2004 KPI Wall charts published by Constructing Excellence in the Built Environment, (see Appendix E, Project Performance Toolkit - Worked Example).

5.2.3 TEAM AND PROJECT PERFORMANCE PRESENTATION

The ratings for the seven team variables and the benchmark scores for the seven project performance indicators are illustrated in a standardised format. Each axis of the radar chart is used to graphically represent a key characteristic of performance, see Figure 5.2.1 (Team Radar Chart) and Figure 5.2.2 (Project Radar Chart).

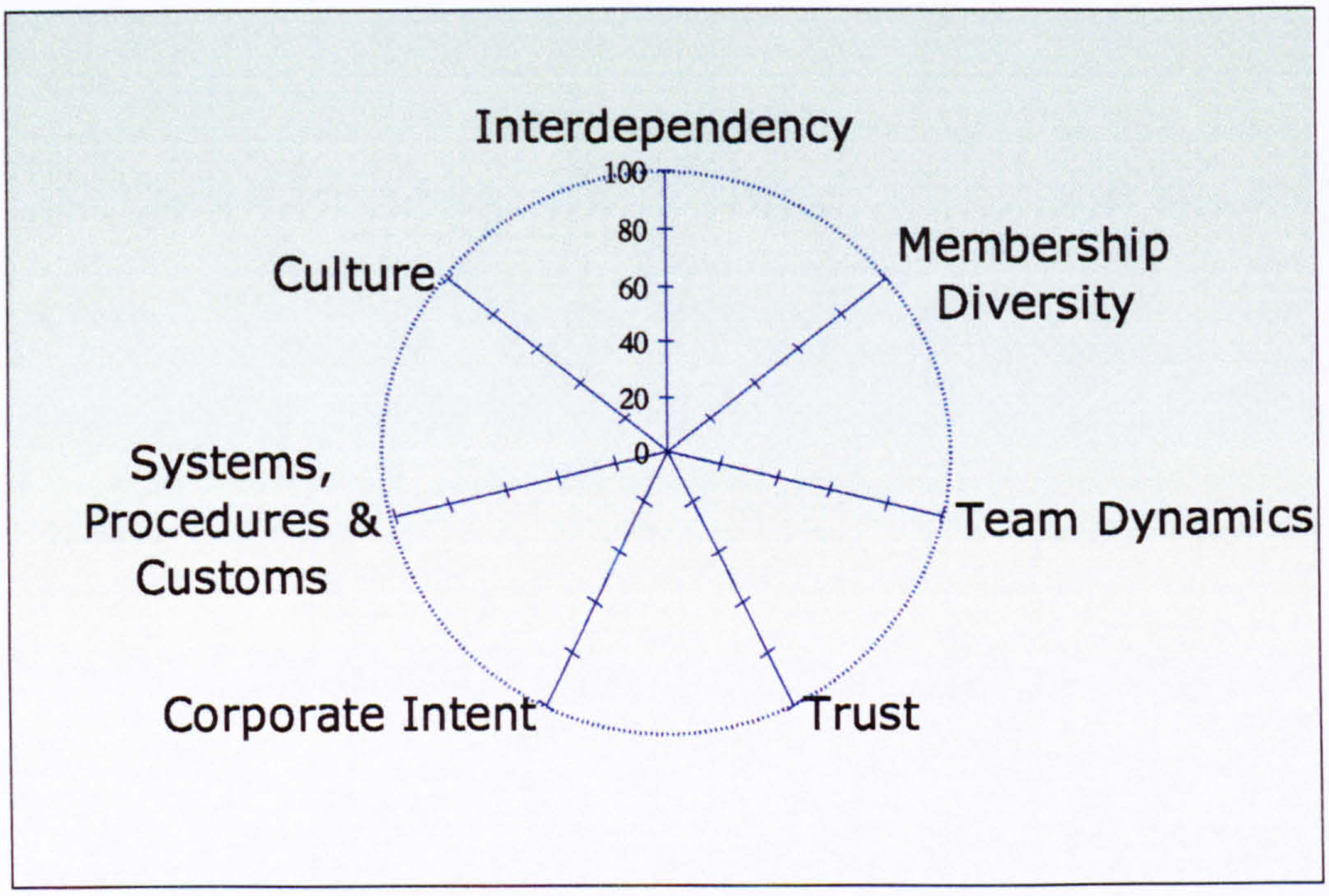


Figure 5.2.1 Team Radar Chart

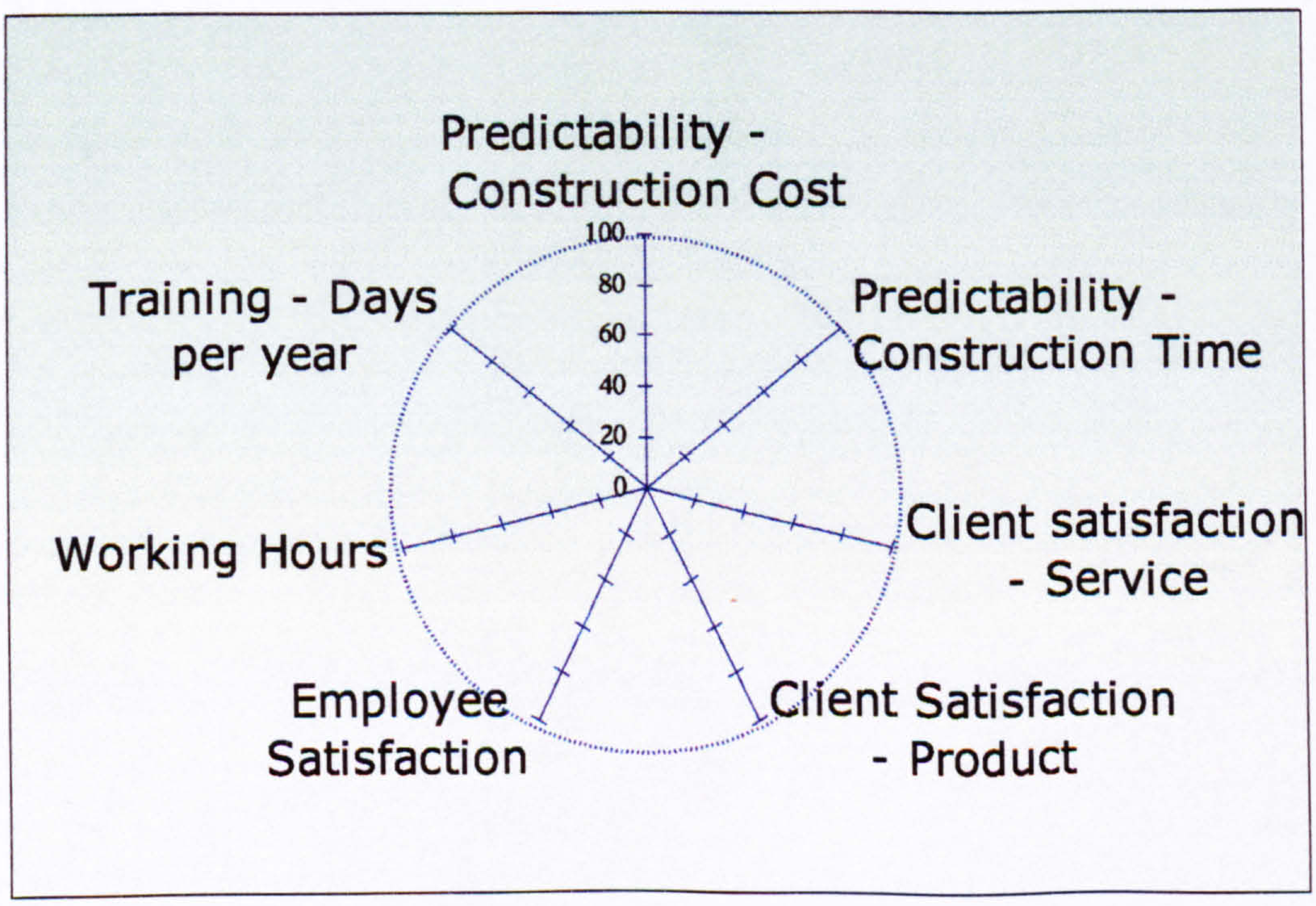


Figure 5.2.2 Project Radar Chart

5.3 RESEARCH CRITERIA

The UK Construction industry is one of the most influential business sectors within the national economy. In 2004, the fiscal period of the study, it was forecast that the UK construction turnover is likely to exceed the £100 million barrier for the first time. The industry contribution to the UK GDP is estimated to be approximately 10% and provides employment for over 2.2 million people across the UK. The industry supports a wide array of construction companies ranging from small and medium enterprises to large multi-national construction organisations. A highly competitive sector the UK construction industry is capable of building the most complex, state-of-the-art, iconic buildings to a world class standard, (Egan, 1998).

The overwhelming number of construction companies in the UK can be classified as small or medium enterprises (SME's). For the purpose of this research project it was decided that only companies classified as 'large construction organisations' would be invited to participate in the case study. This was mainly due to the fact that in all likelihood large companies would have the resources and manpower to facilitate a range of concurrent construction projects. This would enable a number of construction projects to be studied under the direction and management of one organisation. It was also decided to exclude specific industry sectors from the research, namely the domestic sector and in particular traditional house building organisations and their projects. The over-riding reason for excluding the domestic sector was its distinct character with regard to procurement, repetitive build technology and unique interface with multiple clients, for example the prospective buyers / homeowners. The Government sponsored body - Constructing Excellence also recognise industry anomalies associated with housing building projects and accommodate this by publishing Key Performance Indicators unique to the house building market. Constructing Excellence promotes and publishes benchmarking criteria and construction standards that are particular to house building companies. Careful consideration was given to the selection of both company and project case study. The final selection criteria for research participants was large national contractors undertaking new build and/or refurbishment work in connection with industrial, commercial or leisure construction projects. It should be noted that two projects, project A/1 (pilot study) and project B/1 (Company B, case study 1) involved major refurbishment work to existing non-domestic properties in preparation for conversion to housing stock (flats). Both projects have been included in the research. A judgement was made in relation to the company business portfolio, level of site organisation involved, the scale of the project as well as the nature of work being undertaken at the time of the study may be regarded as non-domestic construction activity.

5.3.1 CASE STUDY STATISTICS

The case study and data collection phase of the research project was carried out between June 2004 and April 2005. The research data compilation involved the cooperation of three major UK construction contractors and comprised of thirteen individual construction project case studies, excluding the pilot study company A, project 1(A/1). In total eighty two research questionnaires were completed and returned. This included fifty six 'Team Member' questionnaires', thirteen 'Team Member / Team Leader' questionnaires and thirteen 'Client / Client Representative' questionnaires. The response rate for 'Team member' questionnaires was 96%. Two team member questionnaires were returned uncompleted and one team member questionnaire had been partially completed by a recently employed site member. The site member in question was unable to provide a complete response to all the questionnaire statements due to their very recent involvement within the site management team setting. The response rate for both 'Team Leader' questionnaires and 'Client / Client Representative' questionnaire was 100%. Three 'Client / Client Representative' questionnaires were conducted via the telephone; the other eleven clients or clients' representative posted their responses.

5.3.2 DEMOGRAPHIC COMPOSITION OF RESEARCH PARTICIPANTS

A number of background questions were asked to help determine a demographic profile of a typical research participant. The first table 5.3.1 presents an employment profile, representing job titles of all participating team members' within the construction site management team composition.

Table 5.3.1 Team Members' Employment Status within their site team

Position in Team	Frequency	Percentage
Project Leader	13	19%
Site Manager	23	33%
Site Engineer	7	10%
Quantity Surveyor	11	16%
Works Manager	4	6%
Design Coordinator	2	3%
Project Coordinator	1	1%
Project Surveyor	5	7%
Building Services	3	5%
Total	69	100%

Table 5.3.2 presents a 'length of service' grouping, representing all the participating team members' within the construction site management team composition.

Table 5.3.2 Team Member 'Length of Service with the Company'

Work experience in the firm	Frequency	Percentage
< 1 year	23	33%
1 – 2 years	8	12%
3 – 5 years	10	14%
6 – 10 years	11	16%
>10 years	17	25%
Total	69	100%

Table 5.3.3 presents an age grouping, representing all the participating team members' within the construction site management team composition.

Table 5.3.3 Team Member Age Grouping

Age Profile	Frequency	Percentage
16 - 25	11	16%
26 - 35	16	23%
36 – 45	22	32%
46 – 55	15	22%
56 – 65	5	7%
Total	69	100%

Table 5.3.4 presents a gender profile reflecting the composition of male / female participating team members' within the construction site management team composition and their employers.

Table 5.3.4 Team Member Gender Profile

Company	Male (%)	Female (%)	Total No.
Company B	19 (90%)	2 (10%)	21
Company C	16 (94%)	1 (6%)	17
Company D	31 (100%)	0 (0%)	31
Total	66 (96%)	3 (4%)	69

From the gathered data it is possible to highlight a number of trends. The most obvious and probably unsurprising is the overwhelming majority of male participants. There are no female project leaders. This may be regarded as typical of the construction site environment. Over 50% of respondents may be classified as having a construction management background (Project Leader and Construction Manager). The age profile has the basic characteristics of a nominal curve, with the majority (32%) of respondents aged between 36 – 45 years old. The average length of service with the various construction companies highlighted two extremes. A large percentage of participants had either been with their company for less than a year

(33%) or had worked with the organisation for over five years (41%). On the issue of 'length of service' it is worth noting that employees working for different companies displayed quite different employment characteristics. From the series of background answers received the typical construction site team member will in all probability be male, aged between 36 – 45 years old, have a construction management background and will either only recently have joined the company or on the contrary will have worked with the company for an extended period.

5.4 COMPANY B

Company B is a leading UK building and civil engineering contractor also specialising in private house building, facilities management, property development and PFI / PPP contracts. Company B has a combined corporate turnover in excess of £1.47 billion, employs 7500 people worldwide and rank as one of the UK's top contractors. The construction division is the largest business sector within the group providing nationwide project expertise, along with wide-ranging general building services through locally managed and resourced business units, contributing to an annual sector turnover of approximately £890 million. The Scottish regional office is one of thirty two locally managed business units and provides construction services across the country with particular economic emphasis on the Scottish central belt.

5.4.1 COMPANY B: CASE STUDY PARTICIPANTS

Company B had five construction site case study contributors, see Table 5.4.1.

Table 5.4.1 Company 'B' Project Details

Project	Type of Work	Team No.	Value (£)	Time (Weeks)
Project B/1	Refurbishment	5	9.2 million	43 weeks
Project B/2	New Build	3	6.0 million	44 weeks
Project B/3	Refurbishment	5	8.5 million	64 weeks
Project B/4	New Build	5	3.0 million	52 weeks
Project B/5	New Build	3	3.0 million	52 weeks

5.4.2 COMPANY B: CASE STUDY RESULTS

The following table 5.4.2 presents the mean team rating and the corresponding mean project performance for Company B case studies.

Table 5.4.2 Company 'B' Project Results

Project	Team Rating	Project Performance
Project B/1	72%	54%
Project B/2	68%	48%
Project B/3	62%	29%
Project B/4	70%	43%
Project B/5	74%	61%
Company B Mean:	**69%**	**47%**

1/ Team Rating

Mean team rating for the five Company B case studies = 69%

The following table 5.4.3 is a breakdown of the team variable mean derived from the five Company B Construction Project case study results.

Table 5.4.3 Company 'B' Team Ratings

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 76%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 67%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 77%
4/ Trust	(Group Diversity & Compatibility)	- 66%
5/ Corporate Intent	(Organisational Context)	- 62%
6/ Systems, Policies & Customs	(Organisational Context)	- 68%
7/ Culture	(Industry Context)	- 68%

The percentage scores for each of the seven variables were relatively high. The highest score was 77% relating to Team Dynamics and 76% for Interdependency both from the same category - Group Compatibility and Diversity. The lowest score was 62% relating to corporate intent, (Organisational context). A relatively low standard deviation (5.4) would imply a degree of compatibility in team member attitude across the five projects studied.

2/ **Project Performance**

Mean indicator score for the five Company B case studies = 47%

The following table 5.4.4 is a breakdown of the project indicator mean derived from the five Company B Construction Project case study results.

Table 5.4.4 Company 'B' Project Scores

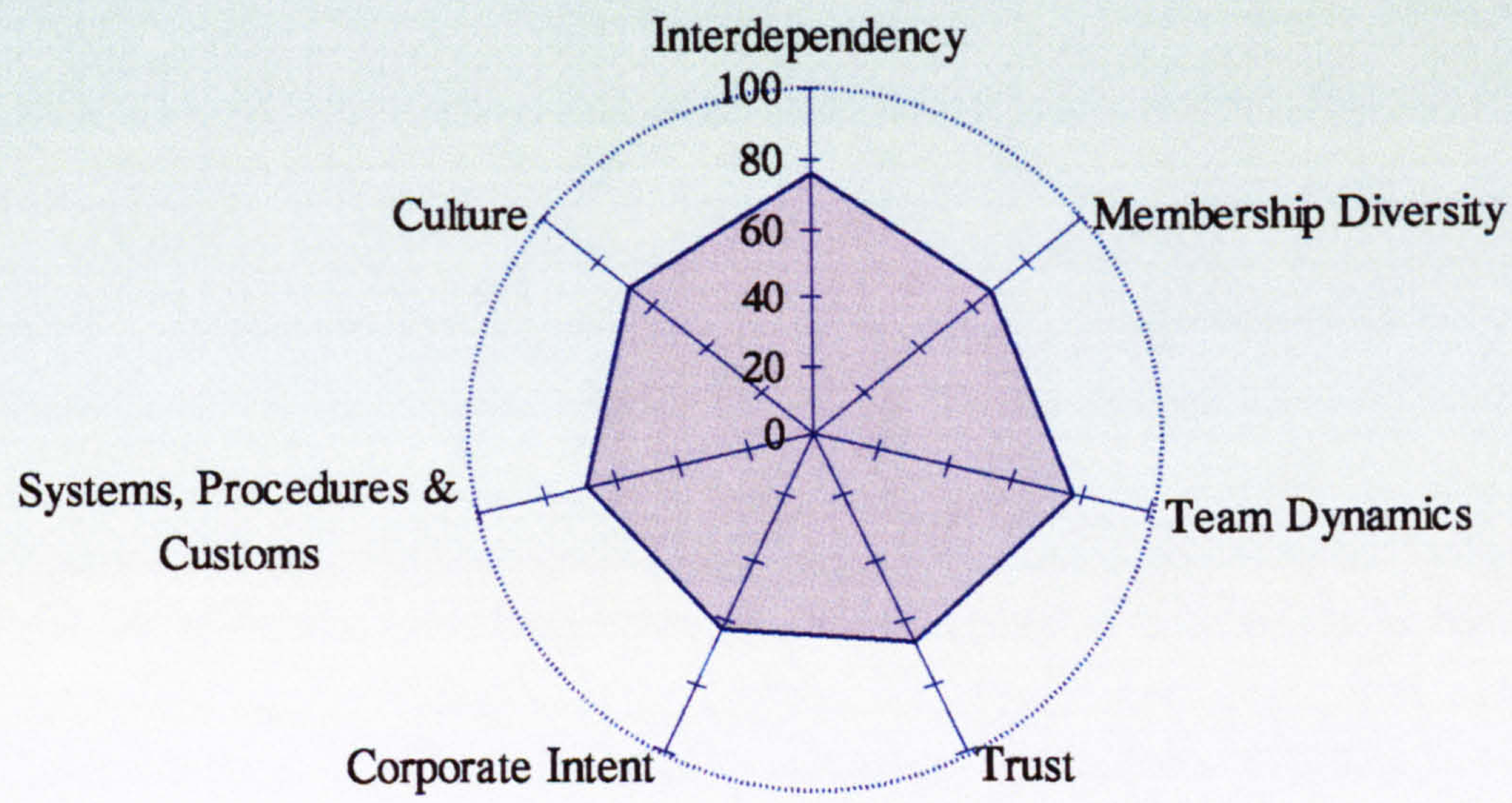
Indicator		Perspective	Company Score
1/ Predictability - Construction Cost (%)		(Financial)	0%
2/ Predictability - Construction Time (%)		(Financial)	+11%
3/ Client Satisfaction – Service (out of ten)		(Customer)	7.2
4/ Client Satisfaction – Product (out of ten)		(Customer)	7.2
5/ Employee Satisfaction	(out of ten)	(Internal)	6.9
6/ Working Hours	(per week)	(Internal)	48.5
7/ Training Days	(per year)	(Innovation & Learning)	3.8

The following table 5.4.5 transfers the project indicator mean from the five Company B Construction Project case study scores in to Construction Industry Benchmarks.

Table 5.4.5 Company 'B' Benchmark Scores

Indicator	Perspective	Benchmark Score
1/ Predictability - Construction Cost	(Financial)	- 70%
2/ Predictability - Construction Time	(Financial)	- 34%
3/ Client Satisfaction - Service	(Customer)	- 31%
4/ Client Satisfaction - Product	(Customer)	- 28%
5/ Employee Satisfaction	(Internal)	- 60%
6/ Working Hours	(Internal)	- 22%
7/ Training - Days per year	(Innovation & Learning)	- 84%

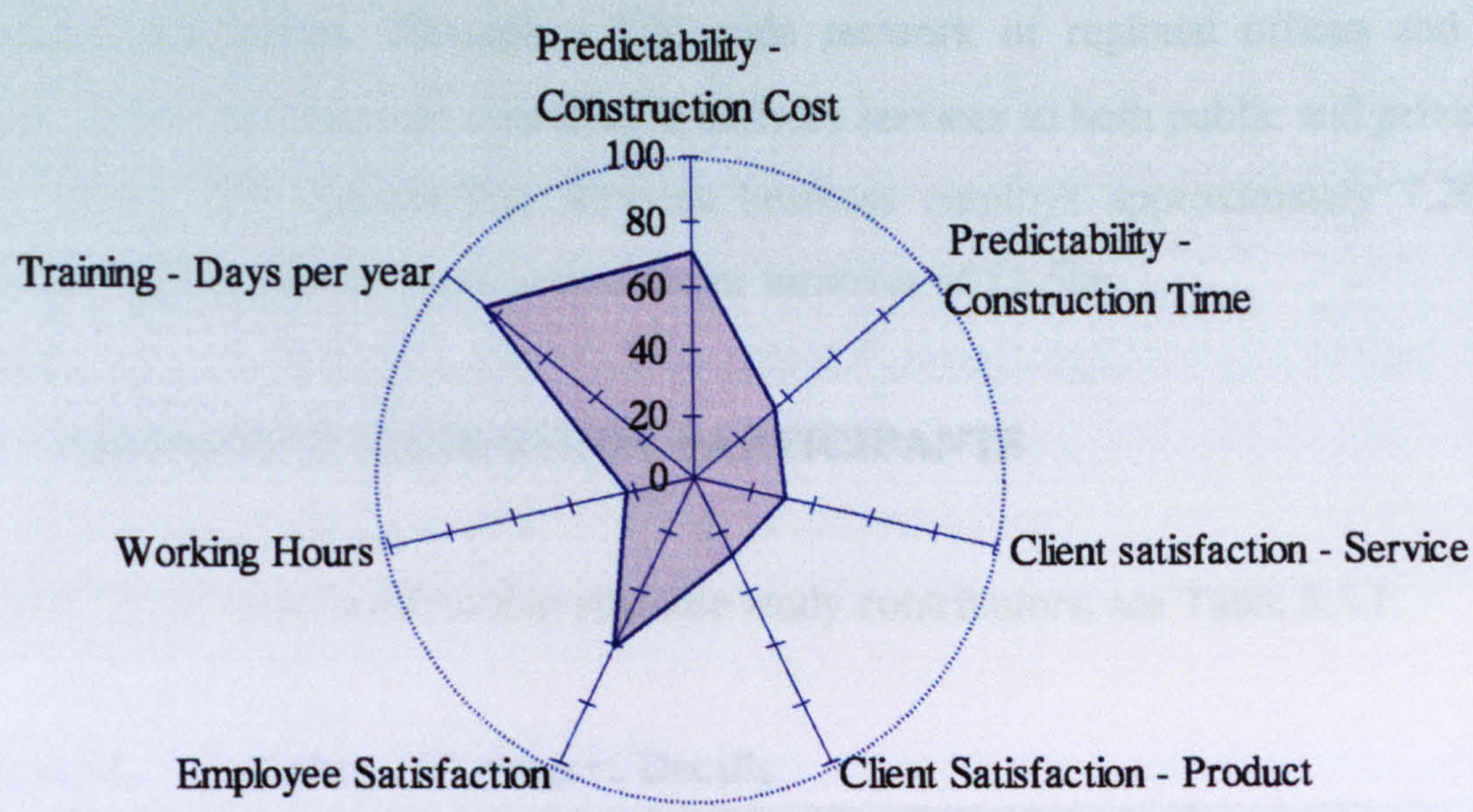
The percentage score for each of the seven performance components was variable with a standard deviation of 23.8. The highest score was 84% relating to number of training days per year (Learning). The lowest score was 22% relating to working hours, (Internal). The project performance results are calculated from the relevant Construction Industry Key Performance Indicators (Economic - All Construction & Respect for People wall chart 2004).



Mean Team Rating = 69%

Standard Deviation = 5.4

Figure 5.4.1 Company B Mean Team Rating Radar Chart



Mean Project Score = 47%

Standard Deviation = 23.8

Figure 5.4.2 Company B Mean Project Performance Radar Chart

Note: The results are presented using a Radar Chart format. In general, the nearer the plotted line is to the outer perimeter of the radar chart, the higher the overall performance.

5.5 COMPANY C

Company C is a leading international provider of construction and support services to public and private sector customers across a comprehensive range of market sectors. Company C offers a full range of construction and support services options, from major building and infrastructure projects through to smaller building and civil engineering works; and from Total Facilities Management through to direct delivery of mechanical & electrical, cleaning and security services. Over the years it has become one of the UK's leading construction and support services groups with an annual turnover of nearly £2 billion and more than 25,000 employees worldwide. Company C Construction Services sector provides a comprehensive national building service from major and special projects to smaller building projects, coupled with a total infrastructure services capability which spans the full range of civil engineering and related disciplines. Through a UK wide network of regional offices and a presence in selected overseas countries it delivers services to both public and private sector clients. The construction services business employs approximately 7,200 people and had an annual construction sector turnover of £1.5bn.

5.5.1 COMPANY C: CASE STUDY PARTICIPANTS

Company C had three construction site case study contributors, see Table 5.5.1.

Table 5.5.1 Company 'C' Project Details

Project	Type of Work	Team No.	Value (£)	Time (Weeks)
1/ Project C/1	New Build	8	20.0 million	78 weeks
2/ Project C/2	Refurbishment	6	6.3 million	72 weeks
3/ Project C/3	New Build	3	7.0 million	47 weeks

5.5.2 COMPANY C CASE STUDY RESULTS

The following table 5.5.2 presents the mean team rating and the corresponding mean project performance for Company C case studies.

Table 5.5.2 Company 'C' Project Results

Project	Team Rating	Project Performance
1/ Project C/1	80%	70%
2/ Project C/2	77%	59%
3/ Project C/3	69%	39%
Company C Mean:	**76%**	**56%**

1/ Team Rating

Mean team rating for the three company C case studies = 76%

The following table 5.5.3 is a breakdown of the team variable mean derived from the three Company C Construction Project case study results.

Table 5.5.3 Company 'C' Team Ratings

Team Variable	Team Category	Rating
1/ Interdependency	(Group Diversity & Compatibility)	- 85%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 74%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 80%
4/ Trust	(Group Diversity & Compatibility)	- 73%
5/ Corporate Intent	(Organisational Context)	- 69%
6/ Systems, Policies & Customs	(Organisational Context)	- 74%
7/ Culture	(Industry Context)	- 74%

The percentage scores for each of the seven variables were relatively high. The highest score was 85% relating to Interdependency from the category - Group Compatibility and Diversity. The lowest score was 69% relating to corporate intent, (Organisational context).

2/ Project Performance

Mean indicator score for the three company C case studies = 56%

The following table 5.5.4 is a breakdown of the project indicator mean derived from the three Company C Construction Project case study results.

Table 5.5.4 Company 'C' Project Scores

Key Performance Indicator		Perspective	Company Score
1/ Predictability - Construction Cost (%)		(Financial)	+2.0%
2/ Predictability - Construction Time (%)		(Financial)	+0.5%
3/ Client Satisfaction – Service (out of ten)		(Customer)	8.8
4/ Client Satisfaction – Product (out of ten)		(Customer)	8.1
5/ Employee Satisfaction	(out of ten)	(Internal)	7.0
6/ Working Hours	(per week)	(Internal)	51.0
7/ Training Days	(per year)	(Innovation & Learning)	4.4

The following table 5.5.5 transfers the project indicator mean from the three Company C Construction Project case study scores in to Construction Industry Benchmarks.

Table 5.5.5 Company 'C' Benchmark Scores

Key Performance Indicator	Perspective	Benchmark Score
1/ Predictability - Construction Cost	(Financial)	- 41%
2/ Predictability - Construction Time	(Financial)	- 42%
3/ Client Satisfaction - Service	(Customer)	- 80%
4/ Client Satisfaction - Product	(Customer)	- 59%
5/ Employee Satisfaction	(Internal)	- 59%
6/ Working Hours	(Internal)	- 20%
7/ Training - Days per year	(Innovation & Learning)	- 92%

The percentage score for each of the seven performance components was variable with a project performance mean of 56% and a standard deviation of 24.5. The highest score was 92% relating to number of training days per year (Learning). The lowest score was 20% relating to working hours, (Internal). The project performance results are taken from the relevant Construction Industry Key Performance Indicators (Economic - All Construction & Respect for People wall chart 2004).

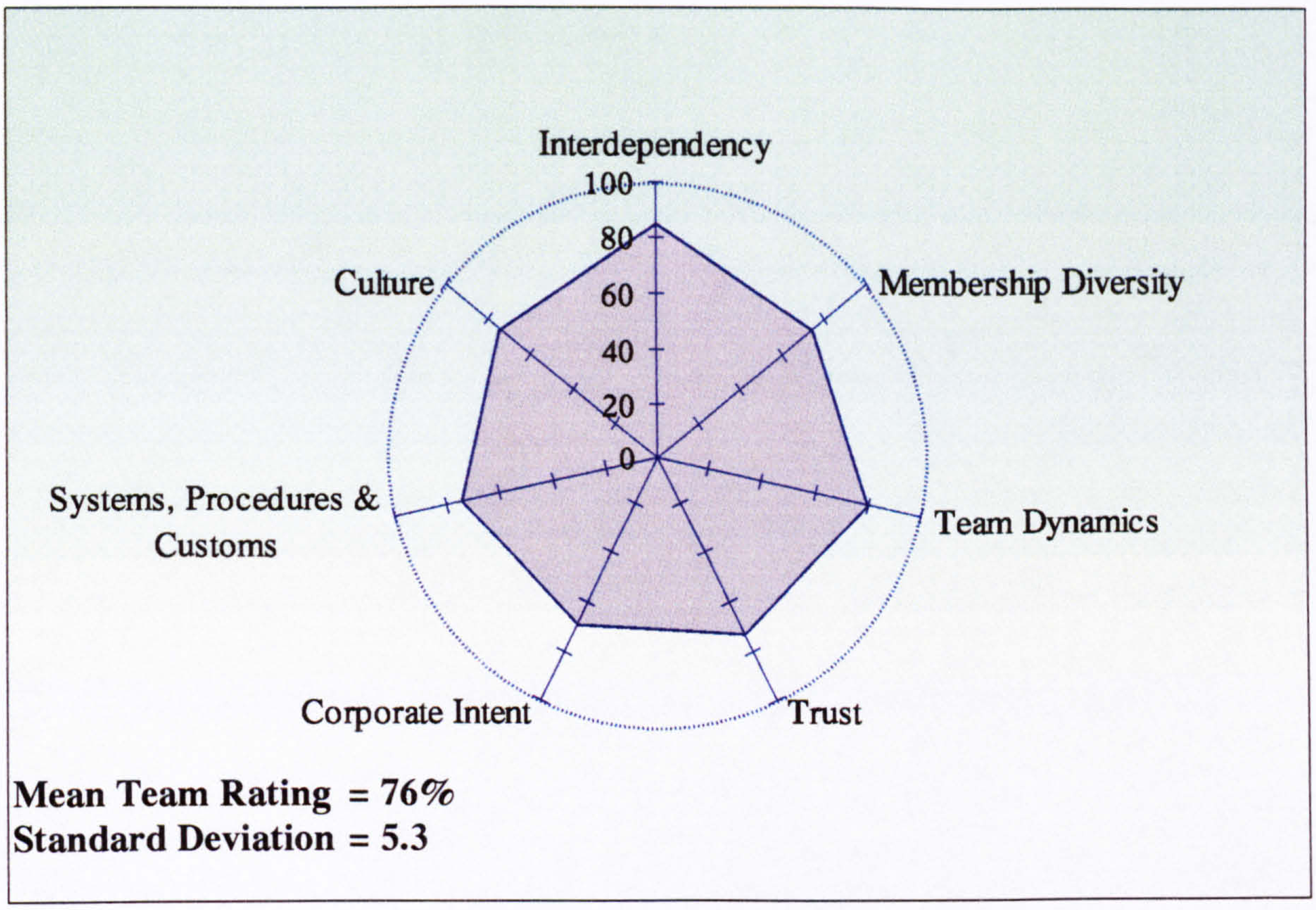


Figure 5.5.1 Company C Mean Team Rating Radar Chart

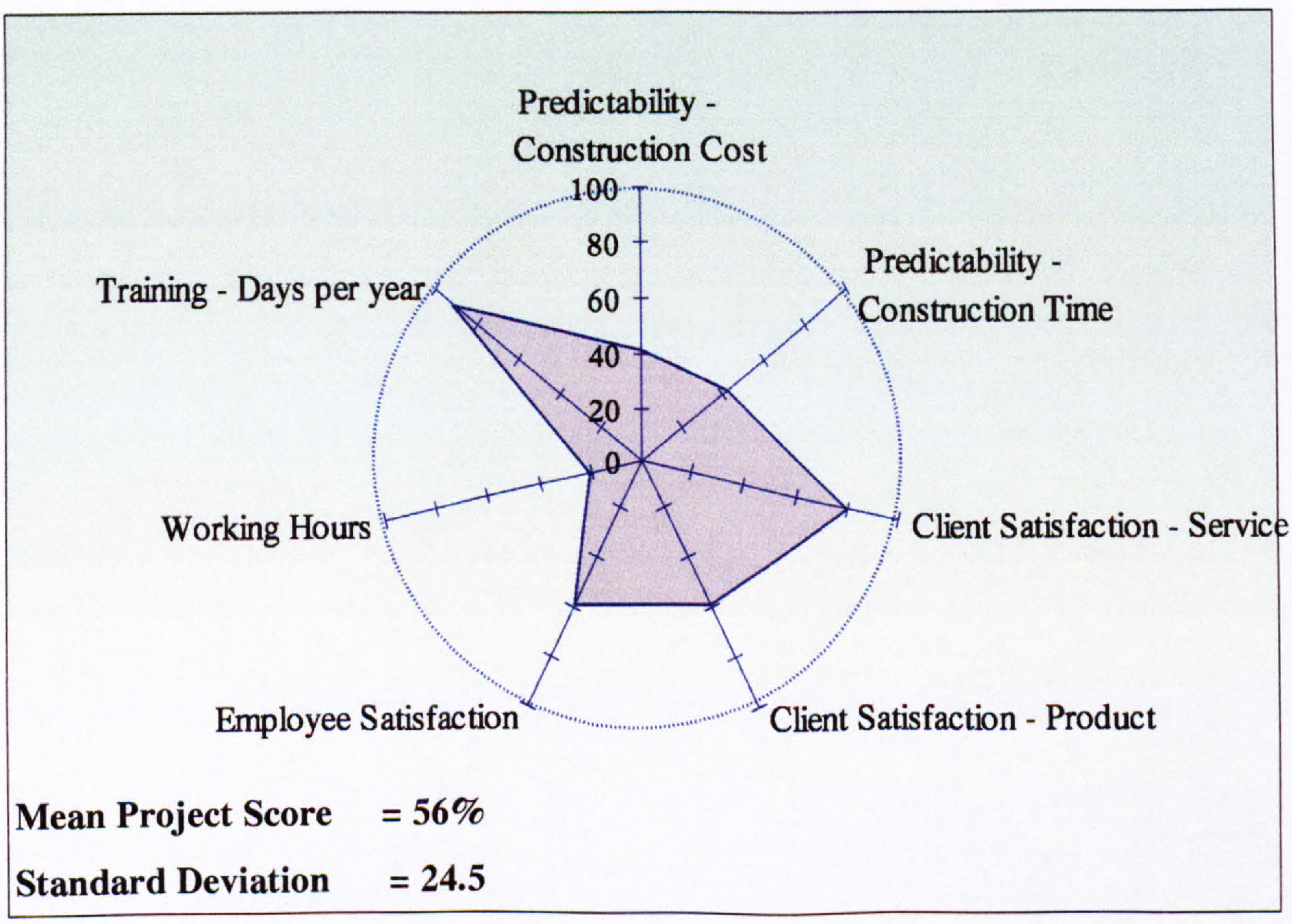


Figure 5.5.2 Company C Mean Project Performance Radar Chart

Note: The results are presented using a Radar Chart format. In general, the nearer the plotted line is to the outer perimeter of the radar chart, the higher the overall performance.

5.6 COMPANY D

Company D is one of the UK's largest construction companies. The parent group ranks among the largest construction firms in Europe with a corporate turnover of approximately £4.5 billion and employ approximately 30000 people worldwide. The company offer a comprehensive range of contracting services – from construction right through to facilities management. The construction arm is one of five distinct corporate business units with regional offices located across the UK. Turnover for 2004 was £1.47 billion and included a diverse range of building type and client base.

5.6.1 COMPANY D: CASE STUDY PARTICIPANTS

Company D had five construction site case study contributors, see Table 5.6.1.

Table 5.6.1 Company 'D' Project Details

Project	Type of Work	Team No.	Value (£)	Time (Weeks)
1/ Project D/1	Refurbishment	5	9.9 million	78 weeks
2/ Project D/2	New Build	2	5.8 million	66 weeks
3/ Project D/3	New Build	7	25.0 million	91 weeks
4/ Project D/4	New Build	8	25.0 million	94 weeks
5/ Project D/5	Refurbishment	9	20.0 million	84 weeks

5.6.2 COMPANY D: CASE STUDY RESULTS

The following table 5.6.2 presents the mean team rating and the corresponding mean project performance for Company D case studies.

Table 5.6.2 Company 'D' Project Results

Project	Team Rating	Project Performance
1/ Project D/1	72%	40%
2/ Project D/2	77%	42%
3/ Project D/3	76%	63%
4/ Project D/4*	79%	74%
5/ Project D/5	70%	59%
Company D Mean:	**75%**	**55%**

*KPI's for Predictability (cost and time) were unavailable and therefore calculated based on 0% variance from the original estimate(s) of cost and time for the project.

1/ Team Rating

Mean team rating for the five company D case studies = 75%

The following table is a breakdown of the team variable mean derived from the five Company D Construction Project case study results.

Table 5.6.3 Company 'D' Team Ratings

Team Variable	Team Category	Rating
1/ Interdependency	(Group Diversity & Compatibility)	- 85%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 69%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 81%
4/ Trust	(Group Diversity & Compatibility)	- 74%
5/ Corporate Intent	(Organisational Context)	- 71%
6/ Systems, Policies & Customs	(Organisational Context)	- 72%
7/ Culture	(Industry Context)	- 72%

The percentage scores for each of the seven variables were relatively high. The highest score was 85% relating to Interdependency from the category - Group Compatibility and Diversity. The lowest score was 69% relating to Membership Diversity (Group Compatibility and Diversity category).

2/ **Project Performance**

Mean indicator score for the five company D case studies = 55%

The following table is a breakdown of the project indicator mean derived from the five Company D Construction Project case study results.

Table 5.6.4 Company 'D' Project Scores

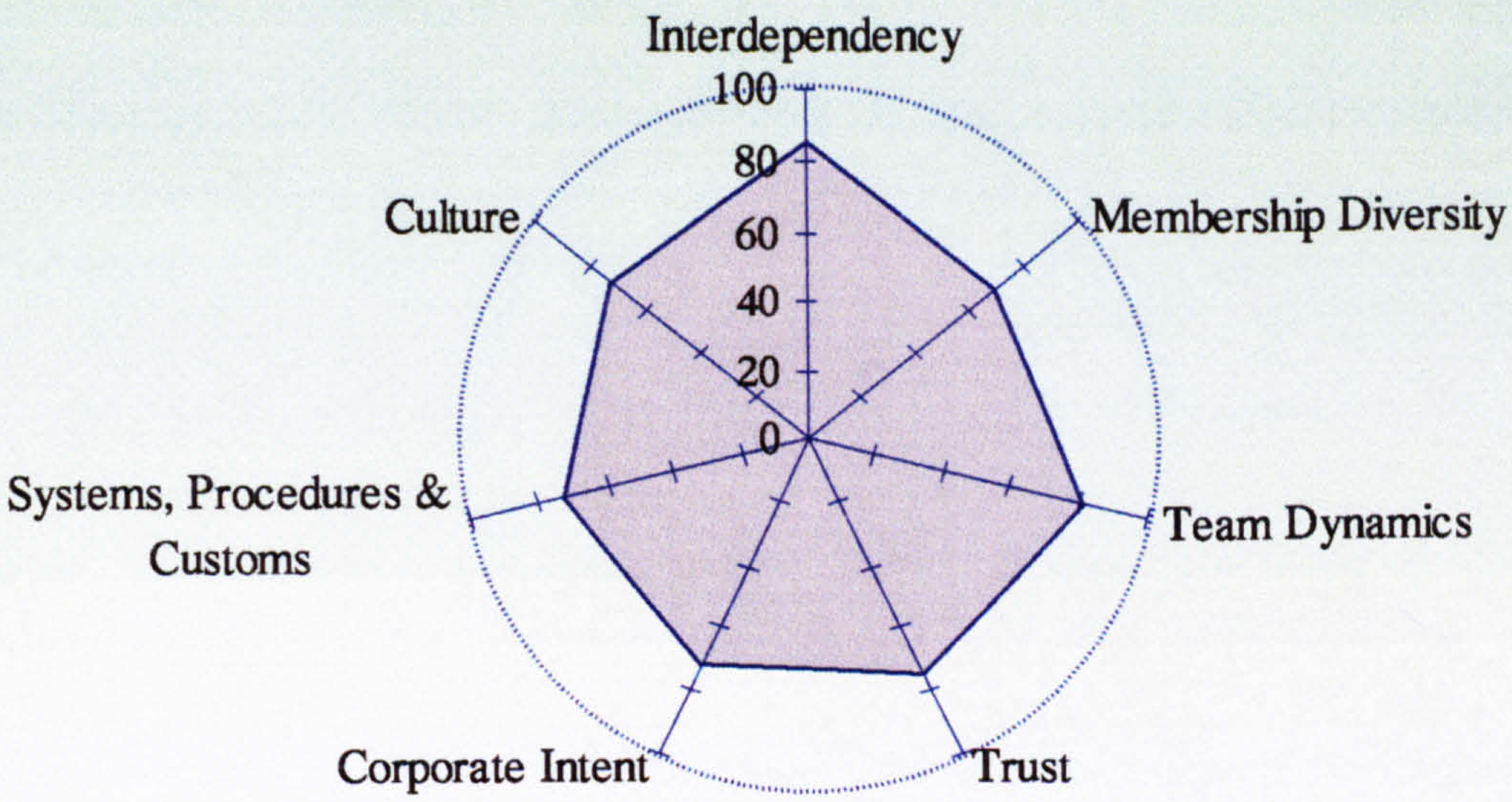
Key Performance Indicator	Perspective	Company Score
1/ Predictability - Construction Cost (%)	(Financial)	+4.0%
2/ Predictability - Construction Time (%)	(Financial)	+7.2%
3/ Client Satisfaction – Service (out of ten)	(Customer)	8.9
4/ Client Satisfaction – Product (out of ten)	(Customer)	8.2
5/ Employee Satisfaction (out of ten)	(Internal)	7.3
6/ Working Hours (per week)	(Internal)	49.1
7/ Training Days (per year)	(Innovation & Learning)	4.2

The following table 5.6.5 transfers the project indicator mean from the five Company D Construction Project case study scores in to Construction Industry Benchmarks.

Table 5.6.5 Company 'D' Benchmark Scores

Key Performance Indicator	Perspective	Benchmark Score
1/ Predictability - Construction Cost	(Financial)	- 33%
2/ Predictability - Construction Time	(Financial)	- 33%
3/ Client Satisfaction - Service	(Customer)	- 82%
4/ Client Satisfaction - Product	(Customer)	- 61%
5/ Employee Satisfaction	(Internal)	- 69%
6/ Working Hours	(Internal)	- 20%
7/ Training - Days per year	(Innovation & Learning)	- 91%

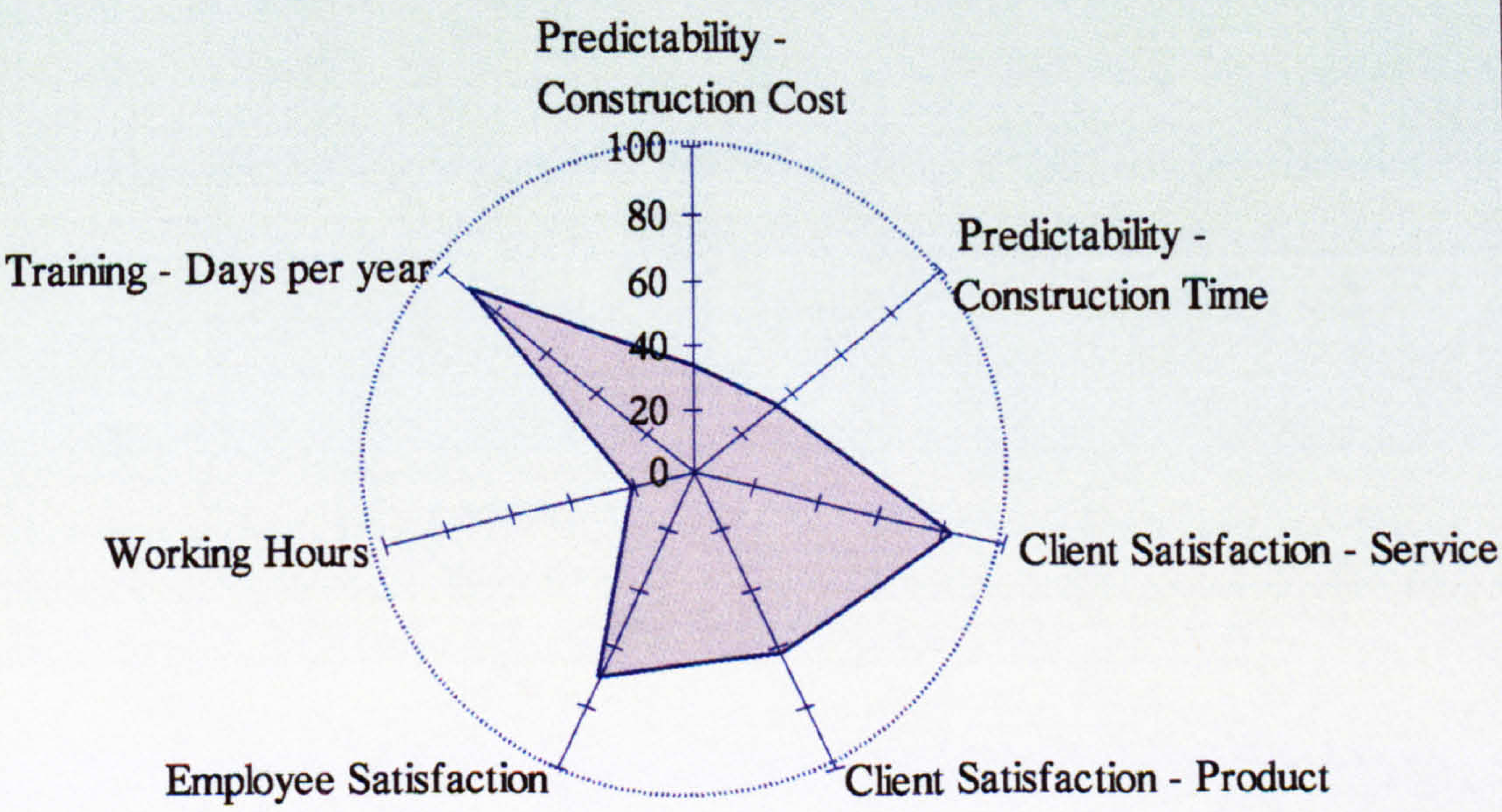
The percentage score for each of the seven performance components was variable with a standard deviation of 27.2. The highest score was 91% relating to number of training days per year (Learning). The lowest score was 20% relating to working hours, (Internal perspective). The project performance results are taken from the relevant Construction Industry Key Performance Indicators (Economic - All Construction & Respect for People wall chart 2004).



Mean Team Rating = 75%

Standard Deviation = 5.8

Figure 5.6.1 Company D Mean Team Rating Radar Chart



Mean Project Score = 55%

Standard Deviation = 27.2

Figure 5.6.2 Company D Mean Project Performance Radar Chart

Note: The results are presented using a Radar Chart format. In general, the nearer the plotted line is to the outer perimeter of the radar chart, the higher the overall performance.

5.7 INTER-PROJECT FINDINGS

The thirteen case study project results have been collated to represent a cross-construction project perspective.

5.7.1 INTER-PROJECT: CASE STUDY RESULTS

The following table 5.7.1 lists the mean team rating and mean project performance measure for all thirteen case studies.

Table 5.7.1 Inter-Project Results

No.	Project Case study	Team Rating	Project Performance
	Company A: Project A/1*	(77%)	(57%)
1/	Company B: Project B/1	72%	54%
2/	Company B: Project B/2	68%	47%
3/	Company B: Project B/3	62%	29%
4/	Company B: Project B/4	70%	42%
5/	Company B: Project B/5	74%	61%
6/	Company C: Project C/1	80%	71%
7/	Company C: Project C/2	77%	59%
8/	Company C: Project C/3	69%	39%
9/	Company D: Project D/1	72%	40%
10/	Company D: Project D/2	77%	42%
11/	Company D: Project D/3	76%	63%
12/	Company D: Project D/4**	79%	74%**
13/	Company D: Project D/5	70%	59%
Inter-Project Mean:		73%	53%

* The Pilot Study results have been presented as part of the total number of case studies undertaken but the figures for both 'team rating' and 'project performance' have not been included in the calculation of the UK Project mean figures.

** Project performance figures relating to 'Predictability – Construction Cost' and 'Predictability – Construction Time' where both taken at 0% variance from the initial estimated project figures and benchmarked accordingly.

The following table outlines the number of participants, both company and case study involved in the research programme.

Table 5.7.2 Profile of Participating Companies

Company	Sector	Case Studies	Sector Turnover
Company A	Contracting	1 – Pilot Study	£762 million
Company B	Contracting	5	£890 million
Company C	Contracting	3	£1.50 billion
Company D	Contracting	5	£1.47 billion

The following table summarises the mean company values derived from their participating projects.

Table 5.7.3 Company Results Summary

Company	Team Rating	Project Performance
Company A*	(77%)	(57%)
Company B	69%	47%
Company C	76%	56%
Company D	75%	55%
UK Company Mean:	73%	53%

*Note: Company A has been excluded from the calculation of the UK average due to the experimental nature of the pilot case study. The function of the case study (Company A) was as a trial, testing feasibility, applicability and evaluation. As a direct consequence of the pilot study review a number of minor amendments where made to the overall research methodology. The pilot study is therefore potentially unrepresentative within the contextual framework of the other three participating companies and resultant thirteen case studies.

1/ Team Rating

Mean team rating for the thirteen case studies = 73%

The following table is a breakdown of the team variable mean derived from the thirteen cross-company Project case study results.

Table 5.7.4 Inter-Project Team Ratings

Team Variable	Team Category	Rating
1/ Interdependency	(Group Diversity & Compatibility)	- 82%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 69%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 79%
4/ Trust	(Group Diversity & Compatibility)	- 70%
5/ Corporate Intent	(Organisational Context)	- 67%
6/ Systems, Policies & Customs	(Organisational Context)	- 71%
7/ Culture	(Industry Context)	- 71%

The percentage scores for each of the seven variables were relatively high. The highest score(s) was 82% Interdependency and 79% Team Dynamics both from the same category - Group Compatibility and Diversity. The lowest score was 67% relating to the variable Corporate Intent from the Organisational Context category.

2/ Project Performance

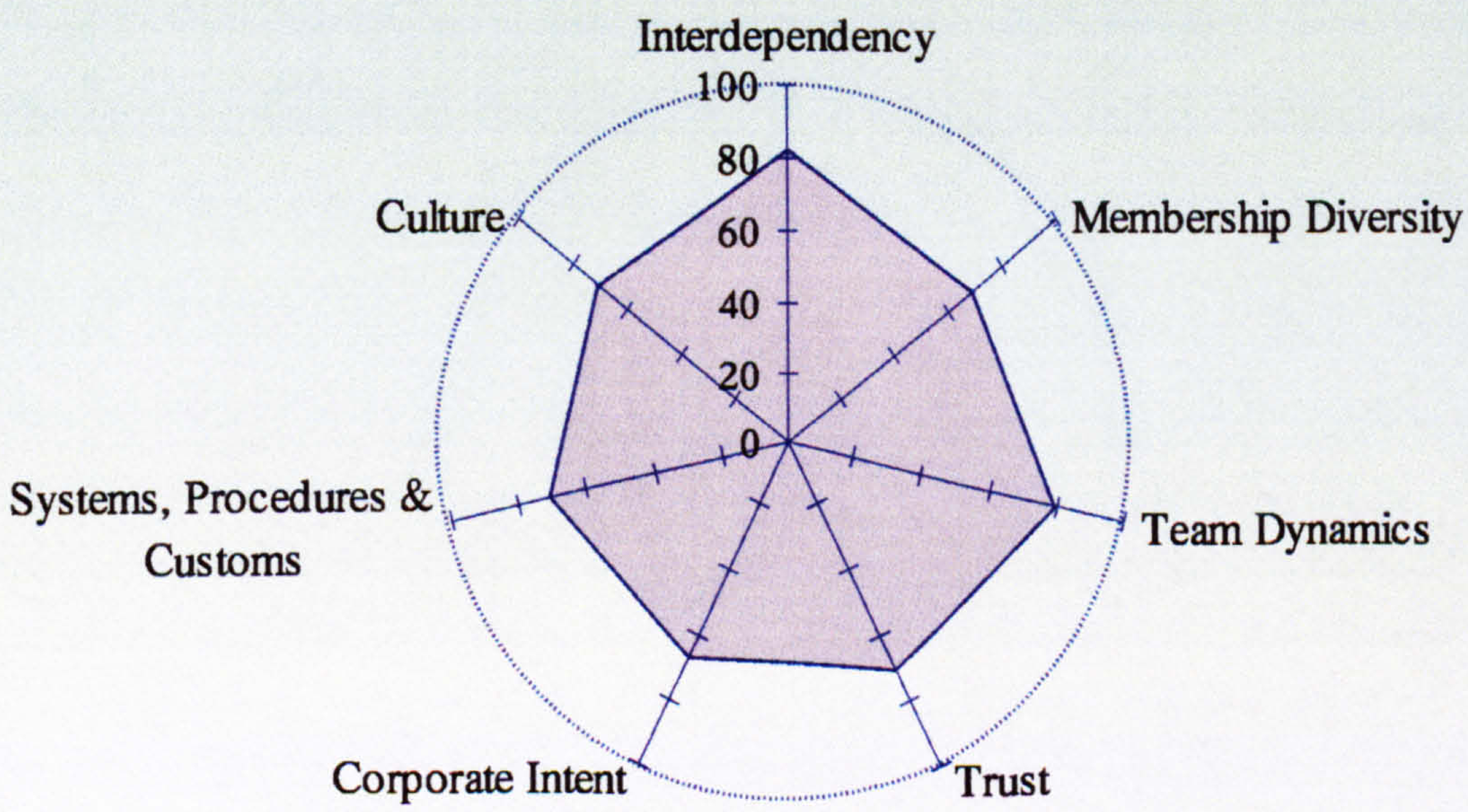
Mean indicator score for the thirteen case studies = 53%

The following table is a breakdown of the project indicator mean derived from the thirteen cross-company Project case study results.

Table 5.7.5 Inter-Project Benchmark Scores

Key Performance Indicator	Perspective	Benchmark Score
1/ Predictability - Construction Cost	(Financial)	- 49%
2/ Predictability - Construction Time	(Financial)	- 35%
3/ Client Satisfaction - Service	(Customer)	- 62%
4/ Client Satisfaction - Product	(Customer)	- 48%
5/ Employee Satisfaction	(Internal)	- 63%
6/ Working Hours	(Internal)	- 21%
7/ Training - Days per year	(Innovation & Learning)	- 88%

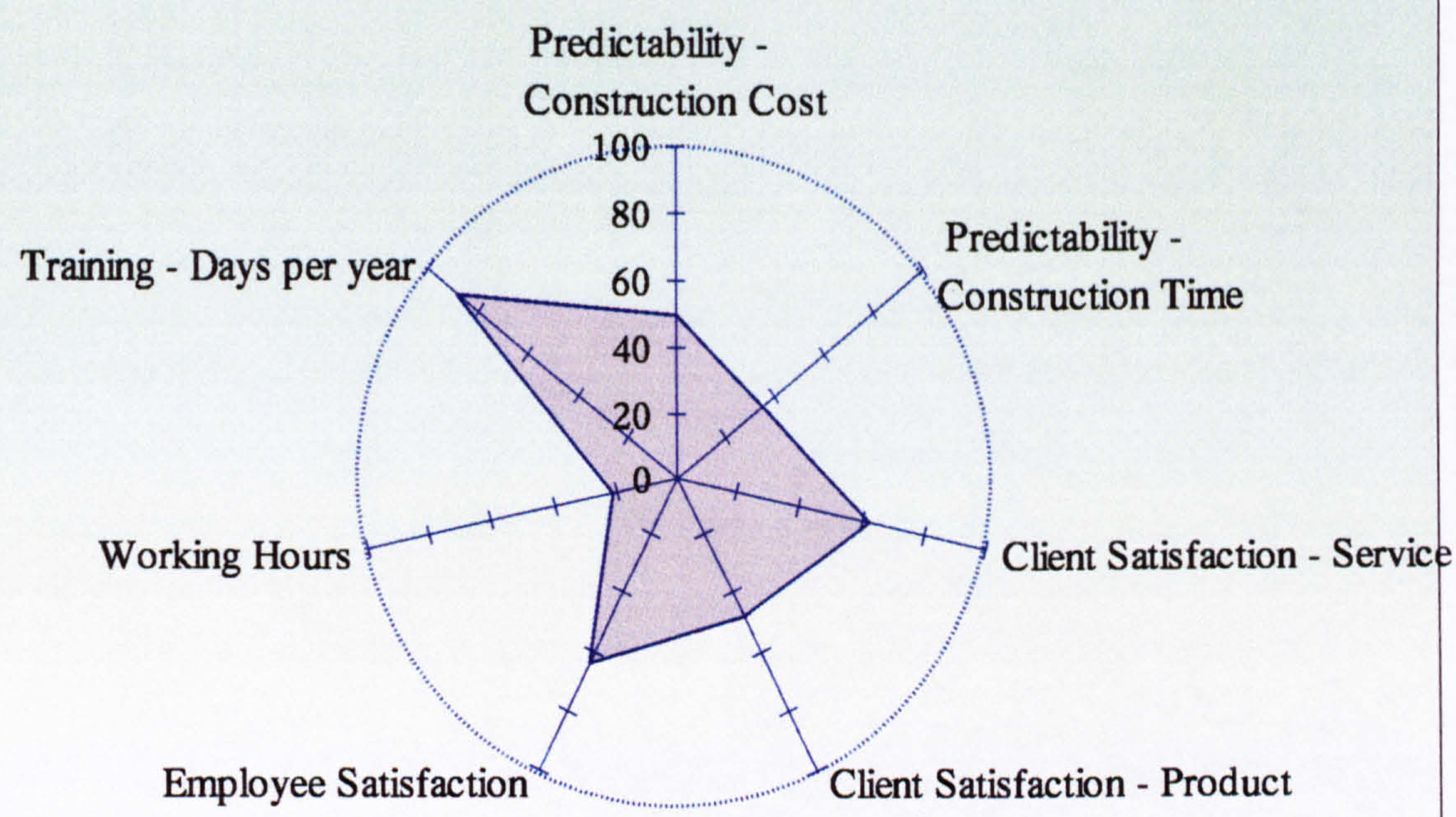
The percentage score for each of the seven performance components was notably variable with a high standard deviation of 21.9. The highest score was 88% relating to number of training days per year (Learning). The lowest score was 21% relating to working hours, (Internal). The project performance results are taken from the relevant Construction Industry Key Performance Indicators (Economic - All Construction & Respect for People wall chart 2004).



Mean Team Rating = 73%

Standard Deviation = 5.3

Figure 5.7.1 Inter-Project Mean Team Rating Radar Chart



Mean Project Score **= 53%**

Standard Deviation **= 21.9**

Figure 5.7.2 Inter-Project Mean Project Performance Radar Chart

Note: The results are presented using a Radar Chart format. In general, the nearer the plotted line is to the outer perimeter of the radar chart, the higher the overall performance.

5.8 RESULTS SUMMARY

Excluding the pilot study the research programme, over a nine month period, administered thirteen individual project case studies (see table 5.7.1). Arranged under company headings the case studies represented five from company B, three from company C and five from company D. In total there were eighty two individual project participants, thirteen team (project) leaders, thirteen client or client representatives and fifty six site based construction professionals. The findings presented in the case study and results chapter illustrates only a collective review of the research data. Individual case study information, results and data interpretation is available in Appendix G, (see Appendix G, Project Case study Reports).

CHAPTER 6: DATA ANALYSIS

6.1 INTRODUCTION

The function of the data analysis chapter is to organise, examine and interpret the data in relation to the research question. "All social research should be directed towards answering research questions about characteristics, relationships, patterns of influences in some social phenomenon. Once appropriate data have been collected or generated, it is possible to see whether, and to what extent, the research question can be answered. Data analysis is one step, and an important one, in this process" (Blaikie, 2003). The purpose of the data analysis is to collate all the field results, review the data, evaluate suitable methods of enquiry and investigate the significance of the relationship between the primary research variables. In this case the focus was directed towards the measurement and evaluation of perceived levels of site management team working and their corresponding project performance.

6.1.1 ORGANISING THE RESEARCH DATA

The individual project data has been arranged at the outset under the appropriate company heading. Presented and assessed first as discrete construction projects within the corporate parameter, intra-company projects. Subsequent analyses extend the boundary to inter-company analysis and finally removing the corporate consideration for a pan-project investigation, inter-project. This may be considered as an analytical industrial generalisation of the research data and outcomes.

The theoretical discussion underpinning the selection and application of the most appropriate statistical measurement is complex. The origin of the debate is based on an influential paper published in 1946 by S.S. Stevens entitled, 'On the Theory of Scales of Measurement'. Stevens not only considers the research question but also takes in to account the classification of measurement obtained, (Pathak, 1979). Although endorsed by some commentators the conceptual directive advocated by Stevens "has also been widely criticized" (Scholten and Borsboom, 2004). "The use of Stevens's categories in selecting or recommending statistical analysis methods is inappropriate and can often be wrong. They do not describe the attributes of real data that are essential to good statistical analysis" (Velleman and Wilkinson, 1993). After careful consideration of the data gathering methodology, a number of statistical methods where identified as most appropriate for this type of study.

The majority of the statistical techniques employed are classified as parametric tests and include Pearson's Correlation Coefficient, Students two-tailed paired t-test and Analysis of Variance (ANOVA) one-way for two variables and two-way for the comparison of mean values in groups greater than two pairs. In support of the parametric statistical testing, elementary statistical inquiry such as numerical means and standard deviations are used extensively. It is important to note that parametric statistical investigation is founded on the assumption that the results under scrutiny are based on interval data, for example the measurement scale applied represents quantity and has equal units and where the outcomes can be expected to be nominally distributed from a representative population.

As part of the site team-member measurement questionnaire methodology a Likert scale was adopted for the quantitative assessment of qualitative information. The team 'efficiency' evaluation is based on a series of attitude statements 'scored' on a scale of 1 to 5, (see Appendix B). Theoretically this level of 'scale of measurement' is classified as ordinal data and is considered to be nonparametric. In theory the outcomes may be vulnerable to misinterpretation when analysed within a parametric stricture. In practice, "parametric tests are highly robust" (Pathak, 1979). Within the behavioural and social sciences the collection of ordinal data is more common and often treated as if the data represents parametric (interval or ratio) measurement. For example, "where ordinal variables permit a large number of categories to be specified the variables can be treated as interval data, especially as techniques like regression and correlation are well known, powerful and quite easy to use and interpret" (Fellows and Liu, 2003). Further expert advice was sought on the soundness of the proposed methodology. The outcome was favourable and deemed acceptable. Whilst acknowledging the theoretical derivation of ordinal measurement an informed judgement was made to exploit the widely acknowledged benefits commonly associated with parametric statistical techniques. In support of the research methodologies adopted it is important to stress "that parametric tests do a very good job of detecting ordinal differences," (Scholten and Borsboom, 2004). One exception has been made with the inclusion of the Spearman Rank Correlation Coefficient, a non-parametric testing technique. This technique was particularly fitting due to the suitability of the organised data. The rank correlation coefficient is also used to test the research hypothesis and may be regarded as an authoritative statistical endorsement of the original findings.

The use of the student two-tailed t-test and ANOVA (one-way and two-way) made an important contribution to the formative phase of the project case study analysis and understanding. Confidence intervals are extremely helpful for the interpretation of results, such as the difference between two means as they demonstrate the degree of uncertainty related to the collated results, (Altman *et al*, 1989). Confidence intervals disclose an exactness of sampling procedure. Calculating research findings at an acceptable level of significance, typically $\varrho=0.05$ for social science studies helps confirm one's subjective judgement, especially if the results of a small sample are presented as a representative snapshot of the population as a whole. The student two-tailed t-test and ANOVA techniques provide a statistically founded level of confidence that the research 'means' between the projects have occurred due to the variables being studied and are not simply the results of sampling chance.

6.1.2 RESEARCH DATA REFERENCING

As a prologue to the main data analysis it is timely to quantify research participation levels and establish the protocol for project labelling. There are a total of eighty two research participants; sixty nine site-based construction professionals (including thirteen project leaders) and thirteen clients or client representatives. The research programme comprises of thirteen separate construction projects and their site management teams. The participation level was approximately 96%. The individual project has been identified as the principal 'unit of analysis' and subsequently may be referred to as a case study. The research programme required the permission and participation of three major UK contractors, referred to in the research as Company B, Company C and Company D. The data referencing system prefix each individual case study with the appropriate company designation. The case studies are numbered in relation to the number of case studies associated with the company. For example case study 1 for company B would be identified as B/1. Case study 1 for company C would be labelled C/1 and so on. Company A, Project 1 (A/1) has been omitted due to the evolving methodology and experimental nature of the pilot case study. Individual project data is presented using a matrix / scorecard format. A colour-coded format was also developed to assist with the presentation and preliminary dissemination of the results. See Appendix I: The Colour Coded Company Balanced Scorecard.

6.2 DATA ANALYSIS: COMPANY B

Company B is a leading UK building and civil engineering contractor. Company B provided access to five construction projects and their site management teams. The five project research case studies were carried out between August and September 2004; all projects were located in the Scottish central belt.

6.2.1 COMPANY B - THE PARTICIPANTS

Construction Company B has five case study contributors, see table 6.2.1.

Table 6.2.1 Company B Project Profile

Project	Type of Work	Team No.	Value (£)	Time (Weeks)
Project B/1	Refurbishment	5	9.2 million	43 weeks
Project B/2	New Build	3	6.0 million	44 weeks
Project B/3	Refurbishment	5	8.5 million	64 weeks
Project B/4	New Build	5	3.0 million	52 weeks
Project B/5	New Build	3	3.0 million	52 weeks

6.2.2 COMPANY B TEAM VARIABLE RESULTS SUMMARY

The following table 6.2.2 charts the seven mean team variable rating for each of the five participating company B projects.

Table 6.2.2 Company B Team Variable Results

Team Variable	Project B/1	Project B/2	Project B/3	Project B/4	Project B/5	Company Mean
Interdependency	78	77	66	82	77	76 std.dev. 6.0
Membership Diversity	70	69	65	66	65	67 std.dev. 2.3
Team Dynamics	78	80	68	78	81	77 std.dev. 5.2
Trust	70	63	53	73	69	66 std.dev. 7.9
Corporate Intent	64	56	52	62	77	62 std.dev. 9.5
Systems, Policies & Customs	76	69	67	59	69	68 std.dev. 6.1
Culture	68	61	60	71	81	68 std.dev. 8.5
Project Mean	72	68	62	70	74	69 std.dev. 5.4

The team rating results were attained using an attitude statement questionnaire issued to all participating project members. For Company B a total of twenty one questionnaires were issued with a 100% response rate. All participants were site based and employed by the principal contractor. The overwhelming majority of respondents were male (19) with two female participants. The average length of company employment for the team members participating with the research was fifteen months. A selection of statistical analysis techniques have been utilised in an effort to evaluate and validate the research data. The primary statistical techniques employed are: means, standard deviations, analysis of variance (ANOVA one-way and two-way), student's two tailed paired t-test, Pearson's Correlation and Spearman Rank Correlation Coefficient.

6.2.3 COMPANY B TEAM VARIABLE ANALYSIS

The team rating for Company B has a mean value of 69% and a standard deviation of 5.4 with a percentage variation in upper and lower values of 15%. This ranges from a high of 77% to a low of 62% across the seven variables. The moderate-to-low standard deviation value may be a reflection of the interrelated nature of the variables within the team theme. For example, a member's perception on levels of group compatibility and diversity is likely to influence team member perception on subsequent variables within the team context.

An analysis of variance (one-way) testing the null hypothesis, H_o: calculates F_{obt} = 3.10* (see Appendix H, Table H.2.1). Since the level of F_{obt} is greater that F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average company B team ratings and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$. A simple assessment of the mean team rating values show that four variables have a narrow range of 2% (66% - 68%). Therefore the variance in team rating values, F_{obt} = 3.10* at 0.05 level of significance, is likely to be associated with the high(s) of Team Dynamics (77%) and Interdependency (76%) and compounded by the low of 62% for Corporate Intent. The two notable highs namely, Team Dynamics and Interdependency both of which are variables within the

Group Compatibility and Diversity category suggest that in general terms Company B project team members have a reasonable and satisfactory working relationship.

Within the project parameters of the research this is not necessarily a surprising outcome due to the relatively small number of members recruited to the site management teams. Averaging four team members per project, most with a construction management background the consequence is that membership diversity records a moderate mean of 67% and is never the dominant variable within the group compatibility context. The degree of interaction formal and informal is likely to be naturally high resulting in frequent group communication and therefore likely to support other team variables in particular team dynamics. The lower than average rating for Corporate Intent, a variable within the Organisational Context category, highlights a trend across most of the Company B projects studied and may infer some misconception between corporate objectives and the purpose construction projects as well as individual team members play in achieving strategic goals. Interestingly, the one project that is at odds with the other four projects (Project B/5) has a small team number and an above average length of service with the parent organisation. A degree of permanence with the company may instil corporate values.

Cross analysis of the data with respect to variances between the seven variables across the five different construction projects produces a two-way ANOVA of $F_{obt} = 5.21^{**}$ for the team variable which is greater than $F_{crit} = 2.51$ at the 0.05 level of significance and $F_{obt} = 5.78^{**}$ for the projects which is also greater than $F_{crit} = 2.78$ at the 0.05 level of significance. It may be concluded that there is a significant difference in the mean values associated between the seven team variables (as per the one-way ANOVA) and between the five Company B projects studied. Therefore reject the null hypothesis in favour of the alternative hypothesis, (see Appendix H, Table H.2.2).

Analysis of the main project values suggest that it is probable that Project B/3 with a project performance benchmark of 62% and a standard deviation 6.7 is performing differently from the other four case study projects. There are two notable team ratings with lower than average values, Corporate Intent (52%) and Trust (53%). The results highlight a difficulty with a socio-emotional variable that has the potential to have a negative effect on the organisation as a whole. Trust is often seen as a key component of effective team working and in this case it would appear that the project may have some personnel pressures that are undermining the confidence of the project group as a collective unit. A Pearson's correlation between the project values for trust and overall mean team rating indicates a very strong level of association between the two sets of data (+0.9). A student's two tailed t-test accepts the null hypothesis (ϱ = 0.14) and this is supported by an analysis of variance at the 0.05 level of significance, H_o: $\mu_1 = \mu_2$. Company B values for the trust variable are not significantly different from the values obtained for the overall mean team rating. However the correlation coefficient does give an indication that there may be a link. Supplementary company data may be required to substantiate this. The lower than average rating for interdependency, when compared with the other project scores tend to support the notion that working relationships are somewhat terse. Reviewing the background data, team members employed on project B/3 have an average length of employment with the company of nine months, notably less than the company mean of fifteen months for this series of five project case studies. Interestingly all three team categories identified in the literature review, Group Diversity and Compatibility, Organisational Context and Industry Context record team variable scores of 63%, 60% and 60% respectively. All are below their respective average when compared with any of the other Company B four project groupings. In general terms and in relation to the issue of team working it may be reasonable to comment that the results lend itself to the expression of group activity for the performance of site management team B/3 as opposed to team working.

6.2.4 COMPANY B KPI RESULTS SUMMARY

The following table 6.2.3 charts the seven mean key performance indicators for each of the five participating company B projects.

Table 6.2.3 Company B KPI Results

Key Performance Indicator	Project B/1	Project B/2	Project B/3	Project B/4	Project B/5	Company Mean
Predictability Construction - Cost	75	75	27	95	76	70 std.dev. 25.3
Predictability Construction - Time	25	39	26	19	60	34 std.dev. 16.4
Client Satisfaction - Service	55	10	10	27	55	31 std.dev. 22.6
Client Satisfaction - Product	55	55	8	2	20	28 std.dev. 25.5
Employee Satisfaction	61	67	45	46	82	60 std.dev. 15.4
Hours Worked (per week)	22	14	18	20	38	22 std.dev. 9.2
Training Days (per year)	88	75	72	89	94	84 std.dev. 9.6
Project Mean	54	48	29	43	61	47 std.dev. 23.8

6.2.5 COMPANY B KPI ANALYSIS

The Key Performance Indicators (KPI's) selected for the measurement and benchmarking of project performance is based on the Kaplan and Norton Balanced Scorecard framework. The effect is a holistic appraisal of project performance based on four interrelated performance perspectives, identified as, Financial, Customer, Internal and Learning & Innovation. It is therefore a reasonable presumption that variations between the selected KPI's are likely to be significant due to the eclectic nature of the data gathering methodology.

The Company B mean for project performance was 47% with a standard deviation of 23.8, considerably greater than the standard deviation for Team Rating (5.4). The range of results is also noteworthy, ranging from a KPI mean high of 84% for the 'Training Days' indicator to a KPI mean low of 22% for the indicator representing 'Working Hours'. An ANOVA (one-way) calculation corresponds with the opening premise and provides a $F_{obt} = 8.00^{**}$ which is greater than F_{crit} at both the 0.05 and 0.01 level of significance (see Appendix H, Table H.2.3). It may therefore be concluded that there is a significant difference in the mean values associated with the seven indicators selected for evaluating company B performance and for that reason reject the null hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$.

In terms of KPI averages it would appear that Company B management place considerable emphasis on cost control with four of the five projects recording an industry benchmark of 75% and above for 'Predictability – Construction Cost'. A company mean benchmark result of 70% implies that in corporate terms they are performing equal to or better than 70% of other construction companies. In construction predictability terms Company B is on average bringing projects in on budget but are approximately +11% over in relation to project(s) timescale. Client Satisfaction for both service and product perform below average with 31% and 28% respectively. It should be noted that the highest benchmark score for both client satisfaction criteria was 55%. This equates to a questionnaire response of eight out of ten. In isolation this is a respectable response, only when put in to the context of a construction industry standard is the value diminished. It may be that time slippage has tempered client perceptions and/or in an effort to manage construction costs client expectations with regard to quality has been compromised. Training days (per year) was consistently high across all the projects delivering a creditable industry benchmark value of 84% and a standard deviation of 9.6. The 'Hours Worked' indicator was the lowest company benchmark at 22% and equates to an average working week of approximately 48.5 hours per week. This was consistent across all company B projects studies and has the lowest standard deviation of 9.2. Employee satisfaction recorded a company mean of 60% and compared favourably with the overall Team Rating of 69%. A Pearson's correlation between the two sets of figures produced a strong coefficient of +0.7, indicating a potential relationship. A student's two-tailed t-test based on the null hypothesis; H_o: $\mu_1 = \mu_2$ produced a value of 0.2 and therefore accept the null hypothesis. This was verified by an analysis of variance, F_{obt} = 1.56, less than F_{crit} at 0.05 level of significance = 5.32. Therefore it may be concluded that there is no significant difference in the mean value between the KPI employee satisfaction standard and Team Rating. The outcome does support the notion that elements of commonality may exist between the overall team cohesion of the project members and individual perceptions of employee satisfaction.

An ANOVA (two-way) was carried out to assess the variance of performance between the key performance indicators and the projects, (see Appendix H, Table H.2.4). Given that the level of F_{obt} = 11.50** 'Indicator' is greater than F_{crit} at both the 0.05 and 0.01 level of significance and the F_{obt} = 4.05* 'Project' is greater than F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated between the seven indicators and between the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A. It is not surprising to have an 'Indicator' value significantly greater than the F_{crit} at both the 0.05 and 0.01 level of significance but the two-way ANOVA results also illustrates a variance in KPI values between the five projects. The project performance benchmarks have a sizeable range of values from a high of 61% (Project B/5) to a low of 29% (Project B/3) with a Company B mean of 47% and a standard deviation of 12.1. It would appear that the performance of Project B/3 is at variance when in comparison with the other projects studied. Across the four business perspectives adopted, Project B/3 has the lowest mean figures for three, namely Financial, Customer and Internal with only Training and Innovation the exception, ranked fourth out of a possible five with 72%. Accepting the premise that the underlying definition of 'true' team work is performance, the underachievement of project B/3 as a whole (team rating and KPI results) is probably best expressed as dysfunctional team work.

6.2.6 COMPANY B TEAM RATING / PROJECT PERFORMANCE ANALYSIS

The overriding declaration of the research programme is that better performing teams will produce better performing projects. By collating the project mean data values for both the team (team rating) and the project (project performance) it may be possible to evaluate the potential of a relationship between these two primary variables. The mean value for company B team rating was 69% with a standard deviation of 3.8 and for project performance the mean project KPI was 47% with a standard deviation of 12.1, across the projects.

In an effort to ascertain the probability of a link an ANOVA (one-way) was carried out, (see Appendix H, Table H.2.5). The result illustrate that the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01level of significance. It may be concluded that there is a significant difference in the mean values associated with the five company B projects based on Team Rating and Project Performance and therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2$. To corroborate the ANOVA test a student's two-tailed paired t-test was undertaken, H_o: $\mu_1 = \mu_2$. This produced a ϱ-value of 0.006 and therefore substantiates the initial findings of the ANOVA, rejecting the null hypothesis in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2$. A Pearson's correlation between the two sets of figures produced a correlation coefficient of +0.8 indicating a strong level of association between the values obtained for the Team Rating and the corresponding results for Project Performance. The findings of all three parametric methods endorse the commonly held premise that varying levels of team working will influence the resultant project performance and support the founding concept that a better performing team will in all probability produce better performing projects.

Ranking the projects from highest to lowest mean team rating highlights a number of exact matches between the order of team rating and corresponding project performance. To quantify the association between the two variables a Spearman rank correlation coefficient produced a value of +0.90 (strong), slightly higher than the parametric Pearson's correlation coefficient, see table 6.2.4.

Table 6.2.4 Company B Project Ranking.

Rank	Project	Team Rating	Project Performance
1st.	Project B/5	74% (rank 1st.)	61% (rank 1st.)
2nd.	Project B/1	72% (rank 2nd.)	54% (rank 2nd.)
3rd.	Project B/4	70% (rank 3rd.)	42% (rank 4th.)
4th.	Project B/4	68% (rank 4th.)	47% (rank 3rd.)
5th.	Project B/3	62% (rank 5th.)	29% (rank 5th.)

Strength of Relationship		
Pearson's Correlation Coefficient	**+0.80**	**Strong**
Spearman Rank Correlation Coefficient	**+0.90**	**Strong**
Confidence Level (H_o: $\mu_1 = \mu_2$)	ρ = **0.006**	**Reject H_o**

In an attempt to determine whether any of the five projects were performing differently, an ANOVA (two-way) was undertaken (see Appendix H, Table H.2.6). Given that the level of F_{obt} 'Team' is greater than F_{crit} at both the 0.05 and 0.01 level of significance for the 'Team' it may be concluded that there is a significant difference in the mean values associated between the Team, therefore reject the null hypothesis. In the case of the variance between the five projects studied F_{obt} 'Project' is less than F_{crit} at the 0.05 level of significance and it may be concluded that there is no significant difference in the mean values associated between the projects studied and therefore accept the null hypothesis, H_o.

The value obtained for 'team' variance verifies the findings of the one-way ANOVA statistical investigation but the 'Project' measurement is somewhat surprising. Previous investigation highlighted a difference in mean values at the 0.05 level of significance when paired with project 'Indicator' values yet when these values are aggregated and coupled with the related team rating no significant deviation from the population mean is identified. This suggests that that none of the projects studied are performing notably different from the other projects although when evaluated individually, i.e. 'Team Rating' and 'Project Performance', there is a significant difference in mean values for team rating, $F_{obt} = 27.49^{**}$, substantiating the one-way ANOVA $F_{obt} = 14.20^{**}$ but not for project performance, $F_{obt} = 2.87$, less than F_{crit}.

6.3 DATA ANALYSIS: COMPANY C

Company C is a leading international provider of construction and support services to public and private sector customers across a diverse range of market sectors. Over the past decade Company C has become one of the UK's leading construction and support services groups with an annual turnover of nearly £2 billion and employs more than 25,000 workers worldwide. The construction services business employs approximately 7,200 people and had an annual construction sector turnover of £1.5bn in 2004. Company C provided access to three construction projects and their site management teams. The data gathering for three case study projects was carried out between November 2004 and April 2005; all projects were located in the Scottish central belt.

6.3.1 COMPANY C - THE PARTICIPANTS

The construction Company C has three project case studies, see table 6.3.1.

Table 6.3.1 Company C Project Profile

Project	Type of Work	Team No.	Value (£)	Time (Weeks)
1/ Project C/1	New Build	8	20.0 million	78 weeks
2/ Project C/2	Refurbishment	6	6.3 million	72 weeks
3/ Project C/3	New Build	3	7.0 million	47 weeks

6.3.2 COMPANY C TEAM VARIABLE RESULTS SUMMARY

The following table 6.3.2 charts the seven mean team variable rating for each of the three participating company C projects.

Table 6.3.2 Company C Team Variable Results

Team Variable	Project C/1	Project C/2	Project C/3	Company Mean
Interdependency	90	87	79	85 std.dev. 5.7
Membership Diversity	73	79	71	74 std.dev. 4.2
Team Dynamics	87	81	72	80 std.dev. 7.5
Trust	75	76	68	73 std.dev. 4.4
Corporate Intent	76	71	61	69 std.dev. 7.6
Systems, Policies & Customs	80	79	62	74 std.dev. 10.1
Culture	81	68	73	74 std.dev. 6.6
Project Mean	80	77	69	76 std.dev. 5.3

The team rating results were obtained using an attitude statement questionnaire issued to all participating project team members. For Company C there were a total of nineteen questionnaires issued with eighteen respondents. One questionnaire received from project C/1 was not included due to the very recent employment of that team member. In total seventeen questionnaires were included in the research, representing a response rate of 89%. All participants are site based professionals and employed by the principal contractor. The majority of respondents were male (16) with one female participant. The average length of company employment of those questioned in the research was seventy two months. In an effort to establish empirical evidence of a relationship between team variables and project performance a number of statistical analysis techniques have again been employed. They are as follows; team and project means, standard deviations, analysis of variance (ANOVA one-way and two-way), student's two tailed paired t-test, Pearson's correlation and Spearman Rank Correlation Coefficient.

6.3.3 COMPANY C TEAM VARIABLE ANALYSIS

Company C has a mean team rating of 76% with a standard deviation of 5.3. The value of the standard deviation suggests that there is marginal variation in team member perception. The result pattern for Company C resembles several of the findings of Company B. For example, the two highest team ratings are Interdependency and Team Dynamics with 85% and 80% respectively, with Corporate Intent the lowest comparative figure, recording a mean of 69%. All three projects rated Interdependency highest within their team evaluation with two out of the three team compositions also rating Team Dynamics second highest in terms of ranking. The team variable 'interdependency' relates to team awareness for the need to work together, recognising that success is dependent on a cumulative effort whereas team dynamic focuses on team size and frequency of communication (formal and informal) between team members. Due to the variation in team compositions, for example the largest sample team size was eight members (Project C/1) with the smallest being three members (Project C/3), it may have been anticipated that the variable(s) associated with communication, interaction and empathy between project participants would rate highly particularly with the smaller sized groups. The other variables represented a more random results pattern across the three projects studied with no obvious configurations to suggest a distinct corporate or cultural influence. In terms of mean team rating across the case study projects the lowest variable score was 'corporate intent' with 69%. Only 5% separated this rating from the third highest rating of 74% and only 16% separated the lowest team variable percentage (69%) from the highest (85%). Taking in to account the research methodology and scale of measurement adopted (Likert Scale) the 16% differential between highest and lowest team rating figures represents a minor disparity between the team variable values.

To test the significance of the team variable outcomes an ANOVA (one-way) calculation produced a F_{obt} value of 1.79 (see Appendix H, Table H.3.1). The level of F_{obt} is less than F_{crit} at the 0.05 level of significance it may be concluded that there is no significant difference in the mean values associated with the seven variables selected for evaluating the average Company C team ratings and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$. The ANOVA result confirms what may have been anticipated with a relatively low standard deviation value of 5.3. The mean team rating for each of the projects does appear to have an equivalence with the respective 'employee satisfaction' key performance indicator benchmark score. The varying levels of personal satisfaction evident within the assorted project group structures may interface with the team environment and personal perspectives. In an effort to analyse the possible relationship between the 'Team Rating' and 'Personal Rating' i.e. Employee Satisfaction a number of statistical computations where undertaken. The strength of relationship via a Pearson's Correlation was calculated at +0.8 coefficient, classified as a strong / marked association. The level of influence, determination of coefficient (RSQ) was estimated at 90% suggesting that improvements in team 'satisfaction' would contribute in a noticeable manner to personal / employee satisfaction. A two-tailed paired t-test assessing the significant difference between the means produced ϱ=0.08, this implies that there is no statistical confidence in the proposed relationship between these two sets of data. Regardless, it is an interesting and noteworthy relationship that may benefit from further investigation using a larger sample size and investigated across corporate boundaries.

A two-way ANOVA was calculated to investigate the relationship between the team rating variables and case study projects (see Appendix H, Table H.3.2). The value of F_{obt} for 'Variable' and F_{obt} for 'Project' are both greater than F_{crit} at the 0.05 level of significance. It should be noted that 'Project' is also greater than F_{crit} at the 0.01 level of significance. It may be concluded that there is a significant difference in the mean values associated between the seven variables and between the five projects studied. Although from the 'F' values obtained it is evident that the variation between the 'Project' is sizeable in comparison with the 'Variable'. It is therefore appropriate to reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A.

On inspection it can be seen that Project C/1 (mean 80% and standard deviation 6.3) and C/2 (mean 77% and standard deviation 6.3) have a very similar team variable rating portfolio and subsequently comparable results. Whereas Project C/3 has a similar range of results producing a project standard deviation of 6.3 but has an overall weaker set of ratings that produce a mean team rating of 69%. It is therefore likely that Project C/3 is, in terms of team rating values performing differently in comparison with the other two projects. The most noticeable variations in the team variable percentages are related to Organisational Context, with 61% for corporate intent and 62% for systems, policies and procedures. The other two Company C projects averaged 74% (Corporate Intent: Project C/1, C/2) and 80% (Systems, Policies & Procedures: Project C/1, C/2) respectively for Organisational Context. In relation to personnel profiles and length of service with the company there does not appear to be any observable reason for the distinction. The sample size was smaller with three participants whereas the other two projects had more team members and this may have diluted the emphasis on organisational influences. It may be an indication of personal and group dissatisfaction with the project performance; the project had the lowest KPI figures, this fact is liable to influence the relationship with senior project stakeholders that represent the company and subsequently shape individual / team perceptions.

6.3.4 COMPANY C KPI RESULTS SUMMARY

The project performance results where collated using a customised suite of seven recognised industry KPI's from the Constructing Excellence All Construction and Respect for People theme. The following table 6.3.4 charts the seven mean key performance indicators for each of the three participating company C projects.

Table 6.3.3 Company C KPI Results

Key Performance Indicator	Project C/1	Project C/2	Project C/3	Company Mean
Predictability Construction - Cost	75	22	26	41 std.dev. 29.5
Predictability Construction - Time	60	34	33	42 std.dev. 15.3
Client Satisfaction - Service	85	100	55	80 std.dev. 22.9
Client Satisfaction - Product	85	85	8	59 std.dev. 44.5
Employee Satisfaction	73	60	45	59 std.dev. 14.0
Hours Worked (per week)	22	26	12	20 std.dev. 7.2
Training Days (per year)	92	89	95	92 std.dev. 3.0
Project Mean	70	59	39	56 std.dev. 24.5

6.3.5 COMPANY C KPI ANALYSIS

The holistic nature of the performance measurement model used to collate project performance data is likely to identify clearly project and company strengths and weaknesses. The mean Company C project performance score is 56% with a high standard deviation 24.5. This supports the initial premise of a variable distribution of value and for company C the extent is 72%, ranging from a high of 92% for Training day per year to a low of 20% for Working Hours per week. Within the KPI Project performance suite of results a number of performance patterns are evident. Training (days per year) consistently scores highly with a company mean benchmark of 92% and a standard deviation of 3.0, the lowest standard deviation of all the KPI's. This result implies that within the UK only 8% of companies are performing better, a commendable benchmark score. Client Satisfaction – service also performs notably with an above average KPI benchmark score of 80% but has a more uneven set of results exemplified in a standard deviation of 22.9. Interestingly the individual client satisfaction – service benchmarks range from a high of 100% to a more moderate 55% but within the context of the individual projects being studied the client satisfaction – service benchmark is either the highest or second highest benchmark result recorded.

On average 'Working Hours' received the lowest benchmark score of 20%. This was relatively consistent across the three project studies and produced the second lowest standard deviation of 7.2. This equates to an average working week for the project participants of approximately 51hours. One project averaged 53 hours per week (12%) and moreover recorded the lowest benchmark score for employee satisfaction with 45%. Whereas the other two projects, C/1 and C/2 recorded 22% and 26% for working hours and 73% and 60%, respectively for employee satisfaction. In light of recent EU developments it may be worth investigating hours worked in an effort to improve work-life balance and comply with the EU 'Working Directive' on a voluntary basis. Client satisfaction – product recorded a satisfactory 59%, this result was tempered due to a neither satisfied / nor dissatisfied client response for Project C/3. Both financial perspective indicators (Predictability – construction cost and

Predictability – construction time) recorded potentially motivating benchmark scores. Small gains in the predictability of both construction cost and time would translate in to significant increases in benchmark performance.

To test the variance between the KPI outcomes an ANOVA (one-way) was calculated, (see Appendix H, Table H.3.3). The resultant F_{obt} was 3.26*. Given that the level of F_{obt} is greater than F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the mean company C project performance indicators and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$. As suggested at the outset of the research due to the methodology associated with the data collection it is unsurprising to conclude that there is a marked difference in the values linked with the KPI's employed. Analysis of company C projects in relation to KPI values suggest that may be a notable difference in KPI means values between the three case study projects.

To test this hypothesis a two-way ANOVA was conducted, (see Appendix H, Table 3.4). The calculated result for F_{obt} 'Indicator' is 5.11** and for F_{obt} 'Project' is 4.96*. The level of F_{obt} 'Indicator' and 'Project' is greater than F_{crit} at the 0.05 level of significance. It may be concluded that there is a significant difference in the mean values associated between the seven indicators and between the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A. This confirms that in all probability one or more of the Company C projects are at odds, KPI wise, with the other projects. Dealing with the projects in pairs, the variation between Project C/1 and project C/2 is 11%. The difference between Project C/2 and Project C/3 is 20% and the difference between Project C/1 and Project C/3 is 31%. It is therefore most likely that Project C/3 is at odds with the other two project values. For Project C/3, five of the seven KPI results failed to score above 50% coupled with having ownership of five of the lowest KPI results recorded. Only Predictability Construction Time and Training (days per year) produced a KPI score better than the lowest when compared with any of the other project KPI's. Two business viewpoints, the financial and internal perspectives recorded results below the company mean. This may also help account for the lower than average results achieved for Project C/3 team rating.

6.3.6 COMPANY C TEAM RATING / PROJECT PERFORMANCE ANALYSIS

To test the principle research premise that improved team working is unrelated to enhanced project performance an ANOVA (one-way) was calculated, (see Appendix H, Table H.3.5). The calculated value of F_{obt} is 4.01. As the level of F_{obt} is less than F_{crit} at the 0.05 level of significance it may be concluded that there is not a significant difference in the mean values associated with the three company C projects based on Team Rating and Project Performance and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2$. To further evaluate the probability of a team – project performance relationship a student's two-tailed t-test of the research hypothesis was also undertaken; H_o: $\mu_1 = \mu_2$. In collaboration with the ANOVA (one-way), the null hypothesis was accepted with a ϱ value of 0.075 suggesting that there is no considerable difference between the mean values and that there is insufficient empirical evidence to support with any significant degree of confidence the notion of a team – project performance relationship with Company C case study data. It is worth noting that a correlation between the two primary variables (Team and Performance) is near perfect with a Pearson's correlation coefficient of +0.99; this figure demonstrates a very strong association between the two principle research variables, team working and project performance. In comparison with the other company projects undertaken Company C has a smaller sample size, three project case studies and a total of seventeen team member participants and therefore the distinction between team and performance may be indeterminate due to the smaller population sample.

In an effort to authenticate the correlation findings the Team Ratings and Project Performance(s) were ranked in order of team rating outcome highest to lowest. Interestingly, the team rating against project performance provide an exact match with Project C/1, Project C/2 and Project C/3 ranked first, second and third respectively resulting in a Spearman rank correlation coefficient of +1.00, see table 6.3.4.

Table 6.3.4 Company C Project Ranking

Rank	Project	Team Rating	Project Performance
1st.	Project C/1	80% (rank 1st.)	70% (rank 1st.)
2nd.	Project C/2	77% (rank 2nd.)	59% (rank 2nd.)
3rd.	Project C/3	69% (rank 3rd.)	39% (rank 3rd.)

Strength of Relationship		
Pearson's Correlation Coefficient	**+0.99**	**Very strong**
Spearman Rank Correlation Coefficient	**+1.00**	**Very Strong**
Confidence Level (H_o: $\mu_1 = \mu_2$)	ρ = **0.075**	**Accept H_0**

An ANOVA (two-way) was conducted, (see Appendix H, Table H.3.6) to test variance between mean team rating and mean project performance. The calculated result for F_{obt} 'Team' is 11.06 and for F_{obt} 'Project' it is 4.51. Since the level of F_{obt} 'Team' is less than F_{crit} at the 0.05 level of significance it may be concluded that there is not a significant difference in the mean values associated between the Team Ratings. Therefore accept the null hypothesis, H_0. The level of F_{obt} 'Project' is also less than F_{crit} at the 0.05 level of significance for the 'Project'. It may be concluded that there is no significant difference in the mean values associated between the projects studied within the context of the Team Rating criteria and therefore accept the null hypothesis, H_o. The results illustrate that for Company C there appears to be no significant difference between the mean values obtained for the team ratings or project performance scores. The results suggest that there is no statistical inference to confidently link perceptions of team 'cohesion' with recorded levels of project performance. This outcome upholds the initial findings of the ANOVA (one-way) and the student's two-tailed t-test, both accepting the null hypothesis. The most likely factor influencing the lack of statistical confidence is the small sample size, three companies participated. In the case of Company C there would appear to be an inclination to support the primary research hypothesis (i.e. correlation results) but remains unsubstantiated due to insufficient sampling.

6.4 DATA ANALYSIS: COMPANY D

Company D is one of the UK's largest construction companies. The parent group ranks among the largest construction firms in Europe with a corporate turnover in excess of £4.5 billion and currently employs approximately 30000 people worldwide. The construction arm is one of five distinct corporate business units with regional offices located across the UK. Construction turnover for 2004 was £1.47 billion. Company D provided access to five construction projects and their site management teams. The five project case studies were carried out between February and March 2005; all projects were located in the Scottish central belt.

6.4.1 COMPANY D - THE PARTICIPANTS

Company D has five project case studies contributing to the research, see table 6.4.1.

Table 6.4.1 Company D Project Profile

Project	Type of Work	Team No.	Value (£)	Time (Weeks)
1/ Project D/1	Refurbishment	5	9.9 million	78 weeks
2/ Project D/2	New Build	2	5.8 million	66 weeks
3/ Project D/3	New Build	7	25.0 million	91 weeks
4/ Project D/4	New Build	8	25.0 million	94 weeks
5/ Project D/5	Refurbishment	9	20.0 million	84 weeks

6.4.2 COMPANY D TEAM VARIABLE RESULTS SUMMARY

The following table 6.4.2 charts the seven mean team variable rating for each of the five participating company D projects.

Table 6.4.2 Company D Team Variable Results

Team Variable	Project D/1	Project D/2	Project D/3	Project D/4	Project D/5	Company Mean
Interdependency	86	86	83	93	76	85 std.dev. 6.1
Membership Diversity	57	78	74	68	67	69 std.dev. 8.0
Team Dynamics	86	80	82	84	71	81 std.dev. 5.8
Trust	70	72	76	82	69	74 std.dev. 5.3
Corporate Intent	60	78	69	78	70	71 std.dev. 7.5
Systems, Policies & Customs	75	70	77	69	70	72 std.dev. 3.6
Culture	67	72	72	78	70	72 std.dev. 4.0
Project Mean	72	77	76	79	70	75 std.dev. 5.8

The team rating results were obtained using an attitude statement questionnaire issued to all participating project members. For Company D there were a total of thirty two questionnaires issued with thirty one questionnaires returned representing a 97% response rate. All participants were site based professionals and employed by the principal contractor. All the respondents were male (100%) with no female participants. The average length of company employment for those participating in the research was one hundred and thirty five months, just over eleven years. A number of statistical investigative techniques are employed, principally means, standard deviations, analysis of variance (ANOVA, one-way and two-way), student's two-tailed paired t-test, Pearson's correlation and Spearman Rank Correlation Coefficient.

6.4.3 COMPANY D TEAM VARIABLE ANALYSIS

The mean value for the team rating was 75% with a standard deviation of 5.8. Taking in to consideration all thirty five individual team rating values the range was 36%, from a Project D/4 high of 93% (Interdependency) to a team variable low of 57% (Membership Diversity) for Project D/1. Analysis based exclusively on the seven team variable means illustrates a more moderate difference in team rating values (16%), ranging from a high of 85% (Interdependency) to a low of 69% (Membership Diversity). Due to the nature of the work and the limited cross-section of professional background it may have been foreseen that membership diversity could be compromised. The results also highlight the issue that little effort is made to balance the bias of team functionality with diverse personality traits. Based on basic employee statistics eighteen out of thirty one employees were employed in a construction management / supervisory function and therefore are likely display a comparable construction related outlook as well as a stereotypical behavioural disposition in their everyday team member role and by doing so diluting the behavioural diversity of the group. Consistent with other projects studied the two most prominent team variables are Interdependency (85%) and Team Dynamics (81%) both variables are grouped within the Group Compatibility and Diversity category.

Very much associated with team awareness at a 'tactical' level is the team variable - trust. It is widely recognised that trust evolves over time spent working in a co-dependent environment. Efforts to maintain team compositions over a number of projects have demonstrated benefits in efficiency. In most of the case studies reviewed the projects were more than two-thirds complete (average 77%) and all site teams had been together for at least a year. The advantage of time spent working together is to some extent substantiated in the third highest team rating of 74% for 'Trust' and a comparatively low standard deviation of 5.3. This suggests that across the projects studied the trust ethos would appear to be a constant factor. Interestingly, the correlation between the Trust rating and mean project ratings is +0.87, the highest correlation value between any of the team variables and project means. Although not the highest recorded team variable value the low standard deviation coupled with the high correlation value may identify the trust variable as a core characteristic of group cohesiveness.

The variable(s) Corporate Intent (71%) and Systems, Policies & Customs endeavour to measure the employees' perception of team working philosophies as an integral spirit of company strategy as well as the administrative structure that would support this business intent. Rating(s) of 71% and 72% respectively illustrate significant team member awareness and recognition of these company attributes. A higher than research average, these figures indicate that a corporate 'training' initiative may be ongoing. A low labour turnover, (average length of service = 11+ years) inevitably helps to contribute to improved company interaction and communication with employees. For an industry that is fundamentally project based and is recognised to have a labour force that is transient in nature which in turn supports short-lived team formations, an average length of employee service of eleven plus years is surprising. The team rating results demonstrate a consistency in outlook between the individual, team and company that is not replicated in the other company project case studies.

To test the level of association between the team variables, Null Hypothesis H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ an ANOVA (one-way) was carried out giving a F_{obt} value of 4.72**, (see Appendix H, Table H.4.1). Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average company D team ratings and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$. Although the statistical data implies that there is a significant difference in the mean values, all values are in relative terms high.

To further test the variance in variable results and include the project values an ANOVA (two-way) was calculated to test the Null Hypothesis, H_o. This resulted in a value of $F_{obt} = 8.93$** for 'Variable' and $F_{obt} = 4.76$** for 'Project', (see Appendix H, Table H.4.2). Given that the level of F_{obt} 'Variable' and 'Project' is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated between the seven variables and between the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A. The two-way ANOVA outcome confirms the initial findings that there is a significant difference between the team variable mean values. It also implies that there is a significant difference between the five company D projects within the context of the team variables. This is somewhat surprising considering some of the basic statistical data such as mean project value 75%, standard deviation 3.6 and a mean project value range of 9% would predispose that there was little to differentiate the Company D case studies. It is likely that the two lowest scoring projects have produced results that are different from the other three. Project D/5 and project D/1 record team ratings of 70% and 72% respectively. Although when pairing the results Project D/5 and D/1 are similar, Projects D/2 and D/3 are comparable as is Project D/3 and D/4. The variance may come about due to the relatively low and high pairing values. That said the team ratings are still high in contrast with the other two companies involved in the research project.

6.4.4 COMPANY D KPI RESULTS SUMMARY

The following table 6.4.3 charts the seven key performance indicators for each of the five participating company D projects.

Table 6.4.3 Company D KPI Results

Key Performance Indicator	Project D/1	Project D/2	Project D/3	Project D/4	Project D/5	Company Mean
Predictability Construction - Cost	16	35	20	75	20	33 std.dev. 24.5
Predictability Construction - Time	28	16	27	60	34	33 std.dev. 16.4
Client Satisfaction - Service	55	55	100	100	100	82 std.dev. 24.6
Client Satisfaction - Product	21	0	100	100	85	61 std.dev. 47.3
Employee Satisfaction	45	85	77	75	62	69 std.dev. 15.7
Hours Worked (per week)	17	17	23	17	24	20 std.dev. 3.6
Training Days (per year)	95	86	91	93	88	91 std.dev. 3.6
Project Mean	40	42	63	74	59	55 std.dev. 27.2

6.4.5 COMPANY D KPI ANALYSIS

The Key Performance Indicator mean value for Company D was 55% with a standard deviation of 27.2. From the results it would appear that Company D has a number of corporate strong points, namely Client Satisfaction – Product, Client Satisfaction - Service, Employee Satisfaction and Training all recording benchmark scores above 50% and exceeding the company mean KPI value. In a similar pattern with other company findings the mean value per KPI ranged from a high of 91% for Training days per year to a low of 20% for Working hours per week. Working Hours per week was the lowest KPI score for most projects reviewed, recording a Company D benchmark score of 20% and a low standard deviation value of 3.6 suggesting little variance in hours worked across the projects studied. This equates to an average working week for employees of just over 49 hours with a range of 47.5 – 50 hours per week. In contrast with 'Working Hours', 'Training Days' (Average per Year) was a consistently high KPI across all the projects partaking in the research programme (standard deviation 3.6). Each employee receives an average of 4.2 days training per year, this equates to a benchmark of 91%. This level of employee / company commitment is apparent in the KPI 'Employee Satisfaction' recording a Company mean value of 69% although the standard deviation was 15.7, suggesting that not all project participants expressed a similar level of personal satisfaction. It is feasible that the generally high level of personal satisfaction crosses over in to the team environment. In an effort to analyse the possible relationship between the 'Team Rating' and 'Personal Rating' i.e. Employee Satisfaction a Pearson's correlation was undertaken to gauge the level of association between the two sets of results. The strength of relationship (Correlation) was calculated at +0.7 indicating a strong / marked association.

Within the KPI Project performance matrix a number of performance patterns are evident. Training and Client Satisfaction - Service both score highly with a company benchmark of 91% and 82% respectively although the standard deviation for Client Satisfaction - Service at 24.6 reflects a more variable set of KPI results. More moderate responses of 69% (standard deviation 15.7) and 61% (standard deviation 47.3) are achieved for Employee Satisfaction and Client Satisfaction – Product. Whereas Construction Predictability - Cost and Time under perform in terms of a corporate benchmark figure with 33% but intriguingly this does not appear to overly influence the client perception of project satisfaction. This signifies that within the UK sector 67% of construction companies are performing better in comparative terms with construction predictability. These figures highlight a particular trend but only in so far as it merits investigation. The research does not take in to account any mitigating circumstances associated with the various projects and therefore client initiated changes and / or other project variations are not factored in to the predictability equation. Taken in congruence with Client Satisfaction it would appear that the 'unpredictability' of the projects studied has in general terms not influenced customer perspectives. Thus giving confidence that the level of predictability associated with construction cost and time is in broad compliance with the client's wishes and would seem to be an acknowledged component of the evolving project process. It may also be an indication that Company D recognise and promote the need for improved communication channels between contractor and client /client representative to match the construction process with customer aspirations.

To assess the significance of the KPI results an ANOVA (one-way) was calculated producing a F_{obt} value of 6.50**, (see Appendix H, Table H.4.3). Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average company D project performance indicators and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$. The result concurs with all the other ANOVA's carried out on the key performance indicator data. This outcome is not surprising considering the methodology associated with the data gathering procedures and the deliberately inherent holistic nature of the performance measurement model.

An ANOVA (two-way) test was calculated to evaluate the Null Hypothesis for both the 'Indicator' values and 'Project' values. This produced a F_{obt} value of 8.90** for 'Indicator' and a F_{obt} value of 3.58* for 'Project', (see Appendix H, Table H.4.4). Since the level of F_{obt} 'Indicator' is greater than F_{crit} at both the 0.05 and 0.01 level of significance for the 'Indicator' and 0.05 level of significance for the 'Project' it may be concluded that there is a significant difference in the mean values associated between the seven indicators, verifying the findings of the one-way ANOVA and therefore rejecting the null hypothesis in favour of the alternative hypothesis, H_A. The obtained value for 'F' 'Project' (F_{obt}) is also greater than F_{crit} at the 0.05 level of significance for the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A. In terms of overall Company D mean project performance the outcome was 55% with a standard deviation of 14.6. Whereas the Company D mean and standard deviation across the averages associated with the seven KPI's was 55% and 27.2. The notable difference in the standard deviation values is reflected in the two-way ANOVA results, the F_{obt} value for the 'Indicator' value was significant at the 0.01 level whilst the F_{obt} value for 'Project' was less prominent but still significant at the 0.05 level. Across the five projects studied the average scores ranged from a high of 74% (Project D/4) to a low of 40% (Project D/1). In terms of performance it would appear that Project D/1 and Project D/2 are performing differently from the other three projects.

Investigating the seven KPI scores it would appear that although Project D/1 and Project D/2 have similar project mean values the underlying explanation for these outcomes is quite different. In the case of Project D/2 a serious technical setback remained unresolved at the time of the study and was a major source of frustration between the project partners. It is probable that as a consequence of the ongoing dispute the Client / Client representative for Project D/2 felt justified in awarding a KPI benchmark score of zero for Client Satisfaction – Product. This is an extreme outcome but represents construction disagreements being experienced on site at the time of the study. It does highlight the fact that a response to questionnaires of this nature is very much time specific and aligned with the emotional experiences being evoked at that moment in the construction process. This may result in occasionally exaggerated responses. In other words it is fundamental to remember that the results offer a snapshot of project well-being. In terms of research methodology this is a potential consequence of lateral studies. The application of longitudinal studies may help mitigate reactions of this nature. The Client Satisfaction – Product KPI does recover within the corporate context and produces a mean benchmark of 61% which is an satisfactory standard. Within a single project performance framework the margin for recovery is limited because aspects of the KPI benchmarks are undoubtedly intra-connected. In a situation where technical difficulties are being experienced it is understandable that client perceptions of the product and possibly service are tainted. It is also conceivable that KPI's such a Construction Predictability - Cost and Construction Predictability - Time become less foreseeable due to likely disruption, probable delay and an increase in associated costs. In this situation Client Satisfaction – Service recorded a moderate 55%, but Construction Predictability – Time scored 16%, the lowest project score for that particular performance indicator. At the time of the survey Construction Predictability - Cost remained relatively unaffected although it could be that related costs had not yet filtered though to the project accounts. In other areas Project D/2 has comparable figures with the three top performing projects. In the case of Project D/1 the KPI's consistently under perform in terms of company averages with only Training days per year (95%) recording a KPI standard comparable with the other projects studied. Employee Satisfaction has a KPI of 45%, the lowest of the five projects but distinctly different from the company mean Employee Satisfaction KPI of 69%. This is also at odds with the team rating value where Project D/1 recorded 72% which was on a par with the Company D mean Team Rating of 75%.

The outcome questions the soundness of a Pearson's correlation between Company D projects mean team ratings and the corresponding Employee Satisfaction KPI value of +0.7, strong / marked. Project D/1 Predictability – Construction Cost, Predictability, Construction Time, Client Satisfaction – Product, Employee Satisfaction and Hours Worked (per week) values are all below the both the Project mean KPI (33%, 33%, 61%, 69% and 20%) and Company D mean KPI value (55%) with 16%, 28%, 21%, 45% and 17% respectively. The difference in project performance values are compounded by Project D/4 with a mean KPI of 74%. Note, Project D/4 KPI values for both predictability scores are estimates due to a request for client confidentiality with regard to both timescales and budgetary amendments.

6.4.6 COMPANY D TEAM RATING / PROJECT PERFORMANCE ANALYSIS

The basic premise of this research programme is that better performing teams are unrelated to any tangible enhancement in project performance. To test the Null

Hypothesis, H_o: $\mu_1 = \mu_2$ an ANOVA (one-way) was conducted giving a F_{obt} value = 8.30*, (see Appendix H, Table H.4.5). Given that the level of F_{obt} is greater than F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated with the five company D projects based on Team Rating and Project Performance and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2$. The ANOVA (one-way) result is significant at the 0.05 level of significance (typical for behavioural studies) and implies that the data is good enough to support a conclusion with 95% confidence but there still remains a 1:20 chance of being wrong.

In an effort to validate the one-way ANOVA a student's two-tailed paired t-test was carried out, H_o: $\mu_1 = \mu_2$. This produced a calculated ϱ-value of 0.033, significant at the 95% level of confidence, therefore reject the null hypothesis in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2$. This concurs with the initial one-way ANOVA findings, supporting the notion that varying levels of team cohesion will correspond to variances in project performance.

The strength of relationship between the project Team Rating and corresponding Project Performance produced a Pearson's correlation of +0.4, moderate. This figure suggests an explicit albeit modest association between the two principal variables and provides further empirical evidence that an improvement in team performance is apt to influence project performance in a correspondingly positive manner. Ranking the projects in order of team rating illustrates the relationship between the two variables, Team and Performance. The relationship between ranks is substantiated with a Spearman rank coefficient of +0.50. There is one exact match; Project D/4* has the highest team rating and corresponding project performance although values for Construction Predictability – Cost and Time are estimated at zero variance from the planned construction cost and time due to client confidentiality. The second placed project performance ranks third in terms of team rating and the fifth place project performance ranks fourth in the order of merit for team rating, see table 6.4.4.

Table 6.4.4 Company D Project Ranking

Rank	Project	Team Rating	Project Performance
1/	Project D/4*	79% (rank 1st.)	74% (rank 1st.)
2/	Project D/2	77% (rank 2nd.)	42% (rank 4th.)
3/	Project D/3	76% (rank 3rd.)	63% (rank 2nd.)
4/	Project D/1	72% (rank 4th.)	40% (rank 5th.)
5/	Project D/5	70% (rank 5th.)	59% (rank 3rd.)

Strength of Relationship

Pearson's Correlation Coefficient	**+0.40 Weak / Moderate**	
Spearman Rank Correlation Coefficient	**+0.50 Moderate**	
Confidence Level (H_o: $\mu_1 = \mu_2$)	**$\rho = 0.033$**	**Reject H_o**

* Project performance figures relating to 'Predictability – Construction Cost' and 'Predictability – Construction Time' where both taken at 0% variance from the initial estimated project figures and benchmarked accordingly.

To assess whether any of the five projects where performing differently an ANOVA (two-way) was calculated producing a F_{obt} value of 10.23* for 'Team' and a F_{obt} value of 1.46 for 'Project', (see Appendix H, Table H.4.6). The level of F_{obt} 'Team' is greater than F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated between the Team / Performance mean values and therefore reject the null hypothesis H_o: in favour of the alternative hypothesis, H_A. In the case of project variability between the five projects studied F_{obt} 'Project' is less than F_{crit} at the 0.05 level of significance it may be concluded that there is not significant difference in the mean values associated between the projects studied and therefore accept the null hypothesis, H_o. This set of results suggest that although there is a significant difference in the values associated with the team / performance value, initially identified in the one-way ANOVA, there is no evidence to suggest that one project is performing differently from any other project within the context of team and performance. There is empirical evidence to support the idea that teams influence performance and the probability, based on the data gathered and statistical techniques employed, is significant giving confidence that anecdotal evidence extolling the virtues of team based working is accurate. The empirical evidence also measures the likelihood of achieving these results entirely by chance is improbable, calculated at 95% confidence.

6.5 INTER - COMPANY DATA ANALYSIS

One of the research goals is to ascertain if the participating companies performed differently from each other and if it was possible to distinguish corporate characteristics from the aggregated project results. In an effort to identify performance patterns three research parameters have been created, 1/ variation in mean team variable ratings between the three companies, 2/ variation in mean KPI scores and 3/ variation in team - project performance. For each of the research parameter an Analysis of Variance (ANOVA) one-way has been calculated and concludes with a Pearson's and Spearman Rank Correlation Coefficient.

6.5.1 THE CONSTRUCTION COMPANY PARTICIPANTS

The research has three construction company contributors, see table 6.5.1.

Table 6.5.1 Construction Company Profile

Company	Sector	No. of Participants	Company Turnover (£)
1/ Company B	Construction	21	£890 million
2/ Company C	Construction	17	£1.50 billion
3/ Company D	Construction	31	£1.47 billion

6.5.2 INTER-COMPANY TEAM VARIABLE RESULTS SUMMARY

The following table 6.5.2 illustrates the seven company mean team variable rating for each of the three UK construction companies participating in this research programme.

Table 6.5.2 Inter-Company Team Variable Results

Team Variable	Company B	Company C	Company D	Variable Mean
Interdependency	76	85	85	82 std.dev. 5.2
Membership Diversity	67	74	69	70 std.dev. 3.6
Team Dynamics	77	80	81	79 std.dev. 2.1
Trust	66	73	74	71 std.dev. 4.4
Corporate Intent	62	69	71	67 std.dev. 4.7
Systems, Policies & Customs	68	74	72	71 std.dev. 3.1
Culture	68	74	72	71 std.dev. 3.1
Company Mean	69	76	75	73 std.dev. 5.3

6.5.3 INTER-COMPANY TEAM VARIABLE ANALYSIS

The three participating construction company team data analysis produces a mean team rating of 73% with a standard deviation of 5.3. Only 15% separate the highest average value of 82% (Interdependency) from the lowest average value of 67% (Corporate Intent). Bearing in mind the methodology for the data collection and subsequent evaluation of the team measurement figures, the Likert scale may dilute the magnitude of the differential between highest and lowest values. The most consistent team variable between the three companies' is Team Dynamic with an average value of 79% and a standard deviation of only 2.1, only 3% separate the mean company team ratings. Across the three companies the average team size was similar and this may be a contributing factor to the uniformity expressed in the data analysis. The highest standard deviation and as such suggesting the broadest range of mean ratings is Interdependency with 5.2 also the highest mean rating. An initial visual inspection of the results shows that Company B (76%) is the primary source of divergence with both Company C and D recording ratings of 85%. Membership Diversity ranged from a low of 67% (Company B) to a high of 74% (Company C), comparing the outcomes Company B and D are comparable (67% and 69%, respectively) with company C demonstrating a slightly more diverse team composition. In broad terms the project data illustrated offers little to distinguish any pertinent company characteristics.

On the other hand the team variable Trust has a similar range of company means, from a low of 66% (Company B) to a high of 74% (Company D) with a three company mean of 71% and a standard deviation of 4.4. In this case Company D and C are comparable (74% and 73%, respectively) with Company B recording a lower than average 66%. A similar pattern is evident with the team variable Corporate Intent. Again Company D and C have comparable results (71% and 69%, respectively) with Company B recording a lower than average 62%. The average length of employment for Company B team participants was considerably less than those employed with Company C and D. Time spent in employment with the company may be an underlying factor contributing to individual perception of team and company confidence. This relationship is replicated for Systems, Policies and Procedures although not to the same magnitude but it does underscore the possible contribution job and team security may bring to the project environment. Culture recorded exactly the same team mean ratings as Systems, Policies and Procedures with 68%, 74% and 72% for Company B, C and D respectively. In terms of team categories all three companies demonstrate a similar pattern of results. All three companies team ratings averaged the highest for team variables associated with the 'Group Diversity and Compatibility' category, 'Industry Context - Culture' was second with the 'Organisational Context' company means at the lower end of the team ratings within this research sample.

The relatively small deviation in team rating values between the variables, across the three companies may suggest comparability between the companies as well as supporting a notion that team member perceptions within the team context are themselves interdependent. In an effort to statistically prove that the team rating results for the three companies are not significantly different an ANOVA (one-way) was calculated, giving a F_{obt} value of 1.47, (see Appendix H, Table H.5.1). As the level of F_{obt} is less than F_{crit} at 0.05 level of significance it may be concluded that there is no significant difference in the mean values associated with the three company mean Team Rating and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$. This signifies that with regard to the average team ratings for the three companies, 69%, 76% and 75% - there is no statistical evidence to imply that any one company is performing differently from any of the other two companies. Taking in to account the project data and empirical evidence collected it can be confidently concluded that in terms of selecting companies for the research programme they have demonstrated similar mean team values and may be perceived to have come from a representative population sample. Although breaking down the suite of seven team variables does disclose specific corporate characteristics.

6.5.4 THE INTER-COMPANY KPI RESULTS SUMMARY

The following table 6.5.3 illustrates the seven company mean key performance indicator for each of the three UK construction companies participating in this research programme.

Table 6.5.3 Inter-Company KPI Results

Key Performance Indicator	Company B	Company C	Company D	KPI Mean
Predictability Construction - Cost	70	41	33	48 std.dev. 19.5
Predictability Construction - Time	34	42	33	36 std.dev. 4.9
Client Satisfaction - Service	31	80	82	64 std.dev. 28.9
Client Satisfaction - Product	28	59	61	49 std.dev. 18.5
Employee Satisfaction	60	59	69	63 std.dev. 5.5
Hours Worked (per week)	22	20	20	21 std.dev. 1.2
Training Days (per year)	84	92	91	89 std.dev. 4.4
Company Mean	47	56	55	53 std.dev. 21.9

6.5.5 INTER-COMPANY KPI ANALYSIS

Analysis of the Key Performance Indicator results illustrates a considerable variation in the range of results, although the company mean KPI(s) appear to be quite similar. The Project Performance mean across the three companies is 53% with a predictability high standard deviation of 21.9. Closer examination of the various company KPI profiles reveals the fact that Company C and D have comparable scoring patterns. In terms of the Kaplan and Norton balanced scorecard perspectives both companies demonstrate very similar strengths (i.e. above 50%) and weaknesses (i.e. below 50%). The strengths for both companies are 'Innovation & Training' and 'Client Satisfaction' whereas the weaker scorecard perspectives are 'Internal' and 'Financial'. Company B recorded an above average KPI for Predictability – Construction Cost (70%) and a more moderate result for Predictability – Construction Time (34%) giving a mean 'Financial' perspective that outperformed the other two companies. Company B also recorded 'Training & Innovation' as a particular corporate asset whereas 'Client Satisfaction' was a notably weak company perspective and underperformed in comparison with Company C and D. Company B 'Internal' perspective recorded KPI scores are not dissimilar with the other two companies of 60% (Employee Satisfaction) and 22% (Working Hours).

Analysis based on individual KPI's demonstrated a number of cross-corporate data patterns. For example, the KPI 'Hours Worked' averaged 21% with a very low standard deviation of 1.2. 'Training Days' (per year) and Employee Satisfaction also exhibited performance consistency across company boundaries with mean KPI's of 89% and 63%, with standard deviation's 4.4 and 5.5 respectively. Based on standard deviation calculations the KPI with the largest measure of difference was 'Client Satisfaction –Service' with a KPI of 64% and a standard deviation of 28.9. As with the team rating analysis, closer examination reveals that Company B is at odds with the other two companies, recording 31% in comparison with 80% and 82% for Company C and D, respectively. It is worth commenting that Company B performs above average for the financial perspective but it would appear to be at the expense of Client Satisfaction. Whereas both Company C and D seem to have more notable variances associated with their Financial KPI's but have managed to record above average Client Satisfaction responses. In terms of company outlook Company B places considerable emphasis on cost and time. Company C and D do not necessarily neglect cost and time variables but places emphasis on client satisfaction.

In an effort to statistically compare the overall company results for significant variations in KPI scores an ANOVA (one-way) produced a F_{obt} value of 0.62, (see Appendix H, Table H.5.2). Given that the level of F_{obt} is less than F_{crit} at 0.05 level of significance it may be concluded that there is no significant difference in the mean values associated with the three company Project Performance scores and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$. As with the ANOVA (one-way) for Team Rating, the ANOVA for Project Performance demonstrates that neither company is producing a performance scorecard that is significantly different from the other participating companies. It may therefore be concluded that Company(s) B, C and D demonstrate similar mean team and mean project performance traits.

6.5.6 INTER-COMPANY TEAM RATING / PROJECT PERFORMANCE ANALYSIS

The final company data analysis explores the level of significance between the three companies participating in the research programme and the corresponding Team and Project Performance results. The ANOVA (one-way) produced a F_{obt} value of 0.18, (see Appendix H, Table H.5.3). Since the level of F_{obt} is considerably less than F_{crit} at 0.05 level of significance it may be concluded that there is no significant difference in the mean values associated with the three company Team / Performance results and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$. As demonstrated by the analysis of variance the F_{obt} value is well below the critical value that would advocate a significant difference in the project data collated from the three companies. In terms of population sampling the outcome does support the idea that the companies selected for the research programme are not dissimilar in terms of both team working and project performance. The results also provide confidence that the sample population selected for the study does align with the initial research premise to engage with construction companies with comparable industry and organisational profiles. Ranking the company results in order of project performance merit demonstrates an exact match between highest and lowest performance values, see table 6.5.4.

Table 6.5.4 Construction Company Ranking

Rank	Company	Team Rating	Project Performance
1st.	Company C	76% (rank 1st.)	56% (rank 1st.)
2nd.	Company D	75% (rank 2nd.)	55% (rank 2nd.)
3rd.	Company B	69% (rank 3rd.)	47% (rank 3rd.)

Strength of Relationship

Pearson's Correlation Coefficient	**+0.99**	**Very strong**
Spearman Rank Correlation Coefficient	**+1.00**	**Very Strong**
Confidence Level (H_o: $\mu_1 = \mu_2$)	**$\rho = 0.001$**	**Reject H_0**

A Pearson's correlation for the two sets of data produces a value of +0.99 (very strong), a Spearman rank correlation coefficient represented an exact positive match ranked highest to lowest for both variables producing a value of +1.00. A student's two-tailed paired t-test equates to 0.001, giving a significant level of confidence and rejects the Null Hypothesis H_o: $\mu_1 = \mu_2$ in favour for the Alternative Hypothesis H_A: $\mu_1 \neq \mu_2$. In conclusion the collated inter-company data demonstrates that the three companies participating in the research programme are not significantly dissimilar and may have been selected from the same population mean. Based solely on the company mean Team Rating and mean KPI scores there would appear to be a significant relationship between the value of the team rating and resultant level of project performance. Persuasive analytical evidence that high performing teams will produce enhanced project performance.

6.6 INTER - PROJECT DATA ANALYSIS

In total there are thirteen individual case studies. The projects have been assembled from three different contributing UK construction companies. There were a total of eighty-two project participants, fifty-six site based construction professionals, thirteen site based project leaders and thirteen clients / client representatives. The response rate for all the research questionnaires issued was approximately 96%. The individual variable results for the thirteen participating projects are presented in section 6.6.1 (see Table 6.6.1) and 6.6.3 (see Table 6.6.2).

6.6.1 INTER-PROJECT TEAM VARIABLE RESULTS SUMMARY

The following table 6.6.1 illustrates the seven mean team variable rating for each of the thirteen construction site projects participating in this research programme.

Table 6.6.1 Inter-Project Team Variable Results

Team Variable	Project B/1	Project B/2	Project B/3	Project B/4	Project B/5	Project C/1	Project C/2	Project C/3	Project D/1	Project D/2	Project D/3	Project D/4	Project D/5	Team Variable Mean
Interdependency	78	77	66	82	77	90	87	79	86	86	83	93	76	82 std.dev. 7.1
Membership Diversity	70	69	65	66	65	73	79	71	57	78	74	68	67	69 std.dev. 5.9
Team Dynamics	78	80	68	78	81	87	81	72	86	80	82	84	71	79 std.dev. 5.7
Trust	70	63	53	73	69	75	76	68	70	72	76	82	69	70 std.dev. 7.0
Corporate Intent	64	56	52	62	77	76	71	61	60	78	69	78	70	67 std.dev. 8.7
Systems, Policies & Customs	76	69	67	59	69	80	79	62	75	70	77	69	70	71 std.dev. 6.3
Culture	68	61	60	71	81	81	68	73	67	72	72	78	70	71 std.dev. 6.5
Project Team Variable Mean	72	68	62	70	74	80	77	69	72	77	76	79	70	73 std.dev. 5.1

6.6.2 INTER-PROJECT TEAM VARIABLE ANALYSIS

The mean team variable rating for all seven variables across the thirteen independent projects was 73% with a standard deviation of 5.1. Across the seven team variables the ratings ranged from an average high of 82% with a standard deviation of 7.1, (Interdependency) to an average low of 67% (Corporate Intent) and a standard deviation of 8.7. Interdependency (82%) was frequently judged as the leading team variable followed closely by Team Dynamics (79%, standard deviation 5.7). These two team variables would appear to be the cornerstone for the majority of the construction site management teams measured. This would imply an explicit understanding by the team members for collaborative working practices coupled with regular communication. Social interplay of this nature is likely to have been facilitated by the relatively small site team compositions. The average team size was five members, one team leader and four team members.

Within the Group Compatibility and Diversity context Membership Diversity recorded a team variable rating of 69% and standard deviation of 5.9. Although the rating is relatively high, within the context of all the other team variables it is the second lowest recorded rating. Project data illustrates that the majority of project team members have similar professional backgrounds and site management functions. The results tend to support this characteristic of site team composition, the emphasis being placed on the management demands of the project with only cursory consideration for the balance between functional roles and personality traits. The fourth team variable within the Group Compatibility and Diversity category is Trust with a mean rating of 70% and standard deviation of 7.0. The trust variable results highlighted a notable variance across the thirteen projects with ratings ranging from 53% to 82%. Interestingly, visual inspection of the results corresponded closely with the lowest and highest project team variable averages of 62% and 79% for Projects B/3 and D/4 respectively. Many commentators (Johnston *et al*, 2000; Tarricone and Luca, 2002) emphasise the necessity for team member trust as a core constituent for high performance team working. To statistically test the possible relationship between the trust variable and the resultant project mean rating a Pearson's

Correlation was calculated giving a value of +0.9. This may be expressed as very strong, although due to the small sample size (13 projects) the chance of error is worth mentioning. The strength of association and the fact that the correlation value was the most marked of all the team variables when paired with their corresponding mean project team rating does appear to highlight a pronounced team tendency. The outcome may influence company thinking for facilitating intra–team member trust.

Corporate Intent recorded the lowest team variable rating of 67% with a standard deviation of 8.7, the highest standard deviation value within the team variable suite. This suggests that project variances exist but due to the potential organisational bias of the team variable it may be that different companies produce differing results. On visual inspection it can be seen that the lower ratings relate to Company B while the higher results belong to Company D projects. This information also aligns with team member's average length of employment with the company. The average length of service for Company B participants was approximately one year whereas for research contributors from Company D it averaged at just over eleven years' continuous employment service. Within the framework of the parent organisation and the relationship with the team member it makes sense that time spent with a company will reinforce the tripartite coalition that fuse organisational objectives, team goals and personal achievements. The other variable within the Organisational Context was Systems, Policies and Customs averaging 71% (standard deviation 6.3). The individual project ratings are more uniform in their distribution and fail to exhibit any of the marked company-specific classifications evident with Corporate Intent. The seventh team variable, Culture recorded a team variable average of 71% with a standard deviation of 6.5 and as with Systems, Policies and Procedures does not appear to demonstrate any particular project or company attribute. This was an unsurprising outcome given the industry emphasis as opposed to any specific organisational or group characteristic.

Statistical techniques were employed to try and establish any underlying patterns of team variable interdependencies and to establish if any one of the seven team variable ratings differs significantly. An ANOVA (one-way) was conducted and produced a F_{obt} value of 7.95**, (see Appendix H, Table H.6.1). Given that the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the mean project team ratings and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$. An unanticipated outcome taking in to consideration the relatively low standard deviation (5.1) for the range of results received for the mean team variable rating. On first inspection it was improbable that an ANOVA would result in a significant difference between the values that contribute to the overall result. Further analysis of the individual values illustrate that while the means would not appear to differ significantly, the range of scores across the projects but within the same team variable do exhibit noticeable variances. The average range within the team variable is 23.4%, the highest is Trust with 29% and the lowest is Team Dynamics with 18%. At this point is important to recognise the methodology employed for the measurement of team efficiency. Therefore interpretation requires a measured viewpoint, acknowledging the empirical evidence while recognising the inherent anomalies associated with the original responses and subsequent data management techniques. Field data of this nature is characteristically difficult to define in to comparable pairs that distinguish significant levels of rating. In this particular situation it is easier to use the predetermined team categories, Group Compatibility and Diversity, Organisational Context and Industry Context in an attempt to identify notable divisions. Group Compatibility and Diversity has an average rating of 75%, Organisational Context 69% and Industry Context 71%. It would seem that team variables associated with organisational context and industry context exhibit similar mean values suggesting that variables connected with Group Compatibility and Diversity are at odds with the others. Closer inspection reveals that two variables, Membership Diversity and Trust have similar values to organisational context and industry context. Therefore it is more probable that the team variables Interdependency and Team Dynamics are recording ratings that differ significantly from the other five variables. The team variables are intended to evaluate specific aspects of the team well-being and are arranged in to three distinct categories. Although bounded by a common theme it may have been anticipated that differences would occur. The ANOVA result substantiates the initial premise of the research methodology to evaluate the team working environment in a holistic and equitable fashion. The deviations associated with the ratings are to be expected because they assess differing values within different perspectives and to this end the research results reflect the disparate team attributes that within the group dynamic create the potential for team synergy.

To test the level of significance between the variables and participating projects an ANOVA (two-way) was conducted, producing a F_{obt} value of 20.07** for 'Variable' and a F_{obt} value of 10.02** for 'Project', (see Appendix H, Table H.6.2). Since the level of F_{obt} 'Variable' and 'Project' is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated between the seven team variables and between the thirteen projects investigated and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A. The two-way ANOVA confirms the initial findings of the one-way ANOVA with regard to the significant difference in mean values for the team variables. The results presents evidence that the projects also demonstrate significant differences in mean values implying that in terms of team rating the projects are performing differently, i.e. they do not come from the same population mean. Closer examination of the individual project results highlight project B/3 (62%) as the most likely to be at odds with the other project team ratings. Taking in to consideration the seven team variables that contribute to the mean project team rating, project B/3 records the least team rating for five of the seven variables. At the opposite end of the team performance spectrum a number of projects share the higher team ratings but there is no dominant project that can be distinguished from the rest. The spread of results across the seven variables within each individual project portfolio ranges from 9% (Project D/5) to 29% (Project D/1) with an average of 18%. This figure corresponds with the percentage difference between the lower and upper mean project team ratings, Project B/3 – 62% and Project C/1 – 80%. The two-way ANOVA highlights significant differences for both the team variables and projects but the calculated value of F_{obt} for team variables is considerably greater than F_{obt} for the projects this may suggest some element of affinity between the projects studied.

6.6.3 INTER-PROJECT KPI RESULTS SUMMARY

The following table 6.6.2 illustrates the seven mean key performance indicator for each of the thirteen construction site projects participating in this research programme.

Table 6.6.2 Inter-Project KPI Results

Key Performance Indicator	Project B/1	Project B/2	Project B/3	Project B/4	Project B/5	Project C/1	Project C/2	Project C/3	Project D/1	Project D/2	Project D/3	Project D/4	Project D/5	KPI Mean
Predictability Construction - Cost	75	75	27	95	76	75	22	26	16	35	20	75	20	49 std.dev.29.2
Predictability Construction - Time	25	39	26	19	60	60	34	33	28	16	27	60	34	35 std.dev.15.3
Client Satisfaction - Service	55	10	10	27	55	85	100	55	55	55	100	100	100	62 std.dev.33.1
Client Satisfaction - Product	55	55	8	2	20	85	85	8	21	0	100	100	85	48 std.dev.39.5
Employee Satisfaction	61	67	45	46	82	73	60	45	45	85	77	75	62	63 std.dev.14.6
Hours Worked (per week)	22	14	18	20	38	22	26	12	17	17	23	17	24	21 std.dev.6.6
Training Days (per year)	88	75	72	89	94	92	89	95	95	86	91	93	88	88 std.dev.7.2
Project KPI Mean	54	48	29	43	61	70	59	39	40	42	63	74	59	53 std.dev.13.4

6.6.4 INTER-PROJECT KPI ANALYSIS

The overall mean key performance indicator result for all seven variables across the thirteen independent projects was 53% with a standard deviation of 13.4. Taking in to account the customised suite of seven KPI's, the benchmarked scores ranged from an indicator mean high of 88% (Training days per year) to an indicator mean low of 21% (Hours worked per week). These results align with the two most consistent KPI inter-project results. For example 'Hours Worked' recorded an average 21% with the lowest standard deviation of 6.6 whilst 'Training Days' recorded 88% with the second lowest standard deviation of 7.2. Client satisfaction produced the greatest deviation in terms of inter-project analysis with Client Satisfaction – Product ranging from 0% to 100%, with a KPI mean of 48% and a calculated standard deviation of 39.5. Client Satisfaction – Service ranged from 10% to 100% with a resultant inter-project average of 62% and a standard deviation of 33.1. The next highest grouping was the financial perspective with Predictability – Construction cost producing an average of 49% and a standard deviation of 29.2, Predictability – Construction Time produced a lower mean of 35% but the spread of results across the projects was more consistent, validated with a lower standard deviation of 15.3. Employee Satisfaction recorded the second highest cross project average with 63% and a standard deviation of 14.6. A Pearson's Correlation between the mean team rating for all the projects and the corresponding employee satisfaction indicator for each project produced a positive value of +0.68 (moderate). It is feasible that there may be an association between the two variables; they both address the individual albeit one as a participating team player and the other as an individual company employee within an organisational context. That said there is a potential for an expressive overlap between the three perspectives of individual, team and organisation.

It is interesting to note that the four indicators with the least consistency across the thirteen projects can be grouped under the Kaplan and Norton balanced scorecard perspectives of 1/ Financial and 2/ External. This indicates specific corporate and allied project strengths and weaknesses within the series of project performance results. Whereas for the 3/ Internal and 4/ Innovation and Training perspectives there is a more uniform set of results suggesting only slight variance between the various project and company outlook.

To assess the level of variance associated with the Key Performance Indicator results an ANOVA (one-way) was calculated, producing a F_{obt} value of 3.13**, (see Appendix H, Table H.6.3). Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the mean project performance indicators and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$. As stated previously it is unsurprising to conclude that the different indicators have significantly different means. The balanced format of the project performance scorecard to some extent dictates that variances will be encountered and for the purposes of a holistic performance model, encouraged. Analysis of the individual scores draws attention to scope of performance results. The smallest spread of results was 'Training Days' with 23% with the greatest being 'Client Satisfaction – product with 100%. The trans-KPI mean was 57% although this was somewhat accentuated due to the extreme extent of results received for Client Satisfaction – Product (100%), Client Satisfaction – Service (90%) and Predictability – Construction Cost (79%).

In an effort to verify the original findings and establish if any of the thirteen construction projects are performing differently an ANOVA (two-way) was conducted. This gave a F_{obt} value of 3.43** for 'Indicator' and 1.66 for 'Project, (see Appendix H, Table H.6.4). Given that the level of F_{obt} 'Indicator' is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated between the seven performance indicators may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A. The calculated outcome for F_{obt} 'Project' is less than F_{crit} at the 0.05 level of significance and it may be concluded that there is no significant difference in the mean values associated between the thirteen projects and may therefore accept the Null Hypothesis, H_o. Assessment of the two-way ANOVA shows a similar value for the level of significance associated with the project KPI's but with regard to the projects themselves there would appear to be an acceptable level of uniformity between the project performances. Due to the noticeable visual disparity between the various projects and taking in to account the results of previous project / company specific analysis of variance this is an unforeseen outcome. The mean cross project performance measurement ranges from a low of 29% (Project B/3) to a high of 74% (Project D/4) with a cross project standard deviation of 13.4. In comparison with the cross KPI standard deviation of 21.6 it is evident that the variances between the projects is noticeably less that the differences between the indicators. The two-way ANOVA result upholds this.

6.6.5 INTER-PROJECT TEAM RATING / PROJECT PERFORMANCE ANALYSIS

To test the core research hypothesis, H_o: $\mu_1 = \mu_2$ an ANOVA (one-way) was calculated producing a F_{obt} value of 25.89**, (see Appendix H, Table H.6.5). Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the thirteen projects based on Team Rating and Project Performance and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2$. To further investigate the potential relationship between the two variables a two-tailed paired t-test was conducted giving a t-test probability value, $\varrho = 0.001$ (99.9%), very highly significant and therefore authenticating the finding of the one-way ANOVA. It may be concluded that based on the population sample used for the research there is a significant level of association between the mean team rating value and corresponding mean project value, giving investigational confidence to the commonly held theory that improved team working will enhance project performance. A Pearson's correlation between the two sets of results is +0.8 (strong, marked) adding further credibility to the fundamental principle of the team / performance equation. The mean team rating value is 73% with a standard deviation of 5.1. The rating percentages ranged from a relative low of 62% (Project B/3) to a team rating high of 80% (Project C/1). The average project performance benchmark score was 53% with a standard deviation of 13.4. The project performance scores ranged from a mean KPI low of 29% (Project B/3) to a high of 74% (project D/4). To further examine the degree of correlation between the array of site management team ratings and associated mean project benchmark scores an order of merit league table was generated. The ranking is based in the first instance on the highest to lowest team rating with the corresponding mean project performance score, (see table 6.6.3). If the team rating is of an equal value the 'league position' is determined using the highest project performance.

Table 6.6.3 Inter-Project Ranking

Rank	Project	Team Rating (x)	Project Performance (y)
1st.	Project C/1	80% (rank 1st.)	70% (rank 2nd.)
2nd.	Project D/4	79% (rank 2nd.)	74% (rank 1st.)
3rd.	Project C/2	77% (rank 3rd.)	59% (rank 5th)
4th.	Project D/2	77% (rank 4th.)	42% (rank 10th.)
5th.	Project D/3	76% (rank 5th.)	63% (rank 3rd.)
5th.	Project B/5	74% (rank 6th.)	61% (rank 4th.)
7th.	*Project B/1	72% (rank 7th.)	54% (rank 7th.)
8th.	Project D/1	72% (rank 7th.)	40% (rank 11th.)
9th.	Project D/5	70% (rank 9th.)	59% (rank 5th.)
10th.	*Project B/4	70% (rank 9th.)	43% (rank 9th.)
11th.	Project C/3	69% (rank 11th.)	39% (rank 12th.)
12th.	Project B/2	68% (rank 12th.)	48% (rank 8th.)
13th.	*Project B/3	62% (rank 13th.)	29% (rank 13th.)

Strength of Relationship

Pearson's Correlation Coefficient	**+0.80**	**Strong**
Spearman Rank Correlation Coefficient	**+0.70**	**Moderate / Strong**
Confidence Level (H_o: $\mu_1 = \mu_2$)	**$\rho = 0.001$**	**Reject H_o**

A Spearman Rank Correlation Coefficient was calculated at +0.70, slightly less that the Pearson's value and in this case has provided little addition insight other than supporting the initial findings and subsequent conclusions. The team / project ranking exercise highlights three exact matches, Project(s) B/1, B/4 and B/3 are ranked 7$^{th.}$, 10$^{th.}$, and 13$^{th.}$ respectively. There are three projects one position out of synchronisation, namely Project(s) C/1, D/4 and C/3 are ranked 1$^{st.}$, 2$^{nd.}$, and 11$^{th.}$ respectively. It is interesting to note that only two of the projects are in the top six with regard to team rating with the other four positioned at the lower end of the 'performance league' table. That said, the top two team ratings align closely with their project performance ranking and two of the bottom three team ratings align in a similar fashion with their associated project performance position. Four of the top five team ratings all align within two places of their corresponding project performance ranking. The anomaly is project D/2. It is worth noting that project D/2 had the smallest team member participation and at that point-in-time of case study was experiencing contractor-client discord. This was exemplified in the KPI client satisfaction – product benchmark score of zero. It may be considered a fair judgement to imply that the small team number coupled with taxing project issues have skewed the team rating – project performance relationship. Across all thirteen projects, including project D/2, only four projects are greater than two places apart in the performance order of merit. This equates to 70% of the construction site team rating being two places or better with their matching project performance. The evidence provides a cogent argument for the existence of an inextricable relationship between enhanced performing teams and better performing projects.

To evaluate the significance of the data gathered from across the thirteen projects an ANOVA (one-way) conducted. This produced a F_{obt} value of 0.62 (see Appendix H, Table H.6.6). Given that the level of F_{obt} is considerably less than F_{crit} at the 0.05 level of significance it may be concluded that there is not a significant difference in the mean values Team Rating and Project Performance associated with the thirteen projects values and may therefore accept the Null Hypothesis, H_o. The outcome implies that no project is performing differently but based on the team rating and project performance there would appear to be significant variations in the associated mean values. Therefore to provide an insight in to the results that underpin the project evaluation the team rating and project KPI's (i.e. Performance) values have been incorporated in an ANOVA (two-way). This produced a F_{obt} value of 3.09* for 'Project' and 53.00** for 'Performance', (see Appendix H, Table H.6.7). In the case of variability between the thirteen projects studied F_{obt} 'Project' is greater than F_{crit} at the 0.05 level of significance for the 'Project' and as a result it may be concluded that there is a significant difference in the mean values associated between the projects studied, therefore reject the null hypothesis in favour of the alternative hypothesis, H_A. Since the level of F_{obt} 'Performance' is considerably greater than F_{crit} at both the 0.05 and 0.01 level of significance for the 'Performance' it may be concluded that there is a significant difference in the mean values associated between the two variables therefore reject the null hypothesis in favour of the alternative hypothesis, H_A. Interpretation of the 'Performance' results add little value to the analysis because they derive from dissimilar origins and may be more appropriately analysed in terms of strength of relationship and ensuing association. The result for project does provided an understanding in to underlying variances in the overall outcome. The results are indicative of a significant difference between case study projects when measured in combination with their generic performance outcomes.

In an effort to better comprehend the principle relationship between measured team 'performance' and their corresponding project 'performance' a scatter chart has been produced. Plotting the results for team rating on the 'x' axis against their corresponding project score on the 'y' axis, see figure 6.6.1.

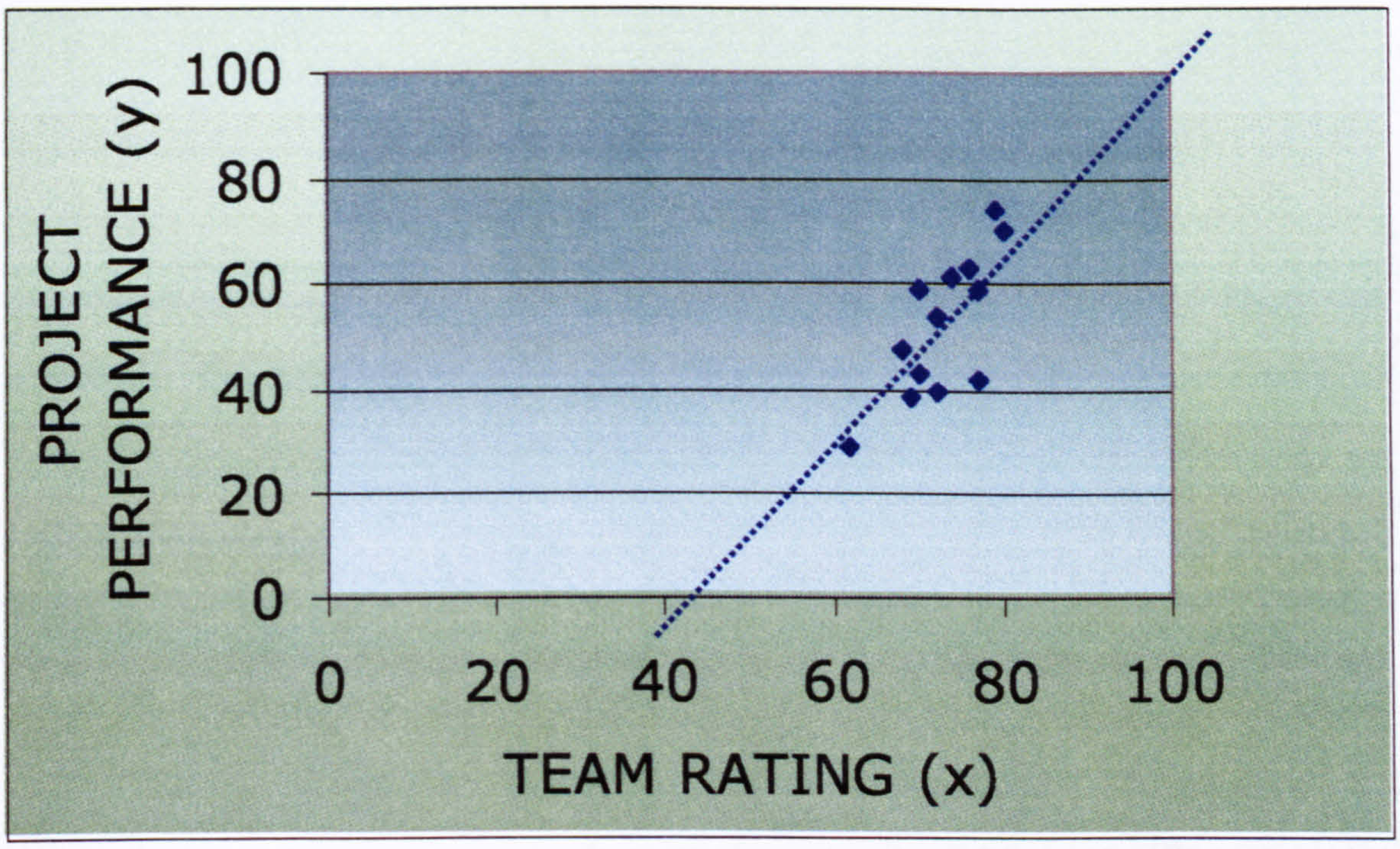


Figure 6.6.1 Team / Project Performance Scatter Chart

From the plot it can be seen that in response to an increase in team rating (x) there is a corresponding increase in the project score (y). As stated earlier a Spearman Rank Correlation Coefficient was calculated at +0.70 implying a moderate to strong relationship between the two variables. The Spearman Rank Correlation Coefficient (rs) was also used to test the null hypothesis, H_o: X and Y are independent against H_A: X and Y are positively correlated. For a sample size of 13 and $\alpha = 0.05$, H_o would be rejected if the calculation produced a value of rs ≥ 0.480 (obtained from Spearman Rank-Correlation Coefficient tables). The calculation shows that rs = $0.692 \geq 0.480$ and therefore reject the null hypothesis in favour of H_A: X and Y are positively correlated with a 95% level of confidence, (see Appendix H.7.1).

The various analytical techniques communicate compelling evidence of a confirmatory team - performance relationship. Construction project variance is significant albeit not as distinct as the team - performance relationship. Evaluation of the projects studied would tend to suggest that the mean performance results for three specific projects contribute more than the other ten construction sites to the two-way ANOVA results. Project B/3 is without doubt the poorest performing project in terms of team rating and project performance and is ranked $13^{th.}$ (lowest) in both categories. As highlighted previously Project B/3 was a consistently below par performer with five out of seven lowest team variable ratings and three out of seven lowest KPI scores. On no occasion did Project B/3 have a team variable rating or a KPI score that surpassed all of the other participating projects. At the other end of the performance continuum Project C/1 and Project D/4 outperformed the other projects. Team ratings of 80% and 79% corresponded with Project performance scores of 70% and 74%, respectively. The results ranked Project C/1 highest and Project D/4 second highest for team rating values. The results for these two projects were reversed when considering project performance, ranking Project C/1 second and Project D/4 highest in terms of project performance. A number of projects recorded similar results for team rating but only these two projects recorded a mean project performance in the seventy percent bracket. Both projects have similar KPI profiles although it should be remembered that the 'Predictability' indicators construction cost and construction time were estimates for Project D/4.

Studying the balanced scorecard performance of the thirteen projects only Project(s) C/1 and D/4 recorded equitable results across the four business perspectives. Most projects recorded similar results for the KPI 'Training' and 'Working Hours' therefore the variances in project outcome would appear to be associated primarily with the financial perspective (Predictability – construction cost and Predictability – construction time) and external perspective (Client satisfaction – Service and Client satisfaction – Product). A balanced scorecard analysis of the projects demonstrates specific strengths and weaknesses, for example only Project(s) C/1, D/4 and B/5 score well for both KPI's contributing to the financial perspective whereas project(s) C/2, B/3, D/1, D/2, D/3 and D/5 under perform in the financial perspective. Project(s) C/1, C/2, D/3, D/4 and D/5 score well in Client satisfaction (external perspective) In terms of company profile it can be seen that similarities in project emphasis exist between Company C and Company D notably within the external perspective whereas for Company B the focus of performance would appear to be the financial perspective and in particular Predictability – Construction Cost.

6.7 RESEARCH DATA ANALYSIS SUMMARY

Data analysis of the thirteen construction projects with the participation of three major UK contractors has produced a stimulating series of outcomes. The results provide an insight in the relationship not only between the measurement of team efficiency and project performance but also between the variable selected. Data analysis of the individual team rating variables and project performance indicators were more diverse in their inference. The range of results for team rating was consistently narrower than that for project performance. This is most likely to have been the result of two divergent ideals. The prescriptive nature underlying the mutual theme of team roles and team working addressed in the team member questionnaire would have been compounded by the holistic performance management system that was deliberately wide-ranging in its design. The array of outcomes did identify distinguishing characteristics between the projects and their associated companies. For example, Company C and D recorded mean project values that have very similar profiles suggesting that there may possibly be facets of corporate compatibility between the two companies. This has been identified by the type of characteristics exhibited in the project performances. For team rating the general pattern for all three companies was essentially similar although Company C & D did perform slightly better across the seven variables resulting in comparable company mean values of 76% and 75% respectively. Company B recorded a Team Rating of 69%.

Scrutiny of the team rating results highlights strengths and weaknesses in the team variables. For example the team variable Interdependency and Team Dynamics consistently rate highly whereas Corporate Intent and Membership Diversity are the noticeable weaker variable(s). The relatively small team numbers probably contributed to the perceived levels of Interdependency, Team Dynamic and Membership Diversity in that the level of interaction is high and vibrant but the functional backgrounds of the members is limited. Corporate Intent may have been influence by corporate employment practices. The longer the team member was in employment with the company the higher the Corporate Intent rating. This was exemplified with Company B having the lowest average employment service and consequently the lowest mean Corporate Intent rating. Interestingly within the series of Company B projects the team formation that had the highest length of employment (Project B/5) recorded a Corporate Intent rating (77%) above the mean percentage for all projects, (67%). That said the organisational context of team working rated lowest for each of the participating companies. This may imply a degree of organisational misfit between companies advocating team working and facilitating team practices.

The project key performance indicator scores drew attention to what would appear to be specific corporate strengths. Again, both Company C & D recorded comparable KPI's for Client Satisfaction but underperformed with regard to the financial perspective of the Kaplan and Norton balanced scorecard. Whereas for Company B the financial perspective was a positive attribute but failed to match Company C & D performance scores for Client Satisfaction. The set of results also highlights the need for careful interpretation of data analysis. For example it may have been reasonable to speculate that financial deviance from the planned budget would have a negative influence on client outlook. This would be inappropriate based on the project information available. Indicating that although modifications have been made that have influenced the financial outcome in terms of accurately predicting cost and time it would seem to have taken place with the sanction of the client. In this research scenario Company C & D appear to place considerable emphasis on contractor – client relations. On the other hand the successful focus for Company B was primarily cost yet client perception was notably poorer than both Company C & D. In terms of overall company results profile, Company C and D appear to have more in common than with Company B.

Reflecting on the principle research hypothesis examining the relationship between perceived levels of team working efficiency and measured project performance there is compelling empirical evidence of a marked association between the two variables. The research outcomes present a cogent argument for encouraging a positive collaborative working environment. The research hypothesis (H_o) stated 'that construction site teams and good project performance are unrelated; you can have one without the other.' Both Company B project case studies and Company D project case studies rejected the null hypothesis. The three inter-company data analysis rejected the null hypothesis and the inter-project data analysis also rejected the null hypothesis. On each occasion the null hypothesis was rejected at an acceptable minimum level of significance (0.05) or in other words with a 95% level of confidence in the outcome. In some cases the level of confidence was 99%. The only phase of the data analysis that failed to identify any significant difference in the mean values between the team rating and project performance was Company C. The level of correlation for Company C employing both Pearson's and Spearman Correlation Coefficient was a perfect +1.00. A Pearson's Correlation Coefficient for all thirteen projects was +0.8. Overall, the level of correlation between the two research variables (team rating and project performance) authenticates the hypothesis testing results. The use of non-parametric statistical analysis further endorsed the initial findings. A Spearman Rank Correlation Coefficient recorded a value of +0.7, and rejected the null hypothesis with a 0.05 confidence limit thus providing further assurance in both the research methodology and research outcomes. In conclusion to the research premise that construction site management teams and good project performance are independent variables the outcome is unequivocal, "teams and good performance are inseparable; you cannot have one without the other" (Katzenbach and Smith, 1993a).

CHAPTER 7: DISCUSSION

7.1 INTRODUCTION

The following discussion chapter endeavours to pull together the various aspects of the research programme, including the innovation, rationale, literature review, methodology, case study, results and data analysis. The intention is to evaluate in terms of expediency and insight the strengths and weaknesses as well as the opportunities and threats of the research agenda. To this end the discussion chapter has two distinctive viewpoints, reflecting back at what has been achieved and looking forward to explore future possible research programmes and new directions in the development and application of a team-performance diagnostic toolkit.

7.2 RESEARCH STRENGTHS & WEAKNESSES

The initial premise of the research was to study construction team working and evaluate the application of the team concept and team management in practice. After all, "a fundamental feature of modern management theory and practice is team working" (McCabe and Black, 1997). Over the past decade construction firms have become receptive to the changing nature of management and organisational behaviour. Government backing for numerous schemes promoting the standards of 'best practice' and 'constructing excellence' have resulted in construction managers becoming increasingly conscious of alternative methods of working, in some cases 'creatively swiped' from other industry sectors. "Construction should not be regarded as any different from other industries and that what works for the automotive industry, for example, can equally work for construction" (Fowler, 2006). In recent times the prime catalyst for advancing a more progressive outlook and accelerating the need for change was the Government sponsored industry review of procurement and contractual arrangements in the UK construction industry, entitled 'Constructing the Team' by Sir Michael Latham (1994). This was followed-up four years later with a report from the construction taskforce entitled 'Rethinking Construction' by Sir John Egan (1998). Both reports as well as subsequent government initiatives

(Construction Best Practice Programme, Movement 4 Innovation and Accelerating Change) have reiterated the belief that a central theme to the future success of the UK construction industry as a competitive national and international force of building excellence is 'teamwork'. Sir Michael Latham (1994) in his foreword identifies the need to provide clients with high quality projects, "that requires better performance, but with fairness to all involved...it needs teamwork." The mantra is continued with Egan (1998) reinforcing the need for better collaborative strategies and further endorsement of integrated team working philosophies. Better management of inter-company dependencies is absolute. A genuine commitment to team working can remodel organisational relationships that better transgress the short-term site environment representative of a project-based industry in to long-term strategic partnerships that will benefit both the client and the provider over several projects. The call for 'true' team working in the construction industry is wide-ranging.

7.2.1 RESEARCH SCOPE

Construction teams come in many guises. There can be clearly defined variations in terms of team 'architecture'. For example site management teams differ in composition, structure and organisational democracy in comparison with the project team. The site management team typically comprise of construction professionals with a managerial and/or technical background, work for the same employer and collectively have a degree of project autonomy. Whereas the project team composition will include a wider stakeholder base with diverse interests including the client / suppliers and specialist sub-contractors. Team management will probably exhibit a matrix configuration which will curb organisational democracy because each project member represents their sponsor organisation. As a consequence the research focus and accompanying parameters required to be carefully defined in order to establish a corresponding match between the team disposition and the scope of project. As discussed, over the last decade government initiatives have highlighted the need for greater team working within the construction sector, particularly integrated teams. That is, a disparate group of construction and non-construction professionals, from different backgrounds and various employers brought together for the duration of a building project and given the responsibility for making it a success. This particular type of team formation and composition creates several logistical problems for a team–performance study. The research would require the co-operation of all the professionals involved, including suppliers and end-users as well as their respective employers. For this type of integrated construction team scenario the data gathering would be better suited to an 'end of project' team and performance measurement. At which point team members usually disperse and regroup on other 'different' projects complete with a new set of participants. There is undoubted merit for the investigation of integrated construction project team working particularly in the current environment of project partnering and joint-venture. Unfortunately the resources and commitment necessary for an undertaking of this nature is prohibitive unless developed as market-led research sponsored and funded by participating companies.

A more manageable approach to the study of construction team working and project performance was to define the research parameters within a distinct company context. Focusing solely on the construction site management team, all the participants are directly employed by the sponsor company, identified with and accountable for a single project performance. Within this setting it is also feasible to study a number of company-wide projects that can then be investigated, analysed, compared and contrasted. This format could also be extended to other construction companies resulting in the opportunity for individual project analysis, intra-company analysis and where the companies have similar corporate profiles it may also facilitate inter-company comparison. The research logistics are controllable. Company contact and co-operation is sanctioned at a senior level with field research being conducted at a site level via site team member co-operation supplemented with occasional feedback information from the project client and/or client representative. A focused approach to the investigation of construction site management team performance would address fundamental questions related to the effectiveness and efficiency of team working. The 'project defined' research would also provide a foundation for future team studies, especially investigation in to higher order construction project teams, for example integrated construction project teams.

7.2.2 TEAM WORKING METHODOLOGY

The literature review chapter identified the recurrent variables cited by behavioural and team specialists to be pivotal for the development of 'true' team working. The research programme intent was fashioned by a report written by distinguished authors J. R. Katzenbach and D. K. Smith, entitled "The Discipline of Teams" (1993a). Katzenbach and Smith stated that the definitive characteristic of team working as opposed to joint working, group work or other types of collaborative effort is performance. It was a fundamental requirement that any investigation in to team theory and practice must equate, in some manner with quantifiable measures of performance. In this particular study, construction site teams and project performance. Much has been written about teams, the volume of team literature, numerous team conferences and the availability of team building workshops act as a tangible testimony to the popularity and allure of the team working ideal. The quantity of team based literature, the variety of team-related courses and the assortment of team building exercises was a motivation for this research programme. The introductory argument was not to develop another team building course that would 'guarantee' high performance team working. The initial concept was to develop a diagnostic toolkit that would skilfully deconstruct the unique group / team synergy back to its elemental building blocks. This would permit investigation in to the current group / team status, eliciting the existing strengths and weaknesses of the corps being studied and guide management to select an appropriate curriculum of 'team-building' courses. Significantly team 'coaching' decisions would be founded on empirical data rather than the customary casual 'management hunch'. The idea was to identify if site management behaved as a group or a team, expressed in terms of project performance. It would then be feasible to identify the potential barriers to achieving 'true' team working and provide direction, via already existing specialist team knowledge. In essence, the innovative 'team–performance diagnostic toolkit' would ascertain a starting point (benchmark) and offer direction (roadmap) for the effective and efficient management of construction site teams.

7.2.3 TEAM VARIABLES

As mentioned earlier the team variables are derived from frequent citation within mainstream team based literature. The selected variables for the study of team 'working' were: interdependency, membership diversity, team dynamics, trust, corporate intent, systems policies & customs and culture. Each is documented as having a fundamental contribution to the synergy of the team environment. For convenience and as a checklist for an encapsulating assessment criterion the seven selected variables were categorised under three broad contextual headings, Group Compatibility & Diversity, Organisational Context and Industry Context. The resultant format has two discreet measures, scope and depth. The range of variables gives breadth to the team evaluation whilst the individual variables provide an insight in to the micro-analysis of the group / team performance.

7.2.4 PROJECT PERFORMANCE METHODOLOGY

For the team deconstruction to be meaningful within the widely acknowledged context of team working and with particular reference to Katzenbach and Smith it was paramount to relate the team efficiency and effectiveness with a corresponding project performance. The requirement to equate levels of collaborative working with project performance as a point of reference for identifying 'true' teams raises two fundamental research questions. First, does improved levels of team working correlate with enhanced levels of project performance? And secondly what is the appropriate unit measurement of project performance? A similar design was adopted for the measurement of performance as used for the team variable rating. The intention being that a holistic methodology could be utilised by embracing already established construction industry key performance indicators (KPI's). The indicators could then be categorised under headings widely accepted within contemporary performance management theory. Kaplan and Norton's Balanced Scorecard provided the prototypical template for the four perspectives of performance measurement whilst industry KPI's endorsed by Constructing Excellence exposed a perfect opportunity to present the research findings in a format not dissimilar to present-day construction industry performance management practice. The successful measurement of project performance was crucial for addressing the research question that would in essence become the overriding hypothesis for the entire research programme. Do better performing teams produce better performing projects? If the answer was yes, then the resultant team–performance toolkit would have merit in that it could identify team virtues as well as limitations. Empirical evidence of discrete project under-performance provides management with a team performance directory on which they could found their team management decisions. If the answer was no, then the results would contradict conventional team wisdom and challenge the authenticity of team working practice as a panacea for below-par corporate performance. Either way, the outcome would be noteworthy, advancing construction management understanding of team theory and practice within the built environment.

7.2.5 PROJECT KEY PERFORMANCE INDICATORS (KPI's)

The formation and implementation of the customised suite of construction key performance indicators was ideally suited to the measurement of project performance. At the outset it was very important to consider the methodology to be adopted for the performance measurement of a 'live' project. The assessment of a 'live' project differed from a completed project in that data requirements needed to accurately reflect a snap-shot of project performance in tandem with the team rating. Dated project information would be out of synchronisation with the team questionnaire. Two very important research objectives were achieved. First, at a strategic level the performance management paradigm adopted did align with current thinking, representing an encapsulating holistic model that captured the breadth of project performance data rather than solely financial information. This differentiated the performance model from a more conventional perspective where "performance indicators traditionally have concentrated on finances" (Kagioglou *et al*, 2001). Secondly, the key project performance indicators would need to exclusively reflect project well-being. At a tactical level the performance metrics selected successfully defined and quantified the performance of the project. Current Key Performance Indicators developed and endorsed by Constructing Excellence are presently grouped together under topical themes such as 'All Construction KPI's', 'Respect for People KPI's' and 'Environment KPI's'. It was therefore necessary to create a unique suite of project KPI's for the measurement of project performance. This would provide a benchmark of team working efficiency.

An auxiliary consideration was the currency of performance data, whether the information was lagging, i.e. historic and therefore representative of pervious performance or leading, i.e. forecasting and therefore likely to influence foreseeable project performance including organisational well-being and profitability. By mapping carefully selected KPI's from the 'All Construction' and 'Respect for People' compilation of KPI's in to the Kaplan and Norton Balanced Scorecard framework a customised set of seven project focused indicators was established. The resultant project performance model incorporated the four perspectives of Kaplan and Norton's framework and incorporated both lagging and leading categories of indicator.

Notwithstanding the importance of the framework, one of the key research considerations was the accessibility of data and the willingness of construction companies to disclose potentially sensitive information. For this reason the 'Safety KPI' (accidents per 100 000 employed) was judged to be problematic. It was likely that companies would be hesitant to co-operate with this measure and as a snapshot figure it was vulnerable to project inconsistencies and possible misinterpretation. Other measures were deemed more appropriate for end of project evaluation such as profitability, productivity and defects and therefore unsuitable for the mid-project, 'live' performance measurement necessary for pooling together with team working data. The outcome is a workable framework which integrates with the main themes of performance management. The model successfully segregates project data from corporate data. This isolates the performance measurement of the 'live' project enabling the results to be wholly attributed to the effort and efficiency of the site-based management team. The seven selected KPI's (Predictability – Construction Cost, Predictability – Construction Time, Client Satisfaction – Service, Client Satisfaction – Product, Employee Satisfaction, Hours Worked (per week) and Training days (per year)), create unique multi-dimensional project performance criteria specific to site team efficiency and effectiveness i.e. team working.

7.2.6 TEAM – PERFORMANCE 'RESEARCH FIT'

It was also important from the outset that careful consideration was given to the 'research fit' between existing team study method and performance management practice. The preliminary idea was to develop an analytical method that would identify the correct type of team training necessary to enhance current levels of team working. The 'diagnostic toolkit' would identify team characteristics that were 'healthy' as well as variables that may benefit from additional support by means of training. These variables could then be developed using recognised team training techniques that are already widely available via existing team-based literature or specialist management consultants. The team diagnostic toolkit would also express an overall 'team rating' in an effort to establish whether team working was a reality or if group work would be a more accurate expression. This would confront the often cited misuse of the term team working; distinguishing team work from group work by means of a quantitative performance appraisal. The concept of aligning team performance with project performance also raised the question that would become pivotal to the research programme, 'do better performing teams produce better performing projects?' For 'research fit' to be achieved there needed to be an explicit link with existing comprehension of team dynamics.

Recurrent themes within team literature were acknowledged and recorded in an effort to segregate the topmost team attributes. The creation of the team literature matrix provided a team performance 'balanced scorecard' for selecting variables that would best epitomise the multifaceted nature of team efficiency on the construction site. Performance management is a developing theme within management exposition. In addition to alignment of research fit with current team theory and practice careful consideration needed to be given to the application of project performance measurement. Due to the current interest in performance management in general and performance measurement techniques in particular, both the strategy (framework - Kaplan and Norton's balanced scorecard) and the tactics (measurement - Constructing Excellence's key performance indicators) had already been developed. The project performance could be evaluated by utilising existing KPI's within a customised project suite of measures under the holistic framework identified by Kaplan and Norton's balanced scorecard. An excellent research fit was achieved by ensuring that both components of the team–performance equation aligned with acclaimed theory and practice. Presentation of the data using a radar chart for both 'team rating' and 'project performance' also complimented current procedure.

7.2.7 RESEARCH CASE STUDIES

From the case study data analysis chapter it may be stated that the research programme was successful in the appraisal of construction site team harmony and associated project performance. With particular reference to the underlying hypothesis, "do better performing teams produce better performing projects," the statistical evidence suggests an overwhelming yes with a significant degree of confidence. Analysis of the team rating and project performance results exhibit only one set of results, Company 'C', which failed to establish an empirically founded relationship between team and project performance. Although it is worth noting that Company C had the smallest project sample size with only three participating projects. Company 'B' and 'D' both had five project case studies. Further team – performance project analysis within Company 'B' and 'D', inter-company analysis between Company 'B', 'C' and 'D' as well as across the thirteen individual projects demonstrated significant levels of correlation between the two principal constituents of team and performance. The findings concur with much of team management literature and in particular is an endorsement of the assertion advocated by Katzenbach and Smith that what distinguishes a team from other forms of working relationship is ultimately 'performance'. Taking in to consideration the complexity of behavioural studies in a team setting, the risk of research contamination from the simple act of being observed (the Hawthorne effect) and the provisional nature of the construction site management team, the research findings are a considerable achievement. As far as the author is aware no other study of this nature specifically isolates and appraises team working against a background of a holistic project performance agenda, has been undertaken within the UK construction environment. The research programme has, derived from first principles and developed in line with modern management thinking a procedure for detecting facets of functional and in some cases dysfunctional team working.

7.2.8 GROUP COMPATIBILITY & DIVERSITY

The four Group Compatibility and Diversity team variables focus on the intra-relationship between the individual project members. From the results across the thirteen case studies a number of trends have been identified. It was noted that interdependency and team dynamic rated highly across the majority of the projects. Functional leadership, small team numbers and clearly defined professional responsibilities probably helped contribute to a strong interaction between the group members. Whereas team variables, membership diversity and trust consistently rated below the category mean of 75%. Further discussion concentrates on the potential for addressing issues related to team membership diversity and building team trust.

7.2.9 BALANCED TEAM WORKING

The basic premise of the 'team–performance diagnostic toolkit' is to highlight 'weaknesses' within the group compatibility and diversity so that efficient use of training resources may be employed to alleviate under-performance in specific team attributes. For example from the case study data averaged across the thirteen projects it is apparent that team variables such as 'interdependency' and 'team dynamics' consistently rate highly and therefore require limited input from management. Whereas, a general analysis encompassing all of the case study projects illustrate team variables, 'membership diversity' and 'trust' in comparison tend to rate lower. This presents an opportunity to address these variables via directed guidance schemes. 'Membership diversity' recorded a mean variable rating of 69% with a standard deviation of 5.9, suggesting limited variance between the participation case study teams, regardless of corporate orientation. It may be expected that within the confines of a construction site management team that diversity in terms of professional occupation and personal characteristics would be somewhat limited. That said research work undertaken by Dr. M. Belbin advocates the need to create 'balanced teams', "what is needed is not well-balanced individuals but individuals who balance well with one another" (Belbin, 1981). Belbin has developed within the UK industry "the best-known model of individual differences in the team context" (Hardingham, 1997). Effective team working requires a mix of group members that will tackle both the functional tasks, necessary for the construction process and specific team behavioural roles required for promoting cohesion and facilitating team development. The functional capability of the team member is easily defined and is based upon their professional qualifications and construction experience. It would appear that this is the principal criteria employed by management for the formation and composition of construction site based management teams. Within the construction sector the "selection processes have thus focused on organisations' individual professional capability rather than their collective ability to integrate and work together effectively" (Baiden *et al*, 2006).

Based on the individual responses to the questionnaire used to evaluate 'membership diversity' it is evident that construction companies place little emphasis on team role playing. In response to the statement that "All team members have participated in company sponsored personality 'psychometric' profiling," the majority of construction professionals stated "slightly true" or "never true", (approximately 77% of respondents). Therefore, from the sixty-nine research questionnaires, across three companies and thirteen projects it can be concluded that very few construction professionals currently participating as fully co-opted team members have undertaken any type of personality 'psychometric' profiling. In reply to the statement that "Team members are fully aware of the behavioural attributes of the other team members," there was a more positive outcome. Most team members felt the statement was "mostly true" or "partly true". It is interesting to compare the two statements. In one statement very little documented inventory testing of team roles has been undertaken, yet in the second statement participants feel confident in recognising the behavioural qualities working colleagues bring to the team dynamic. It would appear that the majority of team behavioural characteristics are assessed in a casual; ad hoc nature based mostly on personal inkling as opposed to critically accepted perception testing. A project-based industry may cite short-term timescales, transient site 'teams' and quick-response management practice as inhibitors of well-designed, rounded teams. In an earlier research project entitled 'Belbin and the formation of construction project teams,' Tennant, (2001) commented that "(resource) availability was a recurring theme, the majority of senior managers interviewed freely admitted to resource difficulties directly related to the combination of people and projects."

The use of personality inventory testing has potential benefits for both managers and members of construction site teams but there appears to be limited awareness or acceptance of such managerial approaches. In response to the questionnaire statement "Improved team performance is dependent on a balance between professional and behavioural characteristics," the overwhelming majority (84%) responded positively with "Completely true" or "Mostly true". From replies to the questionnaire it is evident that team members appreciate and freely accept the need for balanced team compositions. Team inventory testing that includes 360^0 member appraisals would help working colleagues recognise team membership traits and would challenge or corroborate the existing apparent behavioural dynamic in the team. Managers would be able to assess, founded on appropriate information if they felt the composition was 'balanced' and even within restricted resources may be in a position to make an informed judgement on future team needs, confident that small increments in team harmony will have a positive influence on project performance. Better understanding and an awareness of the behavioural composition of team formations may also assist in building trust and enhancing understanding between team members, "some of the most effective and lasting tools for building trust on a team are profiles of team members' behavioural preferences and personality styles" (Lencioni, 2002).

7.2.10 BUILDING TRUST

From the mean 'team rating' results, the 'trust variable was the second lowest recorded rating within the Group Diversity and Compatibility category, averaging 70% with a standard deviation of 7.0. The standard deviation figure suggests that there may be some deviation in member perception across the thirteen projects or between companies. Based on a company perspective it is evident that 'Company B' is scoring differently from 'Company C & D' and that Project B/3 in particular is at odds with the general reaction recorded by the team questionnaire. In the case of Company B it may be appropriate to invest in team training exercises that target issues of confidence and conviction. Recent research in to conditions that promote a group's effectiveness and in particular trust has identified the need to foster the emotional intelligence of teams. Emotional Intelligence recognises the human interaction and social interplay that invariably occurs within team settings. Rather than trying to suppress an individual's perspective by encouraging 'group democracy', emotional intelligence explores the spirit of the collective group. Developing this understanding raises awareness of the various personal experience(s) working in a team environment brings and having the wisdom to act and react accordingly.

> *"Group emotional intelligence is about the small acts that make a big difference. It is not about a team member working all night to meet a deadline; it is about saying thank you for doing so. It is not about in-depth discussion of ideas; its about asking a quiet members for their thoughts. It is not about harmony, lack of tension, and all members liking each other; it is about acknowledging when harmony is false, tension is unexpressed and treating others with respect" (Druskat and Wolff, 2001).*

Managing group emotions is not easy, yet the potential contribution to team effectiveness is widely acknowledged. A model of adopting a mechanistic approach to appraising individual perspectives within a group setting is the recurrent premise of the renowned creativity writer Edward DeBono and his concept of lateral thinking.

In his book, "Six Thinking Hats" published in 1985 DeBono purports that different approaches to thinking and problem solving can be achieved by putting on (actually or metaphorically) a coloured hat. The colour of the hat is significant and will provide, in this case, group guidance to the perspective being investigated. DeBono's six coloured hats are; white, yellow, black, red, green and blue.

- ✓ "The White Hat calls for information known or needed. The facts, just the facts.
- ✓ The Yellow Hat symbolises brightness and optimism. Under this hat you explore the positives and probe for value and benefit.
- ✓ The Black Hat is judgment - the devil's advocate or why something may not work. Spot the difficulties and dangers; where things might go wrong. Probably the most powerful and useful of the Hats but a problem if overused.
- ✓ The Red Hat signifies feelings, hunches and intuition. When using this hat you can express emotions and feelings and share fears, likes, dislikes, loves, and hates.
- ✓ The Green Hat focuses on creativity; the possibilities, alternatives, and new ideas. It's an opportunity to express new concepts and new perceptions.
- ✓ The Blue Hat is used to manage the thinking process. It's the control mechanism that ensures the Six Thinking Hats® guidelines are observed" (The DeBono Group, 2006).

The colour dictates the emotion within the context of a mechanistic creative model designed to collect and combine group member perspective. The confluence of diverse members and organisational interest can create a dysfunctional emotional environment that undermines trust and may endorse compliance, "group life creates conflict between the need for belonging and a sense of frustration at having to conform" (Sinclair, 1992). In team building it is important to recognise that although teams are frequently espoused as a force for enhanced performance, there is a darker side. "Under the banner of benefits to all, teams are frequently used to camouflage coercion under the pretence of maintaining cohesion; conceal conflict under the guise of consensus (and) convert conformity in to a semblance of creativity" (Sinclair, 1992). Although emotive in its rhetoric the musings of Amanda Sinclair highlight the potentially subversive nature of group work if the tripartate relationship between individual, team and organisation breaks down. Recognising and working with the emotional intelligence of the team will play a part in the building of trust between members and develop a 'focused' team work ethic that promotes identity and a sense of team efficacy.

7.2.11 THE IMPORTANCE OF COLOUR

The emotive impact of colour association should not be underestimated. At the end of the case study research for Company D, senior company representatives requested a meeting to discuss the case study findings and to receive some personal feedback and research insight on the participating projects. In an effort to concisely communicate the team and project performance set of results a 'traffic lights' presentation method was adopted. A performance level below 50% was red, 50% - 75% was amber and above 75% was green, (see Appendix I: The Colour Coded Company Balanced Scorecard). Although the figures were supported with careful explanation and expressly cautioned against misinterpretation, senior management found it difficult to ignore the simple message conveyed by the colour. Plainly put, red was poor and green was good. Within this particular medium the colour selection was wholly inappropriate and conspired to inhibit an otherwise constructive debate on the significance and meaning of the case study findings. Reflecting back on the meeting it was ill-judged to use such a system, regardless of the supplementary written explanation the colour red is extremely emotive and universally interpreted as 'stop', 'danger', 'warning' or 'anger'. In hindsight, within a corporate setting this proclamation is more than likely to receive an antagonistic and defensive reaction, raising emotions that create barriers to constructive discussion. At a further meeting the colour system was amended towards a quality management orientated outlook of gold, silver and bronze. The initial interpretation was more favourable, the colours better reflected the message of the diagnostic toolkit and although management may have been disheartened with 'bronze' the emotion of the colour did not obscure the written interpretation or create a barrier to positive discussion.

7.2.12 ORGANISATIONAL CONTEXT

The variables of Organisational Context focus on the three-way inter-relationship between the individual team members, the team as an entity and the parent organisation. Again, a number of trends have been identified with lower than average ratings for corporate intent (67%) and systems, policies and customs (71%). Closer analysis also highlights notable differences between the mean company team ratings. Debate spotlights on the probable reasons for corporate intent being rated the lowest of the seven variables (based on a cross-project mean) and the importance of organisational fit between project team structure and corporate strategy and tactics.

7.2.13 COMMUNICATING CORPORATE INTENT

Corporate intent recorded the lowest overall mean rating. A standard deviation of 8.7 does suggest a degree of variance between the projects and closer analysis indicates that the ratings for Company 'B' are at odds with the other two participating companies. During discussions with senior management, responsible in part for communicating company intentions to site managers and supervisors, it became apparent that they for the most part, communicated directly only with the various site project managers. In turn the project managers became the 'gatekeepers' of the information and it was at their discretion, regardless of senior management intent, how or if they disseminated the information.

For some project leaders it would appear that the link between corporate strategy and the personal and team contribution to the success of the 'bigger picture' was secondary in importance when prioritised against the need of the development and the short-term demands of project cost, time and specification. For all three companies the organisational structure and the position of the project leader as a 'buffer' between organisation and team meant communiqués important to senior management were filtered for project team briefings. The problem with corporate intent is primarily a breakdown in communication between the parent organisation (senior management) and site teams (construction professionals). Based on the questionnaire responses it is interesting to note that the two lowest ratings specifically relate to the section addressing team members' perception of corporate intent. It is a constant theme across the three companies studied albeit the rating value varies greatly. In response to the statement that "All team members have attended team related training seminars," only 5% of company 'B' participants stated that this was either 'completely true' or 'mostly true', whereas 56% of company 'C' participants and 43% of company 'D' participants responded in a positive way. Patterns can be seen across the various projects and it would appear that some teams have received more training opportunities than others.

Training may be related to length of employment with the company. A significant point in general terms when considering employment statistics for the three participating companies. Both company 'C' and 'D' had average employment tenure in excess of six and eleven years respectively. Whereas company 'B' has a considerably shorter mean employment history and as such could be a contributory factor for the lower than average employment profile. This may counter any future initiatives designed for enhancing team training and company communication. In response to the statement that "All team members attend company sponsored training events, regularly," the statistics for the three companies increase. For company 'B', 47% responded with 'completely true' or 'mostly true', a significant improvement in comparison with 5% for team training programmes. The percentage for company 'C' was 61%, up 5% and company 'D' was 57%, up 14%. These figures suggest that all three companies are actively addressing the training needs of the site construction professional. The team questionnaire response is corroborated by findings of the Training (per year) key performance indicator (KPI). All three companies studied recording consistently high KPI training scores and is undoubtedly a prominent project performance strong point. In the case of company 'B' it can be concluded that more could be done to promote training needs that specifically tackle team building issues. For company 'B' the introduction of team training initiatives are likely to help improve construction site member perception of team working in addition to reinforcing corporate commitment to practical team management. The corporate intent variable may also benefit from more frequent communication, for example senior management talking directly to the site teams, including the project leader. This would emphasise the sense of unity, promote a stronger senior management presence and simultaneously remove an unintentional communication 'gatekeeper'. This would increase the potential for the effective dissemination of corporate intent and the strategic role played by site teams.

7.2.14 TEAM PERFORMANCE RELATED PAY

Team member response to the statement linking rewards and recognition to team performance was also muted. The majority of team members questioned felt that there was little or no explicit policy linking individual pay to the combined efforts of the team. This aspect of team member remuneration reflecting team performance has been the subject of numerous articles, (Armstrong 2002, Thompson 1995). The contention is a simple one. Company structure endorses the need for team working and whilst corporate HRM language aligns with the team working ethos the familiar reality is that the hard model of HRM and fiscal control remains prevalent. "A simple example of poor internal fit would be job structures based on teams, but incentive systems and career opportunities entirely linked to individual performance" (Becker and Huselid, 1998). The solution for this type of organisational misfit between collectivism and individualism resides with senior management. Most construction organisations have incentive schemes in place for individuals but in line with most UK companies appear to make minimum effort to reward team working. "Focusing on individual performance goals in such situations can undermine team spirit and cooperation. At the very least, employees may focus their attention on individual targets (especially if they are artificially contrived for the pay system) at the expense of the performance of the unit. Even so, there currently appears to be a widespread insistence on having individual performance related pay – come what may" (Storey and Sisson, 2001). In reply to the questionnaire statement "the company has an explicit policy for linking recognition and rewards to team performance," only 3% of respondents felt confident that this was "completely true" although 35% did state "mostly true." The disparity between working ethos and remuneration may provide a catalyst for addressing problems of organisational mismatch. "Team pay can be seen to enjoy a number of advantages over its better known and more widely used stable-mate, individual merit pay." (Thompson, 1995). Motivating the group unity via a team reward system will also reinforce the need for a common agenda, promoting team working and "may also be more effective in making the link between the individual team member and the wider concerns of both the team and the organisation as a whole." (Thompson, 1995). In other words the implementation of team pay will help convey the organisational strategy by means of corporate intent and tactics by means of company policy, procedure and customs. "After all, compensation is not just about money. Its about communication" (Caudron, 1994).

7.2.15 INDUSTRY CONTEXT

Construction culture is renowned for fashioning stereotypes, shaping attitudes and influencing perception. As a variable it pervades all levels of a construction organisation including team working. The 'culture' variable was neither the strongest nor the weakest possibly implying that while its influence may seem limited within the team working environment the cultural variable acts in a more subconscious manner. In this sense the cultural stimulus may only impact on the group inter-relationships when group unity is unsettled, for example under pressure or if the group diversity is pronounced. All thirteen case studies concentrated on a select group of construction professionals and project site management teams; from the questionnaire responses it is evident that the majority of respondents have very similar construction experience and educational background. It is possible that degree of professional homogeneity diluted the sensitivity of cultural impact on team member perception.

7.2.16 A REVIEW OF STRENGTHS & WEAKNESSES

The essence of the team – performance diagnostic toolkit is to identify weaknesses within the team dynamic and provide information, direction and potential solutions to the situation. In short a roadmap to enhanced team performance. As discussed earlier, team working is an ever present theme within management studies and the quantity of team literature is testimony to the popularity of the subject. The problem with a heavily populated, possibly saturated subject matter is that it can be difficult to differentiate and identify the team product and/or programme that best suits a unique team - project - company permutation. By extricating the quintessential elements, acknowledged by countless team experts, the team – performance diagnostic toolkit deconstructs the team synergy in to 'convenient' parts that can be identified and isolated. The team information provides company managers with an insight in to 'real-time' team functioning and via careful team management the selected variables may be improved by employing a team building initiative that is designed expressly for the circumstances identified. For example in the case study team member questionnaires 'Membership diversity' recorded a mean variable rating of 69% with a standard deviation of 5.9, this suggested limited variance between the participating case study teams, regardless of corporate orientation. Although the professional dimension of the team is fairly consistent and addresses the functional needs of the project, little or no attempt has been made to create balanced teams in terms of team disposition. In this situation the utilisation of a personality indicator will present an insight in to the team composition that can not be achieved by simply looking at a team member's curriculum vitae. The two most popular psychometric testing of this nature are Myers-Briggs Type Indicator (MBTI) and Belbin's Team Role Self Perception Inventory (BTRSPI). In the UK Belbin's Team Role Self Perception Inventory (BTRSPI) is popular and has been successfully applied in other industry sectors. By utilising Belbin's team role approach it will be possible to identify and possibly address 'gaps' in team role composition. It will also generate discussion amongst team members on the importance of team member diversity and by employing a 360^0 team appraisal, individual members will be able to witness how other team members perceive their team role in direct comparison with their own viewpoint. Not only does an exercise of this nature investigate the 'Membership Diversity' variable it is also recognised as helping built 'Trust' among team members, "these tools and exercises (team profiling techniques) can have a significant short-term impact on a team's ability to build trust" (Lencioni, 2002). Other examples can be drawn upon to illustrate the analytical application of the diagnostic toolkit, 'interdependency' would benefit from role-playing scenarios that would develop a better understanding of the functional duties and resultant pressures that different team members' experience over the duration of a construction project. Team dynamics could be addressed via organisational and management study courses. Basic awareness of team traits, the formal and informal communication patterns, relationship between team numbers and effective communication and control along with leadership theory would help create a consistency of thought within the group. Team trust could be improved by employing a number of different training and organisational techniques such as team building using physical challenges or training in lateral / creative thinking. To assist in the effective management of the team unit it may be appropriate for the organisation to embrace the notion that site management teams transfer, where possible, from one project to another. This would promote continuity and familiarity with the team. Team building exercise coupled with personality indicator testing, lateral thinking exercises and the promotion of emotional intelligence practice with the group supported with time spent working together (continuity) should evolve a deeper understanding and appreciation, professional and personal between the group members. The success of organisational context team training (Corporate Intent and Procedures, Policies and Custom) is pivotal on the effective communication both verbal and non-verbal interaction. Verbal communication is necessary with respect to increased direct, face-to-face, interaction between senior management and site teams. This also enhances the visible presence of senior management and conveys a message of importance and interest that would be distorted if passed down through the organisational hierarchy. The implementation of a transparent team remuneration scheme would also communicate company commitment towards team working, reinforcing the rhetoric of team working and addressing issues of corporate misfit between intent (strategy) and procedures, policy and customs (tactics). The potentially contentious issue of team performance pay may also 'communicate' genuine corporate commitment to a 'true' team working ethos. Industry culture is likely to be shaped by both academic background and experience. Therefore the promotion of continued professional development (CPD), encouraging membership of professional bodies and a pro-active attitude across a broad-spectrum of training programmes will inevitably influence the perception and behaviour of company employees, as individuals and their disposition within a team based environment.

7.2.17 THE TEAM TRAINING MATRIX

To summarise the training initiatives reviewed it may be instructive to map a 'Team Training Matrix' of generic team training initiatives against the seven team variables identified in the team – performance diagnostic toolkit, (see Table 7.2.1).

Table 7.2.1 The Team Training Matrix

TEAM VARIABLE / TEAM TRAINING	Interdependency	Membership Diversity	Team Dynamics	Trust	Corporate Intent	Policies/Procedures & Customs	Culture
Role – Play / Project scenario Exercises	☑		☑	☑			☑
Personality Indicator (Myers-Briggs)		☑		☑			
Team Role & 360^0 appraisal (Belbin)		☑		☑			
Team Building via physical challenges	☑			☑			☑
Team Building via cognitive exercises	☑						☑
Leadership & Management Studies			☑		☑	☑	

Table 7.2.1 The Team Training Matrix cont.

TEAM VARIABLE / TEAM TRAINING	Interdependency	Membership Diversity	Team Dynamics	Trust	Corporate Intent	Policies/Procedures & Customs	Culture
Affinity Programming / Networking					☑		☑
Communication & Information Systems					☑	☑	
Team Remuneration & Rewards					☑	☑	
Lateral Thinking Techniques	☑			☑			
Staff Development Programme							☑
Emotional Intelligence / N L P	☑		☑	☑			
Planned Induction Programme						☑	☑
Performance Management Training	☑				☑	☑	
Total Quality Management					☑	☑	

7.3 RESEARCH OPPORTUNITIES & THREATS

The following discussion examines the potential opportunities and threats that may shape and influence the future direction of this research programme. In an effort to promote a holistic approach to the discussion a number of different viewpoints are addressed. In conjunction with an orthodox approach that aligns the research with mainstream perspectives of team working, performance management and organisational behaviour, aspects of the appraisal process adopt a distinctly nonconformist perspective. It is not an attempt to undermine the research finding but an acknowledgement of the inevitable 'invisible' constraints and preconceptions that infuse most research programmes to the extent that "different research methodologies accentuate different aspects of reality" (Green, 2002).

Critical analysis raises awareness that in some sense all research can justifiably be challenged in terms of method, environment and overall appropriateness of application. This may be particularly relevant in the study of behavioural sciences where the very act of doing research impacts on the behaviours and attitudes of the research participants. An observation recorded by Elton Mayo during the often quoted 'Hawthorne Studies' carried out at the Western Electric company between 1927 and 1932. "This phenomenon, arising basically from people being 'noticed', has been known as the Hawthorne effect" (Weihrich and Kootz, 1993). Periodically adopting a less than favourable outlook can be considered healthy. Articulating both conventional and critical reasoning combined with careful examination develops a critique that concedes to the research findings which in this particular study culminates in persuasive empirical evidence, whilst remaining cautious of the fact that what remains 'unconsidered' or 'undiscovered' still exists.

The emergence of Critical Management Theory represents an antithesis on contemporary management thinking, offering a framework for constructive criticism. The 'critical perspective' of current management practice has begun to make a contribution within management discourse, (Green, 1998; Marchington and Grugulis, 2000; Green, 2002; Langford *et al*, 2005). Not only is it expedient to reflect on the necessary assumptions that accentuate the end result but also contemplate future applications and the potential for wider developments within the construction sector. This discussion addresses a number of salient points. Research as an activity creates a cognitive dichotomy; the closed environment experienced during formulation of the research question is 'contradicted' by the open environment necessary for wider implementation. The original idea has relatively few reference points, for example the research question is for practical purposes initiated, developed and understood within a 'think tank' setting. This makes the process manageable and free from cognitive contamination.

In contrast to the privacy of personal deliberation, a practical setting exposes the concept to external interpretation and translation. The implementation of theory becomes a social accomplishment and outcomes may be influenced more by politics than company procedure. In other words, "there is a danger of applying a false and misleading sense of objectivity to the process of designing and introducing new management systems if the social, cultural and political complexities of organisations are ignored" (Bresnen & Marshall, 2001). Other aspects of company management may impinge on the usefulness of new management tools. In this particular case Human Resource Management (HRM) has been identified as having a central role on the potential usefulness of a team–performance toolkit. To date the management of team performance remains the exception rather than the rule, perpetuating a contradiction in action (team work) and HRM policy (the individual).

Disparity of fit between corporate management style and team ethos has the potential to frustrate the supervision of collaborative working practices upon which the construction sector relies. "A simple example of poor internal fit would be job structures based on teams, but incentive systems and career opportunities entirely linked to individual performance" (Becker and Huselid, 1998). The fundamental question of 'theory to practice' raises numerous issues that are beyond the scope of this research programme but provide direction for future studies wishing to advance and improve our understanding of teams and team performance.

7.3.1 RESEARCH LIMITATIONS

Regardless of the findings presented in the 'Data Analysis Chapter' the notion of better performing teams producing better performing projects is always going to be a contentious debate. The argument is inherently complex and depends much on the definitions adopted for both the team rating and performance measurement. Taking in to consideration the indefinable and intangible facets associated with analysis in the field of behavioural sciences the adopted definitions and innovative research models have produced a compelling series of results. The research programme presents empirical evidence of better team working generating enhanced project performance. Many factors could have conspired to dilute the anecdotal support that underpins the presupposition of team synergy. "Every research methodology possesses limitations and assumptions" (Green, 2002) and therefore by its very nature is always susceptible to challenge. That said the conclusiveness of the data analysis is nonetheless noteworthy. For the research to be manageable it is necessary at the outset to accept that environmental limitations are unavoidable, "despite the best intentions and vigorous precautions, it seems inevitable that circumstances, purpose etc., will impact on the work and the results" (Fellows and Liu, 2001). The intention of the investigation is not to be perfect, if this was the case it is probable that very few research projects would be undertaken and even fewer research projects completed.

The overarching objective is to apply academic rigour, intellect and discipline to a precise question and investigate the issues in a way that develops and enlightens further understanding to a specific theme and in a manner that promotes confidence. To this end the research focused primarily on the dynamic of the group structure and created a standardised framework for the study of individual team(s) whilst recognising that their circumstances, company and industry experiences would probably be representative of a setting that was invariably acontextual. The evolving format of the research methodology was always going to exclude particular characteristics that some commentators may consider more pertinent. The construction of a literature review matrix provided direction by charting the recurrent themes that populate management writing on team related studies. The literature matrix was fundamental in the formative phase of the theoretical approach to data gathering but key decisions still need to be taken with regard to the metaphorical 'function, form and mass' of the research methodology. A potentially controversial omission from the team study was the conscious decision to exclude any direct referencing to team leadership. Although correct within the framework of the research programme the resultant absence of team leadership from the qualitative study (Team Rating Questionnaire) highlights a latent censorship that limits and simultaneously delineates the contextual boundary of all research programmes. Team leadership is a central topic in the field of team studies. Commentators such as; G. Borrelli *et al*, 1995, debate the role team leadership plays in the overall effectiveness of the team dynamic. Others (Stewart and Barrick, 2000; Tata, 2000; Glassop, 2002) align the leadership role contingent upon the team structure and subsequent levels of autonomy, self-directed teams may find themselves 'leaderless' whereas 'departmental teams' have a company appointed leader responsible for direction, communication and morale. Team leadership does have a contribution to make towards a better understanding of the overall team dynamic but in terms of evaluating teams and their performance the assumption of an overriding ethos of collaborative accountability precludes the isolation of one particular member, "there is an expectation that all individuals can contribute in some way or another to the leadership of the team" (Baiden *et al*, 2003). The research justification for excluding a specific reference to team leadership issues was primarily based on the 'supposition' that whilst leadership would inevitably influence the dynamic of the group, the assertion that better team working equates with improved performance was to be a wholly egalitarian judgment. Team leadership has not been overlooked. The conscious decision to omit any specific reference to the team leader role is necessary as a demarcation point between what is being studied and what is not. It has been acknowledged that limitations to the research exist, they always do. Where possible an intellectual thoroughness has been applied that helps safeguard against oversights that may significantly undermine the validity and confidence of the research outcomes. It could be argued that by periodically adopting a critical standpoint combined with an acknowledgment of research 'assumptions' will invoke some redress of the subjective bias that can potentially taint research findings.

7.3.2 THEORY TO PRACTICE

As discussed previously, within the field of research it may be considered healthy to be self critical and conscious of the research limitations that unquestionably have an influence on the overall integrity of the planned programme. It is also important to recognise that findings obtained from a highly structured research programme derived from an innovative and unique outlook on a familiar theme may be challenged not only in its methodology but also its expediency within the construction environment. There is a quantum leap in thought between being innovative and being practical. Recent research findings investigating change management and the problems associated with 'Embedding New Management Initiatives in Construction Firms,' (Bresnen *et al*, 2005) concluded that, "work practices common to construction firms who base their activity around projects have an important bearing on the shaping and embedding of new management practice, since they directly influence the ways in which broader organisational initiatives are interpreted, legitimatised, modified and incorporated within practice." One of the key considerations for a successful transition from theory to practice is interpretation. A research programme has a number of inherent advantages that is likely to contribute to the quality of the data obtained. Within the selectively defined parameters of research, the data collection, analysis and discussion has a homogeneous point of interpretation, namely the researcher. The original vision of the research question evolves around the cognitive schemata of a few research practitioners. Ideas may be shaped from experience, interaction with academia and discussion with industry professionals but it is likely that the theoretical and in some cases idealistic perspective of the scholar will predominate the research proceedings. Any practical application of methods imitative of the original research programme is likely to be more complex and in turn challenging. Implementation and interpretation will be devolved to those directly responsible for its execution and their personal judgements of comprehension and applicability will in all probability differ from the creative origins of the research ethos. It may be contended that the first step in the successful execution of management theory to workplace procedure is a social achievement. For successful transition from theory to practice the diffusion of management ideals require to take cognisance of the socio-technical context in which they are delivered. Not to do so could result in the initiative being 'lost in translation'.

7.3.3 SOCIO-TECHNICAL IMPLICATIONS

The socio-technical awareness necessary for the adaptation of an innovative concept to a practical management tool differs from the theoretical origins of the socio-technical theory as proclaimed by the Tavistock Institute in the 1950's. The theory initially focused on the relationship between 'man and machine' and the dynamic that was created by change in the technological procedure. Since the 1950's the question of interpretation has also been applied to socio-technical theory. Contemporary management understanding has redefined the socio-technical paradigm away from the original 'man-machine' definition that was applicable and appropriate at that moment in time, towards an all-inclusive understanding. Contemporary socio-technical theory can assimilate change in a modern business environment that is founded on policy, structure and custom and may extend to clients, suppliers and competitors. For some commentators "this became known as the environmental subsystem" (Akbari and Land, 2005). A more radical philosophical argument, derived from the social sciences and technology is Actor-Network Theory. Actor-Network Theory extends as opposed to modifies, the socio-technical model to a philosophical dimension by arguing that "society and organisations would not exist if they were simply social" (Law, 1992). Analysis takes on a uniquely abstract view of the world, identifying everything as material, including people and that the arrangements and relations between society, technology, knowledge and the textual can be observed as networks. Adopting a philosophical view of the dynamic between man and machine does have its merits, in its theoretical form it can be applied to past, present and future analysis of organisational behaviour without redefinition and may provide a suitable medium for addressing the 'heterogeneous engineering' that shapes society in general, let alone the working environment. Within the context of the research, Actor-Network Theory is an interesting concept and may offer a medium to better understand the 'networks' that exist, but in attempting to comprehend the issues associated with turning theoretical notions in to practical applications the discussion digresses from the practical back to the conceptual.

7.3.4 CONTEMPORARY MANAGEMENT VALUES

Whilst some writers muse over the evolution of organisations and the social hierarchy others adopt a more acquiescing point of view, stating that the socio-technical ideals have simply been absorbed in to conservative management theory, "in the face of rapidly changing markets and innovations there is now a far greater commitment to organisational development and flexibility, teamwork, organisational decentralisation, continuous innovation and learning" (Badham *et al*, 2000). Either way, the implementation of all management tools, systems and / or procedure will be exposed to interpretation and expressed in terms of an individual's judgement, organisational politics and moment in time. The economic and community background to the development of the socio-technical theory meant that technological change was balanced against employee health, safety and welfare. The quality of working life was a central tenet in the naissance of socio-technical thought which is unsurprising given the origins of the research and the trade-union involvement in the UK coal-mining industry during the 1950's.

Today managerial values predominate; "socio-technical principles are merely instruments for achieving primarily economic objectives. Humanistic objectives have no value in themselves but if their achievement produces a better performance from employees leading to the fulfilment of the economic objectives well and good" (Akbari and Land, 2005). It would appear that the question of economic viability pre-occupies much of contemporary management thinking. So much so that organisational structure and policy often reflect the need for evidence in efficiency and productivity before investment is judged to be justifiable. Historical influences should not be ignored. The 1980's witnessed a discernable shift in the wider political context The fiscal rationale of Margaret Thatcher's Conservative Government coupled with resistance to 'sign-up' to the EU social chapter signalled the ascendancy of economic significance before all else. Today economic efficiency still predominates in contemporary management practice. Team working and team performance initiatives would be no different, "the pay-off must be financial in the first instance" (Cornick and Mather, 1999). Not only is there a risk of misinterpretation, improvisation and politicisation but the demand for tangible evidence of profitability, probably within an unrealistic timeframe, may amplify the distortion from encoded theory to decoded practice. The predominance of the 'cost-effective' model will shape corporate policy and procedure. This is particularly true for Human Resource Management (HRM), where 'Hard' philosophies dictated by economic well-being are endorsed in the pursuit for 'competitive advantage' and 'best practice'. Theory to practice presents many challenges, high risk of misinterpretation; management of the socio-technical dynamic and rigorous cost-benefit validation all have to be dealt with for the successful execution of a new initiative. With regard to 'true' team working within the construction industry less evident barriers need to be addressed.

7.3.5 CORPORATE POLICY

Several management issues need to be considered when evaluating the practical application of a team performance measurement toolkit of this type. For most business practitioners the attractiveness of applied theory is the notion of increased efficiency and productivity culminating with improved profits. Therefore the workable operation of a 'Team-Performance model' within the context of a construction company is likely to necessitate the support of two prominent managements groups. From a regional construction project perspective the senior site production management team is an obvious contributor, most likely to be involved in the selection of site team participants and the management of resources made available for fostering team working and project performance. It may be worth noting that historically there appears to be a degree of antipathy for pre-project site team evaluation and team selection, "the utilisation of expert management tools available for supporting team formation has largely gone unnoticed" (Tennant, 2001). "There are undoubtedly an infinite number of reasons why employees and managers within an organisation may obstruct management initiatives recommending alternative practice" (Langford *et al*, 2006). For example, construction management scepticism of successive 'fad' management thinking coupled with conformist beliefs that inhibit risk taking and tolerance of avant-garde values are recognised would-be barriers to change management. It is not just about people and attitudes, the construction site environment conspires to repress new management initiatives, "projects can create barriers to change and innovation, by privileging short-term task performance over long-term knowledge accumulation" (Bresnen *et al*, 2004).

Project-based organisations, which include most construction companies, frequently exhibit contradictory organisational behaviours. At project level construction site teams will display high levels of autonomy conversely at a corporate level standardisation and centralisation becomes the norm. This has the effect of creating semi-autonomous groups governed by the command and control of the corporate body but enacted by regional management procedures set within a distinctly localised social network. The short-term timescales normally associated with project-based industries such as the construction industry will shape company structure and policy including the guiding principles of a human resource management strategy. "As an example of such a mismatch...firms starting to use cross-functional teams, often keep their bureaucratic measurement and payment systems. Internal hybrids, such as project-based firms, will therefore tend to be inherently unstable, spiralling towards becoming either coherent bureaucracies or purely market like team-organisations" (Lindkvist, 2004). A receptiveness to project idiosyncrasies requires to be given careful consideration during the dissemination, training and briefing phase of any new management initiative. Establishing new knowledge will require careful assessment of the participants, the project dynamic and the formal and informal relationship with the sponsor organisation. It is fundamental to the study of research that recognition be given to the fact that the enactment of management initiative "is itself not neutral, but instead influenced by a range of social, cultural, political and psychological factors" (Bresnen and Marshall, 2001). Caution must also be given to the potential negative aspect of team working in practice. In some cases the dynamic of the team may replace company egalitarian practices with their own 'authoritarian' command and control regimes. Internal group discrimination and peer pressure may be more oppressive than the bureaucratic structures of the parent organisation. The 'dark-side' of team working is unsympathetically articulated by Sinclair (1992) in a paper entitled 'The Tyranny of a Team Ideology'. She states that "teams are frequently used to camouflage coercion under the pretence of maintaining cohesion; conceal conflict under the guise of consensus; (and) give unilateral decisions a co-determinist seal of approval." Intentional or otherwise such organisational behaviour is totally unacceptable and displays a serious disregard for employee health and well-being. The unethical manipulation of team related practices highlights the significant social dimension associated with managing people. Within major construction organisations a principal corporate contributor to the 'social accomplishment' of innovation, training and change management is the Human Resource Management function.

7.3.6 HUMAN RESOURCE MANAGEMENT POLICY

In terms of corporate homogeneity and organisational compatibility a key department of influence is arguably Human Resource Management (HRM). An unsympathetic HRM policy would in all probability be inappropriate for the implementation of team working initiatives. The reshaping of policy and procedure to 'fit' with an unorthodox approach to managing people would be pivotal to the successful adaptation of a team measurement and performance criterion. It is widely recognised that HRM policy broadly falls in to two distinct schools of thought, the 'hard' school and the 'soft' school. "The soft model focuses on the management of 'resourceful humans' and it assumes that employees are valued assets and a source of competitive advantage through their skills and abilities" (Marchington and Wilkinson, 2002). Whereas the 'hard' approach adopts a unapologetically commercial perspective that regard an organisations human resource as "much the same as any other resource.....there is no pretence that labour has anything other than commodity status, even though it may be treated well if the conditions are conducive" (Marchington and Wilkinson, 2002). In this guise a number of criticisms have been levied at HRM policy within the construction sector. Green (2002) in a critical examination of HRM policy written in a context addressing the concept of lean construction observed "there is an established dichotomy in the HRM literature between the 'hard' model, reflecting utilitarian instrumentalism, and the 'soft' model reflecting developmental humanism." The review concluded that within the UK construction industry the 'hard' model of HRM policy was in most cases the 'default' model adopted by most construction organisations. This may, in some part explain the earlier observations of dominant organisational behaviour, particularly for project-based industries. For example, evidence from the literature review is that over the past decade there has been a palpable shift in the traditional team philosophy towards a more strategic intent. Aligning team working ideals with the notion of efficiency, better performance-faster. Ultimately the economic-cost efficiency model and the campaign for improved profits would appear to be a manifestation of the 'hard' HRM policy influencing present-day management thinking for team working initiatives. Unfortunately, "each successive financial cycle heralds a new drive towards cost efficiency" (Green, 2002), promoting short-term gains at the likely expense of long-term advantage. Team working in the short-term is unlikely to fulfil its potential beyond that of an efficient group. This viewpoint, first touched upon in the literature review is corroborated when analysing the research in terms of likely socio-technical implications where nowadays economic benefit outweigh any benevolent considerations. The transferral in HRM practice from a 'personnel' function towards a strategic role has only served to heighten the need for HRM policy to be accountable in terms of organisational 'added-value' for the corporation.

Much research recognises the potential gains an efficient HRM policy can have on corporate efficiency, "there is a strong relationship between the quality of a firm's HRM system and its subsequent financial performance" (Becker and Huselid, 1998). At present the introduction of a 'team-performance toolkit' would appear to contradict some core values of a 'hard' HRM policy. On the one hand there is a performance measure that is likely to satisfy the core tenet of greater economic efficiency. The fundamental basis of better performing teams producing better performing projects would contribute directly to the economic welfare of the company. On the other hand the majority of HRM policy is individualistic in nature, "relatively few organisations made specific arrangements for team performance management...it seems to us that performance management for teams deserves more attention" (Armstrong and Baron, 2004). The HRM – organisational fit would require realigning some of its doctrine to accommodate team management initiatives. In practice this may 'soften' HRM policy, amalgamating the 'utilitarian instrumentalism' currently practiced with a measure of humanistic persuasion. A co-operative HRM model, balancing the need of the business with the well-being of the employee in a mutually inclusive, caring corporate environment would embody team management utopia but in the construction industry of the twenty-first century it would be naive to consider such a framework realistic.

7.3.7 TEAM COMMUNICATION

The outcome from the research demonstrates communication misinterpretation. The lowest team variable rating averaged across the three participating construction companies was 67% for corporate intent. In terms of value it is not poor but within the context of the other six team characteristics measured 'corporate intent' recorded a perceived rating that implied miscommunication between the strategy of the company and the tactical importance of the project unit. Analysis of individual projects and company results do highlight some noticeable differences in employee perception of corporate intent towards team working. 'Systems, policies and procedures' fared better (71%) but also indicate that there is room for improved communication between the organisational hierarchy that shape corporate performance and the site production teams that generate performance. The construction companies involved with the research had organisational structures that created prescribed channels of communication. Although open and purporting to be two-way the reality was slightly skewed. In conversation with one senior company director involved in the research it was apparent that the result for 'organisational context' was poorer than had been anticipated. The company via their senior management team seemed to place considerable effort on effective communication between head office and site management. The regular 'team' meetings and associated 'communiqués' did not appear to instil the perceived sense of 'belonging' that senior management had been hoping for. The concern of effective and efficient communication is particularly relevant for construction organisations, project based by nature and promoting an organisational structure that is neither centralised nor decentralised. Traditional channels of communication that disseminated information in a formal manner via senior management to middle management and supervisory staff has limitations. The site based project leaders are ideally placed and are the obvious conduit for the dissemination process but in doing so also behave, consciously and/or unconsciously, as a filter, selecting and translating what should be passed on and how it should be communicated. Senior management aware of the project based model in which they operate may be reluctant to challenge accepted characteristics of construction site autonomy believing that to do so would upset the organisational equilibrium.

7.3.8 FUTURE RESEARCH DIRECTION

The underlying premise for the research programme was to investigate the notion that better performing teams produce better performing projects. Team working is widely regarded as pivotal to organisational success "identified by most employers as a fundamental building block in their organisation" (Marchington and Grugulas, 2004). Despite the widespread interest in team behaviour and team working most of the data produced by research was qualitative in nature and / or relied on anecdotal substantiation. To date very little empirical evidence, particularly within the field of construction research is readily available that evidently demonstrates the potential performance enhancements associated with 'true' team working. The data and statistical analysis from the research programme provide a cogent argument for team working. The theoretical relevance for a construction sector depended on collaborative working practices is noteworthy. The practical application of an innovative 'team-performance toolkit' has the potential to deconstruct qualitative characteristics of the group dynamics with a view to targeting the weaknesses and preserving the strengths. Confident in the knowledge that by addressing team related issues there is a significant probability that enhancements achieved in team well-being will result in improved project performance. That said it may be argued that despite the credible benefits that come with collaborative working practices the construction environment actually conspires against the realisation of 'true' team working. 'Hard' HRM policies, short-term objectives, inconsistencies in organisational structure and individualistic appraisal all challenge the idealistic ethos of 'true' team architecture. To-date the research programme and the resultant 'team – performance (model) toolkit' has authenticated a correlation between construction site management teams and project performance and established a benchmarking framework, derived from renowned procedures against which team development and project performance can be measured. Team-work works.

Future research may digress in a number of directions. Continuing investigation of the original research question, "do better performing site management teams produce better performing construction projects," may be studied with regard to 'integrated construction teams.' This would relate primarily to the 'higher order' professional construction project teams that are inter-company in composition and function solely for the duration of one project. Additional complications exist with this type of study. Not only are the participants employed by different firms as a discrete group they will represent a temporary 'multi-cross-functional' organisation in that they have distinctly different professional backgrounds coupled with unique corporate identities. This could create a conflict of interests. "Extra difficulties lie here, because the nature of the project organisation means that there are many individuals making decisions of one kind or another who belong to different permanent organisations. As well as the objectives and goals of the project itself, they are confronted with possibility conflicting sets of ideals from their permanent organisations and personally held beliefs" (Langford *et al*, 1995). Much has been written about the need for team work in the construction industry and the drive for integrated construction teams at a client project level has received special attention. The 1998 Report of the Construction Taskforce by Sir John Egan entitled

'Rethinking Construction', raised the spectre, "If we are to extend throughout the construction industry the improvements in performance that are already being achieved by the best, we must begin by defining the integrated project process. It is a process that utilises the full construction team, bringing the skills of all the participants to bear on delivering value to the client. It is a process that is explicit and transparent, and therefore easily understood by the participants and their clients." By 2002 it was reported that "it is generally accepted that, at present, the number of projects delivered by integrated teams is less than 10%, (Egan, 2002). The limited uptake on the employment of integrated teams merits further investigation. It is apparent from the unresponsive position that many barriers to integrated teams appear to exist. A research programme investigating the correlation between 'integrated project teams and project performance' would establish a basis on which to examine issues that potentially inhibit team working of this nature.

7.3.9 WIDER APPLICATION WITHIN CONSTRUCTION

Examination of the research outcomes also highlights the potential for a wider application of the team – performance toolkit in to adjoining aspects of construction life. This may be particularly appropriate for companies embarking on project joint-ventures, partnerships or any other associated collaborative developments. Team collaborations may be viewed as a 'cloned' macro organisation dependent on the parent corporation for subsistence and therefore often reflects the attitudes and customs of the 'guardian' company. Studying the results of various construction teams from different companies provides not only an insight in to the team dynamic but also an inkling of the corporate character of the sponsor organisation as a whole. The inference is that team profiles that are similar but belong to different companies are more likely to be 'compatible' in terms of overall corporate intent and the underpinning management and environmental sub-systems. Examination of the research results where emphasis is placed on inter-company data analysis illustrates a similarity in team and performance outcomes for Company 'C' and 'D'. The suggestion is that due to the nature of the team questionnaire and the endeavour to capture three principal contextual facets of the team dynamic, analogous results could imply an increased likelihood of team compatibility if they were to embark on a joint venture. As macro-organisations, cloned from the parent group the argument could be extended to both sponsor companies. If the potential exists for the teams to gel then the companies may also display like-minded organisational behaviours that reinforce already established norms. In circumstances of compatibility the drive would be for harmonious working relations utilising the recognised strengths of participating companies and project teams. The opposite may also be true. Where companies are investigating a relationship that brings something new to the joint venture the team – performance toolkit has a similar potential. Again, from the results it can be seen that within a company context, Company 'B', is at odds (expressed in a general manner), with Company 'C' and 'D'. In a situation of this nature Company 'B' may bring a particular strength to a partnership with Company 'C' or 'D', for example, a financial awareness notably predictability of construction cost. For Company 'B' the trade-off, in terms of performance weakness, would be to benefit from experience and expertise in the discipline of 'client satisfaction'. Regardless of whether the organisational motivation is based on an overarching desire for corporate harmony and matching business ethos or simply augmenting tactical strengths and weaknesses the potential for a wider application of the 'team-performance toolkit' as a diagnostic toolkit in to the character and general disposition of interests and well-being is a reasonable proposition.

7.3.10 EXTENDING THE RESEARCH BOUNDARIES BEYOND CONSTRUCTION

From the discussion it is evident that teams and team working play a significant part in the success or failure of countless company ventures. Although the research programme concentrates exclusively on the specific notion of construction site management team working in the construction industry other business sectors may also benefit from a team – performance appraisal initiative. Teams exist in some form or another in most organisations and consequently the basic framework of the team diagnostic toolkit could be re-modelled to reflect different industry, company and / or team environments. The idea and the mechanics of the 'team – performance diagnostic toolkit' is without doubt transferable. The basic framework for evaluating team member perception of team working and the calculation of a team rating would remain unchanged although the questionnaire statements may be modified to better reflect the current team setting. The Key Performance Indicators would require amendment to align with existing company objectives as well as already established performance management and measurement systems. The application of Kaplan and Norton's balanced scorecard would still provide the template for KPI selection ensuring that the maxim of a holistic approach to the assessment of team performance still predominates. One of the exciting features of the research programme is the potential application beyond the boundaries of the construction industry, developing team performance management practice into mainstream management thinking.

7.3.11 TEAM PERFORMANCE PAY

"Expectancy theory carries the clear implication that if a system is to promote effort leading to superior performance, people must feel confident that by adjusting their behaviour they will be able to affect the performance measures which have been established" (Mabey *et al*, 1998). Much of cotemporary motivational thinking concentrates on the individual yet business literature increasingly places emphasis on the team working philosophy. With the development of a team diagnostic toolkit it would be interesting to link team effort with measured performance. By developing this concept the future direction of the research programme could focus on a team expectancy theory with a view to transfer the theory into practice. Recent research (Bresnen *et al*, 2005) has started to investigate contextual barriers to embedding new knowledge and lessons may be learned from studies of this nature. One field of 'team-related' investigation that has received limited inquiry is reward management. In particular 'team performance related pay' where "the aim of team reward processes is to reinforce the behaviours that lead to and sustain effective team work" (Armstrong, 2000). "Rewarding teamwork will support a paradigm of collaboration, enabling full utilisation of peoples' talents" (Logan, 1995). The Institute for Employment Studies published a report on 'Team Working and Pay' in response to an increasing number of companies adopting team working practices. The 1995 report concluded that "it would appear that the practice of team pay that is emerging in the UK is still firmly rooted in individualised pay systems, and is being shaped by these pay structures. In many ways it is a 'pseudo team pay' where the fiction of teams' is being created before the reality of team working actually exists" (Thompson, 1995). A decade later the actuality remains elusive although the acceptance of contemporary business theory has created a capacity for change. Whilst team working is advocated as a viable business opportunity present-day performance management principles align with a more orthodox, individualistic perspective of organisational wellbeing. The management and reward of team performance remains the exception rather than the rule, perpetuating a contradiction in action (team work) and HRM policy (the individual).

Armstrong and Baron, (1998) noted in their research that "relatively few organisations made specific arrangements for team performance management...it seems to us that performance management for teams deserves more attention". Michael Armstrong (2004), in his book 'Employee Reward' augments his earlier observations on team pay by stating that "team pay as a means of improving team performance does appear to promise much...but relatively few organisations seem to believe that it is relevant to them or that it will achieve its promise." It is surprising to note that the two distinctive management themes of team and performance appear to be inextricably linked yet rarely acknowledged in terms of reward. Katzenbach and Smith in their seminal paper, 'The Discipline of Teams' (1993a), declared that "the defining characteristic of a team from any other collective grouping is performance". For an industry profoundly reliant on collaborative arrangements, the creation of a 'Team – Performance Toolkit' linking team pay to project performance may be pioneering for construction companies wishing to escape the team metaphor in exchange for 'true' team working. For construction site management teams the concept of team related pay is probably the least burdensome to put into practice. "In many ways, a temporary team's performance is the easiest to reward. Objectives are usually very clear, often measurable and the time period for performance is understood by all concerned. For example...construction teams responsible for design and build projects have clear deadlines and various stages of the work can be broken down, measured and set within a timeframe" (Thompson, 1995). To this extent the development of a team remuneration incentive scheme parallel to the team performance appraisal would be a logical and challenging direction for the future enhancement of construction team working.

7.3.12 A REVIEW OF OPPORTUNITIES & THREATS

Teams and team working is a central management theme. It touches on most aspects of business life, regardless of the company, department or project, whether it is technical, procedural or personnel it will have an influence on people, most likely people who work in teams. Therefore many opportunities and threats exist for all team-based research. Research in its initial phases can be introverted and furtive but at some point must transgress from a private deliberation in to a public statement of intent. The social dimension should not be overlooked in any application of the research premise. Ultimately, success or failure will depend on the amount of cooperation, degree of commitment and level of understanding demonstrated by those outside the research congress. It's paradoxical to suggest that a research initiative targeting teams and performance is to a large extent dependent on group / team cooperation. Organisational misfit, stringent fiscal policy and inappropriate communication systems will all conspire to undermine the social accomplishment of research theory to workplace practice. Conversely, success in the social management of any company directive will give an irreversible impetus that will advance future achievements.

The acknowledgement of 'people power' clearly illustrates the important organisational role played by HRM. Interestingly, the perceived threats to the workplace application of theory and team-based research in particular also offer insights in to the potential direction of future studies. Realigning existing HRM policies with a more altruistic standpoint, developing team pay initiatives as well as promoting good communication systems all present opportunities for better understanding and enhancement of team performance in the workplace.

7.4 CONCLUSION

The discussion chapter encapsulates the research programme. Reference is made to the research rationale, the development of the hypothesis, performance criteria for the methodology as well as an analysis of the individual case studies and findings. It is also important to offer direction for future study and a number of salient topics are reviewed, each with a genuine potential for development. The majority of research activity has elements of bias, omissions and supposition simply because research is carried out by people. Recognising the potential 'weakness' and adopting an academic rigour, discipline and questioning philosophy many of the 'assumptions' can be either filtered out, where possible, or recognised and accepted as a delineating factor in defining the parameters of the research topic. This research programme has endeavoured to remain unremitting in its pursuit of research quality. Reflecting back on the evolution and progress on the study it is satisfying recollect that the research question, 'Do better performing teams result in better performing projects?' remained resolute. Taking into consideration the research constraints with regard to resources and time, recognising the complexities associated with behavioural science studies it is satisfying to conclude that in respect of construction management site teams and project performance the research outcome is unequivocal – the team works.

CHAPTER 8: CONCLUSION & RECOMMENDATIONS

8.1 INTRODUCTION

The intention of this chapter is to draw conclusions from the work undertaken in the previous chapters. The closing remarks are expressed with special reference to the original aspiration and optimism of the proposed research strategy. The main chapter headings are reviewed in an attempt to delineate the contribution of each episode towards the success of the overall research programme. Lastly recommendations and supporting comments are given for the future direction of this research theme.

On reflection the research concept appears to be a simple proposition. What is a team? What are the key characteristics of a team? How can team efficiency be measured? Do teams work (in a construction setting)? Can it be proven beyond reasonable doubt? In reality the subject matter is very complex. An exact team definition remains elusive. Everyday team management terminology does not differentiate between team working and other forms of collaborative practices. The casual use of team rhetoric is commonplace, compounded by multifarious connotations fashioned by group configuration, task definition, level of responsibility and organisational ethos. Therefore what exactly is it that distinguishes the team ideal, regardless of type from other categories of group activity? The research literature review acknowledged performance as the key determinant of all teams, "teams and good performance are inseparable; you cannot have one without the other" (Katzenbach and Smith, 1993a). The assertion is congruent with Tuckman's (1965) initial group to team transition model, identifying the ultimate 'team' stage as 'performing'.

Performance management and measurement presented similar challenges. The definition of performance is also multifaceted. Performance management was characterised by two discerning viewpoints, classical and contemporary. The traditional measure of organisational performance is rooted in methods of financial accounting, whereas modern-day performance measurement principles have adopted a holistic outlook on corporate well-being. The literature review identified the Kaplan and Norton (1992) Balanced Scorecard to be the most adaptable framework for the holistic measurement of construction project performance. Providing a performance benchmark against which team efficiency could be evaluated. As a result team evaluation and project measurement methods form the nucleus of the research programme.

8.2 CONCLUSIONS

Taking in to consideration the complexity of behavioural studies in a team setting, the risk of research contamination from the simple act of being observed (the Hawthorne effect) and the provisional characteristic of the construction site management team, the research findings are a notable achievement. From first principles the research results have demonstrated an inextricable link between levels of team synergy and project performance. The resultant team-performance diagnostic toolkit is not another team building programme. On the contrary, it is a management model with the potential to provide an objective measure of site management team performance. The 'team' works, but does team management have the wherewithal to make it perform? After extensive construction management and performance research Prof. Derek Walker (1997b), concluded that "inhibited team management capacity will inhibit team performance." Traditional team building initiatives address the question of team performance. The innovative team-performance toolkit addresses the question of team management capacity. The results offer a roadmap for positive management intervention and the subsequent employment of focused team initiatives. Future performance enhancement of construction site management teams can be based on reasoned judgement rather than the customary management 'hunch'. The ability to identify and challenge explicit aspects of team synergy provides scope for further developments within the team management theme, namely team reward management and team performance related pay. Not a new topic but frequently rejected in favour of an orthodox, individualistic approach to managing people albeit in a team setting.

The following summary provides commentary on key observations of the research.

8.2.1 RESEARCH SUMMARY

Chapter 1 clearly stated the rationale, aims and objectives of the proposed research programme. To create a team performance diagnostic toolkit that can identify specific strengths and weaknesses within a construction site management team composition. The diagnostic framework would be built around accepted team and performance management philosophies. Information output from the toolkit would provide construction management personnel with a unique insight in to the current level of team effectiveness and offer qualified guidance on the selection of the most appropriate team training initiative. Comparison of team efficiency could also be made with other construction site management teams. This would provide companies a corporate representation of team efficiency and may influence selection and implementation of future company wide training schemes.

The team chapter dealt with a number of salient points that illustrates both the attraction and complexity associated with team-based studies. Central to the motivation of collaborative practices was the identification of team working as a viable strategic corporate intent. Nowadays the implementation of team thinking appears to be driven primarily by profit. The construction sector is no different and team working strategies are understandable for an industry that is highly competitive, largely unregulated and increasingly reliant on efficient and effective partnerships.

An inherent problem exists in that the definition of a team lacks precision. This can and does result in managers demanding individuals to work efficiently, as a team without careful consideration of what team working actually represents. One of the key tenets of general management theory is that ‘structure follows strategy’. “Failure to design organisational structure and management systems to the requirements of a firm’s strategy is a common cause of poor performance” (Grant, 2001). It therefore stands to reason that if team working is to become a feasible strategic objective for the company then the corporate structure would need to be sympathetic to a suitable 'site management team - organisational fit'. To help facilitate the integration of collaborative practices, team working may be characterised in contextual terms. This would involve acknowledging and accommodating the tripartite relationship that inescapably exists between (1) the team members, (2) the organisational framework and (3) industry norms. As a consequence of the team literature review the study identified seven key variables that could be conveniently grouped under three definitive categories namely, group compatibility and diversity, organisational context and industry culture. To ignore the contextual facet of a team definition would only serve to further endorse the recurrent misinterpretation of teams-based working.

From the review of available team writing it is also apparent that team working has undeniable socio-technical implications, first described over fifty years ago in Trist and Bamforth's report for the Tavistock Institute of Human Relations. Socio-technical considerations, although still pertinent have given way to more economic pressures, nowadays the driving business incentive is cost efficiency. The shift in emphasis redefines the traditional values of production efficiency and employee morale towards a contemporary paradigm of profit generation and corporate success.

It could therefore be argued that corporate level team strategies require corporate level team structures in accordance with the management axiom that structure follows strategy. A common theme within contemporary team journals was the apparent disregard for team 'friendly' structures, policies, procedures or customs. Analyses of the research results corroborate these remarks. From the research results it is apparent that the poorest performing category is 'Organisational Context'. Recording a category mean of 69% compared with 75% for 'Group Compatibility and Diversity' and 71% for 'Industry Context'. Closer inspection shows that the team variable 'Corporate Intent' received the lowest aggregated rating of 67%. In conclusion the research findings would appear to uphold much of the criticism aimed at the management of teams in the workplace.

It was interesting to learn that much of previous team based research has focused on 'natural' teams. That is teams that function on a continuous day-to-day basis within a relatively stable setting, for example a factory or manufacturing environment. Team research that is project-based was uncommon. Team research that is both project-based and cross-functional in composition is rare. The inventiveness of this study in terms of definition, team type and working environment presents a unique and informative insight in to the dynamics of practical construction site management team working.

Empirically testing the link between teams and performance was pivotal to the research aims and objectives. Katzenbach and Smith (1993a) stated clearly that "teams and good performance are inseparable," but how could team performance be measured? For this research there were two crucial performance measurement features. First the evaluation of performance management systems and the decision to select Kaplan and Norton's balanced scorecard framework. Secondly the development and dissemination of industry designed key performance indicators. The KPI's have been developed and are sponsored by Constructing Excellence in the Built Environment in partnership with the Dti. Nowadays it is possible to measure facets of construction operations and project management using standardised techniques that can be converted in to quantifiable levels of performance output. Collectively these results produce benchmarks that are genuinely representative of industry-wide performance.

The innovation demonstrated in Chapter 3 is to amalgamate a contemporary performance management strategy (The Balanced Scorecard) with the tactical application of existing measurement practice (KPI's). The result was to propose a customised toolkit tailor-made especially for the performance measurement of 'live' construction projects.

Chapter 3 also discussed the performance management of teams. It was surprising to conclude that although performance management as a discipline has progressed the theme of team performance management and in particular team measurement had been largely overlooked.

The research findings mirror those of the team chapter. Performance management strategies were being developed but business structures remained largely unaffected. Examples of organisational dissonance could be seen where team working was being advocated. Organisations would promote the mantra of teams yet continue to employ appraisal procedures and reward structures geared toward the individual. A point demonstrated in the 'Team Member' Questionnaire results. In response to the statement 'the company has an explicit policy for linking recognition and rewards to team performance,' 21% of respondents felt this was 'never true'. The majority of team members (67%) suggested the statement was only 'slightly true'. Only one team member (1.5%) felt the statement was representative of current company policy. It is also interesting to note that on closer inspection there is little discernable difference between the three company profiles. This could imply an industry-wide attitude. It is apparent from both the literature review and the research findings that the contradiction between the behaviour management wish and the behaviour they reward may subvert the corporate desire for genuine team working.

The objective of the research methodology was to unite in a simple formulaic equation the concepts discussed in Chapter 2 (Teams and Team Working) and Chapter 3 (Performance Management). The measurement of team efficiency was considerably more problematic than project performance. A key decision was the role of team leader. Although much has been written about the 'disproportionate' influence team leaders have on members it was decided to design a team questionnaire that would be applicable to all participants. For the objective of this research programme the decision was correct. The performance of the team superseded any specific personnel interests. For future studies it may be justifiable to identify the project leader for special consideration.

The use of an attitude questionnaire with responses evaluated based on a Likert scale proved to be the most suitable method. Research questions relating to data management, analysis and interpretation needed to be resolved to ensure academic confidence in the outcome. This was largely achieved by conducting two pilot studies. The first pilot study tested the style, statements and collating of team member questionnaire data. The second case study acted as a 'dress-rehearsal' for the administration of the practical research phase. Both pilot studies contributed to the adeptness of the complete programme.

The organisation and management of project performance measurement was far more prescriptive and as a result relatively uncomplicated. The concept models and measurement techniques had already been identified. There may be debate on the choice of the seven key performance indicators but within the research parameters of suitability, accessibility and numerical dexterity the indicators selected were warranted. The project performance assessment is built upon an open architectural model. Potential practitioners who feel that other indicators of performance are more suitable can, if they desire and if the information sources are readily available reorganise the measurement techniques. Although in keeping with the holistic outlook the Balanced Scorecard framework should still provide the basic template for the selection criteria.

"Research findings are dependent upon a valid choice of research methodology" (Walker, 1997a). The selection of a case study investigative approach was evident from the earliest phase of the research. Although not immediately acknowledged the effect was to intuitively evaluate investigative techniques that would accommodate a field study.

Chapter 5 gives good reasons for the use of case study and demonstrates the hierarchical configuration adopted. The advantage of this approach was the opportunity to interpret the results beyond the confines of a singular unit of analysis. The case study results could be expressed in terms of project (the case), the company (multi-case) and the construction industry in general, (multi-project / company). It is correct not to perceive the selected case studies as a truly representative sample but at the same time it is difficult to discount the relationships and trends exemplified by lateral studies of this nature. For future studies this could be developed in to a longitudinal case study. Visiting the project at various points in the building process would counteract a common criticism of case study methodology. Case study analysis provides only a snapshot of behaviour and performance. There are resource implications. Longitudinal case study would require more time, closer collaboration with the sponsor company and their project teams. That said the scope and scale of construction industry participation for the adopted case study methodology served the intention of the research programme in a commendable fashion.

Central to the preparation of the data analysis chapter was the resolution of a fundamental research question. This resulted in one of the most challenging circumstances experienced throughout the entire study. Inappropriately evaluated research data could undermine the authenticity of the outcomes. The problem focused on the classification of data and the proper 'means' of statistical measurement. There continues to be debate on the merits of investigating ordinal data under nominal conditions. The theoretical stance is quite clear, dismissing the notion as inappropriate to apply a nominal-level distribution with a set of ordinal-level categories, (Blaikie, 2003). Whereas pragmatists view the research 'fit for purpose' to be more important than the "degree of theoretical coherence of epistemological position" (Snape and Spencer, 2005). Computer simulations have suggested "that it is alright to treat ordinal data..." (for example team variables measured using Never True to Completely True response alternatives), "...as though it were interval level data, and conduct statistical tests that are appropriate for interval level data" (Virginia Technology, 1999). For the empirical assessment of the construction site team–project performance relationship additional advice was sought from qualified mathematicians on the soundness of handling qualitative data using quantitative scales of measurement. The proposed approach does require discretion but has a precedent within the field of social science studies, (Fellows and Liu, 2003). In the final appraisal, the positive contribution of parametric analysis such as familiarity, comprehension, robustness and diagnostic interpretation was deemed to be a valuable research asset. The upshot was the decision to align with a pragmatist viewpoint and select mostly parametric statistical investigation techniques.

The data analysis chapter was also a challenge to write. Information of this type can be difficult to organise in to a coherent argument. As a consequence a minor criticism of the data analysis chapter may be the strict arrangement of the research findings in to an overly structured and sequential depiction. The approach does satisfy the need for painstaking analytical interpretation but to the determent of creative writing.

The findings were conclusive. In all probability (level of significance 95%) higher ratings of team performance demonstrated a positive correlation with enhanced levels of project performance. In response to the original research hypothesis 'that construction site management teams and good performance are unrelated; you can have one without the other,' the answer is unequivocal. Reject the null hypothesis, H_o in favour of the alternative hypothesis, H_A. 'Construction site management teams and good performance are inseparable; you are unlikely to have one without the other.'

Discussion of the research findings adopts two distinct outlooks. A backward reflection on the strengths and weaknesses of the research is offset against a forward thinking examination of latent opportunities and threats. The preceding chapters are refined in to a reasoned assessment of the research outcomes. The hypothesis 'that construction site management teams and good project performance are unrelated; you can have one without the other' is evaluated and rejected in light of the research findings. Evidence suggests with a satisfactory degree of confidence that higher ratings of construction team performance will, in all probability result in better performing projects. The study statistically authenticates the commonly held belief that teams and performance are inter-dependent. It also provides an endorsement for the innovative diagnostic toolkit developed to evaluate the team-performance relationship. The status of the team-performance diagnostic toolkit is reiterated. It is not a remedy for poor team work but rather a roadmap for the selection of appropriate team training techniques already available. The diagnostic toolkit represents the first cycle in a Performance Management System namely; implementation of measures. The second cycle, change action driven by results (Beatham *et al*, 2004) would be applicable to the implementation of team training initiatives. In conclusion, a positive association between construction site management teams and project performance within a specific setting has been analytically proven.

8.2 RECOMMENDATIONS FOR FUTURE RESEARCH

Two omnipresent management themes have been central to this research programme, teams and performance. They appear to be inextricably linked yet rarely acknowledged in terms of team performance, management, measurement and reward. This sub-chapter explores opportunities for future research. There are two broad headings, research refinement and research progression.

8.3.1 RESEARCH REFINEMENT

Refinement of the methodologies undertaken for this research would be a realistic proposition. A number of modifications could be made that would compliment the original findings. For example:

- ✓ Identify the Team Leader for special consideration. This research does not single out the potential impact project leaders may have on the overall performance of the team.

- ✓ Further refinement of the research methodology could involve the implementation of a longitudinal case study. The adopted research methodology offers only a snapshot of the team – project performance relationship. A longitudinal approach would involve carrying out a number of investigations over a period of time, most conveniently the duration of the construction project. The results would augment the current research findings and has the potential to illustrate transitional developments in the level of team efficiency in terms of project performance against project time.

- ✓ Experiment with different performance measurement criteria. Future studies may adopt the same strategies, i.e. Kaplan and Norton's Balanced Scorecard for the concept of holistic performance but employ a different combination of indictors for measurement. Does a positive team–performance correlation still apply?

8.3.2 RESEARCH PROGRESSION

Progression refers to research opportunities that exist to develop the findings of the team performance study in to auxiliary areas of company management.

- ✓ The next key stage may be entitled 'theory to practice.' At present the team performance diagnostic toolkit is a prototype. To further develop the research model a company 'road test' would be required. To be evaluated by construction industry practitioners addressing practical questions; does it work? Is the application of the toolkit a realistic proposition for construction companies? Does the toolkit help management identify suitable team training requirements? Does it add value to management decision making processes? Is it adaptable to different corporate systems? Does it integrate with existing performance management practice? Practical feedback is fundamental to the future development of the team performance diagnostic toolkit.

- ✓ The application of the team performance diagnostic toolkit in conjunction with the development and implementation of a team performance remuneration scheme would be a logical and challenging direction for the future study of team working in the construction industry. Management get the behaviour they reward. If management reward individuals it is unlikely that you will get team work. Teams that perform should to be rewarded.

- ✓ Develop the framework of the toolkit beyond the construction site management team. A key consortium for this type of evaluation would be the integrated project team; this would include the client, designers, principal contractor, sub-contractors and suppliers. It has been suggested that integrated teams in reality perform as groups, research "findings suggest that despite the benefits of integration, cultural and professional interfaces remain which impair team performance and undermine structural change management protocols. This effectively leaves the team operating as work-groups" (Moore and Dainty, 1999). More recently Sir John Egan as Chairman of the Strategic Forum for Construction stated, "Integrated team working is key. Integrated teams deliver greater process efficiency" (Egan, 2002). A team performance diagnostic toolkit may act as a catalyst for integration and performance enhancement.

✓ Extend the concept of the toolkit beyond construction industry boundaries. Team working is a universal phenomenon. Therefore the successful management and subsequent performance of the team is likely to be pivotal to most business strategies.

8.2.3 A POSTSCRIPT TO FUTURE DEVELOPMENTS

The next big 'thing' for many behavioural science experts is the use and organisational application of psychoanalysis techniques. Two of the most common expressions are Emotional Intelligence (EI) and Neuro-Linguistic Programming (NLP). Many self-help books use emotional intelligence techniques to tap in to an individual's sub-consciousness in an effort to recondition the person's mindset. Typically for the individual this may address an internal fear or phobia that inhibits them from performing at what they would consider a satisfactory level. 'Mind programming' or should it be 'reprogramming' techniques are the cornerstone of many 'counselling' texts. The methods presently target everyday anxieties such as losing weight or smoking but increasing interest and acceptance of psychotherapy for personal self improvement could act as a forerunner to the inclusion and possible acceptance of neurologically based training courses in the workplace. This newfound interest represents a shift away from conventional scientific reasoning and explores the potential benefits associated with psychotherapy. Corporate interest is understandable "there now is a considerable body of research suggesting that a person's ability to perceive, identify, and manage emotion provides the basis for the kinds of social and emotional competencies that are important for success in almost any job" (Cherniss, 2000). The formation of The Consortium for Research on Emotional Intelligence in Organisations (2006) is indicative of the growing interest in the application of EI within the workplace environment.

The other prominent contemporary self-improvement technique is Neuro-Linguistic Programming (NLP). The concept of NLP "was developed in the early 1970's when John Grinder and Richard Bandler began working together in the field of what we now know as modelling." (NLP Scotland, 2006). The practice of "NLP is rooted in the psychotherapeutic or self development tradition. It has been described as 'psychology of subjective experience'" (Open University 2002). The technique uses imagery, visualisation and modelling to induce changes in behaviour. In recent times "Neuro-Linguistic Programming (NLP) has received increasing commercial interest and has expanded on a scale that is unusual in this field, (Open University, 2002).
The application of these techniques in the workplace will present complex ethical concerns. The use of emotive terminology such as reprogramming, hypnosis and psychoanalysis in the workplace is liable to cause employee disquiet. Apprehension over the training is likely to remain muted whilst operating on the periphery of performance improvement initiatives. The transition to mainstream change management and behaviour practice is now likely to be a case of when rather than never.

8.3 FINAL COMMENTS

"Teamwork is an inherent part of construction work and seen as one of the major factors in success" (Raiden *et al*, 2006). The challenge for the construction industry, construction organisations and their teams, regardless of team 'architecture' "is to establish a measurement system that provides a reliable assessment of how well team members are working together" (Baiden *et al*, 2006). The innovative team-performance toolkit is specifically designed to address this industry challenge. Tested against the research hypothesis 'that construction site management teams and good project performance are unrelated; you can have one without the other,' the findings were conclusive. You can't have one without the other, construction site management teams and project performance are two inter-dependent variables. It is the fundamental team-performance interrelationship that underpins the near universal endorsement of team working practice. As a result of the research findings the application of the team-performance model can be used as a diagnostic toolkit for assessing the current health of the site team dynamic, helping management to better balance its priorities, allocate resources, generate realistic team management initiatives and make an overall positive contribution to the formation, composition and coaching of construction site management teams.

In conclusion two valuable contributions have been made to construction management research: first, empirically testing the construction team-project performance relationship; and second, creating a methodology and a team-performance template that others can use.

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APPENDIX A: "TEAM MEMBER QUESTIONNAIRE – PILOT"

A.1 TEAM MEMBER QUESTIONNAIRE – PILOT

A.2 INTRODUCTION

The premise of the team study was to design a questionnaire that would measure the seven distinct variables identified in the team literature review. The initial design of the questionnaire raised a number of issues associated with the composition and format that would best measure the level of team working. The pilot study was undertaken to examination the reliability, validity and reproducibility of the team questionnaire. This would provide an opportunity for participant feedback and also permit the collecting, analysing and presentation of data. During the design stage two questionnaire formats were considered with regard to the way respondents indicated their strength of opinion. Option (1) was a rating system, whereby the respondent would be offered a choice of five possible responses and asked to select one that best represented their judgment. This would then be translated in to score of 1 – to – 5 (Likert Scale) and later presented as a percentage. Option (2) was a thermometer system, whereby the respondent would be offered only two extremes of opinion with a 100mm line separating the two possible polar responses. The respondent would be asked to place a cross anywhere on the line depending where their opinion to the initial statement lay. This would then be translated in to a score somewhere between 1 to 100 and therefore could be expressed as a percentage.

Option 1: A Rating Appearance

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Example:		X			

Option 2: A Thermometer Arrangement

STATEMENT Q.1/ Example.	TRUE ◆——X——◆ FALSE

The pilot team questionnaire was presented with four of the seven sections as a rating arrangement and three of the sections as a thermometer arrangement. A question was then asked as to which format did the respondents prefer.

A.3 STUDY GROUPS

Two small departmental groups were selected for the pilot study. Both groups had a comparable structure with three permanent members comprising of a team leader and two group members. The organisations differed greatly, group (1) worked for a major aero-engine manufacturing organisation and group (2) worked for a Higher Education Establishment. All six participants were given the questionnaire to complete in their own time and no explanation, other than the instructions outlined in the questionnaire toolkit, were given.

A.4 ANALYSIS

From the results it can be concluded that the two groups selected have very similar profiles with regard to 'Group Compatibility & Diversity'. The working background of the two groups may explain this in that both groups have small numbers supporting a feeling of personal involvement, familiarity and a localised community of spirit. These are aspects of team working that the first four variables are intended to quantify. In the other two categories, organisational context and industry context, there would appear to be significant disparity. Group (1) operate within a manufacturing environment that has undergone a strategic change to working practices over the past five years. Embracing the notion of team-based working the organisation has invested heavily in training and promotes a collective approach. The organisational structure was realigned with old style foremen being replaced with carefully selected 'team coaches'; the teams also have degrees of autonomy that permits budget discretion and decision-making. 'Cells' were set up and everyone involved participates in regular team meetings to communicate progress and performance. Results have become more visible with the use of notice boards and readily available performance data. Although the results are poorer than those for the Group Compatibility & Diversity category, scores in excess of 50% are recorded for organisational context variables with a slightly lower score of 46% for culture. The culture score is the lowest individual variable score (46%) with trust being the highest (74%). In comparison with Group (2) the variances in results offer encouragement for investment that the manufacturing company have made. Group (2) is a small department within a Higher Education Establishment. Again the variables for Group Compatibility and Diversity have an average score of 69% compared to Group (1)'s 70%. The results for organisational context and industry culture are very poor. Over the past five years the organisation has invested little in team working whilst the bureaucratic character of the workload has increased against a milieu of general disquiet among it's employees. A score of 15% was recorded for 'Corporate Intent', the lowest score, signifying little recognition of teams being employed to support the strategic direction of the organisation. The highest score was team numbers (74%). See table A.2.1 for summary of results.

Table A.4.1 Summary of Results:

Context / Pilot Group	Group Compatibility & Diversity (Mean Score)	Organisational Context (Mean Score)	Industry Context (Mean Score)
Group (1) (Manufacturing)	70.25%	61.50%	46.00%
Group (2) (Education)	68.75%	20.00%	22.00%

From the summary of results it may be concluded that there is a significant weakness in team working ability associated with Group (2). If team working were to be improved it would be beneficial for the organisation to investigate those variables that are attributable to organisational context, such as 'corporate intent' and 'structure, policy & customs'. The results from Group (1) indicate a potential for improvement whilst at the same time demonstrate a considerable commitment to team working across the variables.

A.4.1 COMMENTS

The pilot team study asked the participants to provide comments on any aspect of the questionnaire and in particular the style of presentation preferred, 1/ a rating arrangement or 2/ a thermometer arrangement. The most frequent comment was related to team membership. Most of the participants could identify themselves with a number of 'team' configurations established by the formal organisational structure. An identified leader of the group helped distinguish all the pertinent team members and allowed perceptions to be based on that fact. It will be important to ensure that all project participants are responding to the same team member restrictions, especially in an environment where cross-functional teams are prevalent. Clarifying the group boundaries may be achieved by identifying the team leader and only those working under their leadership whilst employed by the same organisation. In response to the preferred presentation arrangement, four respondents (67%) indicated a preference for a 'rating' arrangement. Two respondents (33%) preferred a 'thermometer' arrangement. The questionnaire will adopt the 'rating' arrangement.

A.4.2 AMENDMENTS

Four statements have been amended as a result of the pilot study.

Section B/1, Question 5 stated, "The success of your role / output is wholly reliant on the performance of others." The term 'output' has been omitted.

Section B/2, Question 1 stated, "Individual team members collectively represent a cross-section of the departments' skill base." The term individual conflicted with the term collectively. The statement was rephrased, "Team members collectively represent a cross-section of the construction professional."

Section B/3, Question 5 stated, "The team leader is more concerned with completing tasks than with managing people." The terms 'tasks' and 'people' have been swapped round. This aligns the scoring with the responses of the other statements, i.e. managing people (5 points, completely true) – to – completing tasks (1 point, never true). The amended statement reads "The team leader is more concerned with managing people than with completing tasks."

Section B/7, Question 4 stated, "Commitment and loyalty to the company from the employees is very high." The statement was amended to "Employee commitment and loyalty to the company is very high."

A.5 CONCLUSION

The team pilot study proved to be a very useful exercise. In term of the original remit the questionnaire proved to be well-founded and balanced. The preferred style of presentation was resolved, with a 'rating' arrangement proving to be the most popular. Minor amendments require to be made to various statements and forethought needs to be taken at the outset to permit the questionnaire participant(s) identify the parameters of the team boundary under deliberation. Otherwise, analyses of two comparable group structures within two very different working environments authenticate the questionnaire objectives. The similar groups' structures scored similar results whereas the environmental variables demonstrated the differences that may have been expected under the circumstances. Therefore the questionnaire format, phraseology and results exemplify a confidence in the validity of the variables being measured, reliability in the measurement criteria and clarity in the presentation of results.

A.6 THE TEAM MEMBER QUESTIONNAIRE - PILOT

An Introduction:

This pilot questionnaire is part of a wider research project that is investigating the relationship between construction site teams and project performance.

After an eighteen-month team literature review seven key variables were identified as a necessary prerequisite for team development. The purpose of the questionnaire is to endeavour to collate quantifiable data for comparison with project performance.

Essentially, the research has two key components, teams and performance. Team variable measures will be obtained using team questionnaires refined from the pilot study and performance data will be collected using key performance measures.

It is hoped that analysis of the results may identify particular team characteristics that may influence project performance and promote improved team selection, management and development.

The Questionnaire Toolkit:

The questionnaire has three sections:

Section A provides an introduction and identifies the team categories and their variables. This section also includes working definitions for the variables identified.

Section B is the main part of the questionnaire. Instructions are given on how to complete the various sections. At the end of section B there is an opportunity to provide feedback on any aspect of the questionnaire.

Section C relates to the two presentation styles adopted in Section B. Tick the appropriate box, indicating your preferred arrangement.

SECTION A: The Questionnaire Toolkit

Introduction

This team questionnaire toolkit has been formulated in an effort to establish a quantifiable measure of construction site team efficiency. Its purpose is to measure the various influences of a team-based environment by concentrating on seven distinct variables. These variables have been identified as significant contributors to modern-day team working and may be collated under three separate categories:

A/	Group Compatibility & Diversity			Abbreviation
	The variables:	1/	Interdependency	- (Id)
		2/	Membership Diversity	- (MD)
		3/	Team Dynamic	- (TD)
		4/	Trust	- (Tr)
B/	Organisational Context			
	The variables:	5/	Corporate Intent (incl. Performance)	- (CI)
		6/	Systems / Procedures (incl. rewards) & Custom	- (SP&C)
C/	Industry Context			
	The variable:	7/	Culture	- (Cl)

SECTION B: The Questionnaire Toolkit (Option 1)

Instructions:

The following questionnaire has been formulated in response to a literature review of team research and development. The findings of the study identified three broad categories of contextual influence on team working and seven distinct variables associated with team performance.

The questionnaire addresses each of these variables individually, via statement analysis with each variable result collated, averaged and plotted on a radar chart.

Section B/ Option 1 of the questionnaire has four sections, within each section there are five statements, with all the statements having five prescribed responses; completely true, mostly true, partly true, slightly true and never true. The appropriate box should be marked with a cross (X) to indicate your strength of opinion associated with the statement made and reflect as accurately as possible the characterisation of the team under considered.

For example:

The following statement has been taken from **Section B/3** and relates to the strength of relationship between the site team leader and their permanent site team members.

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Team harmony is very high with a collective responsibility for a common objective.		X			

SECTION B/1: The Questionnaire Toolkit (Interdependency)

Directions: For each question in **SECTION B/1** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ The team members are fully aware of their individual contribution and personal responsibilities.					
Q.2/ The team members interact, formally and informally on a regular basis.					
Q.3/ The team is very co-operative with members exchanging resources freely and frequently.					
Q.4/ The team leader is very supportive, facilitating and nurturing in leadership style.					
Q.5/ The success of your role / output is wholly reliant on the performance of others.					

SECTION B/2: The Questionnaire Toolkit (Membership Diversity)

Directions: For each question in **SECTION B/2** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

STATEMENT \ RATING	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Individual team members collectively represent a cross-section of the department's skills base.					
Q.2/ The level of team behavioural diversity is very high. i.e. different 'characters'					
Q.3/ All team members have participated in company sponsored personality 'psychometric' profiling.					
Q.4/ Team members are fully aware of the behavioural attributes of the other members.					
Q.5/ Improved team performance is dependent on a balance between professional and behavioural characteristics					

SECTION B/3: The Questionnaire Toolkit (Team Dynamic)

Directions: For each question in **SECTION B/3** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Team harmony is very high with a collective responsibility for a common objective.					
Q.2/ The team leader has a very close working relationship with all the team members					
Q.3/ Informal communication between the team members is frequent and productive					
Q.4/ Everyone within the team is on first name terms.					
Q.5/ The team leader is more concerned with completing tasks than with managing people.					

SECTION B/4: The Questionnaire Toolkit (Trust)

Directions: For each question in **SECTION B/4** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

STATEMENT \ RATING	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Team members have a very high level of professional respect for each other.					
Q.2/ Team members have a very high level of personal confidence in each other.					
Q.3/ Team members celebrate success as a team.					
Q.4/ The team has a policy of promoting trust and openness.					
Q.5/ All team members have worked together on previous projects.					

SECTION B: The Questionnaire Toolkit (Option 2)

Instructions:

Section B/ Option 2 of the questionnaire has three sections; within each section there are five statements with all the statements having a continuum represented with polar responses. The line should be marked with a cross (X) to indicate your strength of opinion associated with the statement made and reflect, as accurately as possible the character of the team under consideration.

For example:
The following statement has been taken from **Section B/5** and relates to the 'truthfulness' associated with company commitment to team working.

Section B/5, Statement 2:

STATEMENT 3/ The company has a very high level of commitment to team working.	TRUE N FALSE X A

SECTION B/5: The Questionnaire Toolkit (Corporate Intent)

Directions: For each question in **SECTION B/5** – mark a cross (X) on the line that you think best represents the extent of truthfulness associated with the question statement. In an extreme case the cross (X) may be located at either furthermost point of the line.

STATEMENT 1/ All team members attend company sponsored training events, regularly.	TRUE ——————————————— FALSE
STATEMENT 2/ All team members have attended team related training seminars.	TRUE ——————————————— FALSE
STATEMENT 3/ The company has a very high level of commitment towards team working.	TRUE ——————————————— FALSE
STATEMENT 4/ The company has an explicit policy for linking recognition and rewards to team performance.	TRUE ——————————————— FALSE
STATEMENT 5/ All team members are fully aware of their team roles and responsibilities within the working environment.	TRUE ——————————————— FALSE

SECTION B/6: The Questionnaire Toolkit (Systems, Procedures and Customs)

Directions: For each question in **SECTION B/6** – mark a cross (X) on the line that you think best represents the extent of truthfulness associated with the question statement. In an extreme case the cross (X) may be located at either furthermost point of the line.

STATEMENT 1/ The team has a very high level of organisational autonomy.	TRUE ◆———————————◆ FALSE
STATEMENT 2/ Head Office and senior management have minimum direct contribution to the overall team performance.	TRUE ◆———————————◆ FALSE
STATEMENT 3/ The team has a philosophy of challenging existing work methods.	TRUE ◆———————————◆ FALSE
STATEMENT 4/ Team member turnover is very low.	TRUE ◆———————————◆ FALSE
STATEMENT 5/ All team members receive an individual staff appraisal by their team leader at least once every year.	TRUE ◆———————————◆ FALSE

SECTION B/7: The Questionnaire Toolkit (Culture)

Directions: For each question in **SECTION B/7** – mark a cross (X) on the line that you think best represents the extent of truthfulness associated with the question statement. In an extreme case the cross (X) may be located at either furthermost point of the line.

STATEMENT 1/ Team leadership may be considered entrepreneurial and innovative.	TRUE ... FALSE
STATEMENT 2/ The company has an enlightened approach to performance measurement.	TRUE ... FALSE
STATEMENT 3/ The company is a very personal place; people are willing to share information and resources.	TRUE ... FALSE
STATEMENT 4/ Commitment and loyalty to the company from employees is very high.	TRUE ... FALSE
STATEMENT 5/ The company supports diversity and equal opportunity of employment.	TRUE ... FALSE

SECTION B: The Questionnaire Toolkit (Comments & Suggestions)

FEEDBACK: Before continuing to section C, if you have any comments and / or suggestions you wish to make with regards to any of the questions in Section B please fill in the boxes below:

COMMENTS:

SUGGESTIONS:

SECTION C: Questionnaire Toolkit

Questionnaire Preference: This questionnaire was presented in two distinct styles, Section B/1-4 as a 'Rating' and Section B/5-7 as a 'Thermometer' style.

Having completed all of Section B, please indicate your preference for a questionnaire style:

Option 1: A Rating Appearance

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Example:		**X**			

Or

Option 2: A Thermometer Arrangement

STATEMENT 1/ Example.	TRUE ◆———X——————————◆ FALSE

Please tick one box only.

Option 1 – A 'RATING' arrangement.. ☐

Option 2 – A 'THERMOMETER' arrangement.................................... ☐

A.7 SCORE SHEET ANALYSIS

A.7.1.1SCORE SHEET ANALYSIS – GROUP 1

Table A.7.1.1 Member: 1

SECTION (Variable) / QUESTION	B / 1 (Id)	B / 2 (MD)	B / 3 (TD)	B / 4 (Tr)	B / 5 (CI)	B / 6 (SP&C)	B / 7 (CI)
Q.1:	4	2	4	5	43%	66%	62%
Q.2:	2	4	4	4	5%	93%	31%
Q.3:	5	1	5	3	74%	98%	62%
Q.4:	4	4	5	4	69%	100%	92%
Q.5:	2	3	2	5	63%	20%	42%
ACTUAL	17	14	20	21	254%	377%	289%
POSSIBLE	**25**	**25**	**25**	**25**	**500%**	**500%**	**500%**
PERCENTAGE	**68%**	**56%**	**80%**	**84%**	**51%**	**76%**	**58%**

Table A.7.1.2 Member: 2

SECTION (Variable) / QUESTION	B / 1 (Id)	B / 2 (MD)	B / 3 (TD)	B / 4 (Tr)	B / 5 (CI)	B / 6 (SP&C)	B / 7 (CI)
Q.1:	4	4	3	3	61%	72%	44%
Q.2:	3	4	1	2	17%	81%	59%
Q.3:	3	2	2	2	92%	66%	35%
Q.4:	3	4	4	2	22%	75%	42%
Q.5:	2	5	4	3	74%	51%	22%
ACTUAL	15	19	14	12	266%	345%	202%
POSSIBLE	**25**	**25**	**25**	**25**	**500%**	**500%**	**500%**
PERCENTAGE	**60%**	**76%**	**56%**	**48%**	**54%**	**69%**	**41%**

Table A.7.1.3 Member: 3

SECTION (Variable) / QUESTION	B / 1 (Id)	B / 2 (MD)	B / 3 (TD)	B / 4 (Tr)	B / 5 (CI)	B / 6 (SP&C)	B / 7 (Cl)
Q.1:	4	4	4	4	26%	61%	59%
Q.2:	4	5	4	4	74%	56%	27%
Q.3:	4	1	4	4	78%	56%	27%
Q.4:	4	4	4	5	27%	88%	37%
Q.5:	3	4	3	5	28%	90%	36%
ACTUAL	19	18	19	22	233%	351%	186%
POSSIBLE	**25**	**25**	**25**	**25**	**500%**	**500%**	**500%**
PERCENTAGE	**76%**	**72%**	**76%**	**88%**	**47%**	**70%**	**38%**

Table A.7.1.4 Overall Team Variable Analysis – Group 1

SECTION (Variable) / QUESTION	B / 1 (Id)	B / 2 (MD)	B / 3 (TD)	B / 4 (Tr)	B / 5 (CI)	B / 6 (SP&C)	B / 7 (Cl)
Member 1:	68	56	80	84	51	76	58
Member 2:	60	76	56	48	54	69	41
Member 3:	76	72	76	88	47	70	38
ACTUAL	204	204	212	220	152	215	137
POSSIBLE	300	300	300	300	300	300	300
PERCENTAGE	68%	68%	71%	74%	51%	72%	46%

Note: See Radar Chart (Figure A.7.3.1) for presentation of results

A.7.2 SCORE SHEET ANALYSIS – GROUP 2

Table A.7.2.1 Member: 1

SECTION (Variable) / QUESTION	B / 1 (Id)	B / 2 (MD)	B / 3 (TD)	B / 4 (Tr)	B / 5 (CI)	B / 6 (SP&C)	B / 7 (Cl)
Q.1:	4	2	3	4	8%	30%	38%
Q.2:	4	4	2	4	8%	19%	4%
Q.3:	5	1	4	4	7%	63%	9%
Q.4:	4	4	5	4	7%	14%	3%
Q.5:	5	5	4	2	35%	6%	3%
ACTUAL	22	16	18	18	65%	132%	57%
POSSIBLE	**25**	**25**	**25**	**25**	**500%**	**500%**	**500%**
PERCENTAGE	88%	64%	72%	72%	13%	27%	12%

Table A.7.2.2 Member: 2

SECTION (Variable) / QUESTION	B / 1 (Id)	B / 2 (MD)	B / 3 (TD)	B / 4 (Tr)	B / 5 (CI)	B / 6 (SP&C)	B / 7 (CI)
Q.1:	4	4	3	4	34%	60%	24%
Q.2:	5	4	3	3	3%	21%	22%
Q.3:	3	1	4	3	4%	18%	69%
Q.4:	3	3	5	2	4%	80%	3%
Q.5:	1	4	2	5	53%	17%	45%
ACTUAL	16	16	17	17	98%	196%	163%
POSSIBLE	**25**	**25**	**25**	**25**	**500%**	**500%**	**500%**
PERCENTAGE	**64%**	**64%**	**68%**	**68%**	**20%**	**40%**	**33%**

Table A.7.2.3 Member: 3

SECTION (Variable) / QUESTION	B / 1 (Id)	B / 2 (MD)	B / 3 (TD)	B / 4 (Tr)	B / 5 (CI)	B / 6 (SP&C)	B / 7 (CI)
Q.1:	4	3	4	4	4%	37%	20%
Q.2:	4	3	4	3	5%	36%	18%
Q.3:	3	1	3	1	15%	22%	38%
Q.4:	4	4	5	2	2%	82%	6%
Q.5:	1	3	4	5	22%	2%	18%
ACTUAL	16	14	20	15	48%	179%	100%
POSSIBLE	**25**	**25**	**25**	**25**	**500%**	**500%**	**500%**
PERCENTAGE	**64%**	**56%**	**80%**	**60%**	**10%**	**36%**	**20%**

Table A.7.2.4 Overall Team Variable Analysis – Group 2

SECTION (Variable) / QUESTION	B / 1 (Id)	B / 2 (MD)	B / 3 (TD)	B / 4 (Tr)	B / 5 (CI)	B / 6 (SP&C)	B / 7 (CI)
Member 1:	88	64	72	72	13	27	12
Member 2:	64	64	68	68	20	40	33
Member 3:	64	56	80	60	10	36	20
ACTUAL	216	184	220	200	43	103	65
POSSIBLE	**300**	**300**	**300**	**300**	**300**	**300**	**300**
PERCENTAGE	72%	62%	74%	67%	15%	35%	22%

Note: See Radar Chart (Figure A.7.3.2) for presentation of results

A.7.3 PRESENTATION OF RESULTS

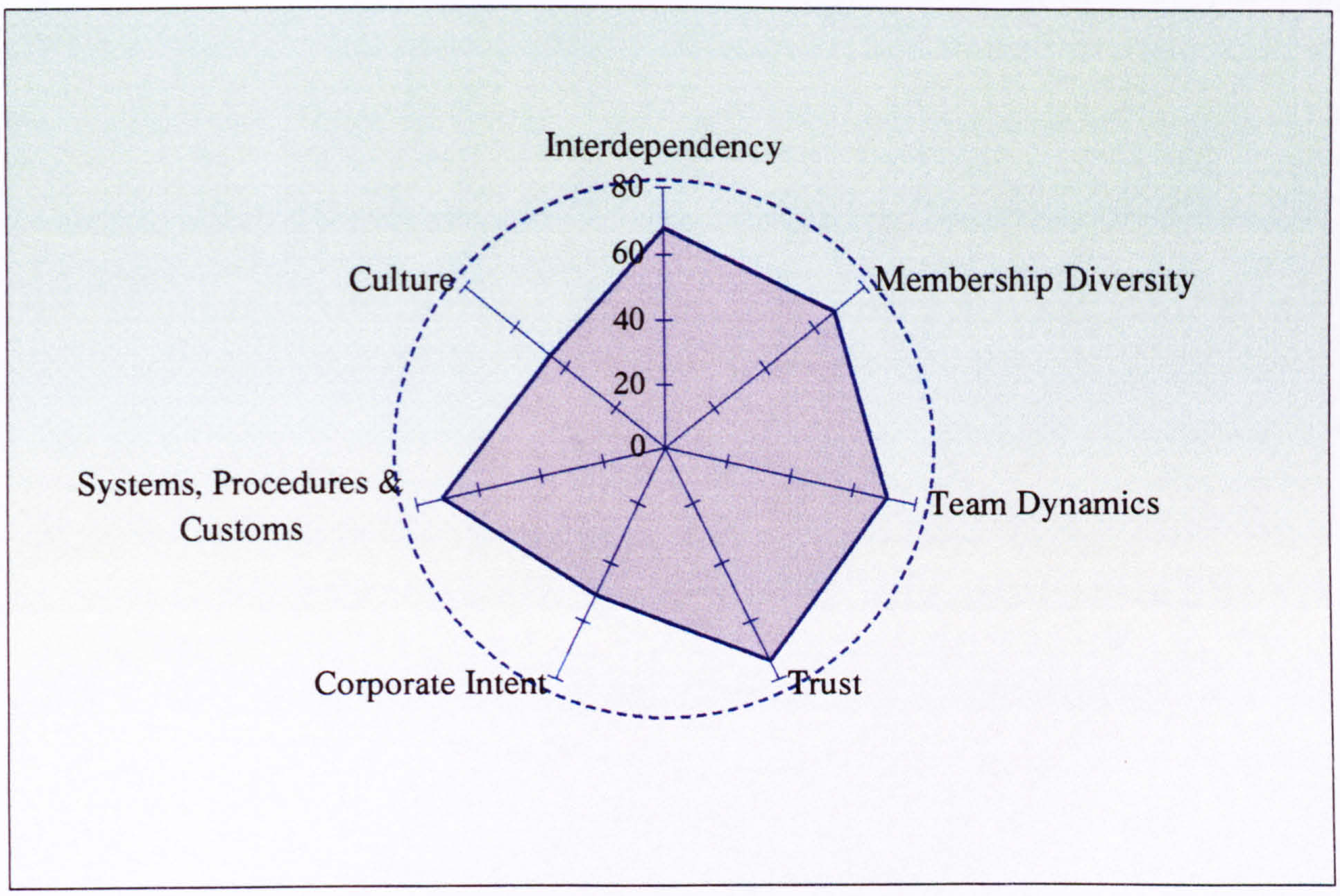


Figure A.7.3.1 Group 1 'Team Rating' Radar Chart

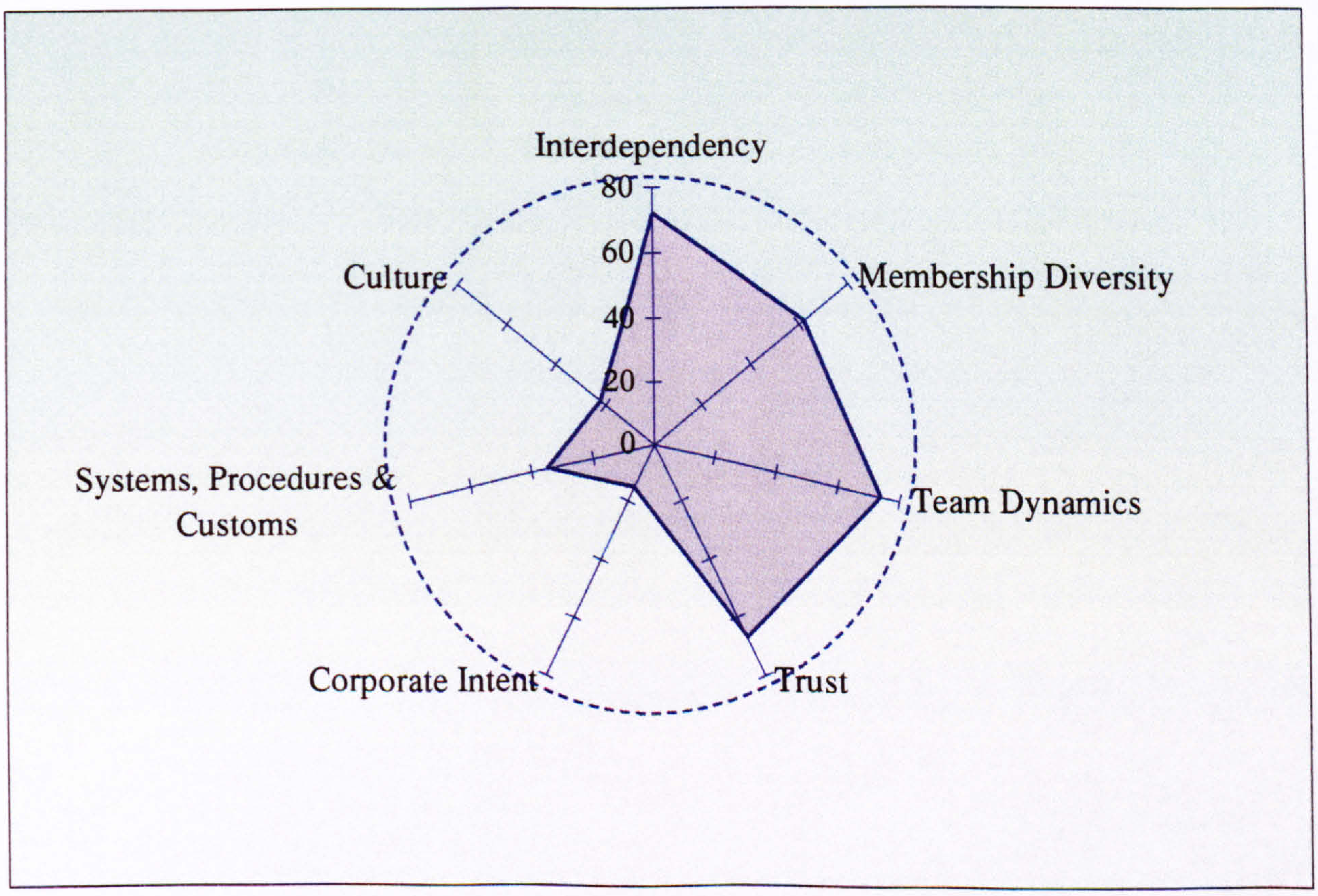


Figure A.7.3.2 Group 2 'Team Rating' Radar Chart

APPENDIX B: "TEAM MEMBER QUESTIONNIARE"

SECTION A: An Overview

Introduction

This team questionnaire toolkit has been formulated in an effort to establish a quantifiable measure of construction site team working. Its purpose is to measure the various intensity of a team environment based on seven different team variables. These variables have been identified as significant contributors to modern-day team working and may be collated under three separate categories. These are as follows:

A/ Group Compatibility & Diversity

B/ Organisational Context

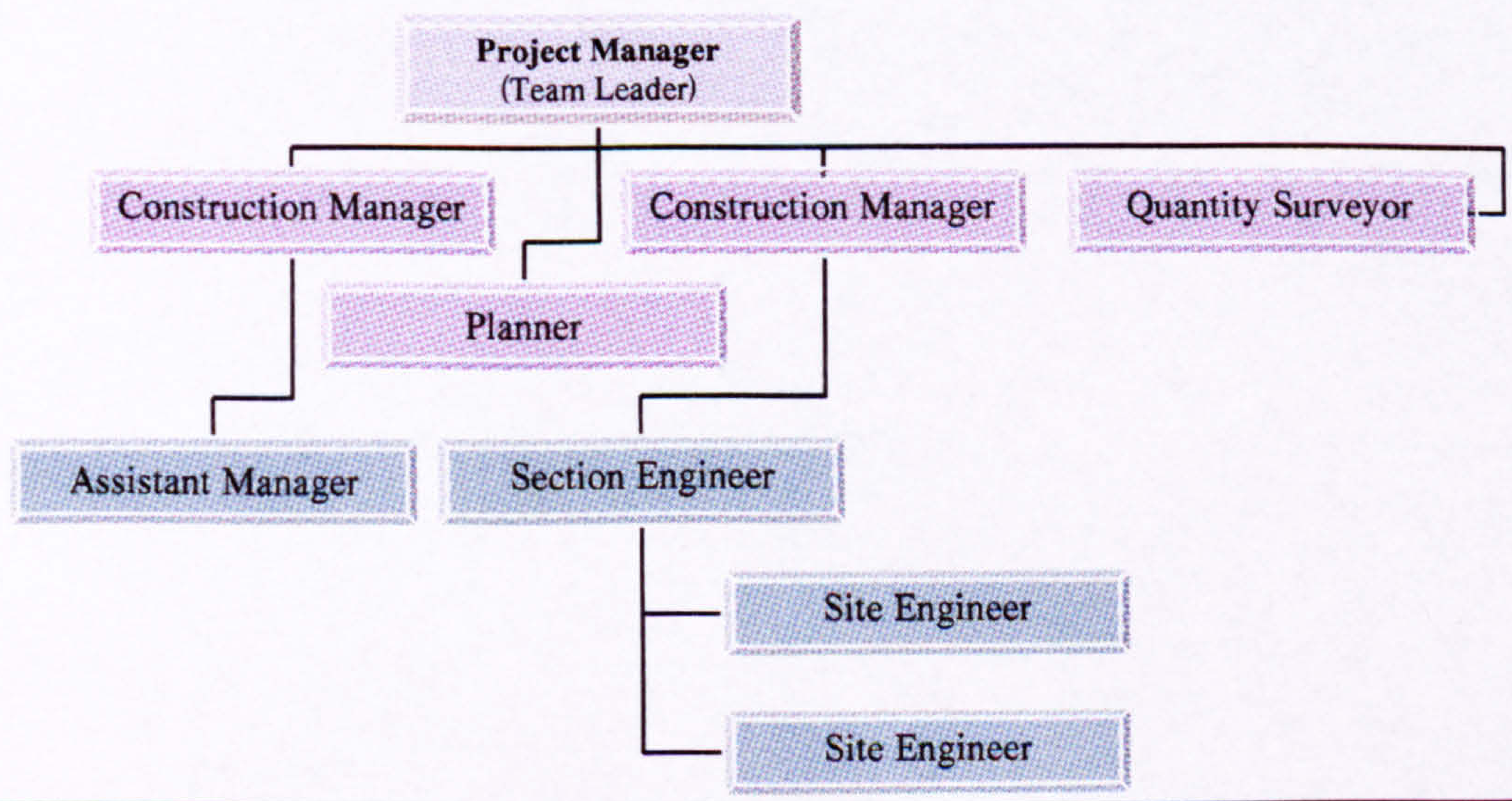
C/ Industry Context

Team Parameters

Within a construction environment company employees may find themselves members of numerous team formations. It important that all participants base their responses on one identified team formation; in this case the Construction Site Project Team parameters may be defined as: All site based construction professionals, production and technical support, working under the direct leadership of the Construction Project Manager (Team Leader) and directly employed by the same company.

Example:

All construction professionals based onsite and employed by the same company



Background Information

Prior to completing the questionnaire could you please provide the following background information:

1/ Company Employer:..

2/ Project :..

3/ Job Title:..

4/ Length of Service with Company

:..

5/ Gender (tick the appropriate box) :

Male	Female

6/ Age (tick the appropriate box) :

16 - 25	26 - 35	36 - 45	46 - 55	56 - 65

SECTION B: The Questionnaire

Instructions:

The following questionnaire has been formulated in response to a literature review of team research and development. The findings of the study identified three broad categories of primary influence on team working with seven distinct variables associated with team performance. The questionnaire addresses each of these variables individually, via statement analysis with each variable result collated, analysed and plotted on a radar chart, similar to those used for construction industry performance indicators.

Section B/ of the questionnaire has eight sections (seven team sections and an 'Additional Information' section). Within each team section there are five statements, all the statements have five prescribed responses; completely true, mostly true, partly true, slightly true and never true. The appropriate box should be marked with a cross (X) to indicate the respondents strength of opinion associated with the statement made and reflect as accurately as possible the characterisation of the team under review.

For example:
The following statement has been taken from **Section B/3** and relates to the strength of relationship between the site team leader and their permanent site team members.

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Team harmony is very high with a collective responsibility for a common objective.		X			

In this example a team member opinion of 'mostly true' has been expressed. This indicates a positive response to the statement and when analysed in conjunction with other team members' judgement will permit a consensus of 'team' opinion to be evaluated.

SECTION B/1: The Questionnaire (Group Compatibility & Diversity)

Directions: For each question in **SECTION B/1** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

STATEMENT \ RATING	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ The team members are fully aware of their individual contribution and personal responsibilities.					
Q.2/ The team members interact, formally and informally on a regular basis.					
Q.3/ The team is very co-operative with members exchanging resources freely and frequently.					
Q.4/ The team leader is very supportive, facilitating and nurturing in style.					
Q.5/ The success of your role is wholly reliant on the performance of others.					

SECTION B/2: The Questionnaire (Group Compatibility & Diversity)

Directions: For each question in **SECTION B/2** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Team members collectively represent a cross-section of the construction professions.					
Q.2/ The level of team behavioural diversity is very high. i.e. different 'characters'					
Q.3/ All team members have participated in company sponsored personality 'psychometric' profiling.					
Q.4/ Team members are fully aware of the behavioural attributes of the other members.					
Q.5/ Improved team performance is dependent on a balance between professional and behavioural characteristics.					

SECTION B/3: The Questionnaire (Group Compatibility & Diversity)

Directions: For each question in **SECTION B/3** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Team harmony is very high with a collective responsibility for a common objective.					
Q.2/ The team leader has a very close working relationship with all the team members					
Q.3/ Informal communication between the team members is frequent and productive					
Q.4/ Everyone within the team is on first name terms.					
Q.5/ The team leader is more concerned with managing people than with completing tasks.					

SECTION B/4: The Questionnaire (Group Compatibility & Diversity)

Directions: For each question in **SECTION B/4** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

RATING / STATEMENT	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Team members have a very high level of professional respect for each other.					
Q.2/ Team members have a very high level of personal confidence in each other.					
Q.3/ Team members celebrate success as a team.					
Q.4/ The team has a policy of promoting trust and openness.					
Q.5/ All team members have worked together on previous projects.					

SECTION B/5: The Questionnaire (Organisation)

Directions: For each question in **SECTION B/5** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

STATEMENT \ RATING	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ All team members attend company sponsored training events, regularly.					
Q.2/ All team members have attended team related training seminars.					
Q.3/ The company has a very high level of commitment towards team working.					
Q.4/ The company has an explicit policy for linking recognition and rewards to team performance.					
Q.5/ All team members are fully aware of their team roles and responsibilities within the working environment.					

SECTION B/6: The Questionnaire (Organisation)

Directions: For each question in **SECTION B/6** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

STATEMENT \ RATING	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ The team has a very high level of organisational autonomy.					
Q.2/ Head Office and senior management have minimum direct contribution to the overall team performance.					
Q.3/ The team has a philosophy of challenging existing work methods.					
Q.4/ Team member turnover is very low.					
Q.5/ All team members receive an individual staff appraisal by their team leader at least once every year.					

SECTION B/7: The Questionnaire (Culture)

Directions: For each question in **SECTION B/7** mark a cross (X) in the box you think best represents the extent of truthfulness associated with the question statement.

STATEMENT \ RATING	Completely True	Mostly True	Partly True	Slightly True	Never True
Q.1/ Team leadership may be considered entrepreneurial and innovative.					
Q.2/ The company has an enlightened approach to performance measurement.					
Q.3/ The company is a very personal place; people are willing to share information and resources.					
Q.4/ Employee commitment and loyalty to the company is very high.					
Q.5/ The company supports diversity and equal opportunity of employment.					

SECTION B/8: The Questionnaire (Additional Information)

Directions: For question 1/ Please put a cross (X) against the response you feel represents your opinion for each of the four questions; Influence, Pay, Achievement and Respect. For question 2/ and 3/ please put a number in the box provided.

1/ Employee Satisfaction: (place a cross in the box you feel best represents your opinion – it may be between given labels, i.e. between 'very satisfied' and 'satisfied'.

Question: How satisfied are you with.....?	**Very Satisfied**		**Satisfied**		**Neither Satisfied Nor Dissatisfied**		**Dissatisfied**		**Very Dissatisfied**
Influence									
Pay									
Achievement									
Respect									

2/ Working Hours:

Over the last four weeks how many hours have you worked. (Include all overtime worked: paid and unpaid).

Total hours worked over the last four weeks =

3/ Training:

Over the past year how many training days have you received from the organisation. (Include on-the-job training as well as the more recognised formal training seminars).

Total number of training days received over the past year =

Date:

<u>THE QUESTIONNAIRE IS COMPLETE: THANK YOU.</u>

APPENDIX C: "TEAM LEADER QUESTIONNAIRE"

TEAM LEADER QUESTIONNAIRE

PROJECT NAME:...

(address)

Re: Teams and Project Performance in Construction

This project information questionnaire is part of a research project that is investigating the relationship between construction site teams and project performance.

In an attempt to quantify the project data and draw comparison between site team accords and project execution it is necessary to gauge up to date performance information using a number of key indicators. Two key performance indicators, recommended by Construction Excellence in the Built Environment are:

1/ Predictability : Construction Cost and
2/ Predictability : Construction Time

I would be obliged if you could provide the following information based on currently

available data for project (Name)...:

1/ Predictability – Construction Cost:

a) Estimated cost at tender (commit to construct). £

b) Current estimated cost at completion. £

2/ Predictability – Construction Time:

a) Estimated construction duration at tender (commit to construct). weeks

b) Current estimated construction duration at completion. weeks

Your participation in this research programme is greatly appreciated, thank you.

Yours sincerely,

Researcher

APPENDIX D: "CLIENT / CLIENT REPRESENTATIVE QUESTIONNAIRE"

CLIENT / CLIENT REPRESENTATIVE QUESTIONNAIRE

PROJECT NAME:...

(address)

Re: Teams and Project Performance in Construction

This client questionnaire is part of a wider research project that is investigating the relationship between construction site teams and project performance.

In an attempt to quantify the project data and draw comparison between site team harmony and project execution it is necessary to gauge current performance perception(s) using a number of key indicators. Two key performance indicators, recommended by Construction Excellence in the Built Environment are:

1/ Client Satisfaction: a) Service and,
b) Product / facility.

I would be obliged if you could complete the following short questionnaire for project,

(Project Name):..

1/ Client Satisfaction:

Please put a cross (X) against the response you feel best represents your opinion for each of the two questions – it may be between given labels, for example your response may be between 'very satisfied' and 'satisfied'.

Question: **How satisfied are you with....?**	**Very Satisfied**		**Satisfied**		**Neither Satisfied Nor Dissatisfied**		**Dissatisfied**		**Very Dissatisfied**
a) Service									
b) Product									

Please use the prepaid stamped addressed envelope to return the questionnaire response. Your participation in this research programme is greatly appreciated, thank you.

Yours sincerely,

Researcher

APPENDIX E: "PROJECT PERFORMANCE TOOLKIT – WORKED EXAMPLE"

E.1 PROJECT PERFORMANCE TOOLKIT

E.1.1 INTRODUCTION

The worked example is calculated using arbitrary 'case study' key performance figures but is translated in to industry benchmark scores using 2003 Constructing Excellence in the Built Environment KPI data.

E.2 WORKED EXAMPLE

The formulae used are extracts from existing KPI information developed and advocated by Constructing Excellence in the Built Environment. Further information on KPI calculation can be found in the Constructing Excellence Handbook.

E.2.1 PREDICTABILITY – CONSTRUCTON COST

c) Estimated cost at tender (commit to construct).

£ 5.75m

d) Current estimated cost at completion.

£ 6.00m

Using the Formula:

$$\frac{£6.00m - £5.75m}{£5.75m} \times 100$$

= +4.4%, therefore benchmark score from 2003 KPI figures is: <u>23%</u>

E.2.2 PREDICTABILITY – CONSTRUCTION TIME

c) Estimated construction duration at tender (commit to construct).

100 weeks

d) Current estimated construction duration at completion.

104 weeks

Using the Formula:

$$\frac{104 \text{ weeks} - 100 \text{ weeks}}{100 \text{ weeks}} \times 100$$

= +4.0%, therefore benchmark score from 2003 KPI figures is: **36%**

E.2.3 CLIENT SATISFACTION

Please put a cross (X) against the response you feel best represents your opinion for each of the two questions; how satisfied are you with a) Service and b) Product.

Question: **How satisfied are you with....?**	**Very Satisfied**		**Satisfied**		**Neither Satisfied Nor Dissatisfied**		**Dissatisfied**		**Very Dissatisfied**
	10	9	8	7	6 / 5	4	3	2	1
a) Service			X						
b) Product			X						

✓ Client Satisfaction – Service = 8, therefore benchmark score from 2003 KPI figures is:

60%

✓ Client Satisfaction – Product = 8, therefore benchmark score from 2003 KPI figures is:

60%

E.2.4 EMPLOYEE SATISFACTION

Question: How satisfied are you with.....?	Very Satisfied		Satisfied		Neither Satisfied Nor Dissatisfied		Dissatisfied		Very Dissatisfied
	10	9	8	7	6 / 5	4	3	2	1
Influence					X				
Pay							X		
Achievement							X		
Respect			X						

Formula:

Performance score (rating) = The average of the overall ratings for all site team members.

Example: (6 + 3 + 3 + 8) divided by 4 = 5, therefore benchmark score from 2003 KPI figures is:

35%

E.2.5 WORKING HOURS

Over the last four weeks how many hours have you worked. (Include all overtime worked: paid and unpaid).

Total hours worked over the last four weeks = 152 hrs

Formula:

$$\frac{152 \text{ hrs}}{4 \text{ weeks}}$$

Working hours = 38 hours per week, therefore benchmark score from 2003 KPI figures is:

83%

E.2.6 TRAINING

Over the past year how many training days have you received from the organisation. (Include on-the-job training as well as the more recognised formal training seminars).

Total number of training days received over the past year = 7.5 days

Formula:

$$\frac{7.5 \text{ days}}{1 \text{ year}}$$

Training days = 7.5 days per year, therefore benchmark score from 2003 KPI figures is:

96%

Table E.2.1 Summary of Results:

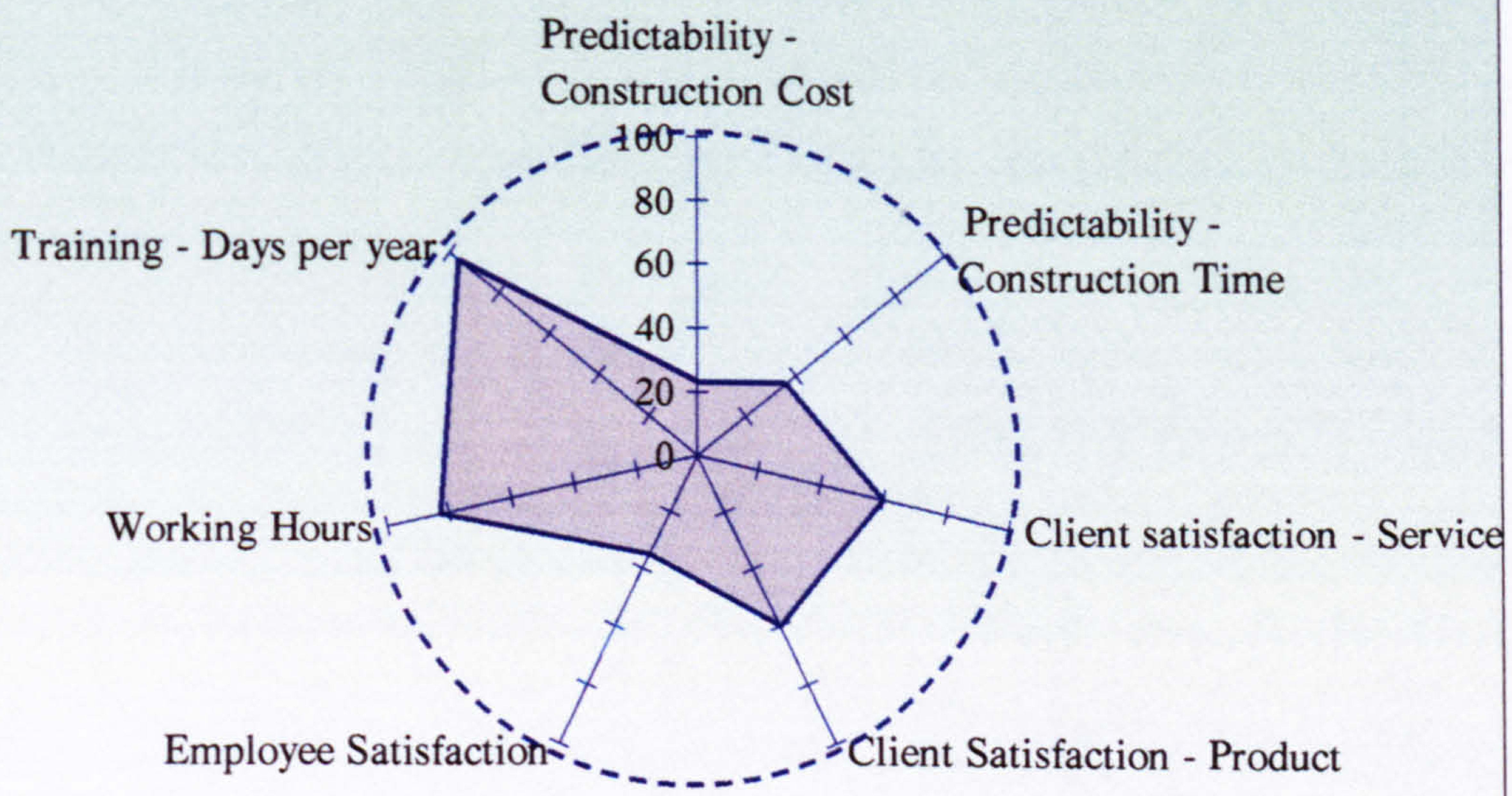
Key Performance Indicator	Questionnaire Response	Benchmark Score (2003)
1/ Predictability – Construction Cost	+ 4.40%	23%
2/ Predictability – Construction Time	+ 4.00%	36%
3/ Client Satisfaction –Service	8	60%
4/ Client Satisfaction –Product	8	60%
5/ Employee Satisfaction–Team Member	5	35%
6/ Working Hours –Average per week	38	83%
7/ Training –Days per year	7.50	96%

Mean : 56%

Standard Deviation : 26.7

E.3 PLOTTING THE RESULTS

The results are presented using a radar chart format. The benchmark score is plotted on the appropriate axis at the relevant score. The closer the point is to the circumference the higher the percentage and vice-versa. Figure E.3.1 is a typical example of plotting the performance results.



Mean Project Score: 56%

Standard deviation: 26.7

Figure E.3.1 Worked Example of Project Performance Radar Chart

APPENDIX F: "PILOT STUDY REPORT"

F.1 THE PILOT STUDY

F.1.1 INTRODUCTION

The pilot study was carried out in June 2004 with the co-operation of a major UK contractor and a designated construction site management team.

F.2 COMPANY 'A'

Company A is a leading UK building and civil engineering contractor. Over the past three years Company A has undergone major strategic restructuring that has resulted in a realigned business focus aimed primarily at the housing sector and property development within the UK, Europe and North America. The company continues to have a significant business interest in other construction activities and provides services for the industrial and commercial construction sector as well as facilities management and engineering projects. Company A has a corporate turnover in the region of £3360 million, £762 million (22%) attributable to construction related performance and is regularly quoted in the top 200 of the FTSE. In 2004 the company employed a total corporate workforce in excess of 7600 employees (UK and Overseas) with over 3400 employed within Company A's construction business unit.

F.2.1 PILOT STUDY PROJECT DETAILS

Project Details	:	Company A / Project 1 (A/1)
Estimated cost of the project	:	£13.6 million
Programmed duration of the project	:	85 weeks
Procurement route	:	JCT Works
Current status of the project	:	Week 52
Staffing Details		
Team size	:	4 Technical Staff
Construction professionals	:	Project Manager
		Site Manager

		Assistant Site Manager
		Site Engineer
Client	:	(Confidential)
Previous client experience	:	Yes
Technical Details		
Type of work	:	Refurbishment and fit-out development

F.2.2 THE PILOT STUDY TEAM MEMBERS

This pilot study had four participants, one senior project manager (Project Leader) and three team members, all male. The four team members are employed by the principal contractor with an average length of service of approximately 12 months. All participants have a construction management background / role and may be viewed as part of the site production management team. The age range of the team members was as follows: '26-35' category – two members, '46-55' category – one member and '56-65' category – one member.

F.2.3 PILOT STUDY RESULTS

The Team Results

Mean rating for the seven team variables = 77%

The percentage scores for each of the seven variables were consistently high. The highest score was 83% relating to culture (Industry Context). The lowest score was 67% relating to membership diversity (Group Compatibility and Diversity).

The Site Performance Results

Mean score for the seven KPI's = 55%

The percentage score for each of the seven performance components was variable. The highest score was 96% relating to training (Learning). The lowest score was 13% relating to Working Hours per week, (Internal).

The following table F.2.1 is a breakdown of the team variable averages from the Project A/1 Construction Project Pilot Study results:

Table F.2.1 Project A/1 Team Variable Ratings

Team Variable	Team Category	Rating
1/ Interdependency	(Group Diversity & Compatibility)	- 81%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 67%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 79%
4/ Trust	(Group Diversity & Compatibility)	- 68%
5/ Corporate Intent	(Organisational Context)	- 78%
6/ Systems, Policies & Customs	(Organisational Context)	- 81%
7/ Culture	(Industry Context)	- 83%

Table F.2.2 is a breakdown of the project key performance indicator score from the Company A/1 Construction Project Pilot Study results:

Table F.2.2 Project A/1 Project KPI Scores

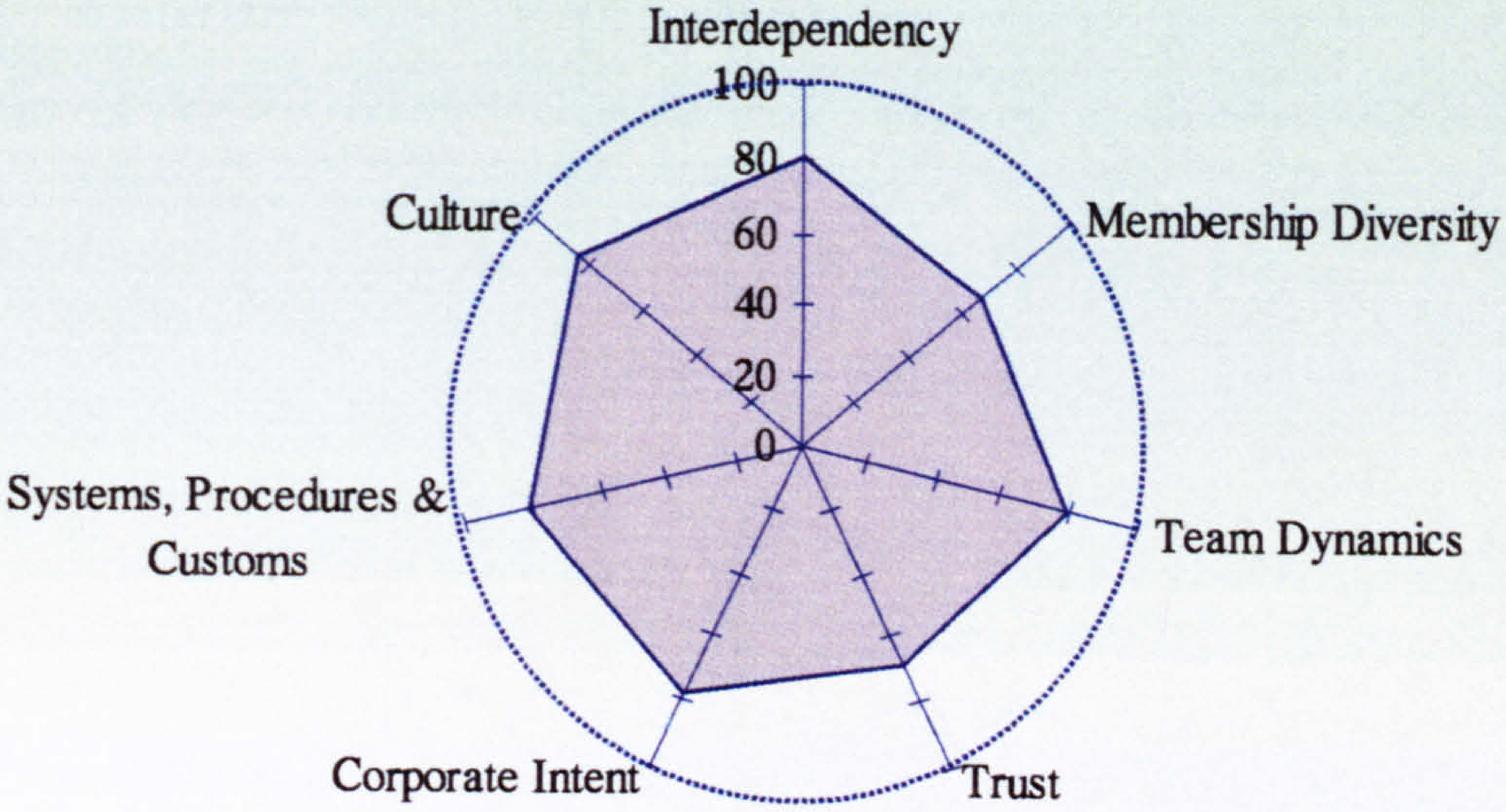
Indicator	Perspective	Company Score
1/ Predictability - Construction Cost (%)	(Financial)	+6.6%
2/ Predictability - Construction Time (%)	(Financial)	-1.2%
3/ Client Satisfaction – Service (out of ten)	(Customer)	8.0
4/ Client Satisfaction – Product (out of ten)	(Customer)	8.0
5/ Employee Satisfaction (out of ten)	(Internal)	7.8
6/ Working Hours (per week)	(Internal)	52.0
7/ Training Days (per year)	(Innovation & Learning)	7.5

Table F.2.3 translates the project key performance indicator score from the Company A/1 Construction Project Pilot Study in to Construction Industry Benchmarks.

Table F.2.3 Project A/1 KPI Benchmark Scores

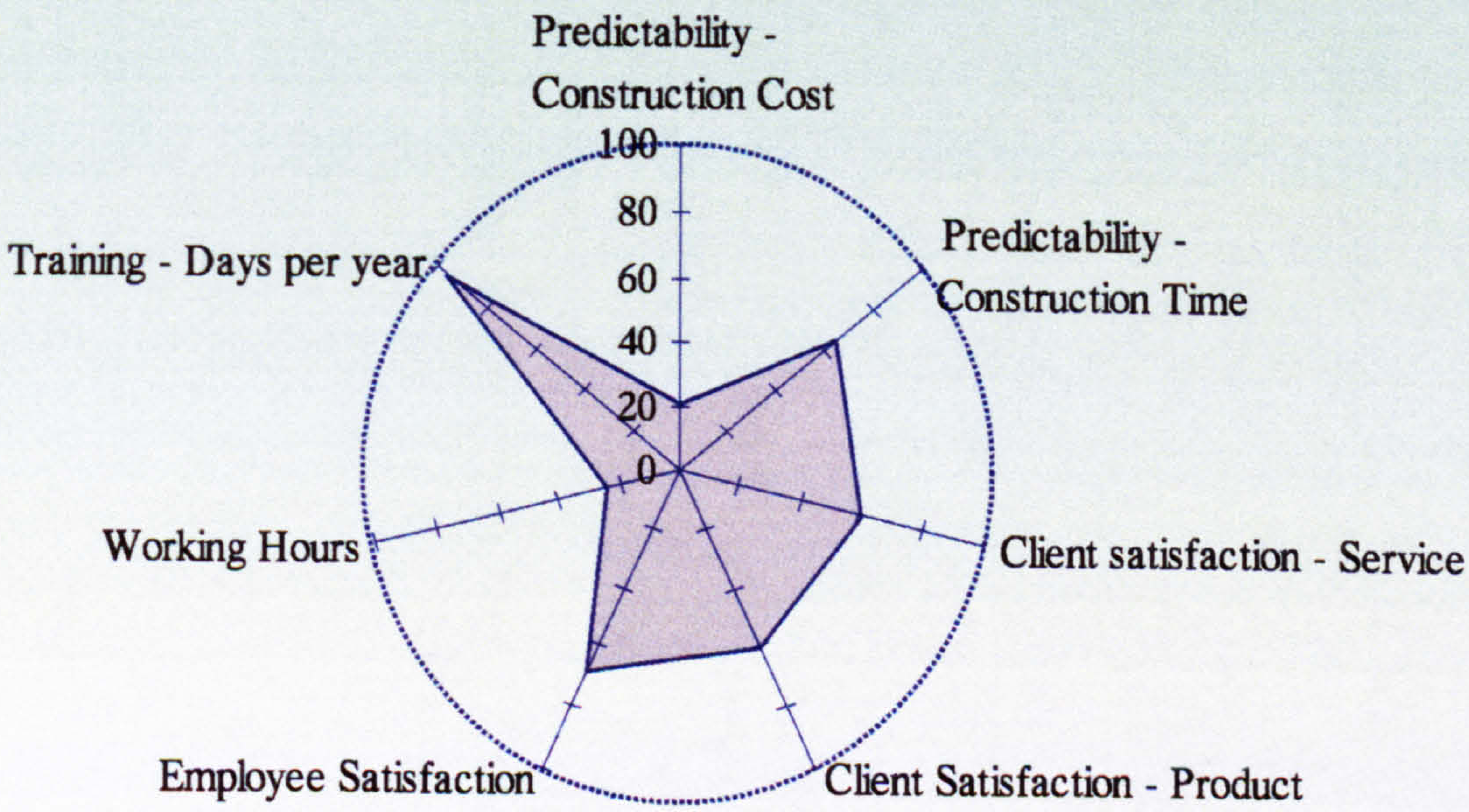
Indicator	Perspective	Benchmark Score
1/ Predictability - Construction Cost	(Financial)	- 23%
2/ Predictability - Construction Time	(Financial)	- 61%
3/ Client Satisfaction - Service	(Customer)	- 55%
4/ Client Satisfaction - Product	(Customer)	- 55%
5/ Employee Satisfaction	(Internal)	- 79%
6/ Working Hours	(Internal)	- 13%
7/ Training - Days per year	(Innovation & Learning)	- 96%

Note: The project performance results are taken from the relevant Construction Industry Key Performance Indicators (Economic - All Construction & Respect for People) 2004.



Mean Team Score = 77%
Standard Deviation = 6.5

Figure F.2.1 Team Rating Radar Chart (Project A/1) – Pilot Study



Mean Project Score = 55%

Standard Deviation = 29.1

Figure F.2.2 Project Performance Radar Chart (Project A/1) – Pilot Study

Note: The results are presented using a Radar Chart format. In general, the nearer the plotted line is to the outer perimeter of the radar chart, the higher the overall performance.

F.2.4 TEAM VARIABLE ANALYSIS

The team variable results were consistently high across the three various categories. The highest score of 83% for culture (Industry Context) may be seen as typical for construction projects. As an industry noted for team working the results seem to support this inherent trait. The lowest score of 67% (Group Compatibility and Diversity) may be attributed to the occupational backgrounds of the participants. All participants had a construction management aspect to their job, for example site manager, assistant site manager etc. and therefore it may be that membership diversity was compromised slightly by the lack of technical support personnel such as Quantity Surveyor or Planner as a permanent member of the site team. It is interesting to note that issues relating to company / organisational management of teams are very high, averaging 80%. This suggests that company policy, procedures and customs are recognising the core value of team working and have put in place a corporate management system that assist site teams and individual members to perform in a team environment.

F.2.5 PROJECT KPI ANALYSIS

The site project performance results illustrate variable levels of achievement. This may be attributable to background information not included in the pilot study remit. For example the second lowest score was 23% for Predictability – Construction Cost. This is due to a +6.6% increase in cost to date from the initial estimate of £13.6 million. The other lower than expected indicator is 'Working Hours', averaging approximately 52 hours per week, this represents a score of 13% as an industry benchmark score. Again, this may be due to site and/or programme circumstances. Other reasons could exist and may be worth investigating in an effort to improve the work – life balance. Employee satisfaction scored 79%, in general representative of a satisfied management workforce and compares positively with the overall team score (77%). The highest score of 96% was associated with training days per year. This figure suggests a company policy for promoting continuous learning and employee development.

F.2.6 CONCLUSION

The results of this pilot study illustrate a number of interesting points. The team variable scores are very good across all the categories with no identifiable weak points, whilst at the same time supporting commonly held view points, e.g. a team culture. The project performance does highlight strengths as well as weaknesses. Not necessarily areas of concern but worthy of investigation to further understand the reasoning behind the below average outcome(s). As far as the relationship between team 'dynamics' and site project performance is concerned additional investigation is necessary in order to establish benchmarks for team and project performance in the UK Construction Industry from which a framework for team / project performance may be formulated.

APPENDIX G: "PROJECT CASE STUDY REPORTS"

G.1 THE PROJECT CASE STUDIES

G.1.1 INTRODUCTION

The case study information contained in Appendix G provides a review of the thirteen individual project case-studies There are five case-studies for Company B, three case-studies for Company C and five case-studies for Company D. All project case studies were carried out between August 2004 and April 2005.

G.2 COMPANY B - THE CASE-STUDIES

G.2.1.1 COMPANY B / PROJECT 1

Project Details	:	**B/1**
Estimated cost of the project	:	£9.3 million
Programmed duration of the project	:	43 weeks
Procurement route	:	JCT Works
Current status of the project	:	Week 24

Staffing Details

Team size	:	5 Technical Staff
Construction professionals	:	Project Manager
		Site Manager
		Site Engineer (x2)
		Quantity Surveyor (x2) (Agency)
		Sub-Agent (Agency)
Client	:	(Confidential)
Previous client experience	:	No

Technical Details

Type of work	:	Refurbishment and fit-out development

G.2.1.2 THE PARTICIPANTS

This case study had five participants, one project manager (Project Leader) and four team members, all male. One team member was on holiday and did not participate in the team questionnaire. The five team members are employed by the principal contractor with an average length of service of approximately 12 months. Four of the participants have a construction management background (Manager / Engineer) and one team member is a Quantity Surveyor. The age range of the team members was as follows: '16 – 25' category – one member, '26-35' category – one member, '36 - 45' category – two members and '46-55' category – one member.

G.2.1.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 72%

The following table is a breakdown of the team variable results:

Table G.2.1.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 78%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 70%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 78%
4/ Trust	(Group Diversity & Compatibility)	- 70%
5/ Corporate Intent	(Organisational Context)	- 64%
6/ Systems, Policies & Customs	(Organisational Context)	- 76%
7/ Culture	(Industry Context)	- 68%

The percentage scores for each of the seven variables were relatively high. The highest equal score was 78% relating to Interdependency and Team Dynamics both from the same category - Group Compatibility and Diversity. The lowest score was 64% relating to corporate intent, (Organisational context).

2/ **Project Performance**

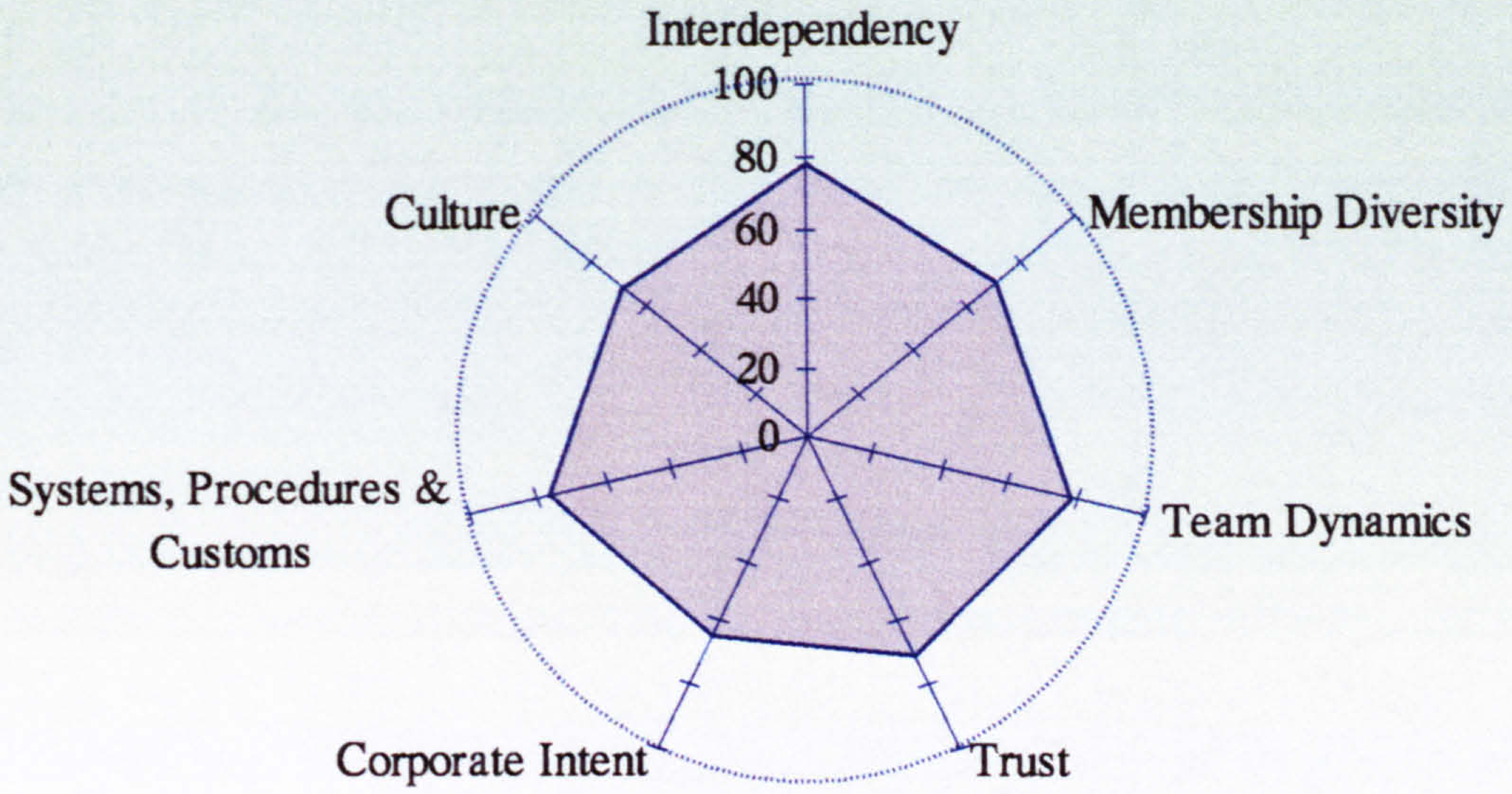
Mean indicator score for the seven components = 54%

The following table is a breakdown of the project indicator results:

Table G.2.1.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 75%
2/ Predictability - Construction Time	(Financial)	- 25%
3/ Client Satisfaction - Service	(Customer)	- 55%
4/ Client Satisfaction - Product	(Customer)	- 55%
5/ Employee Satisfaction	(Internal)	- 61%
6/ Working Hours	(Internal)	- 22%
7/ Training - Days per year	(Innovation & Learning)	- 88%

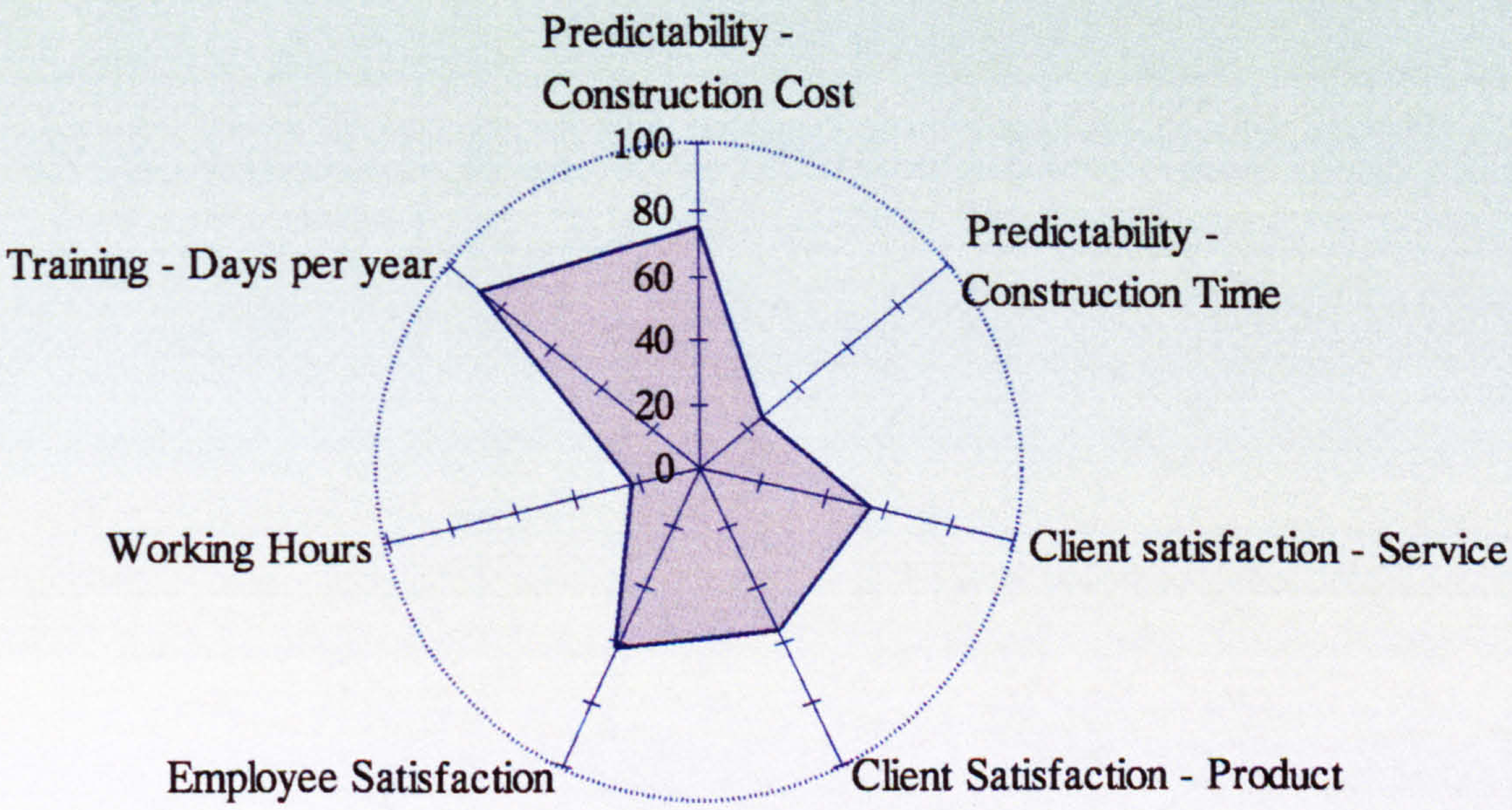
The percentage score for each of the seven performance components was variable with a standard deviation of 24.3. The highest score was 88% relating to number of training days per year cost (Learning). The lowest score was 22% relating to working hours, (Internal perspective).



Mean Team Rating = 72%

Standard Deviation = 5.4

Figure G.2.1.1 Project B/1 Team Rating Radar Chart



Mean Project Score = 54%

Standard Deviation = 24.2

Figure G.2.1.2 Project B/1 Performance Radar Chart

G.2.2.1 COMPANY B / PROJECT 2

Project Details	:	B/2
Estimated cost of the project	:	£6.2 million
Programmed duration of the project	:	44 weeks
Procurement route	:	Traditional
Current status of the project	:	Week 14

Staffing Details:

Team size	:	4 Technical staff
Construction professionals	:	Project Manager
		Site Manager
		Site Engineer
		Site Surveyor (Agency)
Client	:	(Confidential)
Previous client experience	:	No

Technical Details

Type of work	:	New Build

G.2.2.2 THE PARTICIPANTS

This case study had three participants, one project manager (Project Leader) and two team members, all male. The three team members are employed by the principal contractor with an average length of service of approximately 4 months. All participants have a construction management background / role and may be viewed as part of the site production management team. The age range of the team members was as follows: '26-35' category – one member, '36-45' category – one member and '46-55' category – one member.

G.2.2.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 68%

The following table is a breakdown of the team variable results:

Table G.2.2.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 77%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 69%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 80%
4/ Trust	(Group Diversity & Compatibility)	- 63%
5/ Corporate Intent	(Organisational Context)	- 56%
6/ Systems, Policies & Customs	(Organisational Context)	- 69%
7/ Culture	(Industry Context)	- 61%

The percentage scores for each of the seven variables were relatively high. The highest score was 81% relating to Team Dynamics from the category - Group Compatibility and Diversity. The lowest score was 56% relating to corporate intent, (Organisational context).

2/ Project Performance

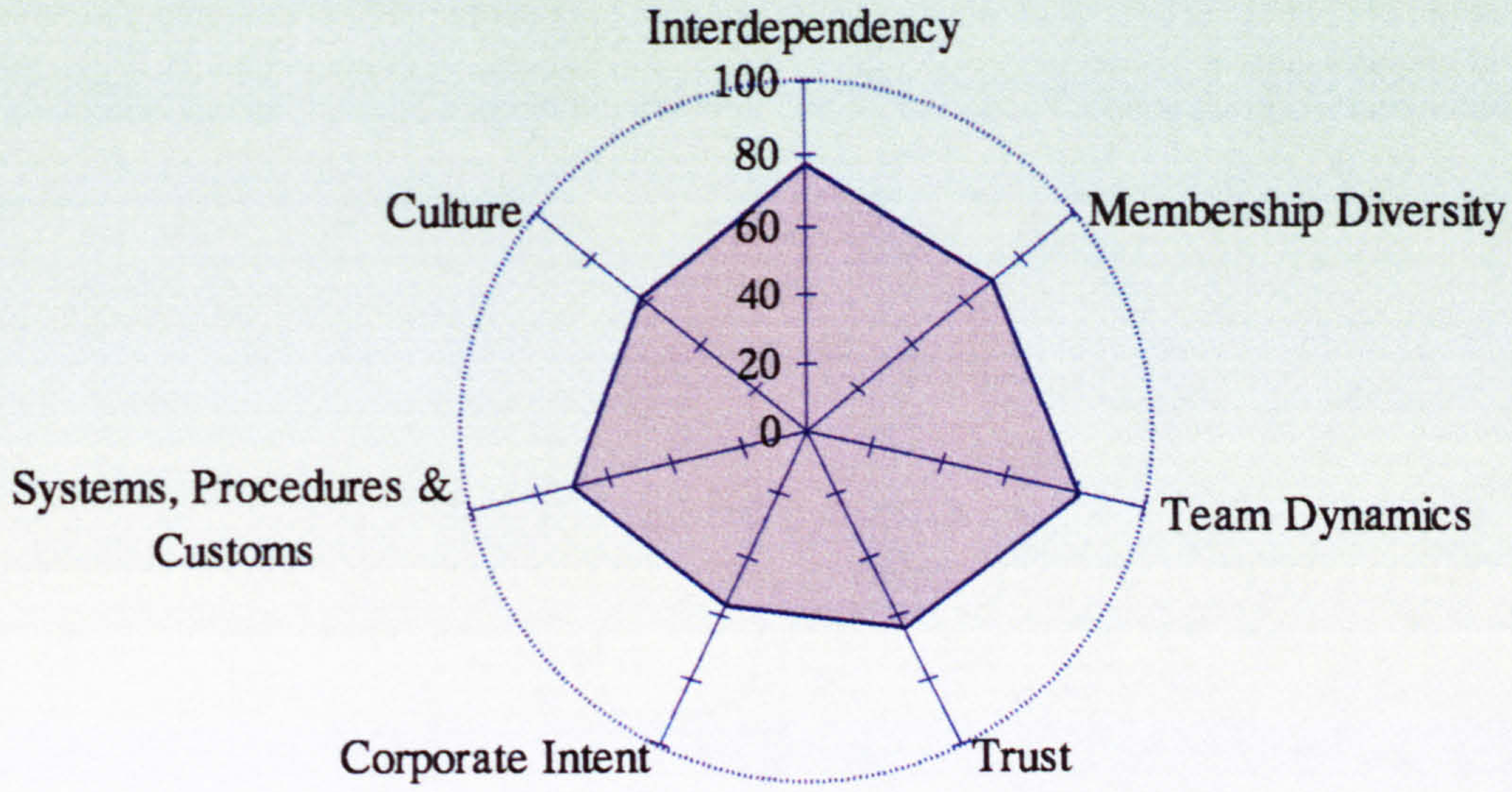
Mean indicator score for the seven components = 48%

The following table is a breakdown of the project indicator results:

Table G.2.2.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 75%
2/ Predictability - Construction Time	(Financial)	- 39%
3/ Client Satisfaction - Service	(Customer)	- 10%
4/ Client Satisfaction - Product	(Customer)	- 55%
5/ Employee Satisfaction	(Internal)	- 67%
6/ Working Hours	(Internal)	- 14%
7/ Training - Days per year	(Innovation & Learning)	- 75%

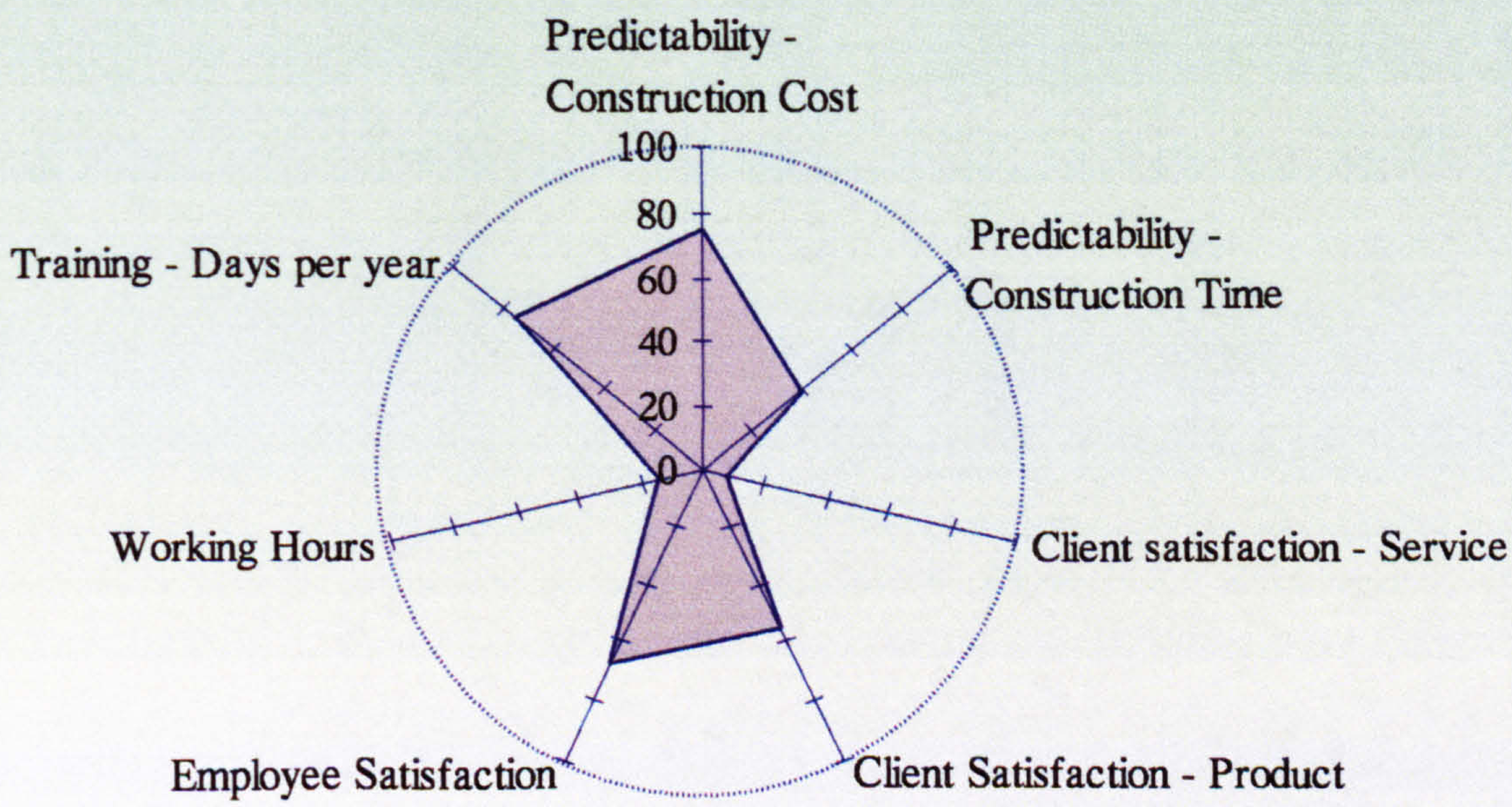
The percentage score for each of the seven performance components was variable with a standard deviation of 28.2. The highest score was 75% relating to number of training days per year cost (Learning). Predictability – construction cost also recorded a score of 75% based on the latest unconfirmed information. The lowest score was 10% relating to Client Satisfaction for service, (Customer). The other notable low performance indicator was working hours, (Internal perspective) with a score of 14%.



Mean Team Rating = 68%

Standard Deviation= 8.9

Figure G.2.2.1 Project B/2 Team Rating Radar Chart



Mean Project Score = 48%

Standard Deviation = 28.2

Figure G.2.2.2 Project B/2 Performance Radar Chart

G.2.3.1 COMPANY B / PROJECT 3

Project Details	:	B/3
Estimated cost of the project	:	£8.5 million
Programmed duration of the project	:	64 weeks
Procurement route	:	Traditional
Current status of the project	:	Week 27

Staffing Details:

Team size	:	8 Technical Staff, 1 Site Administrator
Construction professionals	:	Project Manager
		Site Manager (x3)
		Site Engineer (x2)
		Quantity Surveyor (x2)
Client	:	(Confidential)
Previous client experience	:	No

Technical Details

Type of work	:	New Build

G.2.3.2 THE PARTICIPANTS

This case study had five participants, one project manager (Project Leader) and four participating team members, one female and three male. The five team members are employed by the principal contractor with an average length of service of approximately 9 months. All participants have a construction management background / role and may be viewed as part of the site production management team. The age range of the team members was as follows: '16-25' category – one member, '36-45' category – one member, '46-55' category – two members and '56-65' category – one member.

G.2.3.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 62%

The following table is a breakdown of the team variable results:

Table G.2.3.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 66%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 65%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 68%
4/ Trust	(Group Diversity & Compatibility)	- 53%
5/ Corporate Intent	(Organisational Context)	- 52%
6/ Systems, Policies & Customs	(Organisational Context)	- 67%
7/ Culture	(Industry Context)	- 60%

The percentage scores for each of the seven variables were moderate. The highest score was 68% relating to Team Dynamics from the category - Group Compatibility and Diversity. The lowest score was 52% relating to corporate intent, (Organisational context).

2/ Project Performance

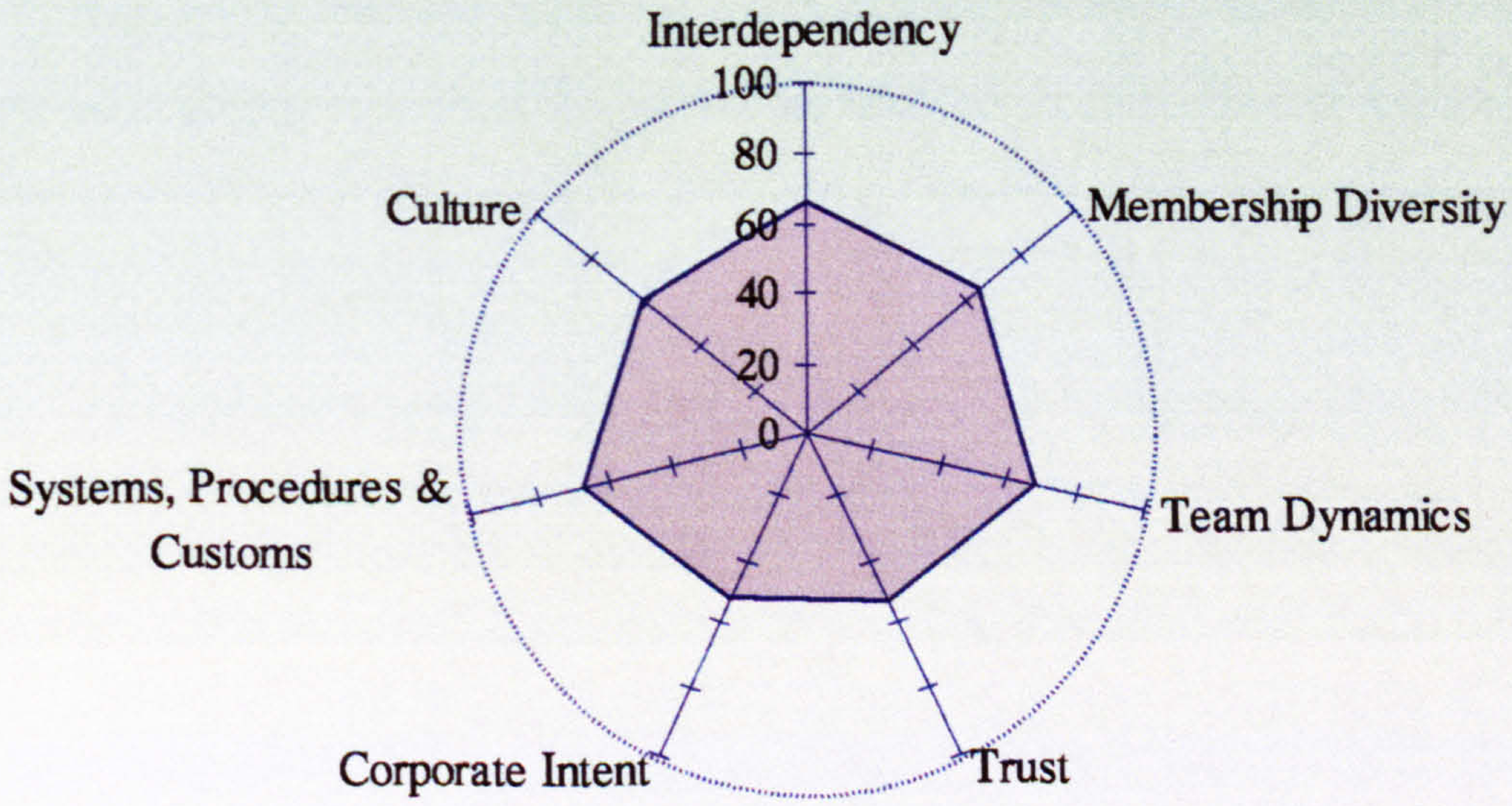
Mean indicator score for the seven components = 29%

The following table is a breakdown of the project indicator results:

Table G.2.3.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 27%
2/ Predictability - Construction Time	(Financial)	- 26%
3/ Client Satisfaction - Service	(Customer)	- 10%
4/ Client Satisfaction - Product	(Customer)	- 8%
5/ Employee Satisfaction	(Internal)	- 45%
6/ Working Hours	(Internal)	- 18%
7/ Training - Days per year	(Innovation & Learning)	- 72%

The percentage score for each of the seven performance components was variable with a standard deviation of 22.5. The highest score was 72% relating to number of training days per year cost (Learning). Predictability – construction cost also recorded a score of 75% based on the latest unconfirmed information. The two lowest scores were 8% and 10% recorded for Client Satisfaction for service and Client satisfaction for product, respectively, both Customer perspectives.



Mean Team Rating = 62%

Standard Deviation = 6.7

Figure G.2.3.1 **Project B/3 Team Rating Radar Chart**

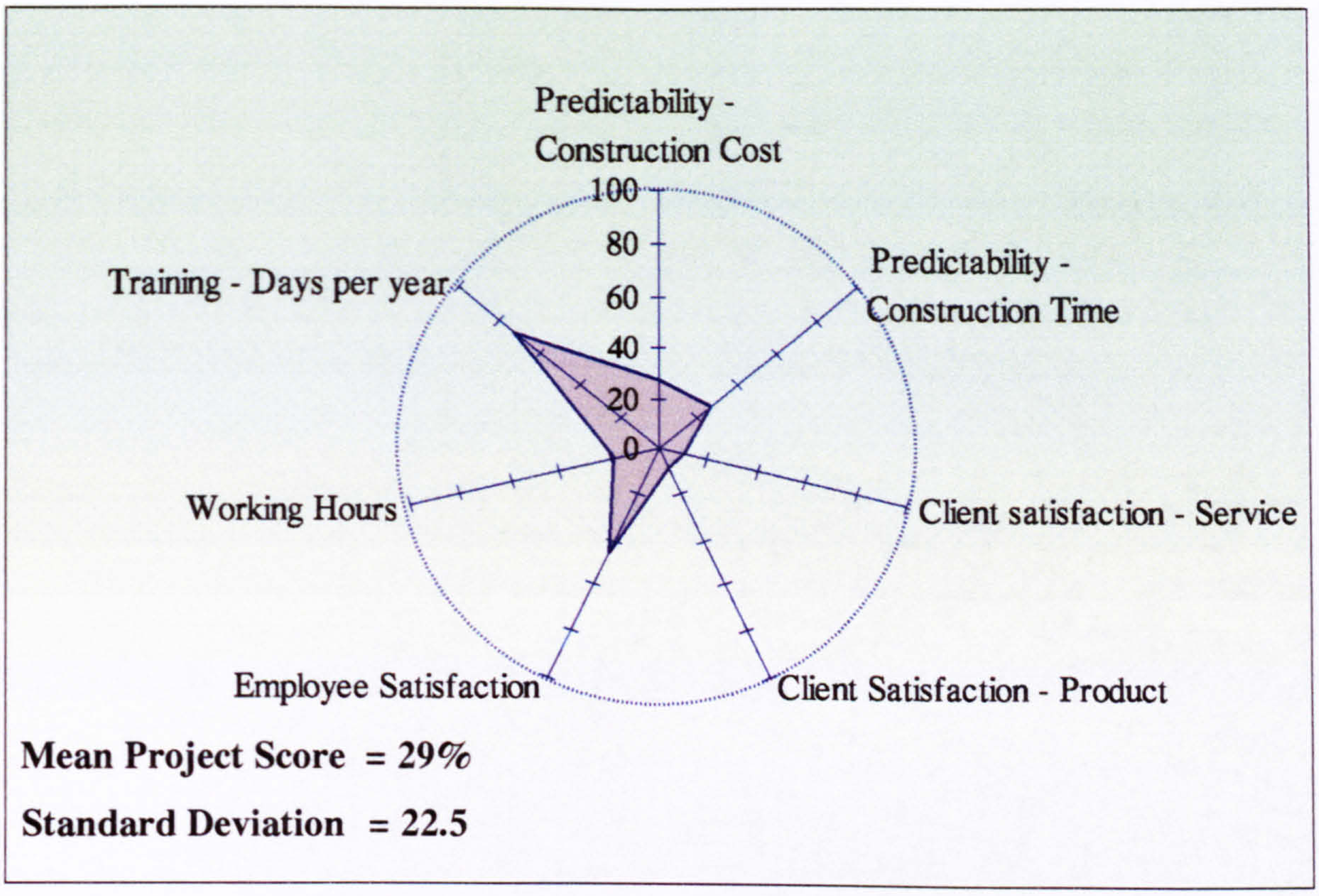


Figure G.2.3.2 Project B/3 Performance Radar Chart

G.2.4.1 COMPANY B / PROJECT 4

Project Details	:	**B/4**
Estimated cost of the project	:	£2.9 million
Programmed duration of the project	:	52 weeks
Procurement route	:	Traditional
Current status of the project	:	Week 31

Staffing Details:

Team size	:	5 Technical Staff	
Construction professionals	:	Project Manager	
		Quantity Surveyor	
		Site Manager	
		Works Manager	(x2)
Client	:	(Confidential)	

Previous client experience : No

Technical Details

Type of work : New build office development

G.2.4.2 THE PARTICIPANTS

This case study had five participants, one project manager (Project Leader) and four team members, all male. The four team members are employed by the principal contractor with an average length of service of approximately 32 months (2yrs, 8months). Four of the participants have a construction management background with one member having a Quantity Surveying profession. The age range of the team members was as follows: '16-25' category – one member, '26-35' category – one member, '36-45' category – two members and '56-65' category – one member.

G.2.4.3 RESULTS

1/ **Team Rating**

Mean team rating for the seven components = 70%

The following table is a breakdown of the team variable results:

Table G.2.4.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 82%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 66%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 78%
4/ Trust	(Group Diversity & Compatibility)	- 73%
5/ Corporate Intent	(Organisational Context)	- 62%
6/ Systems, Policies & Customs	(Organisational Context)	- 59%
7/ Culture	(Industry Context)	- 71%

The percentage scores for each of the seven variables were relatively high. The highest score was 82% relating to Interdependency (Group Compatibility and Diversity). The lowest score was 59% relating to systems, procedures and customs (Organisational Context).

2/ **Project Performance**

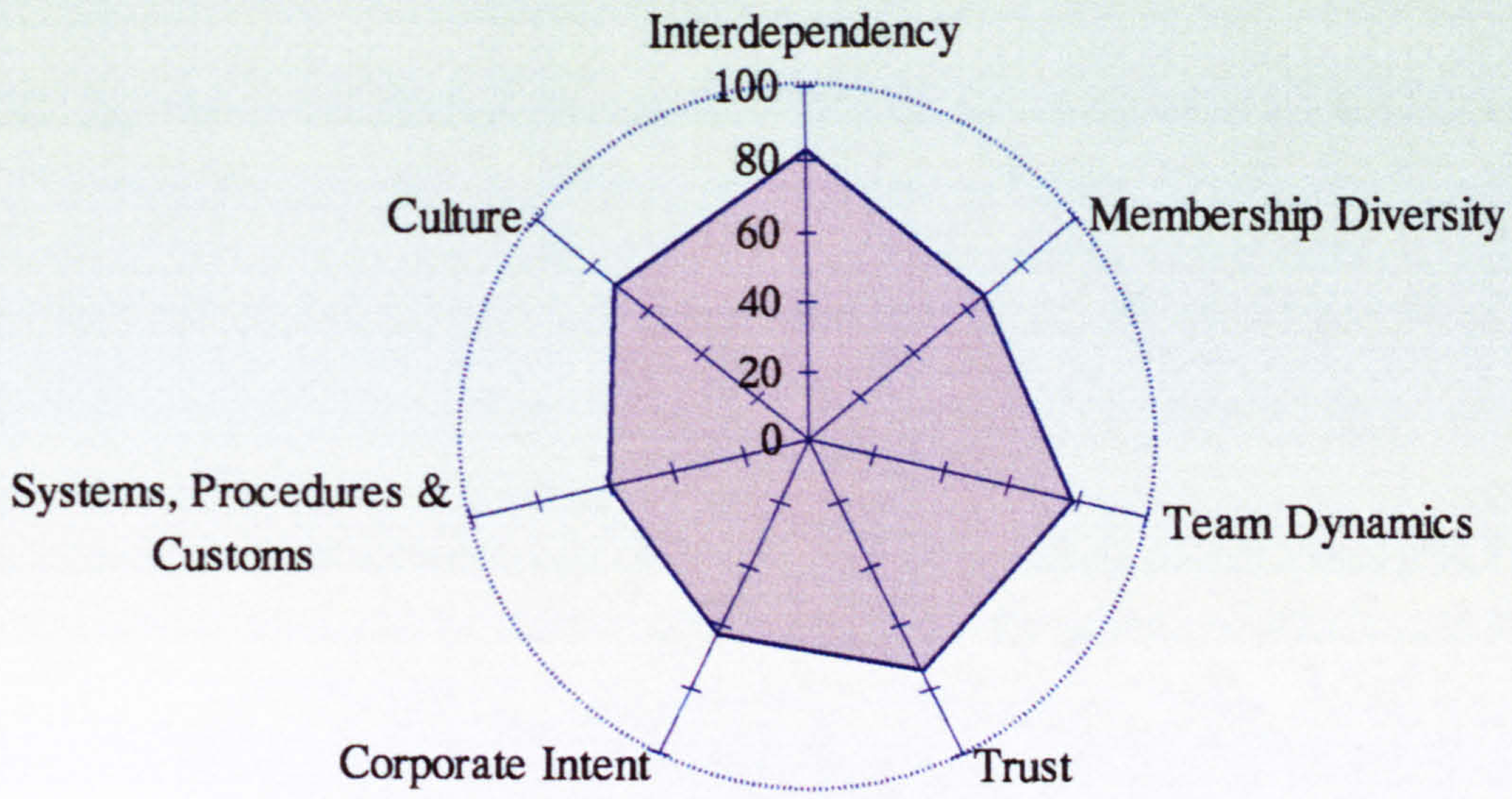
Mean indicator score for the seven components = 43%

The following table is a breakdown of the project indicator results:

Table G.2.4.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 95%
2/ Predictability - Construction Time	(Financial)	- 19%
3/ Client Satisfaction - Service	(Customer)	- 27%
4/ Client Satisfaction - Product	(Customer)	- 2%
5/ Employee Satisfaction	(Internal)	- 46%
6/ Working Hours	(Internal)	- 20%
7/ Training - Days per year	(Innovation & Learning)	- 89%

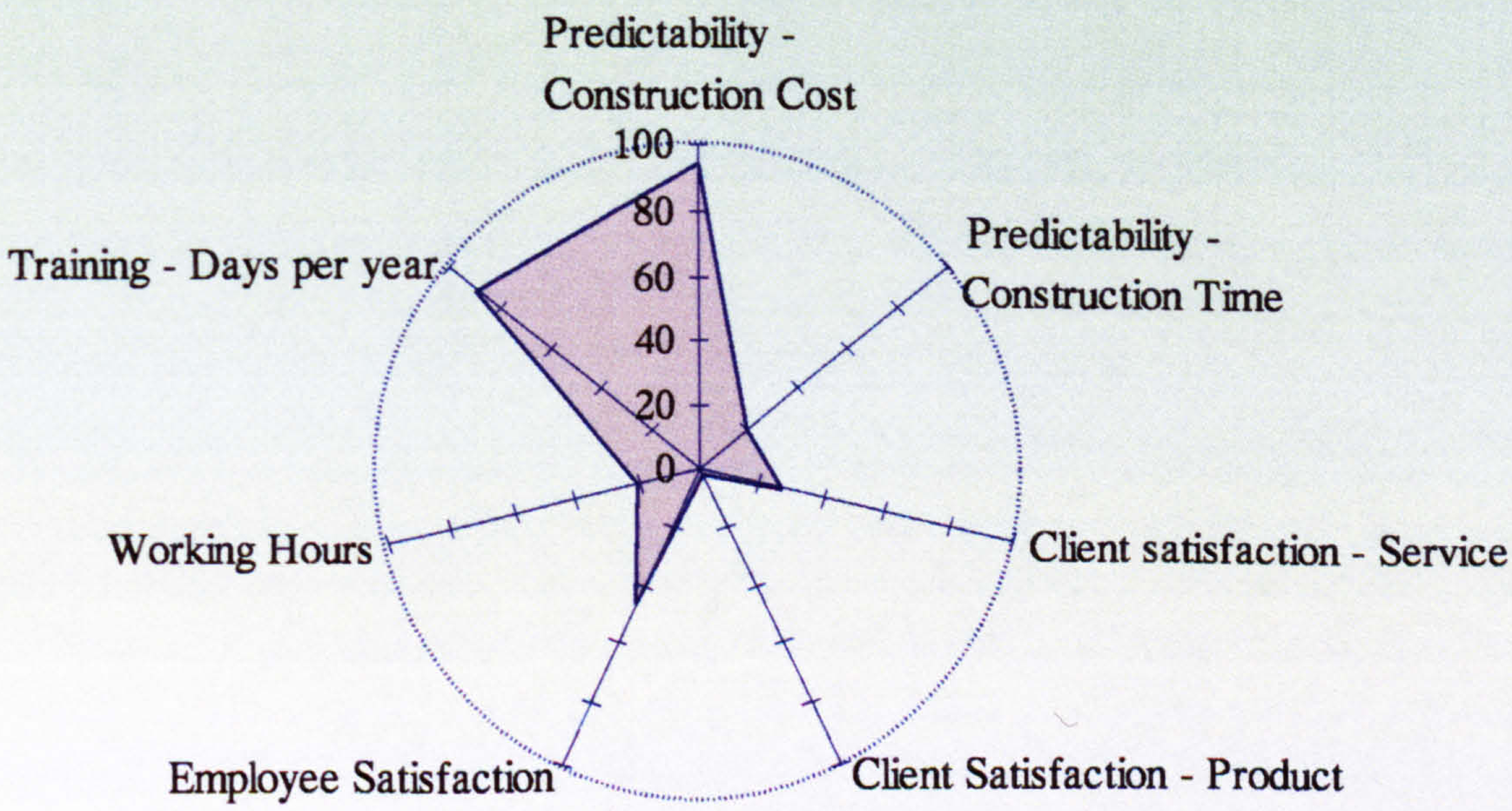
The percentage score for each of the seven performance components was variable with a very high standard deviation – 36. The highest score was 93% relating to predictability of construction cost (Financial). The lowest score was 2% relating to client satisfaction - product, (Customer).



Mean Team Rating = 70%

Standard Deviation = 8.4

Figure G.2.4.1 Project B/4 Team Rating Radar Chart



Mean Project Score = 43%

Standard Deviation = 36

Figure G.2.4.2 Project B/4 Performance Radar Chart

G.2.5.1 COMPANY B / PROJECT 5

Project Details	:	B/5
Estimated cost of the project	:	£3 million
Programmed duration of the project	:	52 weeks
Procurement route	:	Traditional
Current status of the project	:	Week 17

Staffing Details:

Team size	:	3 Technical Staff
Construction professionals	:	Project Manager
		Site Manager
		Quantity Surveyor
Client	:	(Confidential)
Previous client experience	:	No

Technical Details

Type of work	:	New neighbourhood centre

G.2.5.2 THE PARTICIPANTS

This case study had three participants, one project manager (Project Leader) and two team members, one male and one female. The three team members are employed by the principal contractor with an average length of service of 18 months. Two of the participants have a construction management background / role and may be viewed as part of the site production management team; one member has a Quantity Surveying function. The age range of the team members was as follows: '16-25' category – two members, '36-45' category – one member.

G.2.5.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 74%

The following table is a breakdown of the team variable results:

Table G.2.5.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 77%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 65%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 81%
4/ Trust	(Group Diversity & Compatibility)	- 69%
5/ Corporate Intent	(Organisational Context)	- 77%
6/ Systems, Policies & Customs	(Organisational Context)	- 69%
7/ Culture	(Industry Context)	- 81%

The percentage scores for each of the seven variables were consistently high. The highest equal score was 81% relating to Team Dynamics and Culture from the category - Group Compatibility and Diversity and Industry Context, respectively. The lowest score was 65% relating to Membership Diversity, (Group Compatibility and Diversity).

2/ Project Performance

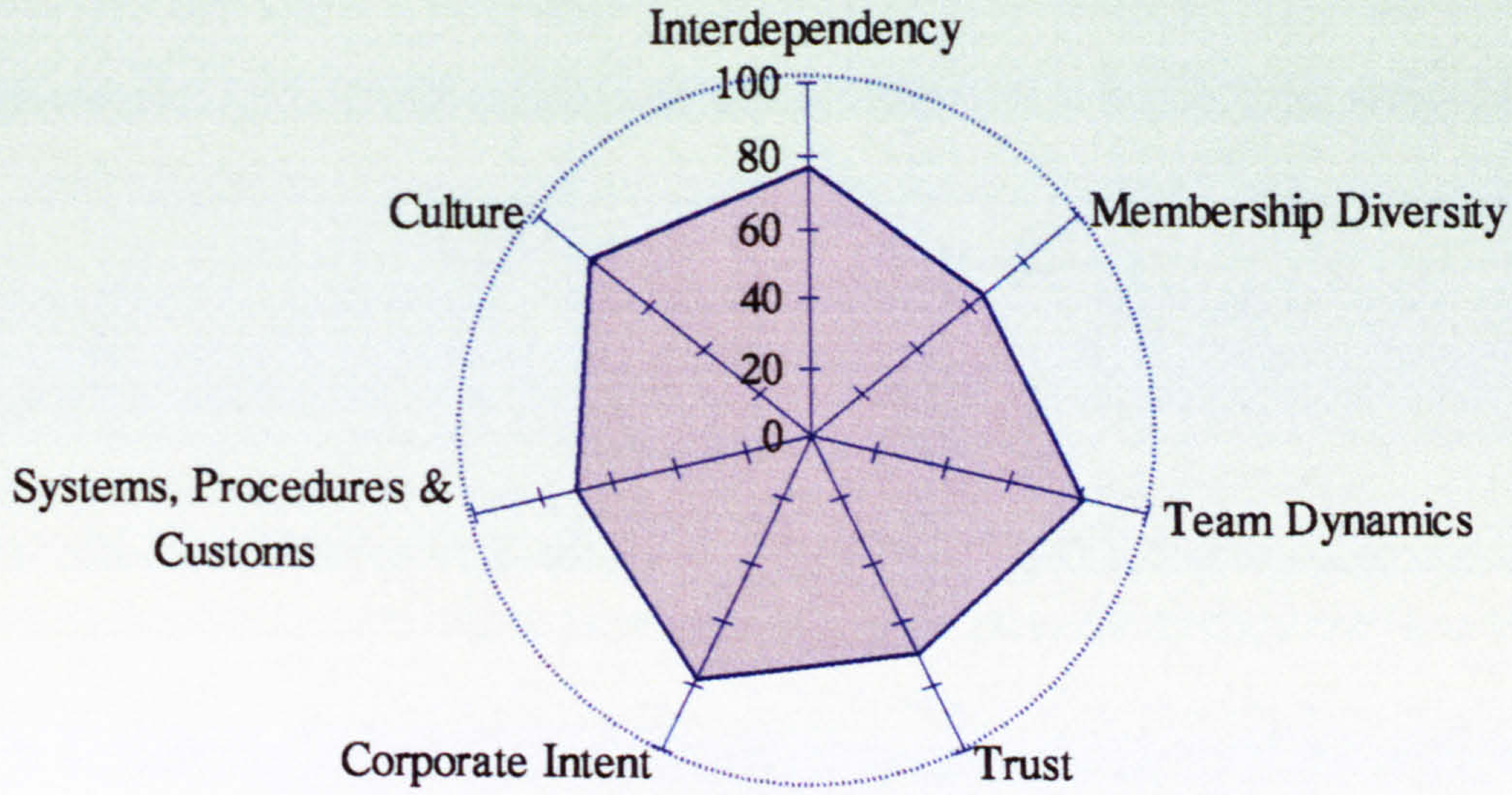
Mean indicator score for the seven components = 61%

The following table is a breakdown of the project indicator results:

Table G.2.5.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 76%
2/ Predictability - Construction Time	(Financial)	- 60%
3/ Client Satisfaction - Service	(Customer)	- 55%
4/ Client Satisfaction - Product	(Customer)	- 20%
5/ Employee Satisfaction	(Internal)	- 82%
6/ Working Hours	(Internal)	- 38%
7/ Training - Days per year	(Innovation & Learning)	- 94%

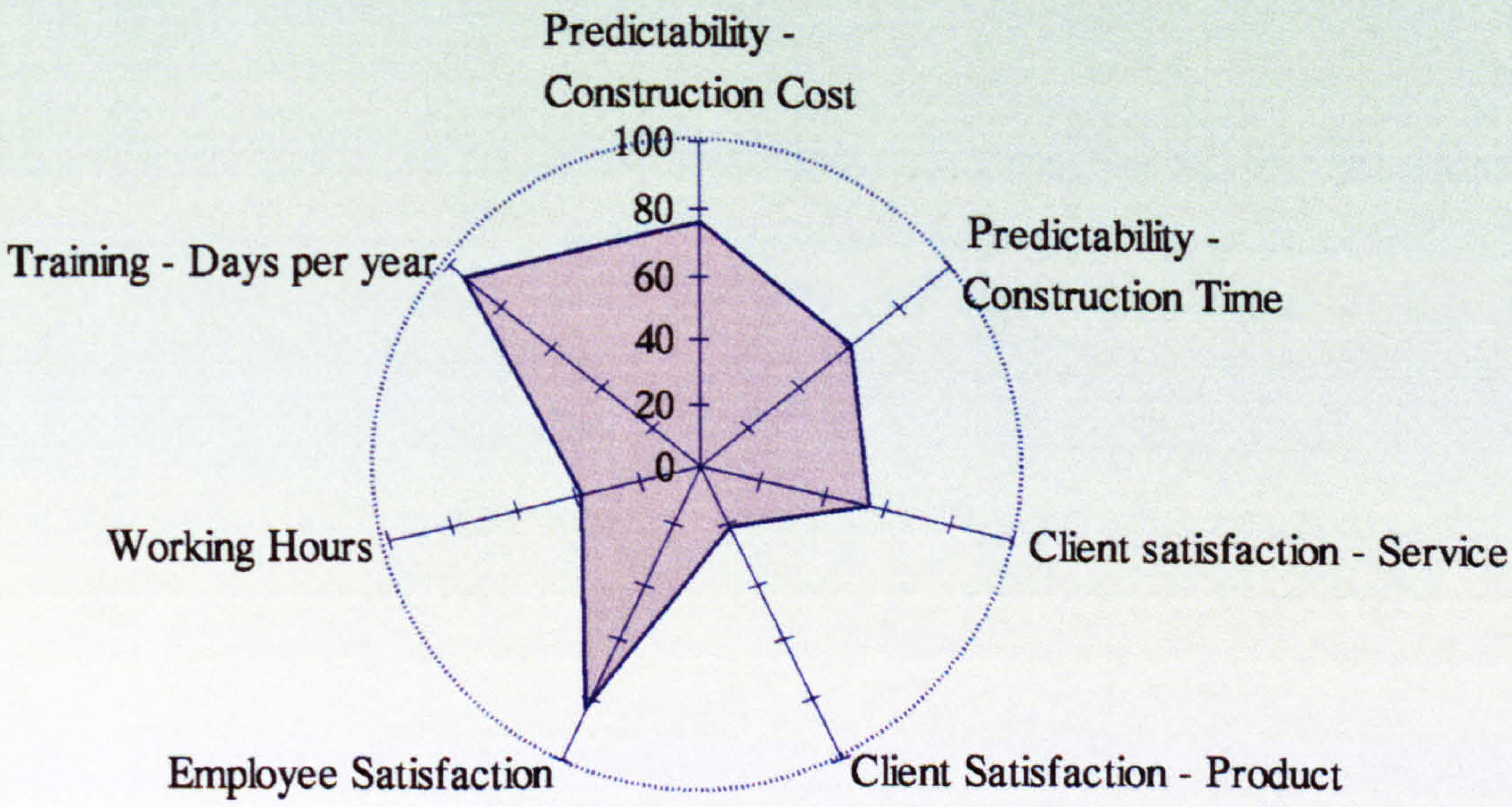
The percentage score for each of the seven performance components was variable with a standard deviation of 28.5. The highest score was 94% relating to number of training days per year cost (Learning). Employee satisfaction recorded a notable 82%, higher than the overall team performance score. The lowest benchmark score was 20% rélating to Client Satisfaction for product, (Customer), although it should be mentioned that this relates to a client perception of seven out of ten.



Mean Team Rating = 74%

Standard Deviation = 6.4

Figure G.2.5.1 Project B/5 Team Rating Radar Chart



Mean Project Score = 61%

Standard Deviation = 28.5

Figure G.2.5.2 Project B/5 Performance Radar Chart

G.3 COMPANY C - THE CASE-STUDIES

G.3.1.1 COMPANY C / PROJECT 1

Project Details	:	C/1
Estimated cost of the project	:	£20 million
Programmed duration of the project	:	78 weeks
Procurement route	:	Design & Build
Current status of the project	:	Week 12
Staffing Details		
Team size	:	11 Technical Staff
Construction professionals	:	Senior Project Manager
		Site Manager
		Works Manager
		Site Engineer (x3)
		Quantity Surveyor (x3)
		Design Coordinator
		Sub-Agent
Client	:	(Confidential)
Previous client experience	:	No
Technical Details		
Type of work	:	New build retail shopping centre

G.3.1.2 THE PARTICIPANTS

This case study had nine participants although one questionnaire was excluded from the study due to recent membership to the team. The eight participants were: one senior project manager (Project Leader) and seven team members, six male and one female. The eight team members are employed by the principal contractor with an average length of service of approximately 60 months (5 years). Seven of the participants have a construction management background (Manager / Engineer) and one team member is a Quantity Surveyor. The age range of the team members was as follows: '16 – 25' category – one member, '26-35' category – two member, '36 - 45' category – three members and '46-55' category – two members.

G.3.1.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 80%

The following table is a breakdown of the team variable results:

Table B.3.1.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 90%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 73%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 87%
4/ Trust	(Group Diversity & Compatibility)	- 75%
5/ Corporate Intent	(Organisational Context)	- 76%
6/ Systems, Policies & Customs	(Organisational Context)	- 80%
7/ Culture	(Industry Context)	- 81%

The percentage scores for each of the seven variables were high. The highest score(s) was 90% relating to Interdependency and 87% for Team Dynamics both from the same category - Group Compatibility and Diversity. The lowest score was 73% relating to Membership Diversity, (Group Compatibility and Diversity).

2/ Project Performance

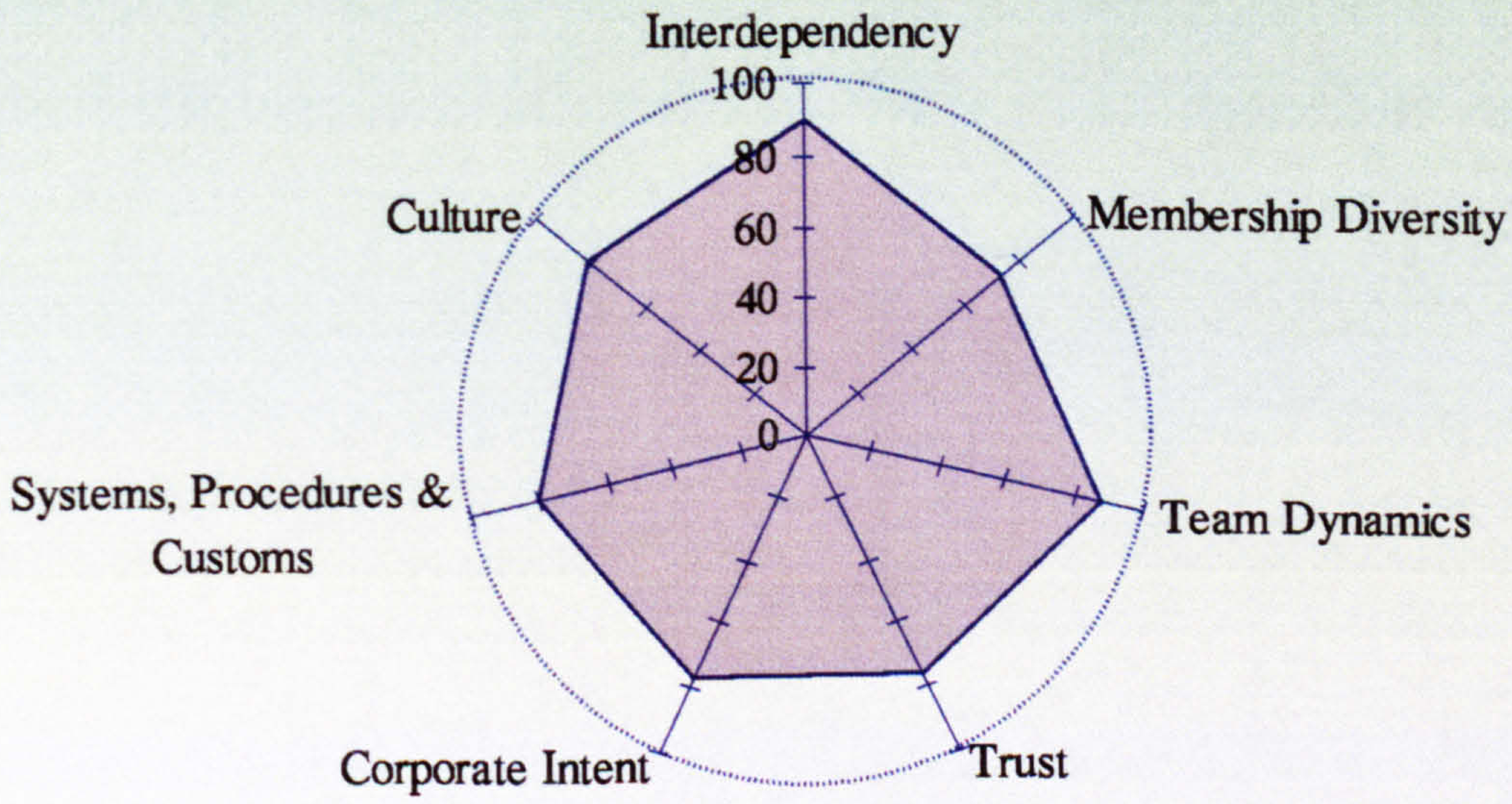
Mean indicator score for the seven components = 70%

The following table is a breakdown of the project indicator results:

Table G.3.1.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 75%
2/ Predictability - Construction Time	(Financial)	- 60%
3/ Client Satisfaction - Service	(Customer)	- 85%
4/ Client Satisfaction - Product	(Customer)	- 85%
5/ Employee Satisfaction	(Internal)	- 73%
6/ Working Hours	(Internal)	- 22%
7/ Training - Days per year	(Innovation & Learning)	- 92%

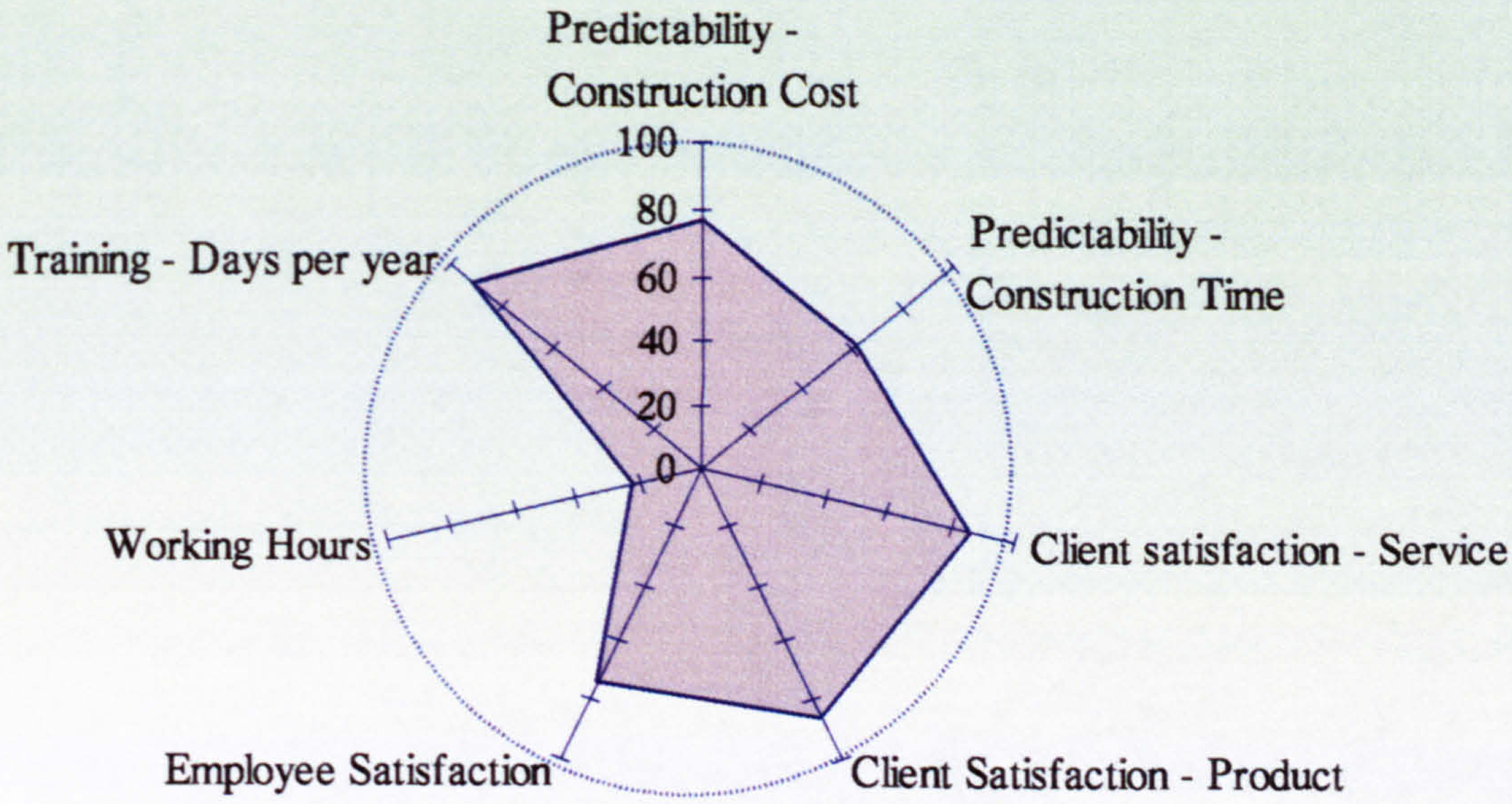
The percentage score for each of the seven performance components was relatively high with a standard deviation of 23.7. The highest score was 92% relating to number of training days per year, (Learning). The lowest score was 22% relating to working hours, (Internal perspective).



Mean Team Rating = 80%

Standard Deviation = 6.3

Figure G.3.1.1 **Project C/1 Team Rating Radar Chart**



Mean Project Score = 70%

Standard Deviation = 23.7

Figure G.3.1.2 Project C/1 Performance Radar Chart

G.3.2.1 COMPANY C / PROJECT 2

Project Details	:	**C/2**
Estimated cost of the project	:	£6.3 million
Programmed duration of the project	:	72 weeks
Procurement route	:	Design & Build (Fixed price)
Current status of the project	:	Week 45

Staffing Details		
Team size	:	6 Technical Staff
Construction professionals	:	Project Manager
		Site Manager
		Site Manager (Mechanical & Electrical)
		Quantity Surveyor
		Assistant Quantity Surveyor
		Foreman

Client	:	(Confidential)
Previous client experience	:	Yes

Technical Details

Type of work	:	Office refurbishment

G.3.2.2 THE PARTICIPANTS

This case study had six participants, one project manager and five technical support members, all male. The six team members have an average length of employment of nine years with the principal contractor. Four of the participants have a construction management background (Manager / Engineer) and two team members having a Quantity Surveying role. The age range of the team members was as follows: '16 – 25' category – one member, '36 - 45' category – three members and '56-65' category – two members.

G.3.2.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 77%

The following table is a breakdown of the team variable results:

Table G.3.2.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 87%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 79%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 81%
4/ Trust	(Group Diversity & Compatibility)	- 76%
5/ Corporate Intent	(Organisational Context)	- 71%
6/ Systems, Policies & Customs	(Organisational Context)	- 79%
7/ Culture	(Industry Context)	- 68%

The percentage scores for each of the seven variables were relatively high. The highest score(s) was 87% relating to Interdependency and 81% for Team Dynamics both from the same category - Group Compatibility and Diversity. The lowest score was 68% relating to Culture, (Industry Context).

2/ **Project Performance**

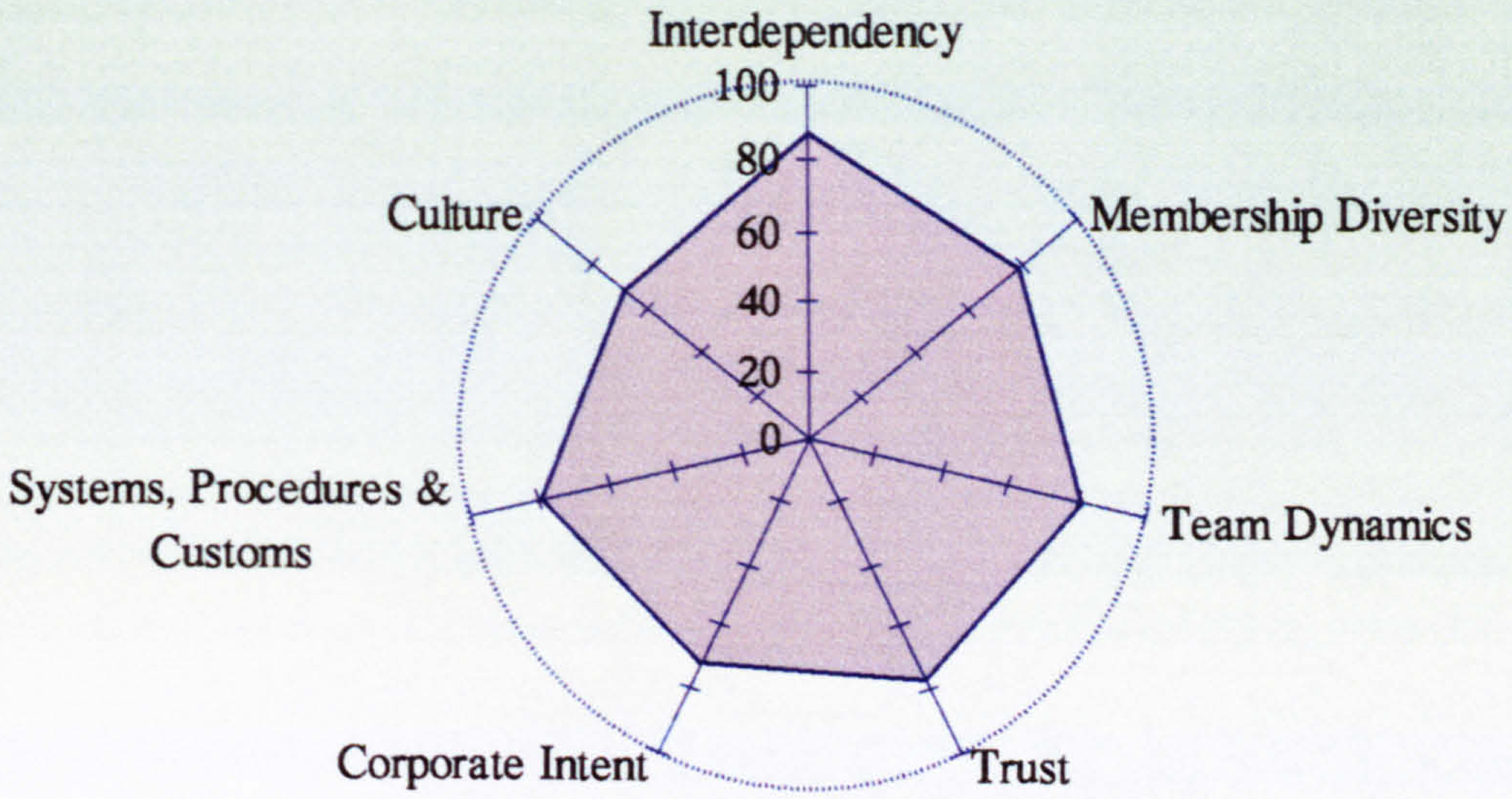
Mean indicator score for the seven components = 59%

The following table is a breakdown of the project indicator results:

Table G.3.2.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 22%
2/ Predictability - Construction Time	(Financial)	- 34%
3/ Client Satisfaction - Service	(Customer)	- 100%
4/ Client Satisfaction - Product	(Customer)	- 85%
5/ Employee Satisfaction	(Internal)	- 60%
6/ Working Hours	(Internal)	- 26%
7/ Training - Days per year	(Innovation & Learning)	- 89%

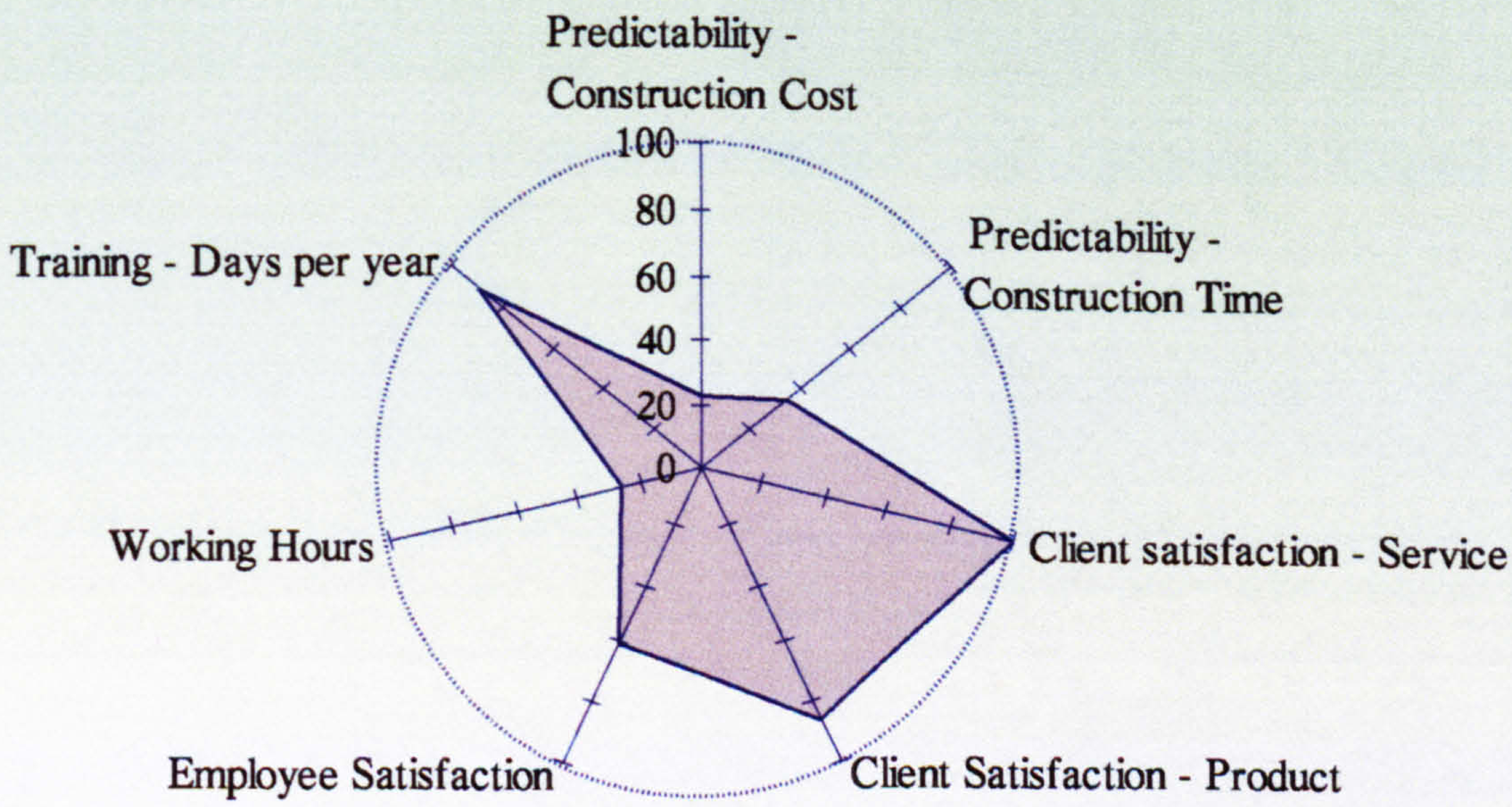
The percentage score for each of the seven performance components was varied with a large standard deviation of 32.5. The highest score was 100% relating to Client Satisfaction – service (Customer perspective) with training days per year, (Learning) and client satisfaction – product (Customer perspective) in the mid-to-high 80's. The lowest score was 22% relating to Predictability – construction cost, (Financial perspective).



Mean Team Rating = 77%

Standard Deviation = 6.3

Figure G.3.2.1 Project C/2 Team Rating Radar Chart



Mean Project Score = 59%

Standard Deviation = 32.5

Fig. G.3.2.2 Project C/2 Performance Radar Chart

G.3.3.1 COMPANY C / PROJECT 3

Project Details	:	C/3
Estimated cost of the project	:	£7 million
Programmed duration of the project	:	47 weeks
Procurement route	:	JCT 98
Current status of the project	:	42

Staffing Details

Team size	:	3 Technical Staff
Construction professionals	:	Project Manager
		Project Co-ordinator
		Site Manager
Client	:	(Confidential)
Previous client experience	:	No

Technical Details

Type of work	:	New Build – Bio-diesel plant

G.3.3.2 THE PARTICIPANTS

This case study had three project participants, one project manager and two technical support staff, all male. The three members of the site team have an average length of employment of approximately four years with the principal contractor. All three of the participants have a construction management background (Manager / Engineer). The age range of the team members was as follows: '36 – 45' category – one member, '46 - 55' category – one member and '56 - 65' category – one member.

G.3.3.3 RESULTS

1/ **Team Rating**

Mean team rating for the seven components = 69%

The following table is a breakdown of the team variable results:

Table G.3.3.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 79%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 71%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 72%
4/ Trust	(Group Diversity & Compatibility)	- 68%
5/ Corporate Intent	(Organisational Context)	- 61%
6/ Systems, Policies & Customs	(Organisational Context)	- 62%
7/ Culture	(Industry Context)	- 73%

The percentage scores for each of the seven variables were moderate to high. The highest score(s) was 79% relating to Interdependency. The lowest score was 61% and 62% relating to Corporate Intent and System, Procedures and Customs respectively, both Organisational Context variables.

2/ **Project Performance**

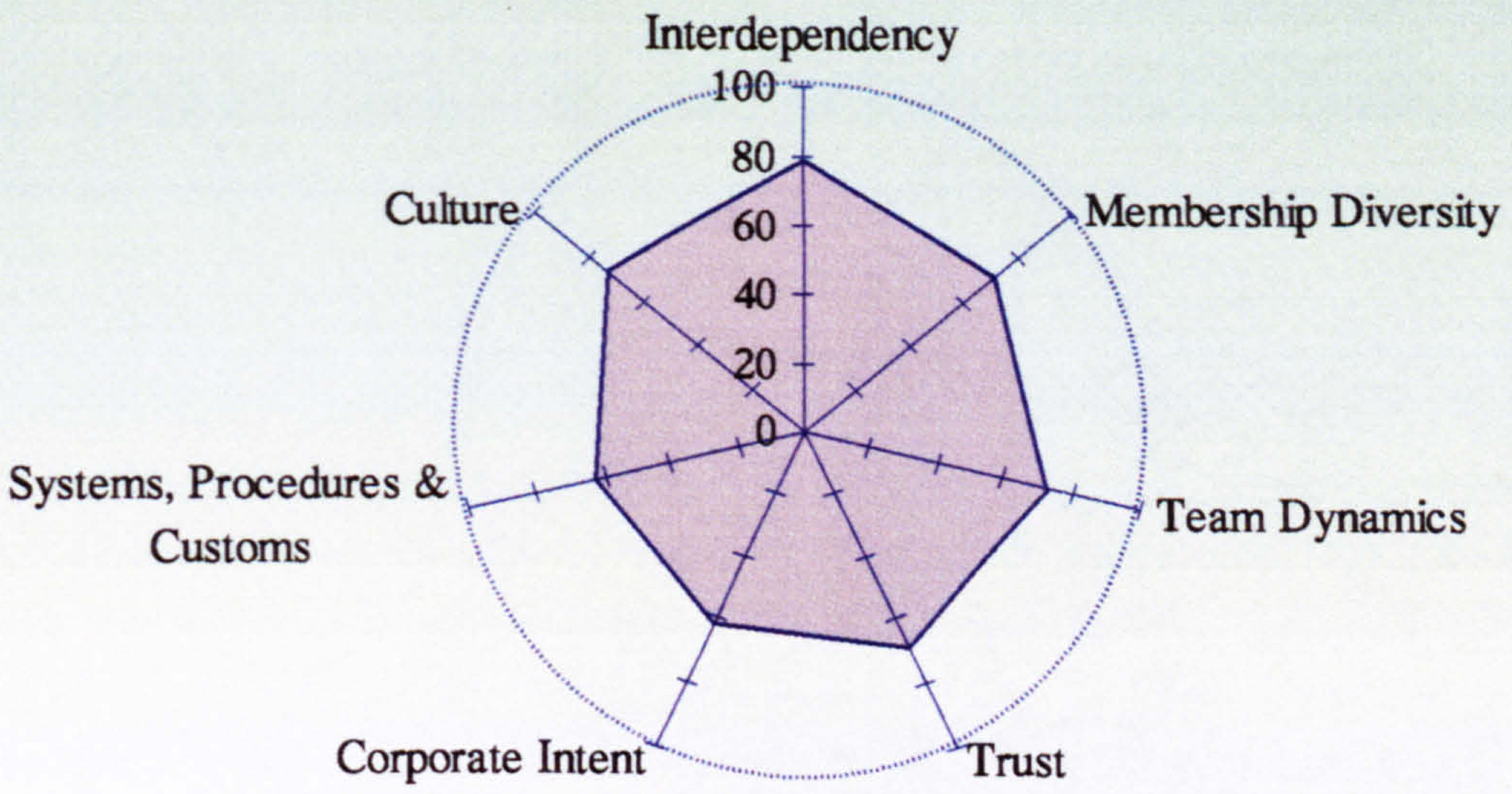
Mean indicator score for the seven components = 39%

The following table is a breakdown of the project indicator results:

Table G.3.3.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 26%
2/ Predictability - Construction Time	(Financial)	- 33%
3/ Client Satisfaction - Service	(Customer)	- 55%
4/ Client Satisfaction - Product	(Customer)	- 8%
5/ Employee Satisfaction	(Internal)	- 45%
6/ Working Hours	(Internal)	- 12%
7/ Training - Days per year	(Innovation & Learning)	- 95%

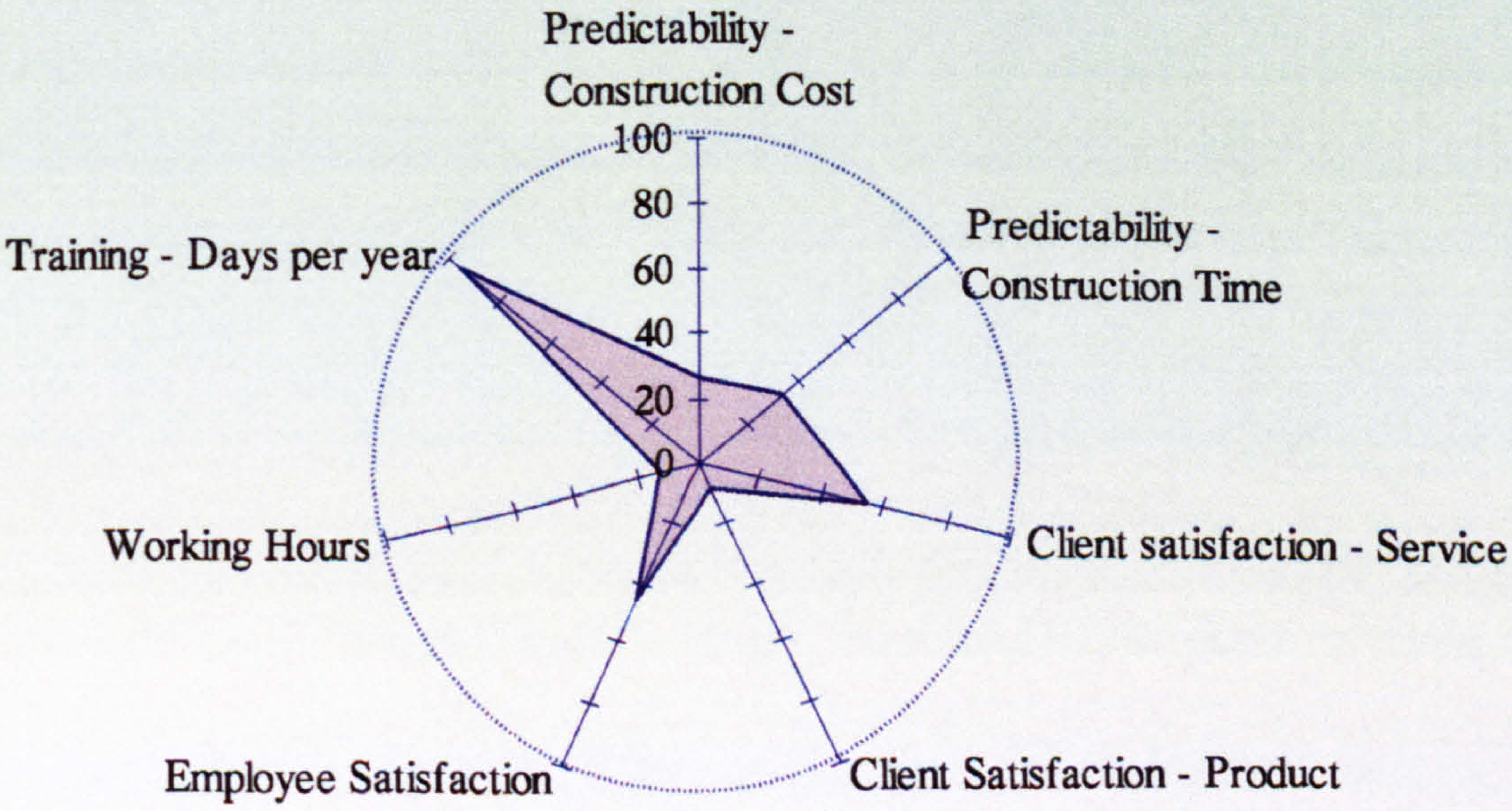
The percentage score for each of the seven performance components was varied with a large standard deviation of 29.8. The highest score was 95% relating to Training days per year, (Learning). The lowest score was 8% relating to Client satisfaction - product (Customer perspective) and 12% - Working Hours (Internal perspective).



Mean Team Rating = 69%

Standard Deviation = 6.3

Figure G.3.3.1 Project C/3 Team Rating Radar Chart



Mean Project Score = 39%

Standard Deviation = 29.8

Fig. G.3.3.2 Project C/3 Performance Radar Chart

G.4 COMPANY D - THE CASE-STUDIES

G.4.1.1 COMPANY D / PROJECT 1

Project Details	:	D/1
Estimated cost of the project	:	£9.9 million
Programmed duration of the project	:	78 weeks
Procurement route	:	Traditional JCT 98
Current status of the project	:	Week 54

Staffing Details

Team size	:	5 Technical Staff
Construction professionals	:	Project Manager
		Site Manager (x2)
		Project Surveyor (x2)
Client	:	(Confidential)
Previous client experience	:	Yes

Technical Details

Type of work	:	Refurbishment and fit-out development

G.4.1.2 THE PARTICIPANTS

This case study had five participants, one project manager (Project Leader) and four team members, all male. The principal contractor directly employs the five members of the site team. The average length of service is approximately 12 years, ranging from 7 months to 23 years. Three of the participants have a construction management background (Project / Site Manager) and two team members are Project Surveyors. The age range of the team members was as follows: '16 – 25' category – one member, '26-35' category – one member, '36 - 45' category – one member and '46-55' category – two members.

G.4.1.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 72%

The following table is a breakdown of the team variable results:

Table G.4.1.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 86%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 57%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 86%
4/ Trust	(Group Diversity & Compatibility)	- 70%
5/ Corporate Intent	(Organisational Context)	- 60%
6/ Systems, Policies & Customs	(Organisational Context)	- 75%
7/ Culture	(Industry Context)	- 67%

The percentage scores for each of the seven variables were relatively high. The highest equal score was 86% relating to Interdependency and Team Dynamics both from the same category - Group Compatibility and Diversity. The lowest score was 57% relating to Membership Diversity also from Group Compatibility and Diversity, followed by Corporate Intent – 67% (Organisational context).

2/ Project Performance

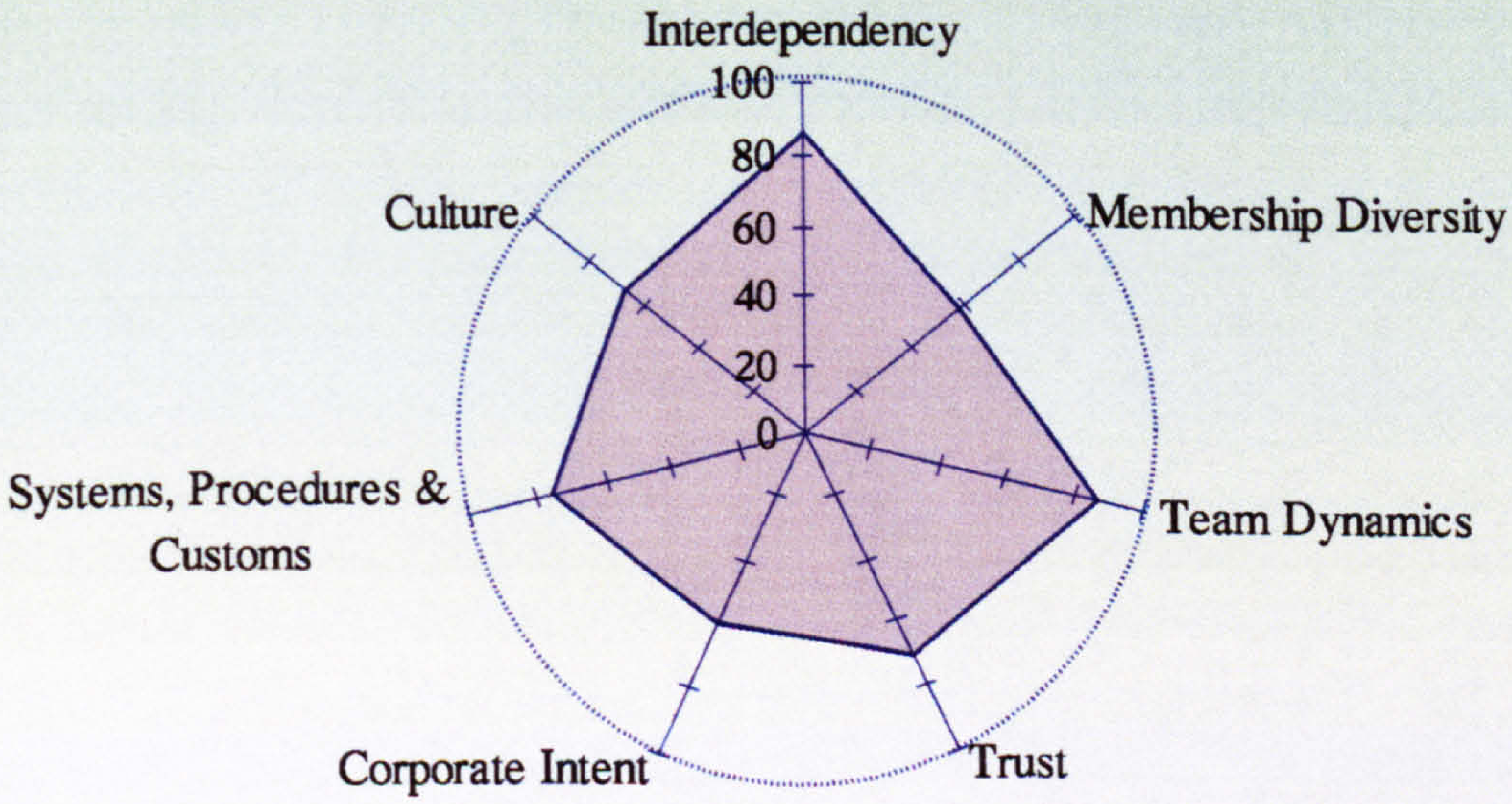
Mean indicator score for the seven components = 40%

The following table is a breakdown of the project indicator results:

Table G.4.1.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 16%
2/ Predictability - Construction Time	(Financial)	- 28%
3/ Client Satisfaction - Service	(Customer)	- 55%
4/ Client Satisfaction - Product	(Customer)	- 21%
5/ Employee Satisfaction	(Internal)	- 45%
6/ Working Hours	(Internal)	- 17%
7/ Training - Days per year	(Innovation & Learning)	- 95%

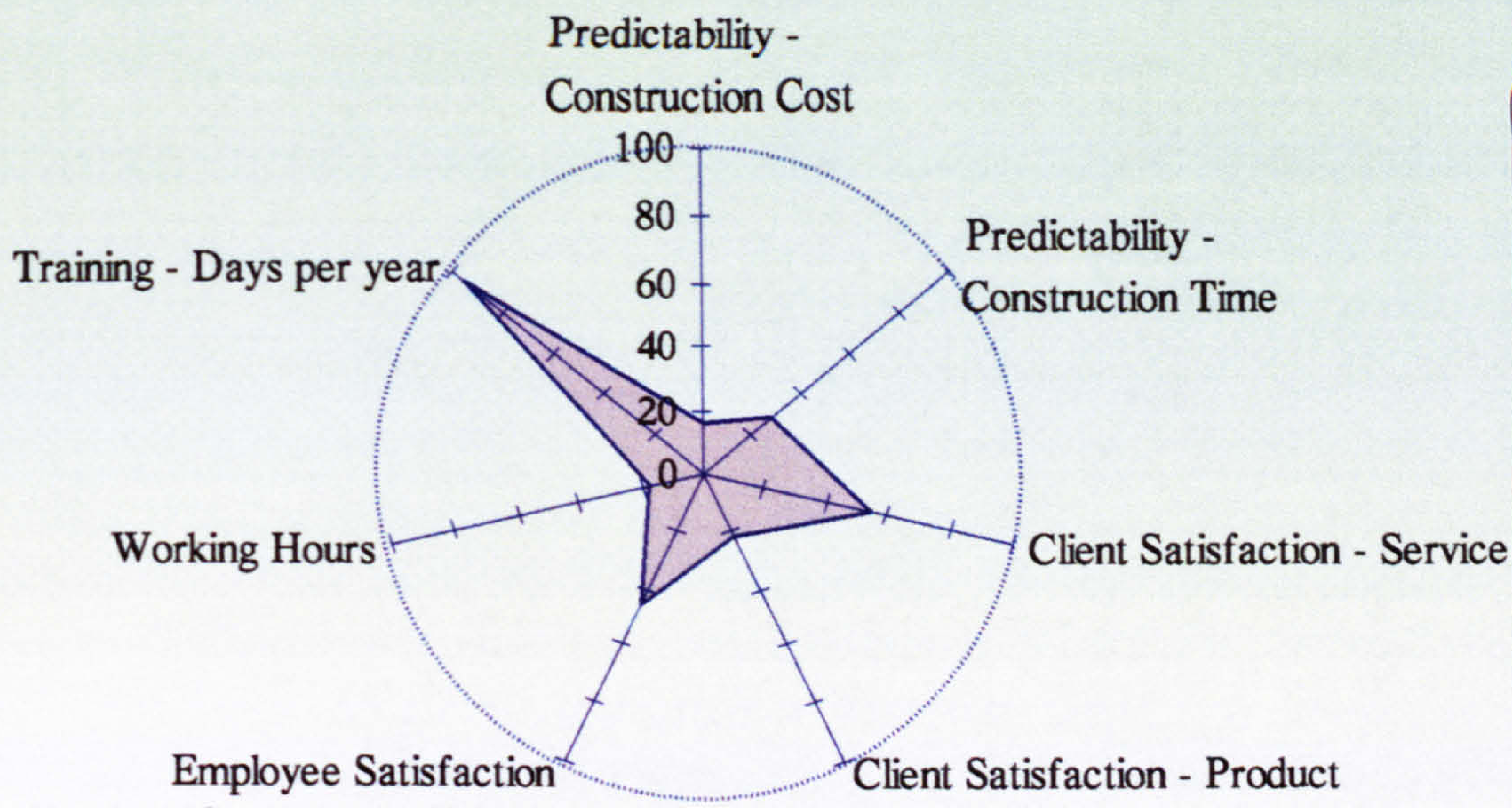
The percentage score for each of the seven performance components was quite varied with a standard deviation of 28.5. The highest score was 95% relating to number of training days per year (Innovation & Learning). The lowest score was 16% relating to Predictability - Cost, (Financial perspective).



Mean Team Rating = 72%

Standard Deviation = 11.5

Figure G.4.1.1 Project D/1 Team Rating Radar Chart



Mean Project Score = 40%

Standard Deviation = 28.5

Figure G.4.1.2 Project D/1 Performance Radar Chart

G.4.2.1 COMPANY D / PROJECT 2

Project Details	:	**D/2**
Estimated cost of the project	:	£5.8 million
Programmed duration of the project	:	66 weeks
Procurement route	:	Management Contract
Current status of the project	:	Week 57

Staffing Details:

Team size	:	2 Technical staff
Construction professionals	:	Project Manager
		Site Manager
Client	:	(Confidential)
Previous client experience	:	Yes

Technical Details

Type of work : New Build with façade retention

G.4.2.2 THE PARTICIPANTS

This case study had only two participants, one project manager (Project Leader) and one site manager, both male. The two permanent team members are employed by the principal contractor with an average length of service of 15 years. Both participants have a construction management background / role and may be viewed as part of the site production management team. The age range of the team members was as follows: '26-35' category – one member and '56-65' category – one member.

G.4.2.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 77%

The following table is a breakdown of the team variable results:

Table G.4.2.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 86%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 78%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 80%
4/ Trust	(Group Diversity & Compatibility)	- 72%
5/ Corporate Intent	(Organisational Context)	- 78%
6/ Systems, Policies & Customs	(Organisational Context)	- 70%
7/ Culture	(Industry Context)	- 72%

The percentage scores for each of the seven variables were relatively high. The highest score was 86% relating to Interdependency from the category - Group Compatibility and Diversity. The lowest score was 70% relating to Systems, Policies & Customs (Organisational Context).

2/ **Project Performance**

Mean indicator score for the seven components = 42%

The following table is a breakdown of the project indicator results:

Table G.4.2.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 35%
2/ Predictability - Construction Time	(Financial)	- 16%
3/ Client Satisfaction - Service	(Customer)	- 55%
4/ Client Satisfaction - Product	(Customer)	- 0%
5/ Employee Satisfaction	(Internal)	- 85%
6/ Working Hours	(Internal)	- 17%
7/ Training - Days per year	(Innovation & Learning)	- 86%

The percentage score for each of the seven performance components was extremely variable with a standard deviation of 34.3. The highest score was 86% relating to number of training days per year cost (Innovation & Learning). Employee Satisfaction (Internal perspective) recorded a score of 85% based on questionnaire responses. The lowest score was 0% relating to Client Satisfaction - product, (Customer perspective) with a score of 16% recorded for Predictability – Construction Time, (Financial).

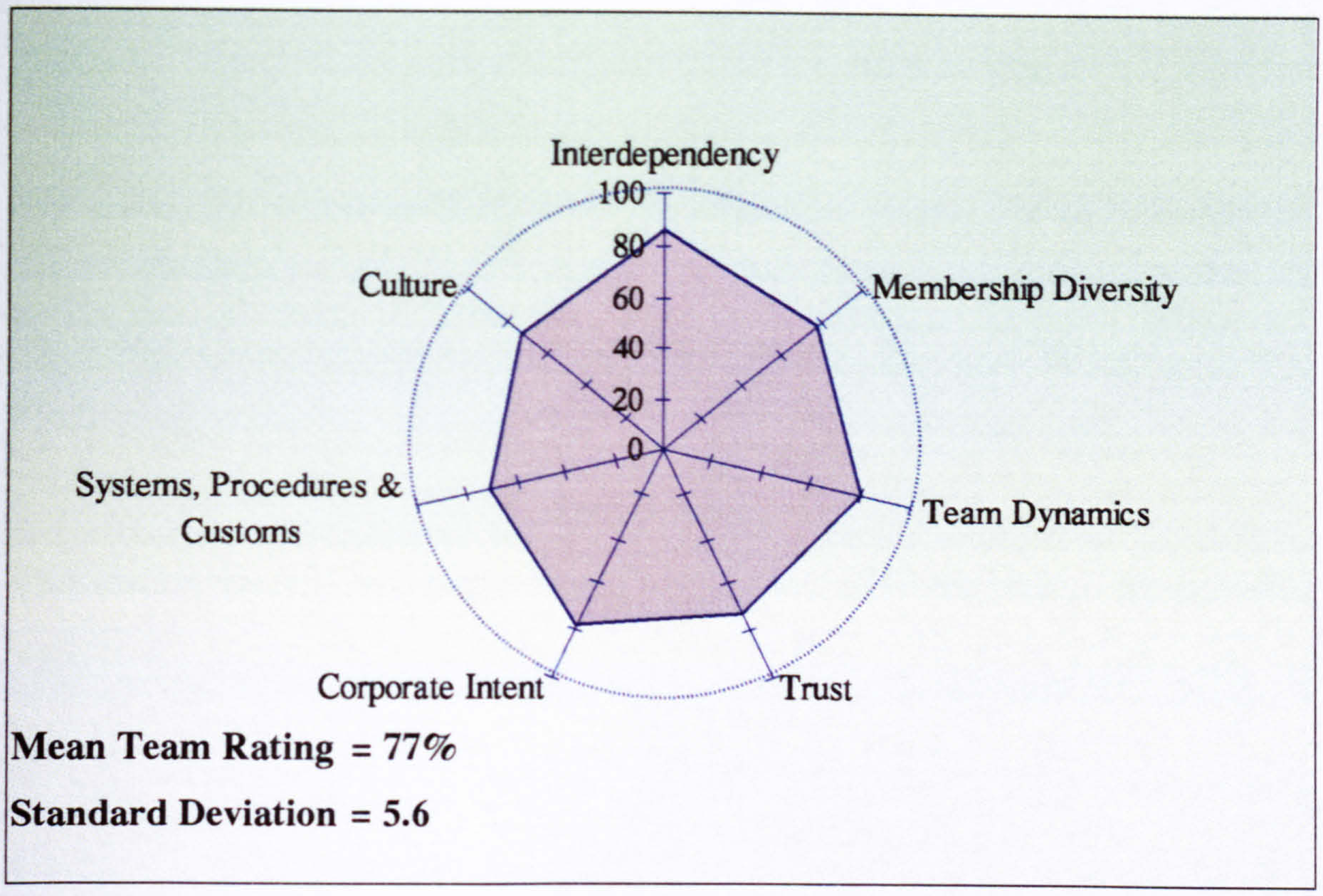


Figure G.4.2.1 **Project D/2 Team Rating Radar Chart**

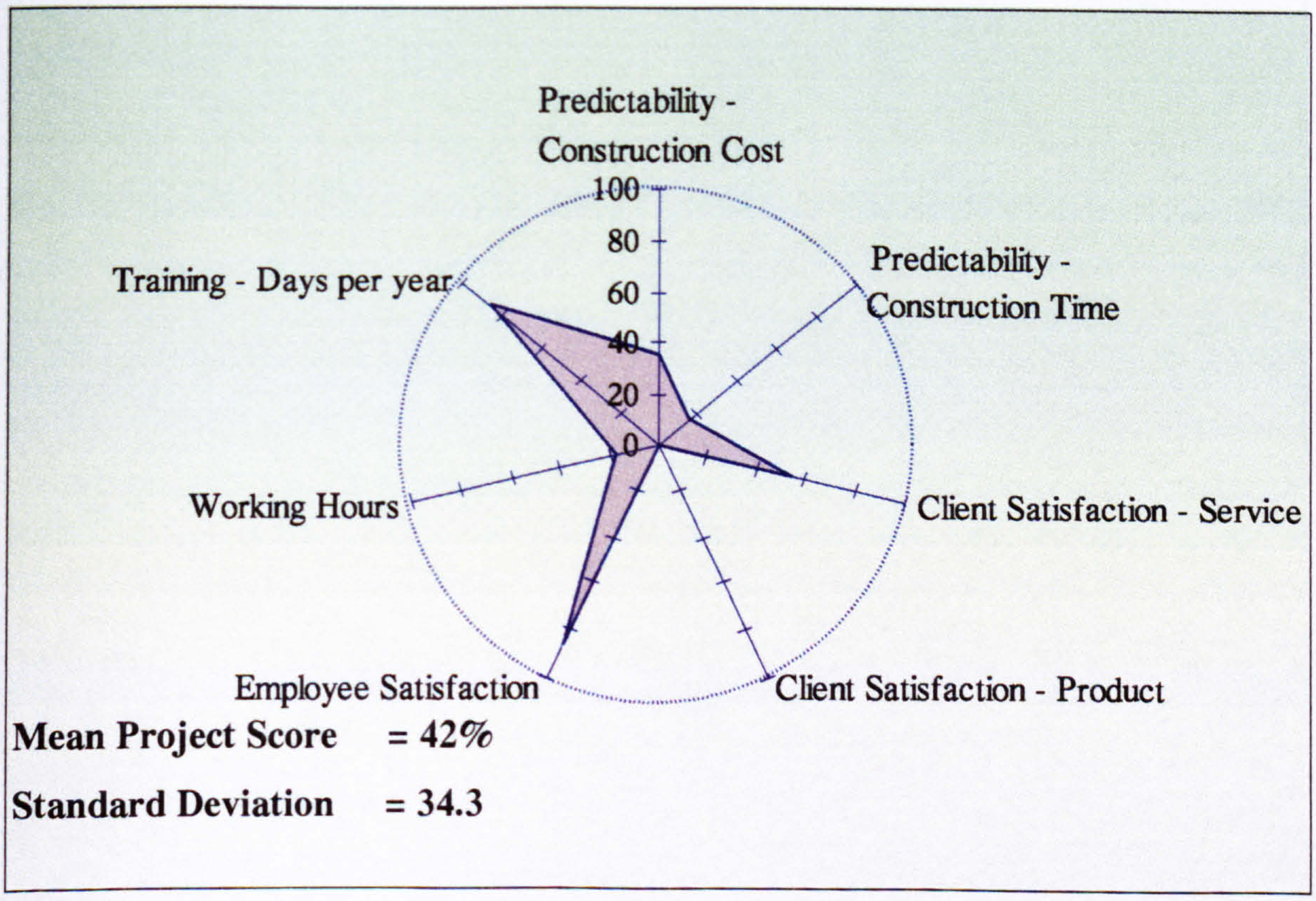


Figure G.4.2.2 **Project D/2 Performance Radar Chart**

G.4.3.1 COMPANY D / PROJECT 3

Project Details	:	D/3
Estimated cost of the project	:	£25 million
Programmed duration of the project	:	91 weeks
Procurement route	:	Traditional – JCT 98
Current status of the project	:	Week 72

Staffing Details:

Team size	:	8 Technical Staff,
Construction professionals	:	Project Manager
		Site Manager (x3)
		Quantity / Project Surveyor (x2)
		Service Manager
		General Foreman
Client	:	(Confidential)
Previous client experience	:	Yes

Technical Details

Type of work	:	New Build, Research Laboratories

G.4.3.2 THE PARTICIPANTS

This case study had seven participants, one project manager (Project Leader) and six participating team members, all male. The seven permanent team members are employed by the principal contractor with an average length of service of approximately 6.5 years. The team members had three distinct technical profiles: four members were Project /Site managers, two Quantity / Project Surveyors and one Services Manager. The age range of the team members was as follows: '16-25' category – two members, '26-35' category – three members and '36-45' category – two members.

G.4.3.3 RESULTS

1/ **Team Rating**

Mean team rating for the seven components = 76%

The following table is a breakdown of the team variable results:

Table G.4.3.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 83%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 74%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 82%
4/ Trust	(Group Diversity & Compatibility)	- 76%
5/ Corporate Intent	(Organisational Context)	- 69%
6/ Systems, Policies & Customs	(Organisational Context)	- 77%
7/ Culture	(Industry Context)	- 72%

The percentage scores for each of the seven variables were high. The highest score(s) were 83% relating to Interdependency and 82% for Team Dynamics, both from the category - Group Compatibility and Diversity. The lowest score was 69% relating to corporate intent, (Organisational context).

2/ **Project Performance**

Mean indicator score for the seven components = 63%

The following table is a breakdown of the project indicator results:

Table G.4.3.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 20%
2/ Predictability - Construction Time	(Financial)	- 27%
3/ Client Satisfaction - Service	(Customer)	- 100%
4/ Client Satisfaction - Product	(Customer)	- 100%
5/ Employee Satisfaction	(Internal)	- 77%
6/ Working Hours	(Internal)	- 23%
7/ Training - Days per year	(Innovation & Learning)	- 91%

The percentage score for each of the seven performance components was variable with a standard deviation of 37.6. The highest score was 100% relating to Client Satisfaction for both Product and Service (Customer perspective). The lowest Industry Benchmark score was 20% for Predictability – Construction Cost (Financial perspective) which showed a +8% increase on the initial tender price.

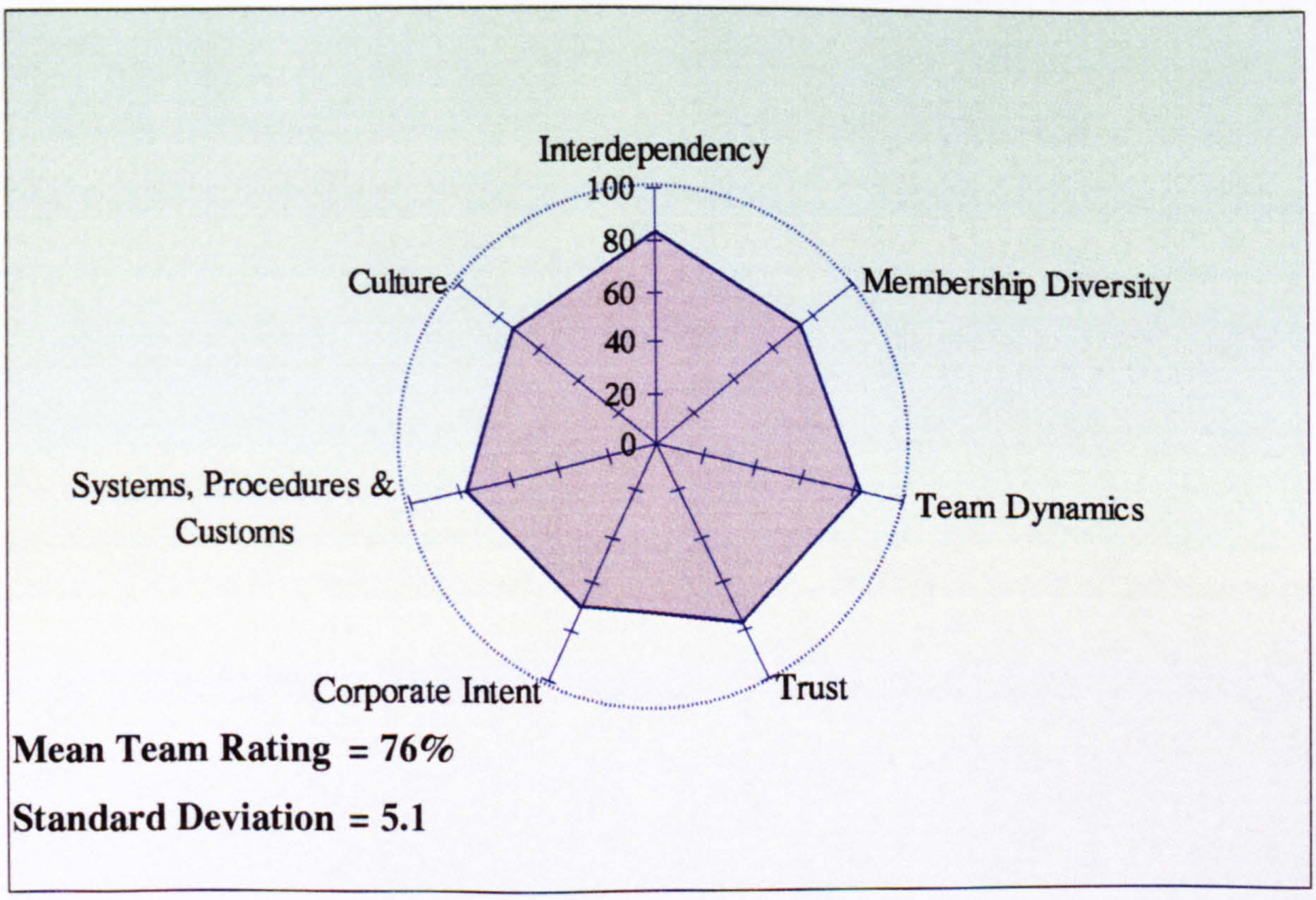
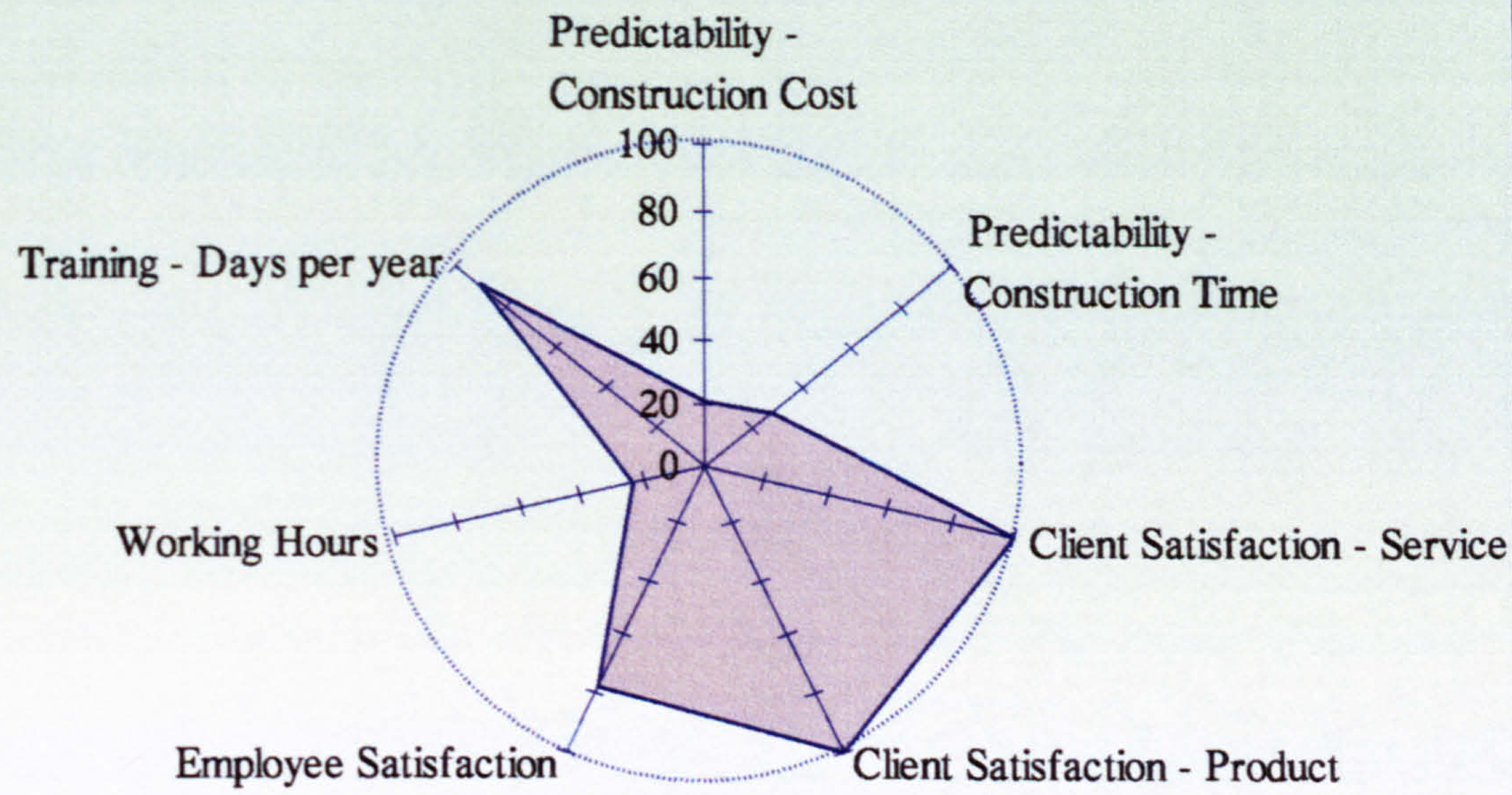


Figure G.4.3.1 **Project D/3 Team Rating Radar Chart**



Mean Project Score = 63%

Standard Deviation = 37.6

Figure G.4.3.2 Project D/3 Performance Radar Chart

G.4.4.1 COMPANY D / PROJECT 4

Project Details	:	**D/4**
Estimated cost of the project	:	£25 million
Programmed duration of the project	:	94 weeks
Procurement route	:	Traditional –Two Stage
Current status of the project	:	Week 63

Staffing Details:

Team size	:	8 Technical Staff
Construction professionals	:	Project Manager
		Site Manager (4)
		Quantity / Project Surveyor (2)
		Building Services Manager
Client	:	(Confidential)
Previous client experience	:	No

Technical Details

Type of work : New office development

G.4.4.2 THE PARTICIPANTS

This case study had eight participants, one project manager (Project Leader) and seven permanent team members, all male. The seven permanent team members are employed by the principal contractor with an average length of service of 9 years. Four of the participants have a construction management background (Project / Site Manager), two members have a Quantity / Project Surveyor technical role and one member a Building Services Management function. The age range of the team members is mixed, ranging from 16 – 25 (two members), 26 – 35 (two members), 36 – 45 (two members) and 46 – 55 (two members).

G.4.4.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 79%

The following table is a breakdown of the team variable results:

Table G.4.4.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 93%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 68%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 84%
4/ Trust	(Group Diversity & Compatibility)	- 82%
5/ Corporate Intent	(Organisational Context)	- 78%
6/ Systems, Policies & Customs	(Organisational Context)	- 69%
7/ Culture	(Industry Context)	- 78%

The percentage scores for each of the seven variables were consistently high. The highest score was 93% relating to Interdependency (Group Compatibility and

Diversity). The lowest score was 69% relating to systems, procedures and customs (Organisational Context).

2/ **Project Performance**

Mean indicator score for the seven components = 74%

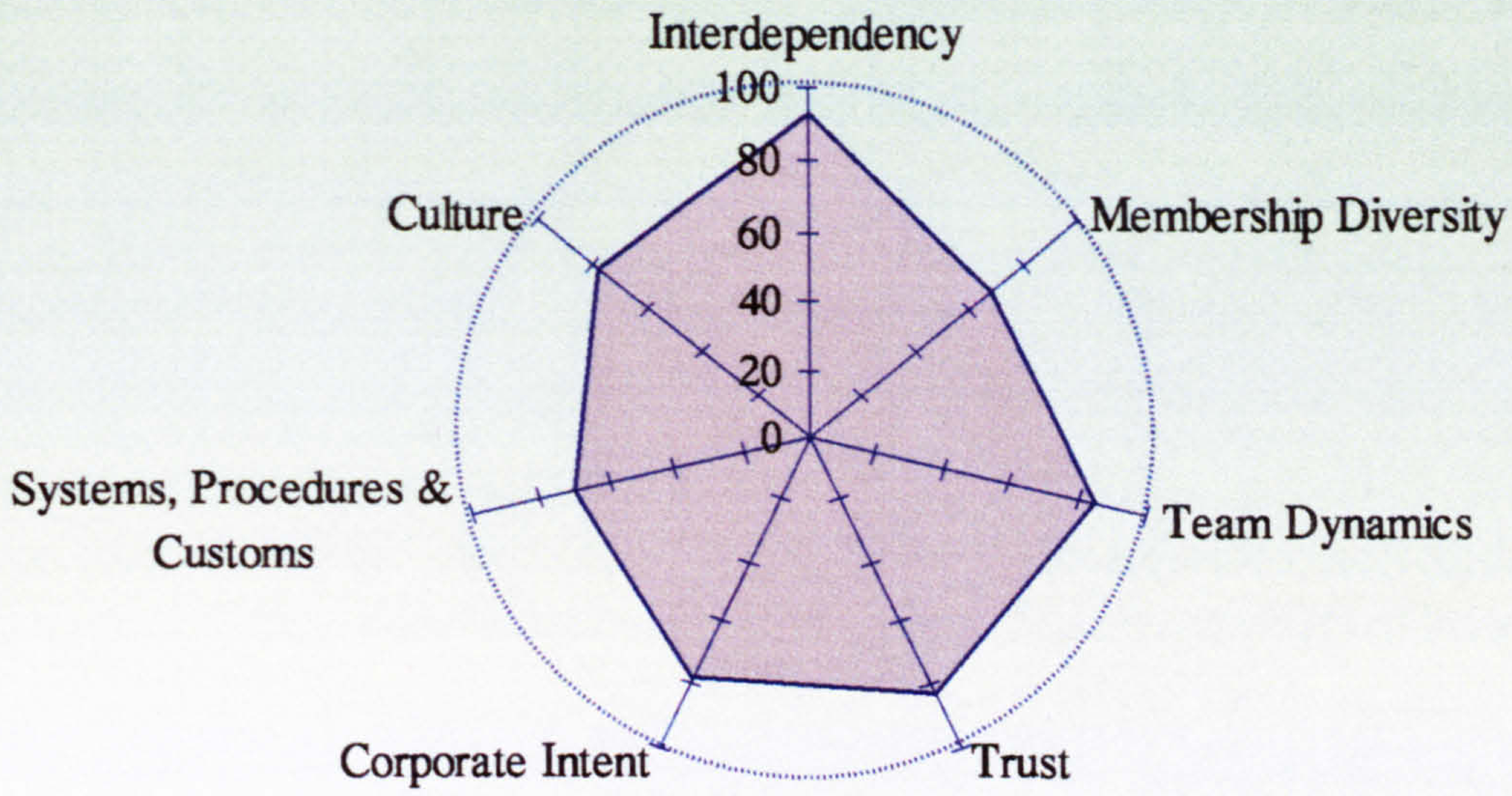
The following table is a breakdown of the project indicator results:

Table G.4.4.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 75%*
2/ Predictability - Construction Time	(Financial)	- 60%*
3/ Client Satisfaction - Service	(Customer)	- 100%
4/ Client Satisfaction - Product	(Customer)	- 100%
5/ Employee Satisfaction	(Internal)	- 75%
6/ Working Hours	(Internal)	- 17%
7/ Training - Days per year	(Innovation & Learning)	- 93%

* Project performance KPI figures relating to 'Predictability – Construction Cost' and 'Predictability – Construction Time' where both taken at 0% variance from the initial estimated project figures and benchmarked accordingly.

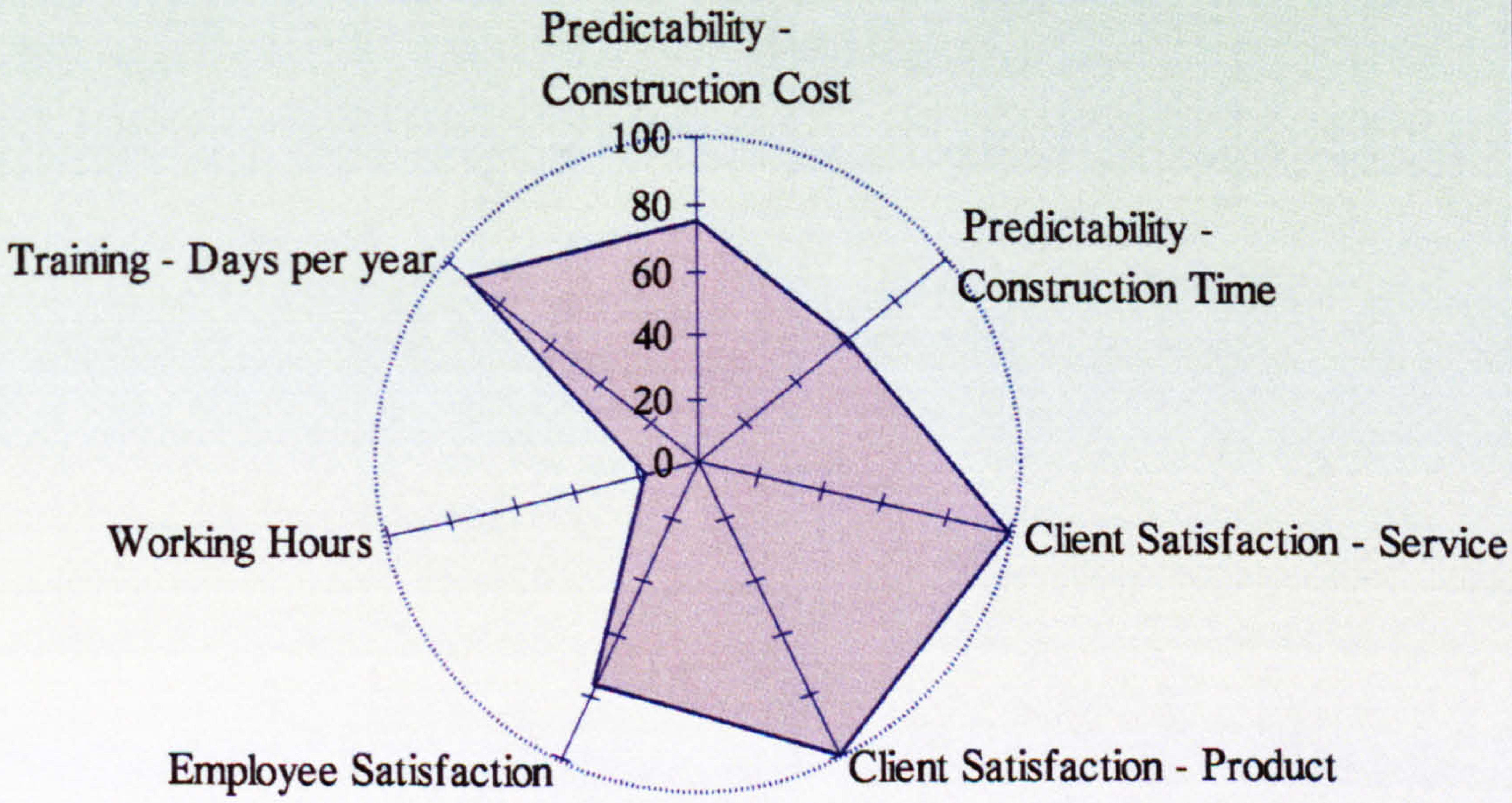
The percentage score for each of the seven performance components was moderate to high with a standard deviation of 29.3. The highest score was 100% relating to Client Satisfaction for both Product and Service (Customer perspective). The lowest industry benchmark score was 17% relating to Hours Worked (Internal perspective); this corresponds to an average working week of 50 hours.



Mean Team Rating = 79%

Standard Deviation = 8.7

Figure G.4.4.1 Project D/4 Team Rating Radar Chart



Mean Project Score = 74%

Standard Deviation = 29.3

Figure G.4.4.2 Project D/4 Performance Radar Chart

G.4.5.1 COMPANY D / PROJECT 5

Project Details	:	**D/5**
Estimated cost of the project	:	£20 million
Programmed duration of the project	:	84 weeks
Procurement route	:	Traditional – Two-stage
Current status of the project	:	Week 70

Staffing Details:

Team size	:	9 Technical Staff
Construction professionals	:	Project Manager
		Site Manager (x3)
		Quantity / Project Surveyor (x3)
		Services Manager (x2)
Client	:	(Confidential)
Previous client experience	:	Yes

Technical Details

Type of work	:	Major refurbishment of art gallery

G.4.5.2 THE PARTICIPANTS

This case study had nine participants, one project manager (Project Leader) and eight team members, all male. The nine team members are employed by the principal contractor with an average length of service of just over fourteen years. Four of the participants have a construction management background (Project / Site Manager), three members have a Quantity / Project Surveyor technical role and two team members have a Building Services Management function. The age range of the team members was as follows: '16-25' category – one member, '26-35' category – two members, '36 – 45' category – three members and the '46 – 55' category – three members.

G.4.5.3 RESULTS

1/ Team Rating

Mean team rating for the seven components = 70%

The following table is a breakdown of the team variable results:

Table G.4.5.1

Team Variable	Team Category	Score
1/ Interdependency	(Group Diversity & Compatibility)	- 76%
2/ Membership Diversity	(Group Diversity & Compatibility)	- 67%
3/ Team Dynamics	(Group Diversity & Compatibility)	- 71%
4/ Trust	(Group Diversity & Compatibility)	- 69%
5/ Corporate Intent	(Organisational Context)	- 70%
6/ Systems, Policies & Customs	(Organisational Context)	- 70%
7/ Culture	(Industry Context)	- 70%

The percentage scores for each of the seven variables varied little with a low standard deviation of 2.8. The highest score was 76% relating to Interdependency from the category - Group Compatibility and Diversity. The lowest score was 67% relating to Membership Diversity, (Group Compatibility and Diversity).

2/ Project Performance

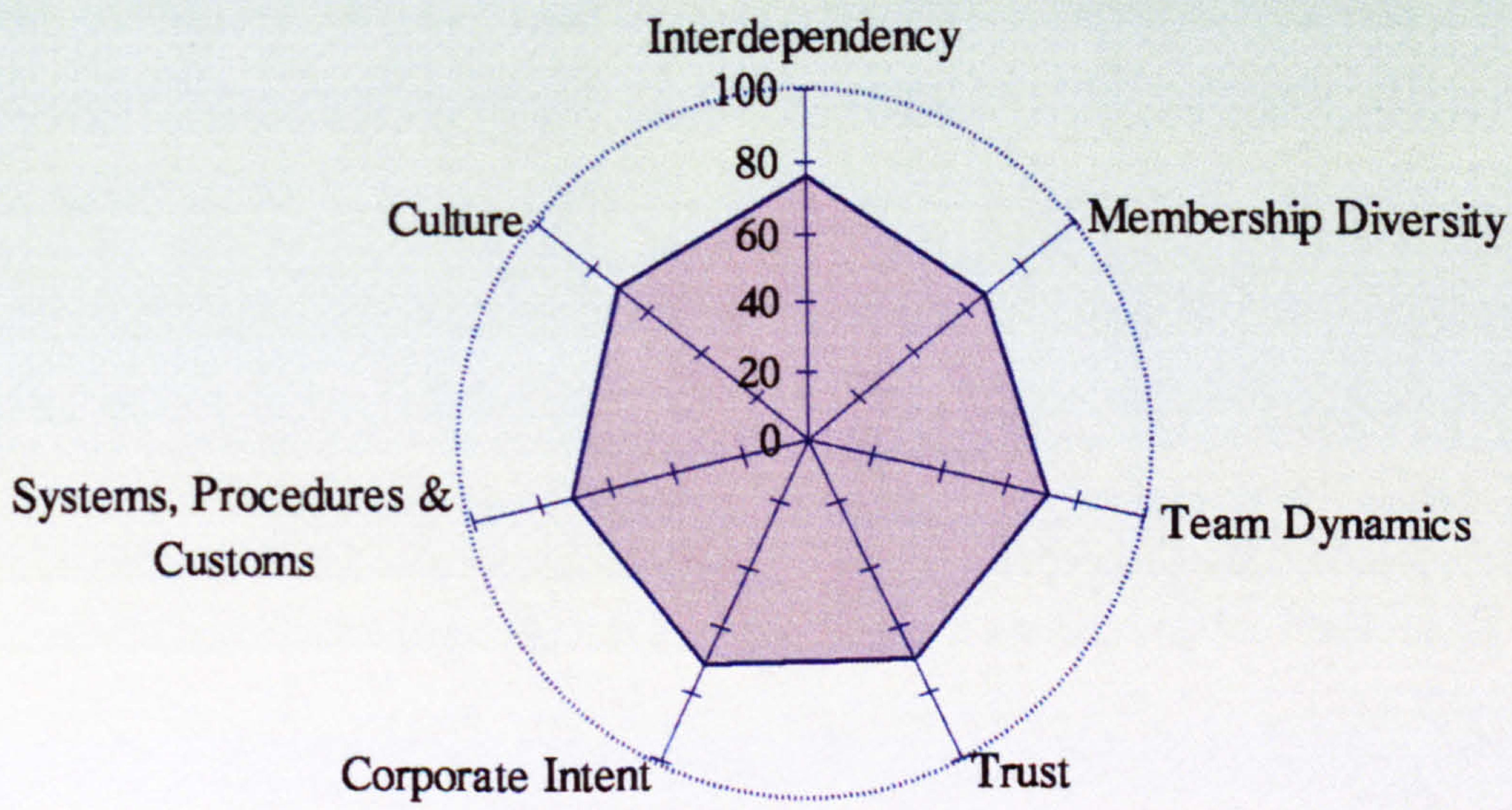
Mean indicator score for the seven components = 59%

The following table is a breakdown of the project indicator results:

Table G.4.5.2

Indicator	Perspective	Score
1/ Predictability - Construction Cost	(Financial)	- 20%
2/ Predictability - Construction Time	(Financial)	- 34%
3/ Client Satisfaction - Service	(Customer)	- 100%
4/ Client Satisfaction - Product	(Customer)	- 85%
5/ Employee Satisfaction	(Internal)	- 62%
6/ Working Hours	(Internal)	- 24%
7/ Training - Days per year	(Innovation & Learning)	- 88%

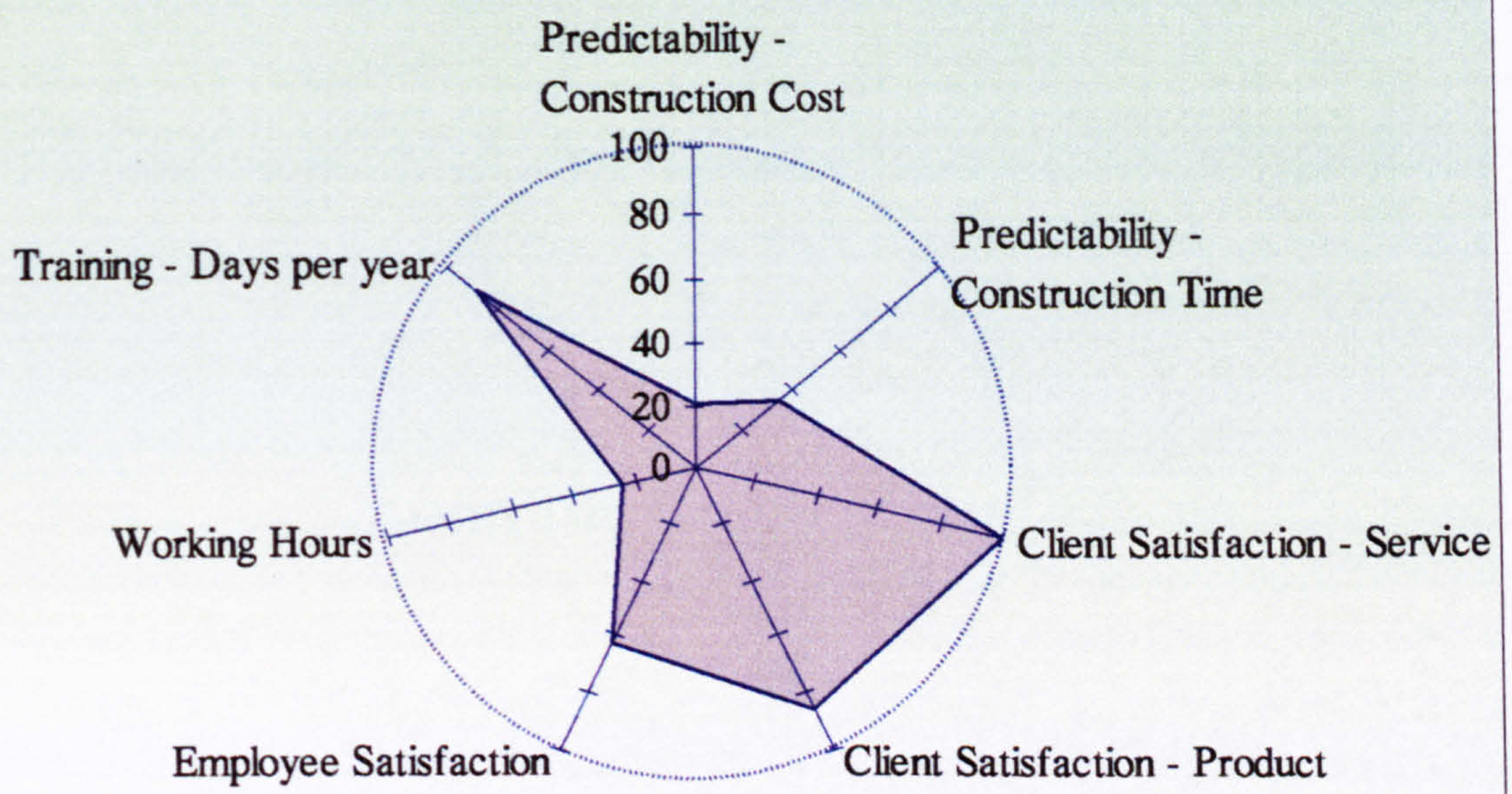
The percentage score for each of the seven performance components was variable with a standard deviation of 33.5. The highest score was 100% relating to Client Satisfaction – Service (Customer perspective). The lowest Industry Benchmark score was 20% for Predictability – Construction Cost (Financial perspective) which showed a +8% increase on the initial tender price.



Mean Team Rating = 70%

Standard Deviation = 2.8

Figure G.4.5.1 Project D/5 Team Rating Radar Chart



Mean Project Score = 59%

Standard Deviation = 33.5

Figure G.4.5.2 Project D/5 Performance Radar Chart

Note: The results are presented using a Radar Chart format. In general, the nearer the plotted line is to the outer perimeter of the radar chart, the higher the overall performance.

G.5 SUMMARY

In total there were thirteen individual project case-studies carried out with the cooperation of three major UK construction contractors. Eighty-two questionnaires were completed and handed in representing a response rate of just under ninety-six percent.

APPENDIX H: "DATA ANALYSIS CALCULATIONS"

H 1 ANALYSIS OF VARIANCE

H.1.1 INTRODUCTION

The following Data Analysis (Appendix C) illustrates the basic calculations undertaken as part of Chapter 6.00 – Data Analysis.

H 2 COMPANY B ANOVA CALCULATIONS

Table H 2.1 ANOVA (one-way)

Analysis of Variance for Team Variable Ratings only (Company B).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 881.49$	$MS_B = \frac{SS_B}{Df}$ $= \frac{881.49}{6}$ $= 146.92$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{146.92}{47.39}$ $= 3.10$*
Within (*W*)	$N_T - k$ $35 - 7$ $= 28$	$SS_W = II - III$ $= 1326.80$	$MS_B = \frac{SS_W}{Df}$ $= \frac{1326.80}{28}$ $= 47.39$	
Total	$N_T - 1$	$SS_T = 2208.29$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 2.44
F_{crit} 0.01 = 3.53

Since the level of F_{obt} is greater than F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average company B team ratings and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$.

Table H 2.2 ANOVA (two-way)

Analysis of Variance for Team *Variable* Ratings and Projects (Company B).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
VARIABLE Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 881.49$	$MS_B = \frac{SS_B}{Df}$ $= \frac{881.49}{6}$ $= 146.92$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{146.92}{28.20}$ $= 5.21^{**}$
PROJECT Between (*B*)	$k - 1$ $5 - 1$ $= 4$	$SS_B = III - I$ $= 652.00$	$MS_B = \frac{SS_B}{Df}$ $= \frac{652.00}{4}$ $= 163.00$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{163.00}{28.20}$ $= 5.78^{**}$
Error	24	$SS_E = 674.80$	$MS_E = \frac{SS_E}{Df}$ $= \frac{674.80}{24}$ $= 28.20$	
Total	$N_T - 1$	$SS_T = 2208.29$		

Level of Significance taken from table of 'Critical Values of F' at:

Variable: $F_{crit}\ 0.05 = 2.51$
$F_{crit}\ 0.01 = 3.67$

Level of Significance taken from table of 'Critical Values of F' at:

Project: $F_{crit}\ 0.05 = 2.78$
$F_{crit}\ 0.01 = 4.22$

Since the level of F_{obt} 'Variable' and 'Project' greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated between the seven variables and between the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A.

Table H.2.3 ANOVA (one-way)

Analysis of Variance for Project Performance Indicators only (Company B).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Source of Variation	**Degrees of Freedom**	**Sum of Squares**	**Mean Squares**	**F**
Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 17041.60$	$MS_B = \frac{SS_B}{Df}$ $= \frac{17041.60}{6}$ $= 2840.27$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{2840.27}{354.87}$ **= 8.00****
Within (*W*)	$N_T - k$ $35 - 7$ $= 28$	$SS_W = II - III$ $= 9936.40$	$MS_B = \frac{SS_W}{Df}$ $= \frac{9936.40}{28}$ $= 354.87$	
Total	$N_T - 1$	$SS_T = 6978.00$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 2.44
F_{crit} 0.01 = 3.53

Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average company B project performance indicators and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$.

Table H.2.4 ANOVA (two-way)

Analysis of Variance for Project Indicators and Projects (Company B).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
INDICATOR Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 17041.60$	$MS_B = \frac{SS_B}{Df}$ $= \frac{17041.60}{6}$ $= 2840.27$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{2840.27}{247.08}$ **= 11.50****
PROJECT Between (*B*)	$k - 1$ $5 - 1$ $= 4$	$SS_B = III - I$ $= 4006.57$	$MS_B = \frac{SS_B}{Df}$ $= \frac{4006.57}{4}$ $= 1001.64$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{1001.64}{247.08}$ **= 4.05***
Error	24	$SS_E = 5929.83$	$MS_E = \frac{SS_E}{Df}$ $= \frac{5929.83}{24}$ $= 28.20$	
Total	$N_T - 1$	$SS_T = 6978.00$		

Level of Significance taken from table of 'Critical Values of F' at:

Indicator: F_{crit} 0.05 = 2.51
F_{crit} 0.01 = 3.67

Level of Significance taken from table of 'Critical Values of F' at:

Project: F_{crit} 0.05 = 2.78
F_{crit} 0.01 = 4.22

Since the level of F_{obt} 'Variable' and 'Project' is greater than F_{crit} at both the 0.05 and 0.01 level of significance for the 'Indicator' and 0.05 level of significance for the 'Project' it may be concluded that there is a significant difference in the mean values associated between the seven indicators and between the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A.

Table H.2.5 ANOVA (one-way)

Analysis of Variance based on Team Rating and Project Performance (Company B).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $2 - 1$ $= 1$	$SS_B = III - I$ $= 1144.90$	$MS_B = \frac{SS_B}{Df}$ $= \frac{1144.90}{1}$ $= 1144.90$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{1144.90}{80.65}$ $= 14.20$**
Within (*W*)	$N_T - k$ $10 - 2$ $= 8$	$SS_W = II - III$ $= 645.20$	$MS_B = \frac{SS_W}{Df}$ $= \frac{645.20}{8}$ $= 80.65$	
Total	$N_T - 1$	$SS_T = 1790.10$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} $0.05 = 5.32$
F_{crit} $0.01 = 11.26$

Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the five company B projects based on Team Rating and Project Performance and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2$.

Table H.2.6 ANOVA (two-way)

Analysis of Variance for Team Performance and Projects (Company B).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
TEAM Between (*B*)	k – 1 2 – 1 = 1	SS_B = III – I = 1144.90	$MS_B = \frac{SS_B}{Df}$ $= \frac{1144.90}{1}$ =1144.90	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{1144.90}{41.65}$ = 27.49**
PROJECT Between (*B*)	k – 1 5 – 1 = 4	SS_B = III - I = 478.60	$MS_B = \frac{SS_B}{Df}$ $= \frac{478.60}{4}$ = 119.65	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{119.65}{41.65}$ = 2.87
Error	4	SS_E = 166.60	$MS_E = \frac{SS_E}{Df}$ $= \frac{166.60}{4}$ = 41.65	
Total	N_T - 1	SS_T = 1790.10		

Level of Significance taken from table of 'Critical Values of F' at:

Team F_{crit} 0.05 = 7.71
F_{crit} 0.01 = 21.20

Level of Significance taken from table of 'Critical Values of F' at:

Project F_{crit} 0.05 = 6.39
F_{crit} 0.01 = 15.98

Since the level of F_{obt} 'Team' is greater than F_{crit} at both the 0.05 and 0.01 level of significance for the 'Team' it may be concluded that there is a significant difference in the mean values associated between the Team, therefore reject the null hypothesis. In the case of the variance between the five projects studied F_{obt} 'Project' is less than F_{crit} at the 0.05 level of significance and it may be concluded that there is no significant difference in the mean values associated between the projects studied and therefore accept the null hypothesis, H_o.

H 3 COMPANY C ANOVA CALCULATIONS

Table H.3.1 ANOVA (one-way)

Analysis of Variance for Team Variable Ratings only (Company C).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Source of Variation	**Degrees of Freedom**	**Sum of Squares**	**Mean Squares**	**F**
Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 504.00$	$MS_B = \frac{SS_B}{Df}$ $= \frac{504.00}{6}$ $= 84.00$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{84.00}{47.05}$ **= 1.79**
Within (*W*)	$N_T - k$ $21 - 7$ $= 14$	$SS_W = II - III$ $= 658.67$	$MS_B = \frac{SS_W}{Df}$ $= \frac{658.67}{14}$ $= 47.05$	
Total	$N_T - 1$	$SS_T = 1162.67$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 2.85
F_{crit} 0.01 = 4.46

The level of F_{obt} is less than F_{crit} at the 0.05 level of significance it may be concluded that there is no significant difference in the mean values associated with the seven variables selected for evaluating the average company C team ratings and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$.

Table H.3.2 ANOVA (two-way)

Analysis of Variance for Team Variable Ratings and Projects (Company C).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
VARIABLE Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 504.00$	$MS_B = \frac{SS_B}{Df}$ $= \frac{504.00}{6}$ $= 84.00$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{84.00}{18.13}$ **= 4.63***
PROJECT Between (*B*)	$k - 1$ $3 - 1$ $= 2$	$SS_B = III - I$ $= 440.10$	$MS_B = \frac{SS_B}{Df}$ $= \frac{440.10}{2}$ $= 220.05$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{220.05}{18.13}$ **= 12.14****
Error	12	$SS_E = 217.57$	$MS_E = \frac{SS_E}{Df}$ $= \frac{217.57}{12}$ $= 28.20$	
Total	$N_T - 1$	$SS_T = 1162.67$		

Level of Significance taken from table of 'Critical Values of F' at:

Variable F_{crit} 0.05 = 3.00
F_{crit} 0.01 = 4.82

Level of Significance taken from table of 'Critical Values of F' at:

Project F_{crit} 0.05 = 3.89
F_{crit} 0.01 = 6.93

The level of F_{obt} 'Variable' and F_{obt} 'Project' are greater than F_{crit} at 0.05 and F_{obt} 'Project' is also greater than F_{crit} at a 0.01 level of significance. It may be concluded that there is a significant difference in the mean values associated between the seven variables and between the five projects studied particularly at the 0.5 level of significance.

Table H.3.3 ANOVA (one-way)

Analysis of Variance for Project Performance Indicators only (Company C).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 10804.29$	$MS_B = \frac{SS_B}{Df}$ $= \frac{10804.29}{6}$ $= 1800.72$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{1800.72}{552.00}$ $= 3.26$*
Within (*W*)	$N_T - k$ $21 - 7$ $= 14$	$SS_W = II - III$ $= 7728.00$	$MS_B = \frac{SS_W}{Df}$ $= \frac{7728.00}{14}$ $= 552.00$	
Total	$N_T - 1$	$SS_T = 8532.29$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 2.85
F_{crit} 0.01 = 4.46

Given that the level of F_{obt} is greater than F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average company B project performance indicators and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$.

Table H.3.4 ANOVA (two-way)

Analysis of Variance for Project Indicators and Projects (Company C).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$

Source of Variation	**Degrees of Freedom**	**Sum of Squares**	**Mean Squares**	**F**
INDICATOR Between (*B*)	$k-1$ $7-1$ $=6$	$SS_B = III - I$ $= 10804.29$	$MS_B = \frac{SS_B}{Df}$ $= \frac{10804.29}{6}$ $= 1800.72$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{1800.72}{352.48}$ $= 5.11^{**}$
PROJECT Between (*B*)	$k-1$ $3-1$ $=2$	$SS_B = III - I$ $= 3498.29$	$MS_B = \frac{SS_B}{Df}$ $= \frac{3498.29}{2}$ $= 1749.15$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{1749.15}{352.48}$ $= 4.96^{*}$
Error	12	$SS_E = 4229.71$	$MS_E = \frac{SS_E}{Df}$ $= \frac{4229.71}{12}$ $= 352.48$	
Total	$N_T - 1$	$SS_T = 8532.29$		

Level of Significance taken from table of 'Critical Values of F' at:

Indicator F_{crit} 0.05 = 3.00
F_{crit} 0.01 = 4.82

Level of Significance taken from table of 'Critical Values of F' at:

Project F_{crit} 0.05 = 3.89
F_{crit} 0.01 = 6.93

The level of F_{obt} 'Variable' and 'Project' is greater than F_{crit} at the 0.05 level of significance and F_{obt} 'Variable' at the 0.01 level of significance. It may be concluded that there is a significant difference (F_{crit} 0.05) in the mean values associated between the seven indicators and between the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A.

Table H.3.5 ANOVA (one-way)

Analysis of Variance based on Team Rating and Project Performance (Company C).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $2 - 1$ $= 1$	$SS_B = III - I$ $= 560.66$	$MS_B = \frac{SS_B}{Df}$ $= \frac{560.66}{1}$ $= 560.66$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{560.66}{139.67}$ $= 4.01$
Within (*W*)	$N_T - k$ $6 - 2$ $= 4$	$SS_W = II - III$ $= 558.67$	$MS_B = \frac{SS_W}{Df}$ $= \frac{558.67}{4}$ $= 139.67$	
Total	N_T - 1	SS_T = *1119.33*		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 7.71
F_{crit} 0.01 = 21.20

As the level of F_{obt} is less than F_{crit} at the 0.05 level of significance it may be concluded that there is not a significant difference in the mean values associated with the three company C projects based on Team Rating and Project Performance and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2$.

Table H.3.6 ANOVA (two-way)

Analysis of Variance for Team Performance and Projects (Company C).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
TEAM Between (*B*)	$k-1$ $2-1$ $=1$	$SS_B = III - I$ $= 560.66$	$MS_B = \frac{SS_B}{Df}$ $= \frac{560.66}{1}$ $= 1144.90$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{560.66}{50.67}$ $= 11.06$
PROJECT Between (*B*)	$k-1$ $3-1$ $=2$	$SS_B = III - I$ $= 457.33$	$MS_B = \frac{SS_B}{Df}$ $= \frac{457.33}{2}$ $= 228.67$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{228.67}{50.67}$ $= 4.51$
Error	2	$SS_E = 101.34$	$MS_E = \frac{SS_E}{Df}$ $= \frac{101.34}{2}$ $= 50.67$	
Total	$N_T - 1$	$SS_T = 1119.33$		

Level of Significance taken from table of 'Critical Values of F' at:

Team $F_{crit}\ 0.05 = 18.51$
$F_{crit}\ 0.01 = 98.50$

Level of Significance taken from table of 'Critical Values of F' at:

Project $F_{crit}\ 0.05 = 19.00$
$F_{crit}\ 0.01 = 99.00$

Since the level of F_{obt} 'Team' is less than F_{crit} at the 0.05 level of significance it may be concluded that there is not a significant difference in the mean values associated between the Team Ratings and therefore accept the null hypothesis, H_o. The level of F_{obt} 'Project' is less than F_{crit} at the 0.05 level of significance for the 'Project' it may be concluded that there is not a significant difference in the mean values associated between the projects studied in context with the Team Ratings and therefore accept the null hypothesis, H_o.

H 4 COMPANY D ANOVA CALCULATIONS

Table H.4.1 ANOVA (one-way)

Analysis of Variance for Team Variable Ratings only (Company D).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 1003.94$	$MS_B = \frac{SS_B}{Df}$ $= \frac{1003.94}{6}$ $= 167.32$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{167.32}{35.47}$ $= 4.72$**
Within (*W*)	$N_T - k$ $35 - 7$ $= 28$	$SS_W = II - III$ $= 993.20$	$MS_B = \frac{SS_W}{Df}$ $= \frac{993.20}{28}$ $= 35.47$	
Total	$N_T - 1$	$SS_T = 1997.14$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 2.44
F_{crit} 0.01 = 3.53

Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average company D team ratings and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$.

Table H.4.2 ANOVA (two-way)

Analysis of Variance for Team Variable Ratings and Projects (Company D).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
VARIABLE Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 1003.94$	$MS_B = \frac{SS_B}{Df}$ $= \frac{1003.94}{6}$ $= 167.32$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{167.32}{18.73}$ **= 8.93****
PROJECT Between (*B*)	$k - 1$ $5 - 1$ $= 4$	$SS_B = III - I$ $= 356.28$	$MS_B = \frac{SS_B}{Df}$ $= \frac{356.28}{4}$ $= 89.07$	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{89.07}{18.73}$ **= 4.76****
Error	24	$SS_E = 636.92$	$MS_E = \frac{SS_E}{Df}$ $= \frac{636.92}{24}$ $= 18.73$	
Total	$N_T - 1$	$SS_T = 1997.14$		

Level of Significance taken from table of 'Critical Values of F' at:

Variable $F_{crit}\ 0.05 = 2.51$
$F_{crit}\ 0.01 = 3.67$

Level of Significance taken from table of 'Critical Values of F' at:

Project $F_{crit}\ 0.05 = 2.78$
$F_{crit}\ 0.01 = 4.22$

Since the level of F_{obt} 'Variable' and 'Project' greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated between the seven variables and between the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A.

Table H.4.3 ANOVA (one-way)

Analysis of Variance for Project Performance Indicators only (Company D).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Source of Variation	**Degrees of Freedom**	**Sum of Squares**	**Mean Squares**	**F**
Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 22179.94$	$MS_B = \frac{SS_B}{Df}$ $= \frac{22179.94}{6}$ $= 3696.66$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{3696.66}{568.89}$ **= 6.50****
Within (*W*)	$N_T - k$ $35 - 7$ $= 28$	$SS_W = II - III$ $= 15928.80$	$MS_B = \frac{SS_W}{Df}$ $= \frac{15928.80}{28}$ $= 568.89$	
Total	N_T - 1	$SS_T = 8108.74$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 2.44
F_{crit} 0.01 = 3.53

Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average company D project performance indicators and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$.

Table H.4.4 ANOVA (two-way)

Analysis of Variance for Project Indicators and Projects (Company D).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
INDICATOR Between (*B*)	k – 1 7 – 1 = 6	SS_B = III – I = 22179.94	$MS_B = \frac{SS_B}{Df}$ $= \frac{22179.94}{6}$ = 3696.66	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{3696.66}{415.46}$ **= 8.90****
PROJECT Between (*B*)	k – 1 5 – 1 = 4	SS_B = III - I = 5957.84	$MS_B = \frac{SS_B}{Df}$ $= \frac{5957.84}{4}$ =1489.46	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{1489.46}{415.46}$ **= 3.58***
Error	24	SS_E = 9970.96	$MS_E = \frac{SS_E}{Df}$ $= \frac{9970.96}{24}$ = 415.46	
Total	N_T - 1	SS_T = 8108.74		

Level of Significance taken from table of 'Critical Values of F' at:

Indicator F_{crit} 0.05 = 2.51
F_{crit} 0.01 = 3.67

Level of Significance taken from table of 'Critical Values of F' at:

Project F_{crit} 0.05 = 2.78
F_{crit} 0.01 = 4.22

Since the level of F_{obt} 'Indicator' is greater than F_{crit} at both the 0.05 and 0.01 level of significance for the 'Indicator' and 0.05 level of significance for the 'Project' it may be concluded that there is a significant difference in the mean values associated between the seven indicators, verifying the findings of the one-way ANOVA and therefore rejecting the null hypothesis in favour of the alternative hypothesis, H_A. The obtained value for 'F Project' (F_{obt}) is also greater than F_{crit} at the 0.05 level of significance for the five projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A.

Table H.4.5 ANOVA (one-way)

Analysis of Variance based on Team Rating and Project Performance (Company D).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2$

Source of Variation	**Degrees of Freedom**	**Sum of Squares**	**Mean Squares**	**F**
Between (*B*)	$k - 1$ $2 - 1$ $= 1$	$SS_B = III - I$ $= 921.60$	$MS_B = \frac{SS_B}{Df}$ $= \frac{921.60}{1}$ $= 921.60$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{921.60}{111.00}$ $= 8.30^*$
Within (*W*)	$N_T - k$ $10 - 2$ $= 8$	$SS_W = II - III$ $= 888.00$	$MS_B = \frac{SS_W}{Df}$ $= \frac{888.00}{8}$ $= 111.00$	
Total	$N_T - 1$	$SS_T = 1809.60$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 5.32
F_{crit} 0.01 = 11.26

The level of F_{obt} is greater than F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated with the five company D projects based on Team Rating and Project Performance and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2$.

Table H.4.6 ANOVA (two-way)

Analysis of Variance for Team Performance and Projects (Company D).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$

Source of Variation	**Degrees of Freedom**	**Sum of Squares**	**Mean Squares**	**F**
TEAM Between (*B*)	k – 1 2 – 1 = 1	SS_B = III – I = 921.60	$MS_B = \frac{SS_B}{Df}$ $= \frac{921.60}{1}$ = 921.60	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{921.60}{90.10}$ **= 10.23***
PROJECT Between (*B*)	k – 1 5 – 1 = 4	SS_B = III - I = 527.60	$MS_B = \frac{SS_B}{Df}$ $= \frac{527.60}{4}$ = 131.90	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{131.90}{90.10}$ **= 1.46**
Error	4	SS_E = 360.40	$MS_E = \frac{SS_E}{Df}$ $= \frac{360.40}{4}$ = 90.10	
Total	N_T - 1	SS_T = 1809.60		

Level of Significance taken from table of 'Critical Values of F' at:

Team F_{crit} 0.05 = 7.71
F_{crit} 0.01 = 21.20

Level of Significance taken from table of 'Critical Values of F' at:

Project F_{crit} 0.05 = 6.39
F_{crit} 0.01 = 15.98

The level of F_{obt} 'Team' is greater than F_{crit} at the 0.05 level of significance it may be concluded that there is a significant difference in the mean values associated between the Team mean values and therefore reject the null hypothesis. In the case of project variability between the five projects studied F_{obt} 'Project' is less than F_{crit} at the 0.05 level of significance it may be concluded that there is not significant difference in the mean values associated between the projects studied and therefore accept the null hypothesis, H_o.

H 5 INTER-COMPANY ANOVA CALCULATIONS

Table H.5.1 ANOVA (one-way)

Analysis of Variance for Team Rating Results only (Company Average).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k-1$ $3-1$ $= 2$	$SS_B = III - I$ $= 60.04$	$MS_B = \frac{SS_B}{Df}$ $= \frac{60.04}{2}$ $= 30.02$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{30.02}{20.43}$ $= 1.47$
Within (*W*)	$N_T - k$ $13-3$ $= 10$	$SS_W = II - III$ $= 204.27$	$MS_B = \frac{SS_W}{Df}$ $= \frac{204.27}{10}$ $= 20.43$	
Total	$N_T - 1$	$SS_T = 264.31$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 4.10
F_{crit} 0.01 = 7.56

Since the level of F_{obt} is less than F_{crit} at 0.05 level of significance it may be concluded that there is no significant difference in the mean values associated with the three companies Team Rating and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$.

Table H.5.2 ANOVA (one-way)

Analysis of Variance for Indicator Results only (Company Average).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$.

Source of Variation	**Degrees of Freedom**	**Sum of Squares**	**Mean Squares**	**F**
Between (*B*)	$k - 1$ $3 - 1$ $= 2$	$SS_B = III - I$ $= 235.88$	$MS_B = \frac{SS_B}{Df}$ $= \frac{235.88}{2}$ $= 117.94$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{117.94}{191.32}$ **= 0.616**
Within (*W*)	$N_T - k$ $13 - 3$ $= 10$	$SS_W = II - III$ $= 1913.20$	$MS_B = \frac{SS_W}{Df}$ $= \frac{1913.20}{10}$ $= 191.32$	
Total	$N_T - 1$	$SS_T = 2149.08$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 4.10
F_{crit} 0.01 = 7.56

Since the level of F_{obt} is less than F_{crit} at 0.05 level of significance it may be concluded that there is no significant difference in the mean values associated with the three company Project Performance scores and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$.

Table H.5.3 ANOVA (one-way)

Analysis of Variance for Team / Performance Results only (Company Average).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$.

Source of Variation	**Degrees of Freedom**	**Sum of Squares**	**Mean Squares**	**F**
Between (*B*)	$k - 1$ $3 - 1$ $= 2$	$SS_B = III - I$ $= 76.00$	$MS_B = \frac{SS_B}{Df}$ $= \frac{76.00}{2}$ $= 38.00$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{38.00}{214.00}$ **= 0.18**
Within (*W*)	$N_T - k$ $6 - 3$ $= 3$	$SS_W = II - III$ $= 642.00$	$MS_B = \frac{SS_W}{Df}$ $= \frac{642.00}{3}$ $= 214.00$	
Total	$N_T - 1$	$SS_T = 718.00$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 9.55
F_{crit} 0.01 = 30.82

Since the level of F_{obt} is considerably less than F_{crit} at 0.05 level of significance it may be concluded that there is no significant difference in the mean values associated with the three company Team / Performance results and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3$.

H 6 INTER-PROJECT ANOVA CALCULATIONS

Table H.6.1 ANOVA (one-way)

Analysis of Variance for Team Variable Ratings only *(All Projects).*

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 2222.30$	$MS_B = \frac{SS_B}{Df}$ $= \frac{2222.30}{6}$ $= 370.34$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{370.34}{46.61}$ $= 7.95$**
Within (*W*)	$N_T - k$ $91 - 7$ $= 84$	$SS_W = II - III$ $= 3915.00$	$MS_B = \frac{SS_W}{Df}$ $= \frac{3915.00}{84}$ $= 46.61$	
Total	$N_T - 1$	$SS_T = 6137.03$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 2.21
F_{crit} 0.01 = 3.03

Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average project team ratings and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu 3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$.

Table H.6.2 ANOVA (two-way)

Analysis of Variance for Team Variable Ratings and Projects (All Projects).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Testing Null Hypothesis,

H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8 = \mu_9 = \mu_{10} = \mu_{11} = \mu_{12} = \mu_{13}$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
VARIABLE Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 2222.03$	$MS_B = \frac{SS_B}{Df} = \frac{2222.03}{6} = 370.34$	$F_{obt} = \frac{MS_B}{MS_E} = \frac{370.34}{18.45}$ **= 20.07****
PROJECT Between (*B*)	$k - 1$ $13 - 1$ $= 12$	$SS_B = III - I$ $= 2217.33$	$MS_B = \frac{SS_B}{Df} = \frac{2217.33}{12} = 184.78$	$F_{obt} = \frac{MS_B}{MS_E} = \frac{184.78}{18.45}$ **= 10.02****
Error	72	$SS_E = 1697.67$	$MS_E = \frac{SS_E}{Df} = \frac{1697.67}{72} = 18.45$	
Total	$N_T - 1$	$SS_T = 6137.03$		

Level of Significance taken from table of 'Critical Values of F' at:

Variable $F_{crit}\ 0.05 = 2.23$
$F_{crit}\ 0.01 = 3.07$

Level of Significance taken from table of 'Critical Values of F' at:

Project $F_{crit}\ 0.05 = 1.89$
$F_{crit}\ 0.01 = 2.45$

Since the level of F_{obt} 'Variable' and 'Project' greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated between the seven variables and between the thirteen projects studied and may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A.

Table H.6.3 ANOVA (one-way)

Analysis of Variance for Project Performance Indicators only (All Projects).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $7 - 1$ $= 6$	$SS_B = III - I$ $= 15592.46$	$MS_B = \frac{SS_B}{Df}$ $= \frac{15592.46}{6}$ $= 2598.74$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{2598.74}{829.73}$ **= 3.13****
Within (*W*)	$N_T - k$ $91 - 7$ $= 84$	$SS_W = II - III$ $= 69697.50$	$MS_B = \frac{SS_W}{Df}$ $= \frac{69697.50}{84}$ $= 829.73$	
Total	$N_T - 1$	$SS_T = 5289.96$		

Level of Significance taken from table of 'Critical Values of F' at: $F_{crit}\ 0.05 = 2.21$
$F_{crit}\ 0.01 = 3.03$

Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the seven variables selected for evaluating the average project performance indicators and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$ in favour of *the* alternative hypothesis, H_A: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4 \neq \mu_5 \neq \mu_6 \neq \mu_7$.

Table H.6.4 ANOVA (two-way)

Analysis of Variance for Project Indicators and Projects (All Projects).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7$

Testing Null Hypothesis,

H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8 = \mu_9 = \mu_{10} = \mu_{11} = \mu_{12} = \mu_{13}$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
INDICATOR Between (*B*)	k – 1 7 – 1 = 6	SS_B = III – I = 15592.46	$MS_B = \frac{SS_B}{Df}$ $= \frac{15592.46}{6}$ = 2598.74	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{2598.74}{757.83}$ **= 3.43****
PROJECT Between (*B*)	k – 1 13 – 1 = 12	SS_B = III - I = 15133.66	$MS_B = \frac{SS_B}{Df}$ $= \frac{15133.66}{12}$ = 1261.14	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{1261.14}{757.83}$ **= 1.66**
Error	72	SS_E = 54563.84	$MS_E = \frac{SS_E}{Df}$ $= \frac{54563.84}{72}$ = 757.83	
Total	N_T - 1	SS_T = 5289.96		

Level of Significance taken from table of 'Critical Values of F' at:

Indicator F_{crit} 0.05 = 2.23
F_{crit} 0.01 = 3.07

Level of Significance taken from table of 'Critical Values of F' at:

Project F_{crit} 0.05 = 1.89
F_{crit} 0.01 = 2.45

Since the level of F_{obt} 'Indicator' is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated between the seven indicators may therefore reject the Null Hypothesis, H_o in favour of the alternative hypothesis, H_A. The level of F_{obt} 'Project' is less than F_{crit} at the 0.05 level of significance and it may be concluded that there is no significant difference in the mean values associated between the thirteen projects and may therefore accept the Null Hypothesis, H_o.

Table H.6.5 ANOVA (one-way)

Analysis of Variance based on Team Rating and Project Performance (All Projects).

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $2 - 1$ $= 1$	$SS_B = III - I$ $= 2721.38$	$MS_B = \frac{SS_B}{Df}$ $= \frac{2721.38}{1}$ $= 2721.38$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{2721.38}{105.89}$ **= 25.89****
Within (*W*)	$N_T - k$ $26 - 2$ $= 24$	$SS_W = II - III$ $= 2523.08$	$MS_B = \frac{SS_W}{Df}$ $= \frac{2523.08}{24}$ $= 105.13$	
Total	$N_T - 1$	$SS_T = 5244.46$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 4.26
F_{crit} 0.01 = 7.82

Since the level of F_{obt} is greater than F_{crit} at both the 0.05 and 0.01 level of significance it may be concluded that there is a significant difference in the mean values associated with the thirteen projects based on Team Rating and Project Performance and may therefore reject the Null Hypothesis, H_o: $\mu_1 = \mu_2$ in favour of the alternative hypothesis, H_A: $\mu_1 \neq \mu_2$.

Table H.6.6 ANOVA (one-way)

Analysis of Variance based on Team Rating and Project Performance (All Projects).

Testing Null Hypothesis,

H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8 = \mu_9 = \mu_{10} = \mu_{11} = \mu_{12} = \mu_{13}$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
Between (*B*)	$k - 1$ $13 - 1$ $= 12$	$SS_B = III - I$ $= 1906.46$	$MS_B = \frac{SS_B}{Df}$ $= \frac{1906.46}{12}$ $= 158.87$	$F_{obt} = \frac{MS_B}{MS_W}$ $= \frac{158.87}{256.77}$ **= 0.62**
Within (*W*)	$N_T - k$ $26 - 13$ $= 13$	$SS_W = II - III$ $= 3338.00$	$MS_B = \frac{SS_W}{Df}$ $= \frac{3338.00}{13}$ $= 256.77$	
Total	$N_T - 1$	$SS_T = 5244.46$		

Level of Significance taken from table of 'Critical Values of F' at: F_{crit} 0.05 = 2.60
F_{crit} 0.01 = 3.96

Since the level of F_{obt} is less than F_{crit} at the 0.05 level of significance it may be concluded that there is not a significant difference in the mean values associated with the thirteen projects based on both Team Rating and Project Performance values and may therefore accept the Null Hypothesis, H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8 = \mu_9 = \mu_{10} = \mu_{11} = \mu_{12} = \mu_{13}$.

Table H.6.7 ANOVA (two-way)

Analysis of Variance for Projects and Team Rating / KPI (Performance).

Testing Null Hypothesis,

H_o: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8 = \mu_9 = \mu_{10} = \mu_{11} = \mu_{12} = \mu_{13}$

Testing Null Hypothesis, H_o: $\mu_1 = \mu_2$

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	F
PROJECT Between (*B*)	k – 1 13 – 1 = 12	SS_B = III – I = 1906.46	$MS_B = \frac{SS_B}{Df}$ $= \frac{1906.46}{12}$ = 158.87	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{158.87}{51.39}$ **= 3.09***
PERFORMANCE Between (*B*)	k – 1 2 – 1 = 1	SS_B = III - I = 2721.38	$MS_B = \frac{SS_B}{Df}$ $= \frac{2721.38}{1}$ =2721.38	$F_{obt} = \frac{MS_B}{MS_E}$ $= \frac{2721.38}{51.39}$ **= 53.00****
Error	12	SS_E = 616.62	$MS_E = \frac{SS_E}{Df}$ $= \frac{616.62}{12}$ = 51.39	
Total	N_T - 1	SS_T = 244.46		

Level of Significance taken from table of 'Critical Values of F' at:

Project F_{crit} 0.05 = 2.69
F_{crit} 0.01 = 4.16

Level of Significance taken from table of 'Critical Values of F' at:

Performance F_{crit} 0.05 = 4.75
F_{crit} 0.01 = 9.33

In the case of project variability between the thirteen projects studied F_{obt} 'Project' is greater than F_{crit} at the 0.05 level of significance for the 'Project' it may be concluded that there is a significant difference in the mean values associated between the projects studied and therefore reject the null hypothesis in favour of the alternative hypothesis, H_A. Since the level of F_{obt} 'Performance' is considerably greater than F_{crit} at both the 0.05 and 0.01 level of significance for the 'Performance' it may be concluded that there is a significant difference in the mean values associated between the variables therefore reject the null hypothesis in favour of the alternative hypothesis, H_A. Although little may be interpreted from the 'Performance' results because they derive from dissimilar origins and may be more appropriately analysed in terms of correlation and resultant association. The result for project provides an insight in to the underlying variances related to individual projects and ultimately the overall outcome.

H.7 THE RANK-CORRELATION COEFFICIENT

H.7.1 THE SPEARMAN RANK-CORRELATION COEFFICIENT

The Spearman rank-correlation coefficient is a non-parametric statistical technique that can be used to evaluate the strength of association between two variables. The standard 'Pearson's' correlation coefficient is based on the assumption that the data is observed and obtained from a random sample of pairs. The Spearman rank-coefficient side steps the issue of population sample by basing the calculation on the rank rather than on any directly observed measurements. See formula for rs:

$$r_s = 1 - \frac{6\sum(Xi - Yi)^2}{n(n^2 - 1)}$$

Where rs denotes the Spearman rank-correlation coefficient:

n = number of pairs of observations

Xi = rank of Xi; and

Yi = rank of Yi.

Table C.7.1

No.	Case study	Xi	Yi	$(Xi - Yi)^2$
1	B/1	7	11	16
2	B/2	12	8	16
3	B/3	13	13	0
4	B/4	9	9	0
5	B/5	6	4	4
6	C/1	1	2	1
7	C/2	3	5	4
8	C/3	11	12	1
9	D/1	7	11	16
10	D/2	3	10	49
11	D/3	5	3	4
12	D/4	2	1	1
13	D/5	9	5	16
$\sum$				128

From the formula:

$$r_s = 1 - \frac{6\sum(128)^2}{13(168)}$$

$$r_s = 1 - \frac{672}{2184}$$

$$r_s = 1 - 0.308$$

$\underline{\mathbf{r_s = 0.692}}$

Procedure for testing null hypothesis:

H_o: X and Y are independent, against

H_A: X and Y are positively correlated

For a sample size of 13 and $\alpha = 0.05$, Ho would be rejected if the calculation produces a value of $rs \geq 0.480$ (from tables).

$Rs = 0.692 \geq 0.480$, therefore reject null hypothesis in favour of H_A: X and Y are positively correlated with a 95% level of confidence.

APPENDIX I: "THE COLOUR CODED COMPANY BALANCED SCOREDCARD"

I 1 THE COLOUR CODED COMPANY BALANCED SCORECARD

I.1.1 INTRODUCTION

In an attempt to facilitate the data interpretation of both the team rating and project performance a colour coding criteria was adopted. The concept was to highlight initial trends for individual projects and for the company as a whole. Interpretation of the data vertically would illustrate project trends whereas reading the information horizontally would highlight individual variable trends across the participating company. Appendix I represents the company scorecards for all three participating construction companies. The original format adopted a 'traffic light' approach to highlight facets of both team rating and project performance that may merit further investigation. The adopted colour coding criteria was as follows:

GREEN: A percentage equal to or above 75% would be coloured green, representing an above satisfactory outcome and required no immediate action.

AMBER: A percentage equal to or greater than 50% but less than 75% would be coloured amber, representing satisfactory but should be monitored.

RED: The lowest grading was a percentage less than 50%. This was coloured red and would represent the need further investigation.

A worked example of the original balanced scorecard 'traffic light' format can be seen for company 'B' in Table I.1.1 and Table I.1.2.

Table I.1.1 Company B Team Rating Balanced Scorecard (original format)

TEAM PERFORMANCE RATING	B/1	B/2	B/3	B/4	B/5		COMPANY 'B' MEAN TEAM RATING
INTERDEPENDENCY	78	77	66	82	77		76
MEMBERSHIP DIVERSITY	70	69	65	66	65		67
TEAM DYNAMICS	78	80	68	78	81		77
TRUST	70	63	53	73	69		66
CORPORATE INTENT	64	56	52	62	77		62
SYSTEMS, POLICIES & CUSTOMS	76	69	67	59	69		68
CULTURE	68	61	60	71	81		68
PROJECT MEAN	72	68	62	70	74		69

Table I.1.2 Company B Team Rating Balanced Scorecard (original format)

KEY PERFORMANCE INDICATOR	B/1	B/2	B/3	B/4	B/5		COMPANY 'B' BENCHMARK MEAN
PREDICATABILITY COSTRUCTION COST	75.0	75.0	27.0	95.0	76.0		70
PREDICATABILITY COSTRUCTION TIME	25.0	39.0	26.0	19.0	60.0		34
CLIENT SATISFACTION SERVICE	55.0	10.0	10.0	27.0	55.0		31
CLIENT SATISFACTION PRODUCT	55.0	55.0	8.0	2.0	20.0		28
EMPLOYEE SATISFACTION	61.0	67.0	45.0	46.0	82.0		60
HOURS WORKED (Average per Week)	22.0	14.0	18.0	20.0	38.0		22
TRAINING DAYS (Per Year)	88.0	75.0	72.0	89.0	94.0		84
PROJECT MEAN	54	48	29	43	61		47

I.1.2 COMPANY FEEDBACK

After presenting the results in this particular format it became apparent that the colours, far from assisting with the interpretation of the various outcomes actually hindered the process. The primary source of consternation was the use of the colour red indicating results that achieved less than fifty percent. The colour red was very emotive. Although the intent was to assist with preliminary perceptions of team and project well-being company managers did not welcome results presented in this way. Consequently it was difficult to see beyond the colour, even although in a number of instances closer inspection revealed that whilst the performance was a ‘category’ red there was little company concern due to other salient project circumstances. It was therefore decide to amend the colour coded company balance scorecard.

I.2 REVISED FORMAT

After careful reflection an alternative colour coding criteria was necessary. The idea to use colour to communicate a particular outcome within this context was deemed helpful. The revised colours would need to be carefully chosen to communicate a more muted statement of preliminary intent. There is also the consideration of an implicit relationship between the colours. It would be preferential if the selected colours represented a hierarchy that could display a potential progression between the various levels of attainment. The report "A toolkit for Measuring Awareness of the 1998 'Egan' Report," (Murray *et al*, 2002) utilised the colours gold, silver and bronze to represent a scoring range. The emotive connotations associated with this colour scheme were more positive in their meaning and in terms of communicating results this aligned more closely with current quality management principles. The link with performance was also explicit and offered an ideal opportunity to convey numerous case study outcomes in a simple to read format. The revised colour coding criteria was as follows:

GOLD: The top percentage category was equal to or above 75% and would be coloured gold, representing an above satisfactory outcome and required no immediate action.

SILVER: The second percentage category would be equal to or greater than 50% but less than 75% and would be coloured silver, representing satisfactory but should be monitored.

BRONZE: The third grade was a percentage less than 50%. This was coloured bronze and would represent the need further investigation to ascertain the likely causes of this outcome and possible remedies.

I.3 COMPANY B BALANCED SCORECARD

Company examples of the revised balanced scorecard 'gold / silver / bronze' format can be seen for Company 'B' in Table I.3.1 and Table I.3.2; Company 'C' in Table I.4.1 and Table I.4.2; Company 'D' in Table I.5.1 and Table I.5.2.

I.3.1 TEAM RATING BALANCED SCORECARD

Table I.3.1 Team Rating Balanced Scorecard

TEAM PERFORMANCE RATING	B/1	B/2	B/3	B/4	B/5		COMPANY 'B' MEAN TEAM RATING
INTERDEPENDENCY	78	77	66	82	77		76
MEMBERSHIP DIVERSITY	70	69	65	66	65		67
TEAM DYNAMICS	78	80	68	78	81		77
TRUST	70	63	53	73	69		66
CORPORATE INTENT	64	56	52	62	77		62
SYSTEMS, POLICIES & CUSTOMS	76	69	67	59	69		68
CULTURE	68	61	60	71	81		68
PROJECT MEAN	72	68	62	70	74		69

I.3.2 PROJECT PERFORMANCE BALANCED SCORECARD

Table I.3.2 Project Performance Balanced Scorecard

KEY PERFORMANCE INDICATOR	B/1	B/2	B/3	B/4	B/5		COMPANY 'B' BENCHMARK MEAN
PREDICATABILITY COSTRUCTION COST	75.0	75.0	27.0	95.0	76.0		70
PREDICATABILITY COSTRUCTION TIME	25.0	39.0	26.0	19.0	60.0		34
CLIENT SATISFACTION SERVICE	55.0	10.0	10.0	27.0	55.0		31
CLIENT SATISFACTION PRODUCT	55.0	55.0	8.0	2.0	20.0		28
EMPLOYEE SATISFACTION	61.0	67.0	45.0	46.0	82.0		60
HOURS WORKED (Average per Week)	22.0	14.0	18.0	20.0	38.0		22
TRAINING DAYS (Per Year)	88.0	75.0	72.0	89.0	94.0		84
PROJECT MEAN	54	48	29	43	61		47

I.4 COMPANY C BALANCED SCORECARD

I.4.1 TEAM RATING BALANCED SCORECARD

Table I.4.1 Team Rating Balanced Scorecard

TEAM PERFORMANCE RATING	C/1	C/2	C/3		COMPANY 'C' TEAM MEAN RATING
INTERDEPENDENCY	90	87	79		85
MEMBERSHIP DIVERSITY	73	79	71		74
TEAM DYNAMICS	87	81	72		80
TRUST	75	76	68		73
CORPORATE INTENT	76	71	61		69
SYSTEMS, POLICIES & CUSTOMS	80	79	62		74
CULTURE	81	68	73		74
PROJECT MEAN	80	77	69		76

I.4.2 PROJECT PERFORMANCE BALANCED SCORECARD

Table I.4.2 Project Performance Balanced Scorecard

KEY PERFORMANCE INDICATOR	C/1	C/2	C/3		COMPANY 'C' BENCHMARK MEAN
PREDICATABILITY COSTRUCTION COST	75.0	22.0	26.0		41
PREDICATABILITY COSTRUCTION TIME	60.0	34.0	33.0		42
CLIENT SATISFACTION SERVICE	85.0	100.0	55.0		80
CLIENT SATISFACTION PRODUCT	85.0	85.0	8.0		59
EMPLOYEE SATISFACTION	73.0	60.0	45.0		59
HOURS WORKED (Average per Week)	22.0	26.0	12.0		20
TRAINING DAYS (Per Year)	92.0	89.0	95.0		92
PROJECT MEAN	70	59	39		56

I.5 COMPANY D BALANCED SCORECARD

I.5.1 TEAM RATING BALANCED SCORECARD

Table I.5.1 Team Rating Balanced Scorecard

TEAM PERFORMANCE RATING	D/1	D/2	D/3	D/4	D/5		COMPANY 'D' MEAN TEAM RATING
INTERDEPENDENCY	86	86	83	93	76		85
MEMBERSHIP DIVERSITY	57	78	74	68	67		69
TEAM DYNAMICS	86	80	82	84	71		81
TRUST	70	72	76	82	69		74
CORPORATE INTENT	60	78	69	78	70		71
SYSTEMS, POLICIES & CUSTOMS	75	70	77	69	70		72
CULTURE	67	72	72	78	70		72
PROJECT MEAN	72	77	76	79	70		75

I.5.2 PROJECT PERFORMANCE BALANCED SCORECARD

Table I.5.2 Project Performance Balanced Scorecard

KEY PERFORMANCE INDICATOR	D/1	D/2	D/3	D/4	D/5		COMPANY 'D' BENCHMARK MEAN
PREDICATABILITY COSTRUCTION COST	16.0	35.0	20.0	75.0	20.0		33
PREDICATABILITY COSTRUCTION TIME	28.0	16.0	27.0	60.0	34.0		33
CLIENT SATISFACTION SERVICE	55.0	55.0	100.0	100.0	100.0		82
CLIENT SATISFACTION PRODUCT	21.0	0.0	100.0	100.0	85.0		61
EMPLOYEE SATISFACTION	45.0	85.0	77.0	75.0	62.0		69
HOURS WORKED (Average per Week)	17.0	17.0	23.0	17.0	24.0		20
TRAINING DAYS (Per Year)	95.0	86.0	91.0	93.0	88.0		91
PROJECT MEAN	40	42	63	74	59		55