A Model of Safety Climate for the Manufacturing Sector

by

Alistair James Thomas Cheyne

A Doctoral Thesis Submitted in fulfilment of the requirements for the award of Doctor of Philosophy of Loughborough University.

September 2000

ABSTRACT

This research examines the structure of safety climate in the manufacturing sector. It does so by examining and comparing attitudes to, and perceptions of, safety issues in two manufacturing organisations and one organisation involved in the supply of construction materials. The concept of safety climate, and the associated concept of safety culture, have been the subject of much research and theory building in recent years and this thesis builds on previous work. The research framework used here employed a mainly quantitative methodology in order to investigate the architecture of safety climate using structural modelling. Statistical modelling has been applied in other safety studies, often involving safety climate as one variable in a global description of safety systems. However it has rarely been used to model and describe the structure of safety climate as an indicator of safety culture, as in this research.

The structure of safety climate described in this research is characterised by the interaction of organisational, group interaction, work environment and individual variables, which provide indicators of influences on individual levels of safety activity. Structural models of the data from all three participating organisations fitted the broad pattern of organisational variables influencing group and work environment variables, which, in turn influence individual variables. A more detailed comparison of organisational structures, however, highlighted slight differences between the two manufacturing organisations and more pronounced differences between these and the construction material supply organisation, suggesting that most elements in the structure of attitudes to safety described here are industry specific. These results are explained in terms of working environments. Differences in structure, consistent with job roles, were also apparent between occupational levels.

The research, in line with previous work in the field, has highlighted the importance of management commitment to, and actions for, safety, as well as the role of individual responsibility in the promotion of safety activity. The work reported here has emphasised their importance in developing and maintaining an organisational culture for safety.

KEYWORDS: SAFETY CLIMATE, EMPLOYEE ATTITUDES, SAFETY CULTURE, ORGANISATIONAL CULTURE, SAFETY MANAGEMENT, STATISTICAL MODELLING

ACKNOWLEDGEMENTS

I would like to thank the many individuals and organisations who made this research possible. Firstly I am indebted to my supervisor Professor Sue Cox, without whose guidance, support and encouragement this thesis could not have been realised. I would also like to thank many of my colleagues in the Centre for Hazard and Risk Management and in The Business School at Loughborough for their helpful comments and advice on my research. I would also like to thank the three organisations that took part in the research, without their help and co-operation this research would not have been possible.

I am particularly grateful to Dr José Manuel Tomás Miguel and Dr Amparo Oliver Germes of the University of Valencia for introducing me to Structural Equation Modelling and then helping tame the monster they created. For the initiation into this methodology, their help with my early analyses and their continued friendship and guidance, I am forever in their debt.

Finally, I would like to thank my family for their help and support and Jason for his patience, encouragement and expert proofreading skills.

Unless otherwise indicated by references to published literature, or noted above, the work contained herein is that of the author. The findings presented in this thesis have been reported, in part, in the following article:

Cheyne, A., Cox, S.J., Oliver, A. and Tomás, J.M., Modelling safety climate in the prediction of levels of safety activity, *Work & Stress*, **12(3)**, 1998, pp 255-271.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS USED

Countries

UK	United Kingdom of Great Britain and Northern Ireland
US	United States of America

Organisations

ACSNI	Advisory Committee on the Safety of Nuclear Installations
CBI	Confederation of British Industry
HSC	Health and Safety Commission
HSE	Health and Safety Executive
IAEA	International Atomic Energy Authority
INSAG	International Nuclear Safety Advisory Group

Technical terms

CFI	Comparative Fit Index
GFI	Goodness of Fit Index
HRO	High Reliability Organisation
LM	Lagrange Multiplier
NNFI	Non-Normed Fit Index
RMSEA	Root Mean Square Error of Approximation

CHAPTER ONE

Introduction and Overview

This chapter provides an introduction to, and an overview of, the thesis. It will elaborate the reasons behind conducting the research, define the research question as well as outlining the thesis structure.

1.1 INTRODUCTION

In the quest to describe and understand the social, political and unpredictable nature of organisations (Brown, 1995), theorists have, since the early 1980s (Denison, 1996; Hatch, 1993), turned to the concept of culture. This understanding has, in turn, lead to the expectation that culture might promote improvements in individual and organisational performance and effectiveness (Kopelman et al., 1990). Attempts to identify and exploit possible linkages have, however, been hindered by the apparent complexity of the culture concept. This is reflected not only in the numbers of competing operational definitions of organisational culture that have been offered (Brown, 1995; Rousseau, 1990), but also in the number of layers that have been suggested as present in an organisational culture (Schein, 1985). Both issues are detailed in Chapter 2.

The concept of organisational climate also provides interpretations of the working environment, based on individual descriptions of the organisational setting. This concept has emerged, albeit as a result of longer evolution (Denison, 1996), as a potential manifestation of organisational culture (Moran and Volkwein, 1992), and one which, as such a manifestation, may be easier to describe and ultimately manipulate through the study and measurement of organisational attitudes (Brown, 1995). The relationship between culture, climate and attitudes, and previous attempts to identify links to performance are also discussed in Chapter 2 of this thesis.

The potential influence of culture on more specific areas of organisational activity has also been investigated, for example in terms of quality (Bright and Cooper, 1993) and safety (Cox and Flin, 1998). The specific notion of organisational safety culture has increased in popularity since it was identified as a factor in numerous industrial disasters (Rochlin and von Meyer, 1994). Several of the culture definitions and conceptualisations described in Chapter 2 have informed current thinking, theory and research in this more focussed area which is detailed in Chapter 3 of this thesis. Like organisational culture, safety culture is linked throughout the literature with the concept of safety climate, which is often the focus of organisational research. Safety climate has been assessed in this research through the measurement of employee attitudes to safety issues (Glendon and McKenna, 1994).

Many safety climate studies cover similar areas and issues to those of safety culture, and these have been related to various outcome measures. Little work has focussed, however, on the inter-relationships between these areas and they can be mapped onto theoretical models (for example International Atomic Energy Authority (IAEA), 1991) of safety culture. The evolution of a proposed structure of safety climate, based on previous research, is detailed in Chapter 3 of this thesis.

1.2 Research Question

The research aims to investigate the structure and relationships between components of safety climate as measured by individual attitudes to safety. Safety climate is studied here as an indication of overall safety culture, reflecting it at one point in time (Cox and Flin, 1998). The structure described in this research is characterised by the interaction of organisational, group process, environmental and individual variables, which provide indicators of influences on individual safety activity. The results are discussed in terms of planning and implementing improvement strategies.

1.3 JUSTIFICATION FOR THE RESEARCH

The justifications for this research stem from three main sources. The first of these was organisationally driven. The research described here was commissioned by three multi-national organisations. These organisations recognised that they needed help in identifying suitable strategies for improving safety performance. This need arose from all three organisations recognising that improvements in their safety performance had slowed down and it was becoming more and more difficult to maximise the impact intervention strategies. As a result they, like many other industrial and commercial organisations, became interested in novel and innovative approaches to health and safety management. Coupled with this desire for improvement was a basic business need within the organisations to maximise the impact of initiatives and use the resources involved efficiently.

This move to new approaches, in part, reflects the fact that, for many organisations, accident and incident rates have plateaued (Donald and Canter, 1993; Krause, 1994) and there is a perceived failure of safety technology to help organisations move off this plateau. It has been argued that what is needed is an integrated systems approach (Cox and Cox, 1996; Toft and Reynolds, 1994) in which all the contributing factors to potentially unsafe incidents are considered. This includes not only a consideration of safety technology and engineering controls, but evaluations of the management systems alongside an active consideration of human factor issues. In the offshore oil and gas exploration sector, for example, their Cross Industry Safety Leadership Forum (1997) have confirmed that much of the existing efforts in support of safety performance improvements have been focused upon technology and management systems rather than human factors. They suggest that potential for future improvements may best be realised through enhanced efforts in the areas of human factors and through the associated developments in health and safety culture.

The second justification for conducting the research was linked to previous research and theory building in the area of safety culture and associated climate. The importance of safety culture is not only recognised by organisations wishing to improve their safety management practices, but also by governments and their regulators. Safety culture is constantly referred to in connection with failures and accidents; in early October 1999 the UK Minister of Transport stated that failures and omissions leading to the Paddington rail disaster, should be considered as:

> "tragic factors symptomatic of more general problems - in the organisation, culture and systems which should together constitute an effective safety regime."
>
> and that
>
> "the lasting legacy of this awful accident at Paddington .... must surely be a more open, more responsive, more rigorous culture of safety across our whole rail industry." (Statement on Rail Safety, 1999)

This continuing emphasis on safety culture has driven the development of culture and related climate theories and models, proposing that culture could be modelled in terms of organisational, environmental and individual variables. Few of these models have been empirically tested and this research provides an opportunity to do so.

The final, and most practical, justification is the potential usefulness of such a model of safety climate. In general terms the relationships described in the model could help many different organisations construct an intuitive model based on evaluations of their own safety climate. More specifically the models derived in this research may help the participating organisations to improve communication and management of safety through focussed improvement strategies. Glendon and McKenna (1995) suggest that it may be possible to change safety attitudes and behaviours but simple communications are not likely to be effective. Such initiatives need to be targeted and backed up by other measures, such as training, if they are to be successful (Hale, 1974).

An additional justification for the particular approach detailed here, relates to the appropriateness of the research methodology employed in the construction of the explicative models. Structural modelling (described in detail in Chapter 4) provides a means of identifying relationships between variables, which have been identified as important in terms of safety culture and climate. The process allows all aspects of a model to be considered to produce a structure consistent with the collected data.

This type of statistical modelling has been applied to other safety studies, often involving safety climate as one variable in a global description of safety systems. It has not been used in an attempt to describe the structure of safety climate as an indicator of safety culture, as it will here.

1.4 Field Research Problems

As with any applied organisational research, there were a number of problems associated with conducting the studies described here. Griffiths (1999) points out that carrying out experiments, or even quasi-experiments, in an organisational setting is difficult, if not impossible. What is generally under investigation are the social settings where the researcher is a guest and not always in complete control of how the research proceeds. The problems associated with this research can be summarised as:

1. Lack of control over organisational events. It was not possible to control for every initiative or change that took place before or during the research window. This is especially problematic when several different units or plants are involved in each organisation;
2. Lack of complete control over questionnaire design in the participating organisations. The sponsoring organisations made a series of changes to the survey instrument in line with their views and this had implications for organisational comparisons;
3. Limited administrative control over data collection opportunities, which had to be taken when, and if, the participating organisations could schedule them. Data collection was not made possible in one of the manufacturing units proposed by the primary sponsoring organisation and it had, therefore, to be excluded from the studies; and
4. Lack of primary contact with participating organisational units since the research was commissioned at group and divisional levels. Direct liaison and attendance was not possible in all cases. This was particularly problematic when ensuring participating units had sufficient questionnaires and when checking as many completed responses as possible had been collected.

1.5 THESIS OUTLINE

The thesis is set out in ten chapters covering all aspects of background, design, method and results. This initial chapter has provided an introduction to the research, together with details of the research question and justifications. The second chapter deals with recent thinking on the concept of organisational culture, including its definition, evolution and its relationship to organisational climate and attitudes. The third chapter introduces the concepts of organisational safety culture and climate, based on discussions in the Chapter Two. This third chapter draws on a more detailed examination of recent work in the safety field and introduces a number of hypotheses on the nature of safety climate, including a potential general structure.

Chapter Four focuses on the methods of data gathering and analysis. Specific attention is paid to methods for collecting employee attitudes to, and perceptions of, safety. A full discussion of the main data analysis techniques to be used is presented in this chapter together with justifications for the chosen research method are presented here. The fifth chapter carries on from the description of methodology and describes the steps involved in developing a survey instrument to measure employee attitudes to safety, including details of pre-testing and pilot studies.

Chapter Six presents the results of initial surveys of individual's views of organisational culture for safety in one participating organisation. The data are subjected to both exploratory factor analysis and structural modelling and the derivation of a model of employee attitudes to safety in the first organisation, based on the hypotheses introduced in earlier chapters, are described here. The seventh chapter of the thesis details the adaptation and application of the survey instrument in the second participating organisation, including a confirmatory factor analysis and structural model of the data from this organisation. The eighth chapter presents the results of the survey in a third organisation and includes confirmatory and structural analysis of the data. Chapter Nine describes the comparison of the models detailed in the preceding chapters and includes the construction of a multi-sample model for two of the organisations as well as a comparison between models for different employment levels.

The tenth chapter discusses the results described in previous chapters and centres on examining the utility of safety culture assessment and its impact on improving organisational culture in general in the participating organisations. The nature and utility of intervention strategies based on culture assessment are also discussed. The eleventh and final chapter discusses the results with reference to the literature introduced in the opening chapters. The chapter reviews the methodology and highlights the contribution made by this research to the field of safety culture and climate. The chapter rounds off the thesis with suggestions for future work based on the research results.

1.6 Summary

This chapter has laid the foundations for this thesis. It has introduced the research area and research problem, and provided a brief description of each chapter's content. The thesis continues in the next chapter with a detailed review of relevant organisational culture and climate literature, on which subsequent discussion of safety culture and climate are based.

CHAPTER TWO

Organisational Culture

The main focus of this research is safety and how it might be considered in the wider organisational context and specifically organisational culture. In terms of organisational studies, the concept of organisational culture has become increasingly important and the quantity of organisational culture research has increased dramatically since the early 1980s (Siehl and Martin, 1990). This introductory chapter, therefore, outlines recent theory and research in organisational culture and related climate. In doing so, it provides the conceptual framework for the examination of safety culture and safety climate in the following chapters. It deals with some current perspectives used in research on organisations, their culture and climate, which have influenced safety specific research.

2.1 ORGANISATIONS

Hatch (1997) suggests that organisations can be defined in many different ways, including, as social structures, technologies, physical structures, or even parts of an environment. More specifically, organisations have been defined as collections of people in a formal association in order to achieve certain goals; they are described in terms of their output and the means by which that output is achieved (Dawson, 1992). Similarly Robey (1991) has described organisations as a system of roles and stream of activities designed to accomplish shared purposes where the system of roles denotes the organisation's structure and the stream of activities refers to organisational processes. The shared purposes and goals of the organisation do not, however, remain unchanged. Goals are likely to change as the distribution of power amongst various interest groups, such as trade unions and consumer groups, shifts (Robey, 1991).

The above definitions reflect accepted perspectives which hold that organisations comprise (a) a collection of individuals and (b) political systems, joined together by power and influence (Handy, 1981). In this context these individuals have separate personalities, needs and ways of adapting. The socio-political systems have defined boundaries, goals, values, administrative systems and power hierarchies. The power and influence exerted by these systems usually takes the form of ensuring compliance through remuneration and fringe benefit inducements (Etzioni, 1961). Organisations thus control their members' behaviour by rewarding desirable actions and formalising this into a control system (Robey, 1991). The focus on social and political systems and processes within an organisation has parallels with the anthropological study of these systems in societies. In recent research this focus has become synonymous with the study of the culture of the organisation (Brown, 1995) comparable with the study of the culture of societies.

2.2 CONCEPT OF CULTURE

Culture as a concept derives from the fields of social anthropology and sociology. In general its description has come to characterise an organisation or group of individuals within a social structure. Culture is, however, not a well defined concept (Münch and Smelster, 1992); it describes roles and interactions that derive from norms and values in the sociological tradition, or from beliefs and attitudes in the social psychological field (Wunthow and Witten, 1988). In addition to these distinctions, there are at least two major approaches to the study of culture. The first views culture as an implicit feature of social life, and the second holds culture to be an explicit social construction (Wunthow and Witten, 1988), in other words culture as the structure of a socio-political group or culture as a product of that group.

In the same vein, two models of culture have been proposed: that which defines culture in terms of behaviour (or product) and that which defines it in terms of meaning (or structure). Rohner (1984) states that:

> "there are, for example, those who view culture as being behavior; the regularly occurring, organised modes of behavior in technological, economic, religious, political, familial and other institutional domains within a population. In contrast to the various 'behavioral' models of culture are a group of theorists who hold that culture is a symbol system, an ideational system, a rule system, a cognitive system, or, in short, a system of meanings in the heads of multiple individuals within a population." (pg 113)

The second of these models is supported by Trice and Beyer's (1984) assertion that culture is a system of publicly and collectively accepted meanings operating for a given group at a given time.

Such views of culture have been incorporated into organisational theory to give rise to the concepts of organisational culture (Brown, 1995) and the somewhat similar corporate culture (Peters and Waterman, 1982). Furthermore, it has been suggested (Shipley, 1990) that culture is central to the understanding of, control of and resistance to change in society, organisations and social groups. Researchers and practitioners have attached growing importance to this culture concept in the study and management of organisations (Brown, 1995). It is becoming more important, therefore, to examine the term 'organisational culture', and the closely related concept of 'organisational climate'.

2.3 ORGANISATIONAL CULTURE

As noted earlier, the study of culture has been influential in the field of organisational studies for over 20 years (Denison, 1996; Trompenaars and Hampton-Turner, 1997). Its importance stems, in part, from the notion that it provides a dynamic and interactive model of organising (Jelinek et al., 1983; Smircich, 1983) and as such can help explain how organisational environments might be characterised, assessed and ultimately controlled (Deal and Kennedy, 1982; Schneider, 1990). Furthermore, a number of authors have proposed that successful organisations have a strong or positive corporate culture (Deal and Kennedy, 1982; Kilmann et al., 1985; Peters and Waterman, 1982; Weick, 1985). The notion of culture can, therefore, provide a practical way of explaining how and why particular organisations enjoy differing levels of success (Brown, 1995; Trompenaars and

Hampton-Turner, 1997). The study of excellent companies by Peters and Waterman (1982) lends weight to this notion:

> "Without exception, the dominance and coherence of culture proved to be an essential quality of the excellent companies. Moreover the stronger the culture and the more it was directed towards the marketplace, the less the need there was for policy manuals, organization charts or detailed procedures and rules" (pg 75)

A number of definitions of culture have been proposed and it is possible to discern a number of common themes among these. Moorhead and Griffin (1992) suggest that organisational culture is a set of values that help people in an organisation to understand which actions are considered acceptable and which are unacceptable. Similarly, Schein (1985) has defined organisational culture in terms of employees shared values and perceptions of the organisation, beliefs about it, and common ways of solving problems within the organisation. Schein (1985) has also described organisational culture in terms of an ongoing process through which an organisation's behaviour patterns become transformed over time, installed in new recruits, and refined and adapted in response to both internal and external changes. Culture helps an organisation's members to interpret and accept their world, and so it is not so much a by-product of an organisation as an integral part of it which influences individuals' behaviours and contributes to the effectiveness of the organisation.

In a review of the concept of organisational culture Rousseau (1990) found that various authors have defined culture as:

- A set of common understandings, expressed in language (Becker and Geer, 1970).
- Transmitted patterns of values, ideas and other symbolic systems that shape behaviour (Kroeber and Kluckhohn, 1952).
- As having three aspects (1) some content (meaning and interpretation) (2) peculiar to (3) a group (Louis, 1983).

- The glue that holds together an organisation through shared patterns of meaning. Three component system: context or core values, forms and strategies to reinforce content (Martin and Siehl, 1983).
- Set of symbols, ceremonies and myths that communicate the underlying values and beliefs of the organisation to its employees (Ouchi, 1981).
- Pattern of beliefs and expectations shared by members that produce norms shaping behaviour (Swartz and Jordon, 1980).
- Shared values and beliefs that interact with an organisation's structures and control systems to produce behavioural norms (Uttal, 1983).
- Values, beliefs and expectations that members come to share (Van Maanen and Schein, 1979).

While it is apparent from the literature that there have been a number of disagreements over the nature of organisational culture, the above definitions do bear some resemblance to each other. Several salient points emerge upon comparing these definitions. Emphasis, in many cases, is on values, beliefs and expectations that are shared within the group and/or organisation, and which, in turn, can help the members make sense of their environment. Rousseau (1990) agrees that it is not really the definitions of organisational culture that vary widely but the approaches to data collection and operation (see later). Pettigrew (1990) offers one explanation of the problem in defining organisational culture. He suggests that it is, in part, due to the fact that culture is:

> "... not just a concept but the source of a family of concepts (Petigrew, 1979), and it is not just a family of concepts but also a frame of reference or root metaphor for organisational analysis" (pg 414).

Pettigrew's explanation reflects two very different understandings of the concept of organisational culture. A fundamental distinction can be made between those who think that culture is a metaphor which helps understand organisations in terms of other entities (Morgan, 1986), and those who see culture as an objective entity that distinguishes one organisation from another (Gold, 1982). The view that culture is an objective entity can be sub-divided, as pointed out by Rohner (1984), into something an organisation is (or its structure and meaning) or something and organisation has (for example, its behaviour) as embodied by most of the definitions summarised by Rousseau (1990) and detailed above. Figure 2.1, adapted from Brown (1995), represents the relationships between these positions in an attempt to clarify some of the issues.

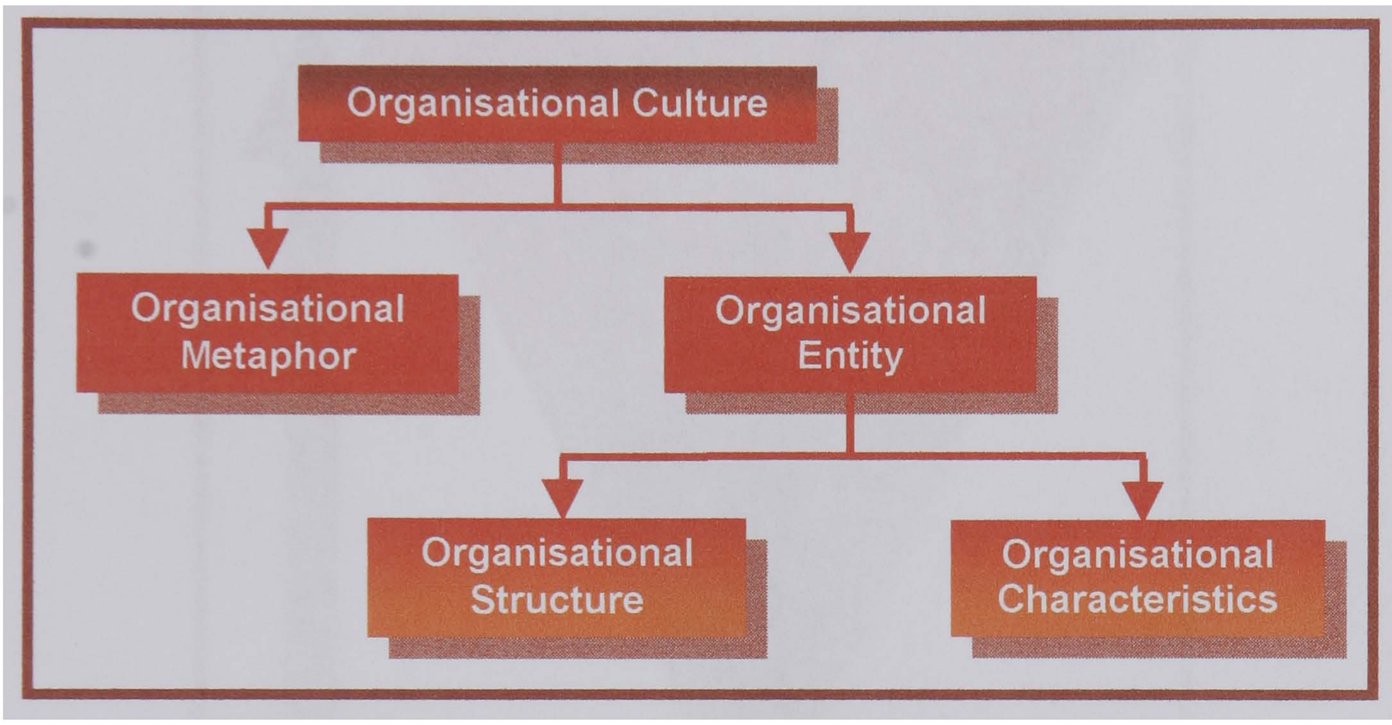

Figure 2.1
Map of culture definitions (adapted from Brown, 1995)

2.3.1 Layers of Organisational Culture

It may be that the use of culture as a concept can be seen to be too embracing, and some writers (Morgan, 1986; Rousseau, 1990; Schein, 1985) describe culture as having a series of different layers. Schein (1985) suggests that there are three levels of culture: artefacts, values and basic assumptions. Figure 2.2 shows a representation of how Rousseau (1990) describes these layers of culture, organised from readily accessible, and, therefore, more easily studied, to difficult to access.

At the most accessible level are visible artefacts, or products of cultural activity. Next are patterns of behaviour (Cooke and Rousseau, 1988), or the structures that reflect patterns of activity. Both of these layers are observable to those outside the culture. The third layer relates to group behavioural norms, or beliefs about what is acceptable and unacceptable behaviour within the organisation, similar to Moorhead and Griffin's (1992) definition of culture. Values and priorities assigned to organisational outcomes are found on the next layer. The third and fourth layers can be learned about through interaction with, and questioning of group members. Patterns of unconscious assumptions (Schein, 1984) are the deepest of the layers of culture, and these may not be directly known by the organisations members and therefore require a period of intensive interaction to uncover.

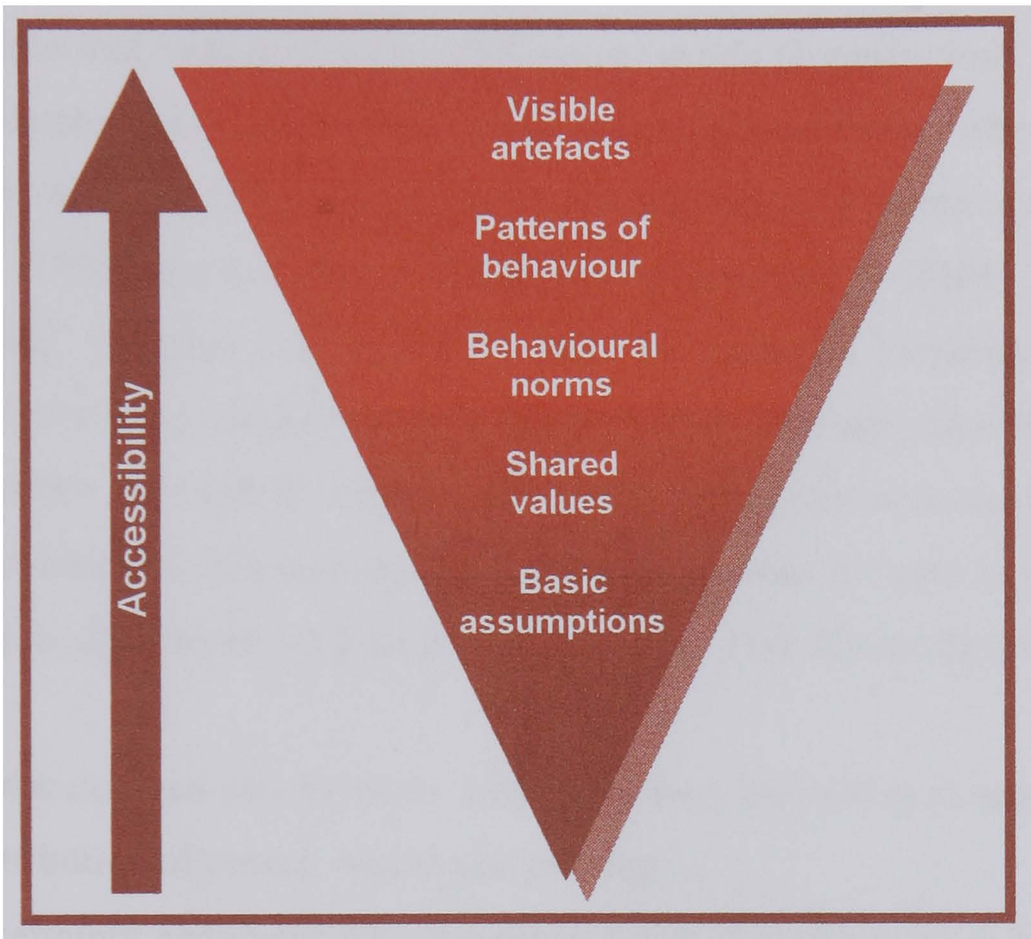

Figure 2.2
Layers of organisational culture (Source: Rousseau, 1990)

This type of representation of cultural layers has been further embellished, to present a more complex picture. Hatch (1993) has adapted Schein's (1985) original layers model to incorporate organisational symbols and processes in a more dynamic model. Similarly Hofstede, et al. (1990) have divided the manifestations (or more accessible elements) of culture into values, at the deepest level, through rituals and heroes to symbols at the shallowest.

Cooper and Bright (1993) suggest that identifying different levels of culture is an important step in understanding how culture may be managed and influenced. Once the layers have been established in an organisation then the more visible elements, for example poor communications, can be improved by focusing on the deeper elements, for example the assumption that no one attends to corporate messages. While strategies such as this would address a wide range of levels, Huse and Cummings (1989) have noted that advocates of cultural change programmes tend to focus only on the more accessible surface level elements, whereas those who argue culture change is difficult concentrate on the deeper levels.

2.3.2 Societal and National Culture Differences within Organisations

The consideration of organisational culture is complicated further when the effects of societal and national cultures upon individual organisations' cultures are considered. Hofstede (1980) studied these influences in relation to IBM, the American multinational company, operating in over 40 countries worldwide. Hofstede collected survey data concerning work-related values from international affiliates and found evidence of national cultural differences within the organisation. Hofstede (1991) demonstrated that managers in different countries differed in the strength of their attitudes and values regarding various issues. Five dimensions were identified including:

- power distance (the extent to which members are willing to accept an unequal distribution of power, wealth and privilege);
- uncertainty avoidance (the manner in which individuals have learned to cope with uncertainty);
- individualism (the degree to which individuals are required to act independently of others);
- masculinity (related to the clear separatism of gender roles in society); and
- confucion dynamism (the degree to which long-termism or short-termism is the dominant orientation in life).

In summary, the results of this work suggest that organisations in the UK will have low power distance, be highly individualist, masculine, able to cope with uncertainty and short-termist. By contrast organisations in France and Spain will enforce greater distance between employees and managers and Scandinavian organisations will tend to accept the blurring of gender roles. Hofstede's work is not only deemed to be important for the identification of specific cultural differences (Hatch, 1997) but it has also showed that organisational culture is an entry point for societal influence on organisations. This notion has been developed further in the work of Fons Trompenaars (Trompenaars and Hampton-Turner, 1977). It further illustrates the complexity of culture and benefit of systems approaches.

2.3.3 Culture in terms of Organisational Systems Theory

In addition to being layered, culture may also have different effects at different levels in the organisation. Sub-cultures might develop (Trice and Beyer, 1993) which can be associated with different roles, functions and levels in the organisation (Hampden-Turner, 1990). Schein (1999) agrees that cultures are found at every level of an organisation, as well as at the level of the organisation as a whole, but further and suggests that cultures might exist at the level of a whole industry. There may also be differences in manifest culture between management and staff levels (Furnham and Gunter, 1993) and these differences should be consistent with the organisation's hierarchy (Deal and Kennedy, 1982). The status differences created by these hierarchies provide a basis for the formation of subcultures (Trice and Beyer, 1993). It may be useful, given the multiple layers and potential sub-cultures, to consider culture in terms of a complex system.

In terms of systems theory, organisational culture can be treated as an emergent property of the organisation as a social system (Cox and Cox, 1996). Cox and Cox (1996) propose that:

> "culture is a property of the whole system, a reflection of the interaction between its individual components and processes. It is a reflection of the state and function of those individual components and processes, and their interactions and it influences them, but it is not located in any single or particular component, process, or interaction. It is a gestalt: it resides in the sum of its parts and not in any one of them." (pg 116)

Any system can be deconstructed into its component sub-systems and many, if not all of them, might be treated as systems in their own right. Thus each sub-system has the potential for a culture, and just as these systems and sub-systems may be hierarchically arranged and reflect different organisational structures and functions, so might their associated cultures and sub-cultures. Adams and Ingersoll (1989) have proposed that the best way to conceive of organisational culture is in terms of its constituent sub-cultures. Indeed organisations have been described as umbrellas for diffuse collections of sub-cultures, which may or may not cohere harmoniously (Martin et al., 1985). It has also been argued that these organisational cultures and sub-cultures are nested (Pidgeon, 1991) and overlapping, being mutually influential across, and between, levels and groups.

2.3.4 Organisational Culture Summary

It is clear from the literature examined above that some progress has been made in agreeing objective definitions of organisational culture. Many researchers agree that organisational culture involves beliefs and values, exists at a variety of different levels and which manifests itself in a wide range of artefacts, symbols and processes within any particular organisation. Culture helps an organisation's members to interpret meaning and understand their working environment. It is an integral part of an organisation and as such can influence individuals' behaviour and potentially contribute to the effectiveness or ineffectiveness of the organisation.

The concept of organisational climate focuses on similar aspects of the social psychological environment (Denison, 1996). Indeed much discussion of the concept and study of organisational culture is related to that of organisational climate.

2.4 ORGANISATIONAL CLIMATE

In any attempt to understand the nature of organisational culture it is also important to establish the nature of climate. Climate in organisations can be viewed as a collective subjective construct in which there are multiple subsystem climates that can be referenced to criteria such as structure, effectiveness, and safety (discussed in the next chapter), and can be analysed across levels over time (Falcione et al., 1987). Climate has been held to be the individual descriptions of the social setting or context of which the person is part. Tagiuri (1968) defined climate as

> "the relatively enduring quality of the total (organisational) environment that (a) is experienced by the occupants, (b) influences further behaviour and (c) can be described in terms of the values of a particular set of characteristics (or attributes) of that environment". (pg 25)

Investigations into organisational climate pre-date organisational cultural studies by at least a decade and some of the current interest in cultural perspectives of organisations is a result of the earlier research focus on climate (Brown, 1995).

The earliest reference to the concept of climate occurs in Lewin et al.'s (1939) study of experimentally created social climates in boys groups (Lewin, 1951; Lewin et al, 1939), and was developed later in observations of natural organisational settings (Barker, 1965; Likert, 1961). Since its use by Argyris (1958) and Forehand and Gilmer (1964) to characterise employee perceptions of their organisations, climate has become a central concept of organisational research (Rousseau, 1988). Early approaches ranged from considering climate as an objective set of organisational conditions to the subjective interpretation of organisational characteristics. Litwin and Stringer (1968) focused their work on the consequences of organisational climate for individual motivation, thus supporting the general idea that climate encompasses both organisational conditions and individual reactions, or manifest and latent aspects similar, in some respects, to the layers of culture described above. In this vein, Guion (1973) compared organisational climate to the wind chill index, in that it involved the subjective perception of the joint effects of two objective characteristics, temperature and wind speed. This reasoning was used to argue that research on organisational climate would require the measurement of both objective organisational conditions and the individual perceptions of those conditions. The issue of whether climate is a shared perception, a shared set of conditions, or a combination of both has remained a topic of debate in the climate literature to this day (Denison, 1996) and is reminiscent of the structure/product debate in the study of culture (see Section 2.2).

Moran and Volkwein (1992) have incorporated previous definitions of climate and proposed that it is:

> "a relatively enduring characteristic of an organization which distinguishes it from other organizations: and (a) embodies members collective perceptions about their organization with respect to such dimensions as autonomy, trust, cohesiveness, support, recognition, innovation, and fairness; (b) is produced by member interaction;

(c) serves as a basis for interpreting the situation; (d) reflects the prevalent norms values and attitudes of the organization's culture; and (e) acts as a source of influence for shaping behavior." (pg 20)

The above definition makes reference to organisational culture and the similarities between the two concepts do not stop at parallels in the structure/product discussion.

2.4.1 Culture versus Climate

Many authors have addressed the relationship between culture and climate. Denison (1996) has written:

"On the surface, the distinction between organizational climate and organizational culture may appear to be quite clear. Climate refers to a situation and its link to thoughts, feelings and behaviours of organisational members. Thus, it is temporal, subjective and often subject to direct manipulation by people with power and influence. Culture, in contrast refers to an evolved context (within which a situation may be embedded). Thus it is rooted in history, collectively held, and sufficiently complex to resist many attempts at direct manipulation."(pg 644)

Glick (1985) has attempted to clarify the differences between the two concepts. He suggests that one thing that distinguishes culture from climate is that:

"climate research tends to be nomothetic, using quantitative techniques to describe phenomena at a given time from an external perspective. Culture research, however, is primarily idiographic, employing qualitative techniques to explain dynamic processes" (pg 612)

Denison (1996) agrees that the research methods used by the earlier researchers could help distinguish most culture and climate studies. Studying culture required qualitative research methods and an appreciation for the unique aspects of individual social settings. Studying organisational climate, in contrast, required quantitative methods. The differences between approaches are presented in Table 2.1. (adapted from Denison, 1996). As can be seen from Table 2.1, a culture study would have been concerned with uncovering unit values and beliefs through on-going observations of the individual in their group. Climate research, on the other hand, would have been characterised by surveys of members attitudes about their organisation.

Table 2.1
Differences of focus in early culture and climate studies (Denison, 1996).

Difference	Cultural Studies	Climate Studies
Epistimology and Focus	Contextualised and idiographic	Comparative and nomothetic
Methodology	Qualitative utilising field observation studies	Quantitative utilising survey data
Level of analysis	Underpinning values, beliefs and assumptions	Surface –level manifestations
Time-frame	Historical evolution	Snapshot in time
Theoretical Foundations	Social construction, critical theory	Lewinian Field Theory, person/situation interaction

Despite their distinct evolution, culture and climate are now often used as interchangeable terms (Cox and Flin, 1998; Denison, 1996). However, distinctions can still be made between these concepts. Ashforth (1985) distinguishes between the shared assumptions of culture and the shared perceptions of climate and argues that culture informs climate by helping group members to define what is important. Reichers and Schneider (1990) suggest that culture and climate both deal with the ways by which members of an organisation make sense of their environment, and that both are learned through socialisation and interaction. However culture exists at a higher level and relates to longer term and overarching policies and goals, whereas climate has been more generally described as 'the way we do things around here ' (Furnham, 1997). Thus, measures of climate generally focus on individual or 'group' perceptions of the prevailing organisational structures and culture measures generally focus on the patterns of values and beliefs that lead to the emergence of these structures (Cooke and Szumal, 1983). A further distinction is offered by Hofestede et al. (1990) who see climate as describing shorter-term characteristics of the organisation which indicate how it treats its members. Culture, on the other hand, reflects longer-term characteristics which describe the types of people that the organisation employs.

Researchers in the field have proposed various connections between culture and climate as described above. At the very least the two constructs are complementary

(Schneider, 1987), at most they provide different interpretations of the same phenomenon (Denison, 1996). For the purposes of this research, climate has been viewed as a 'mood' indicator, which may be reflected in the perceptions of organisational policies at a discrete point in time (Cox and Flin, 1998). This is in line with Schein's (1985) view that climate can most accurately be understood as a manifestation of culture. In this way a 'positive' culture will be promoted and maintained by a 'positive' climate and vice versa. Culture and climate can be viewed as reciprocal processes in a cyclic relationship.

This relationship is echoed by Moran and Volkwein (1992) who agree that climate and culture are related in two respects. First, they overlap one another as components of the socially constructed dimensions of organisations. Climate exhibits behavioural and attitudinal characteristics of participants while culture represents a more implicit feature of organisations. The second way in which climate and culture are related is through the influence that the core, values, and meanings embodying the organisation's culture have in determining the attitudes and practices that comprise the organisation's climate.

2.5 ATTITUDES

The relationship between culture and climate proposed by Moran and Volkwein (1992) highlights the role of attitudes in organisational climate. Other authors also underline the role played by individuals' attitudes. For example, Brown (1995) suggests that, within an organisational culture, attitudes manifest the central values and beliefs component of culture. Similarly, Glendon and McKenna (1995) argue that attitudes are relevant because they are a component of behaviour, which is, in turn, an important feature of overall culture.

Allport (1935) provided an early definition of attitudes:

> "An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related." (pg 810)

Fishbein and Ajzen (1974) have elaborated that attitudes are learned, involve a tendency to act and are consistent and specific to particular stimuli. From this extrapolation it can be seen how attitudes might reflect shared values and beliefs learned through interaction with the organisation, and that they might influence behaviour.

Attitudes are commonly considered to have three components (Rosenberg and Hovland, 1960) and these have been termed as the ABCs of attitudes (Rajecki, 1990) referring to their affective, behavioural and cognitive aspects. The affective component is concerned with feelings and emotions. It is essentially the evaluative element in an attitude, on the basis of which the attitude holder judges the object (Rajecki, 1990). The cognitive component refers to the thinking aspect of an attitude. Cognitions are what inform their holder about the functions, implications and consequences of the object of the attitude. This component is subject to a wide range of influences from various sources of information (Glendon and McKenna, 1995). The affective and cognitive components are held to be relatively consistent in that both affect changes when cognition changes (Rajecki, 1990) and cognition changes as a result of affective reaction (Niedenthal and Cantor, 1986). It is their relationship with the behavioural component which has the greatest potential for the attitude concept (Glendon and McKenna, 1995). The behavioural component particularly describes the intention to act and Fishbein and Ajzen (1974) have proposed that it mediates overt behaviour and is influenced, not only by an individual's attitude and perceived control, but also by subjective norms derived from immediate social groups (Ajzen, 1991). This component can involve a consideration of past behaviour towards the attitude object or even imagining future behaviour relating to an attitude.

The three component description of attitude adds further weight to the suggestion that attitudes can be indicative of culture and climate. For example shared values and basic assumptions can influence the affective and cognitive aspects, while the cultural behavioural norms and organisational practices could influence the behavioural intention component. In this way attitudes can be seen as on a similar level in the culture hierarchy (Rousseau, 1990) as visible artefacts, or climate, outlined in Figure 2.2. The nature of the links between attitude and overt behaviour (another layer of culture represented in Figure 2.2) is not, however, clearly established.

2.5.1 Attitudes and Behaviour

The application of the tripartite model to attitude change, and potentially behaviour change, has been described as the 'winning of hearts and minds' (Cox and Cox, 1996) where both emotions (hearts) and cognitions (minds) should be targeted if behavioural intention is to be altered. Several inconsistencies in the relationships between attitude and behaviour have, however, arisen since Allport's (1935) assertion that attitude exerts "a direct or dynamic influence upon the individual's response". In fact measured attitudes often fail to predict, or provide only weak evidence of, relevant behaviour (Wicker, 1969). Some of this inconsistency can be explained by researchers trying to predict single actions by asking about global attitudes and vice versa (Ajzen, 1982); the attitude measure should be tailored to the behaviour in question.

Other explanations have been offered in terms of an individual-situation interaction impact in the attitude/behaviour relationship (Cox and Cox, 1996; Rajecki, 1990). Snyder and Kendzierski (1982) suggest that, before an attitude can guide behaviour it has to be available to the individual (that is the individual has to be aware of the attitude) and relevant to the situation in question. Similarly, Ajzen's (1991) theory of planned behaviour proposes that intentions to act are not only influenced by attitudes but also by social and/or organisational norms, and perceived control. Despite the debates regarding the exact nature of attitude behaviour consistency, it does appear that there is a relationship, either direct or indirect. This gives further weight to the utility of attitudes as component of climate and indicator of culture.

2.5.2 Attitudes, Climate and Culture

In terms of summary of the relationship between the three concepts, attitudes can be considered a component of climate (Moran and Volkwein, 1992) which, in turn, is a manifestation of culture (Schein, 1995). This relationship (illustrated in Figure 2.3) has been detailed further by Kopelman et al (1990), in terms of human resource practices, to include organisational productivity, the final output of these relationships. In their linear model, Kopelman et al (1990) suggest that societal and organisational culture impact on management practices. These practices, in turn, influence organisational climate, which affects cognitive and affective states, behaviour and ultimately productivity.

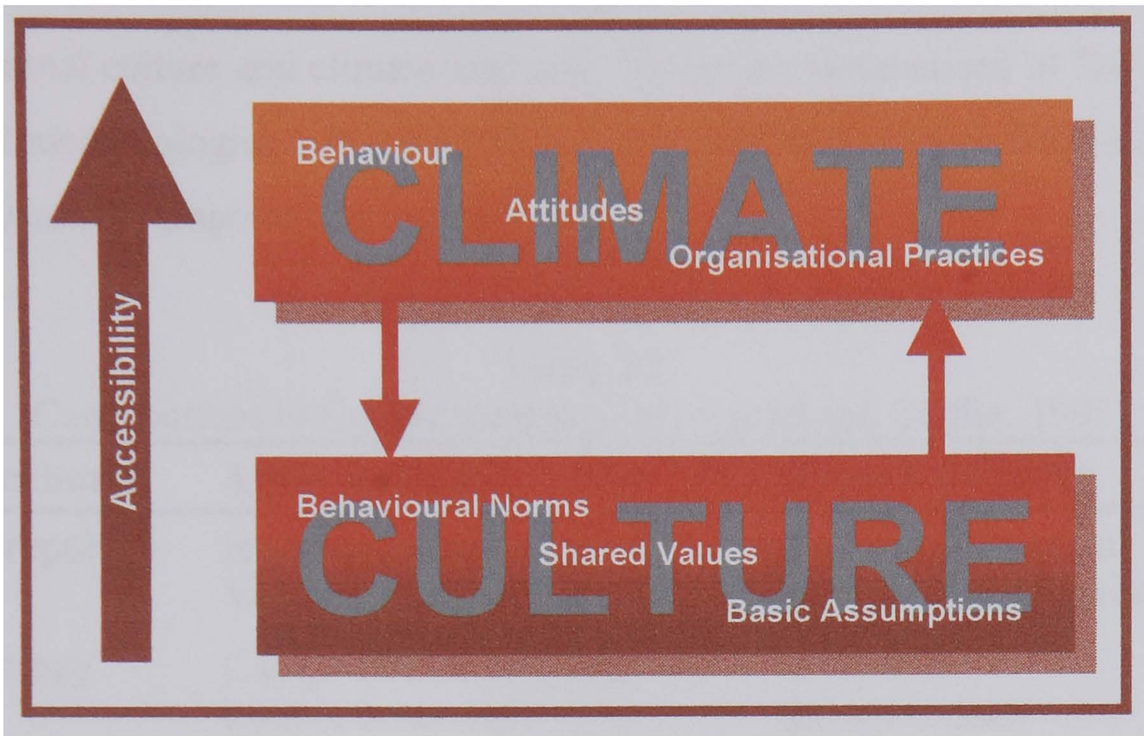

Figure 2.3
Culture, climate and their components

The accessibility of attitudes and perceptions, and related behaviours, often makes them the focus of culture and climate assessment (Rousseau, 1988).

2.6 ASSESSING ORGANISATIONAL CULTURE

Meyerson (1991) has noted that

> " culture was the code word for the subjective side of organisational life ..... its study represented an ontological rebellion against the dominant functionalist or 'scientific' paradigm" (pg 256)

In other words organisational culture research came about in part as a reaction to the existing orthodoxy in the study of organisations, and their characterisation, to some extent, as machine-like entities (Brown, 1995). This reaction also resulted from the growing influence of postmodernism within the Social Sciences, advocates of which often charged positivist social science with placing too much emphasis on quantitative approaches (Parker, 1992). Such an approach discounted any attempt to systemise organisational studies and develop a universal set of dimensions that would allow for comparative evaluations.

Nevertheless, both quantitative and qualitative methods persist in the study of organisational culture (Rousseau, 1990; Brown, 1995). Moorhead and Griffin (1992) trace these differences back to the historical foundations, or antecedents, of current organisational culture and climate research. These are summarised in Table 2.2 and consist of methodologies influenced by economics as well as those from psychology, sociology and anthropology introduced earlier.

Table 2.2

Contributions to Culture Analysis (Moorhead and Griffin, 1992)

Contributor	Areas of Study	Methods of Study
Anthropology	Human cultures Values and beliefs of society	Detailed description Interviews and observations
Sociology	Categorisation of social system structures	Interviews Questionnaires Statistics
Psychology	Creation and manipulation of symbols Use of stories	Surveys Observations Statistics
Economics	Economic conditions of a company or society	Statistics Mathematical modelling

Rousseau (1990) argues that recent debates over organisational research methods are the result of the resurgence of qualitative methodologies, originally based in anthropology and sociology, and the perceived shortcoming of quantitative approaches. Smircich (1983), however, proposes that standardised measures of culture cannot describe a culture, which is essentially a frame of reference. Similarly, Schien (1984) suggests that, since each organisation is unique, it is difficult for an outside researcher to form a priori questions or measures to tap into its culture. Furthermore, Schein (1984) asserts that the use of such quantitative methods is unethical in its use of aggregated data and not the participants' own words. Given the definitions of culture discussed earlier, it is important for quantitative organisational culture research to address these criticisms.

In addition to alternative research strategies and data collection methods, Pettigrew (1979; 1990) has identified seven analytical issues, related to the complexity of the concept, that make the study of culture difficult. These are:

- Levels - Organisational culture exists at different levels in the organisation (Schein, 1985).
- Pervasiveness - Culture has breadth encompassing everything about organisation.
- Implicitness - Much of organisational culture is taken for granted.
- Imprinting - Takes into account the history.
- Political - Organisational politics can be difficult to comprehend.
- Plurality - Several apparently different cultures may co-exist.
- Interdependency - Culture is connected with the organisational system, sub-systems and the external environment.

These issues, together with varying data collection and research strategies, would seem to make a comprehensive study of organisational culture almost impossible. Rousseau (1990) suggests that different approaches and strategies may suit the investigation of different levels and aspects of culture. Few empirical researchers claim to uncover everything about an organisation's culture in their investigations; they mainly focus on one or two of the elements discussed above, or the more accessible manifestations such as climate.

2.6.1 Culture Studies

Despite the complex multi-dimensional and multi-level nature of the construct many attempts have been made to assess and characterise culture, usually based on an evaluation of its 'surface' or manifest elements and using a variety of methods including interview schedules and questionnaires (see Table 2.2). These types of study have focused on behavioural norms (Cooke and Lafferty, 1989, Kilman and Saxton, 1983), on organisational values and processes (Enz, 1986; Gordon and DiTomaso, 1992; Hofstede, et al., 1990; O'Reilly et al., 1991; Sashkin and Fumer, 1985) and on individual perceptions or climate (Allen and Dyer, 1980; Glaser et al., 1987). Three such instruments, one examining behavioural norms, one values and the other climate, are described below.

The *Organizational Culture Inventory* (Cooke and Lafferty, 1984; 1989) assesses behavioural norms that facilitate individuals fitting into the organisation and meeting the expectations of colleagues. It uses a circumplex of twelve scales based on two dimensions: task/people and security/satisfaction. The task/people dimension refers to the extent to which there is focus on the work in hand or the individual. The security/satisfaction dimension refers to the extent to which individuals are encouraged to avoid conflict and protect themselves, or to innovate and take risks. Assessment is based on individual completion of the inventory items on a 5 point Likert scale and results are aggregated to group or organisational level. This self report instrument attempts to tap into the behavioural norms level of culture described above by asking individuals to characterise their own behaviours. Significant relationships have been found between the Organizational Culture Inventory and job satisfaction, person-job fit and propensity to leave.

The *Organizational Culture Profile* (O'Reilly et al., 1991), on the other hand, assesses values and makes an attempt to measure to what extent they are shared. Individuals are asked to sort 54 items relating to what is important, how to behave and what attitudes are important in their organisation. This is done via a Q-sort technique (Block, 1978) where each of the items is placed in a one of nine categories from most to least characteristic. Individual descriptions of the organisation are obtained as well as person-organisation fit, assessed by comparing individual preference scores with aggregated organisational scores. This and similar instruments (Ryan and Schmit, 1996) have been used to assess levels of agreement amongst organisations' members. Results using this instrument have also been related to job satisfaction, commitment to the organisation and incentive to stay with the company.

The *Organizational Culture Survey* (Glaser, 1983; Glaser et al., 1987) measures culture through a climate survey of 31 attitude statements using a five-point response scale. These items are arranged into five sub-scales; climate/atmosphere, involvement, communication, supervision and meetings. Responses are aggregated to group level (Glaser et al., 1987) and the sub-scales are used to measure differences between organisational levels. Glaser et al. (1987) found that patterns of differences between levels in an organisation, exposed using the *Organizational Culture Survey*, were confirmed by interview data. In this study managers were found to have more positive views on all of the sub-scales, except meetings, than supervisors or ordinary shopfloor workers.

Many similar dimensions appear on several culture and climate assessment instruments, suggesting that values and behaviours can be expressed, and in turn assessed, in similar terms (Rousseau, 1990). Furthermore, Xeniko and Furnham (1996) found significant correlations between four instruments and went on to suggest a six factor model based on the work of Cooke and Lafferty (1989), Glaser (1983), Kilman and Saxton (1983) and Sashkin and Fulmer (1985). The factors uncovered related to:

- openness to change;
- values of excellent organisations;
- bureaucratic culture;
- organisational artefacts;
- resistance to new ideas and
- workplace social relations.

Not surprisingly, these factors relate, almost exclusively to the more accessible layers of culture outlined in Figure 2.1.

Cultural assessment aimed at behaviours, values and norms, such as those discussed above, have been used to test the assumption that culture can impact on organisational effectiveness (Peters and Waterman, 1982). Several researchers have sought to define and assess the link between culture and various organisational outcomes, often in the hope of identifying or nurturing the 'best' culture associated with those outcomes, although Rousseau (1990) argues that there has been little systematic research in this area. One example of theoretical links being drawn between culture and outcome measures is given by the role for organisational culture and climate in productivity modelled by Kopelman and colleagues (1990) (described in Section 2.5.2 above). Their model is based on the influence of human resource management on productivity and individual satisfaction and motivation and illustrates how culture, management practices and climate can influence the outcome measure. Similarly, Bright and Cooper (1993) have proposed that quality management and organisational culture are closely aligned, with overall culture change being central to the development of quality management systems and essential to their functioning, although no empirical data is presented.

The domain of financial performance provides an example of an area where systematic research has been conducted. Both qualitative (Ouchi and Johnson, 1978; Peters and Waterman, 1982) and quantitative (Denison, 1984; Gordon, 1985; Gordon and DiTomaso; 1992) measurements of organisational culture have been linked to levels of financial performance. These studies can be criticised in terms of the financial measures taken, the sample size and to an extent the way in which culture was characterised, in one case by the researchers themselves (Peters and Waterman, 1982). On the whole, however, these studies produce results which support the assertion that a strong culture is associated with enhanced financial performance. Furthermore, Gordon and DiTomaso (1992) suggest that the appropriate culture for achieving results in the insurance organisations they examined may not be best described only as 'strong' in terms of consistency, but also as flexible. The organisational culture related to effectiveness may best, therefore, be conceived as a combination of several characteristics, which facilitate enhanced performance.

Petty and colleagues (1995) have attempted to link the assessment of organisational culture with broader performance measures. Their assessment of performance incorporated evaluations of operations, customer accounting, support services, marketing and employee health and safety into one overall performance measure. This study found evidence of associations between the measures of performance and organisational culture, with the strongest indication of the link being evident in the correlations between 'teamwork' and performance. They conclude that a culture that fosters co-operation may be the most effective in the organisations included in their study. While Petty, et al. (1995) included health and safety in their evaluation of overall performance, the nature of links between organisational culture and climate and safety performance in particular have also been investigated in some detail. These are discussed in the next chapter.

2.7 *SUMMARY*

In summary, organisational culture can be described as:

- a phenomenon that involves beliefs, values and behaviours, exists at a variety of different levels and which manifests itself in a wide range of artefacts within any particular organisation;
- a description of organisational environments, which facilitate their comprehension, interpretation, acceptance and control, and may help explain their success in terms of performance;
- difficult to assess directly, given the varying data collection methods and the multi-level nature of the construct; and
- closely related to the concept of organisational climate, which can be described as a manifestation of organisational culture, and assessed through the examination of attitudes.

The concepts of organisational culture and climate have provided the basis for many of the definitions and measures proposed for safety culture and climate (Cox and Flin, 1998). Each of the main points of this chapter, therefore, form the basis for the more detailed examination of safety culture and climate in the next chapter.

CHAPTER THREE

Safety Culture and Climate

The previous chapter provided a summary of current theories and conceptualisations of organisational culture and related climate. The aim of this chapter is to extend these concepts to those of safety culture and safety management, examine their use to date, and provide the context for the research described in this thesis. The chapter develops the research question and ends with the formulation of the hypotheses.

3.1 BACKGROUND

Just as the concept of organisational culture is important in theories of organisations, the more particular concept of safety culture is equally important for the understanding of occupational health and safety management. Ostrom et al. (1993) suggest that an organisation can determine how to focus safety management efforts by assessing its safety culture. Until relatively recently, however, very little work had been carried out on the effects of culture on the normal operation of complex technologies and was limited to its role in the context of technical disasters (Rochlin and von Meyer, 1994). Accidents such as that at Chernobyl (Ballard, 1988) have been attributed, in part, to the 'safety culture' of the organisation. After this incident a UK government minister allayed fears that a similar accident could befall the new pressurised water nuclear reactor at Sizewell in Essex (UK), because the nuclear industry in the UK had a 'superior safety culture' (Ministerial Statement, 1987, p.36). Since the Chernobyl disaster, the development of a positive or 'appropriate' safety culture has been seen within the working environment in general, and the nuclear industry in particular, as an important human factors requirement (Broadbent, 1989).

The concept of a safety culture has also surfaced in other inquiries and analyses of safety failures and related disasters, including the Clapham Junction rail disaster in London. The public inquiry into that disaster found a poor safety culture within British Rail to be an important determinant of that accident (Hidden, 1989) and is still popularly believed to be an important feature of subsequent rail accidents, such as the train collision at Ladbrook Grove in late 1999. Lord Cullen (1991) also recognised the importance of safety culture in the report on the Piper Alpha disaster in the North Sea:

> "It is essential to create a corporate atmosphere or culture in which safety is understood to be, and is accepted as, the number one priority" (pg 300)

Interest in safety culture has grown in response to a realisation that technical and systems solutions to safety problems were limited in achieving improvements in safety performance (Cox and Cox, 1996). Many authors have also noted the inadequacy of relying on one particular variable in, for example 'carelessness' in the analysis of incident and accident data without accounting for the social, economic and cultural context in which accidents occur (Nichols, 1975). In relation to this, Leather (1987) argues for a scheme of understanding, which takes the interrelation of job, individual, and organisation into account in the analysis of safety performance. The Health and Safety Executive (HSE) have also acknowledged the importance of an appropriate safety culture in the quest for improvements, in the foreword to the Process Guidelines of their Health and Safety Climate Survey Tool (HSE, 1997):

> "Developing a positive health and safety culture is important if high standards of health and safety are to be achieved and maintained. There is a limit to the health and safety performance an organisation can achieve without addressing the contribution which human factors have to play in eliminating occupational accidents and ill health." (Eves, November, 1997)

However, it has been suggested (Cox and Flin, 1998) that, perhaps as a result of this current enthusiasm, attaining a good safety culture might be seen as a solution to all safety-related problems, and some caution should be exercised in regarding it a s a 'cure-all' for safety problems. In addition, Kennedy and Kirwan (1995) have noted that safety culture is underspecified in theoretical terms. At the very least more understanding of the concept is needed to take matters forward.

3.2 DEFINITIONS OF SAFETY CULTURE

As the discussion in the previous chapter on organisational culture has illustrated, the literature does not present a unanimous definition. The same can be said to be true of of safety culture. One result of investigations and enquiries into disasters was the need for an operational definition of the concept of safety culture. After exploration of the concept in the wake of the Chernobyl incident, the International Nuclear Safety Advisory Group (INSAG) (IAEA, 1991) prepared a working definition of safety culture in nuclear plants. INSAG defines safety culture as:

> "That assembly of characteristics and attitudes in organisations, which establishes that, as an over-riding priority, nuclear plant safety issues receives the attention warranted by their significance." (IAEA, 1991; pg 1)

They also distinguished the characteristics of safety culture at management and individual levels (shown in Figure 3.1). In this model, it is postulated that legal, governmental and policy frameworks, organisational management and the individuals who work in the organisation influence its safety culture.

One of the most widely used definitions of safety culture, derived from the INSAG definition, has since been provided by the Advisory Committee on Safety in Nuclear Installations (ACSNI) Human Factors Study Group (HSC, 1993):

> "The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures." (pg. 23)

Figure 3.1
Scheme of safety culture (IAEA, 1991)

Whereas the INSAG (IAEA, 1991) definition underlined that safety issues should be a priority and identified the main components, the ACSNI (HSC, 1993) conceptualisation offers a breakdown of the elements necessary to achieve a good, or positive, safety culture and specify their inter-relationships. Like the more detailed ACSNI definition, and more general definitions of organisational culture, other definitions of safety culture emphasise shared values and beliefs that interact with an organisation's safety structures and control systems to produce behavioural norms (Reason, 1998; Uttal, 1983). Indeed the notion that safety culture is a shared, or social, phenomenon is central to many of its definitions, although Turner (1991) has noted that safety culture also has a technical aspect and is perhaps better considered as sociotechnical, rather than purely social.

Pidgeon (1991) argues, in line with organisational culture definitions, that safety culture can be conceived of as the constructed systems of meanings through which a given person or group understand the hazards of their world. In relation to safety, such a constructed meaning system specifies what is important and legitimate to them and explains their relationship to matters of life and death, work and danger and is reinforced within the work environment through formal and informal mechanisms.

Turner et al. (1989) have emphasised the organisational perspective on safety culture. They suggested that it is:

> "the set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimising the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious."

Many researchers and practitioners in the field (for example, Rycraft, 1997) stress the belief that the safety culture of an organisation is indivisible from the whole organisation's culture. Each aspect of the company ethics and management systems influences the whole and, to a certain extent, determines how the balance between safety and other business imperatives is managed. Booth and Lee (1995) also highlight that safety culture is a subset of the overall organisational culture and that it is:

> "essentially a description of the attitudes of personnel about the company they work for, their perceptions of the magnitude of the risks to which they are exposed and their beliefs in the necessity, practicality and effectiveness of controls." (pg 393)

The parallels in definition and conceptualisation between organisational culture and safety culture are, then, rooted in the notion that safety culture is in fact an organisational culture which emphasises safety. As such, it will exhibit the same, or similar, characteristics and relationships with other phenomena as its parent concept. For example, the nature of an organisation's business or its business environment also influences the organisational system and helps define its culture (Ott, 1989), and this is also held to be the case for the organisation's safety culture, where, amongst others, legal and governmental frameworks assert an influence (IAEA, 1991). Klein et al. (1995) found some evidence for similarities within high reliability organisations, and differences between these and other types of organisations. In high reliability organisations characteristics stemming from the inherent dangers of their technologies are shared and therefore, cultural characteristics may also be shared.

3.2.1 Systems Approach to Safety Culture

The major components of safety specific definitions of culture can be summarised in a systems representation of safety culture, which illustrates the relationships between them (Cox and Cheyne, 1998). The main elements of safety culture as defined by INSAG (IAEA, 1991) (that is policy, management and individual levels) are included and the model illustrates how the individual interacts with the organisation both directly and through their standing in their work group (Dalling, 1997), introduced here. It also postulates that, whereas individual awareness, responsibility and control are supported within the immediate work group, the resulting safety behaviours are also reinforced through the organisational safety management process and the communication lines within the organisation. The model is shown in Figure 3.2.

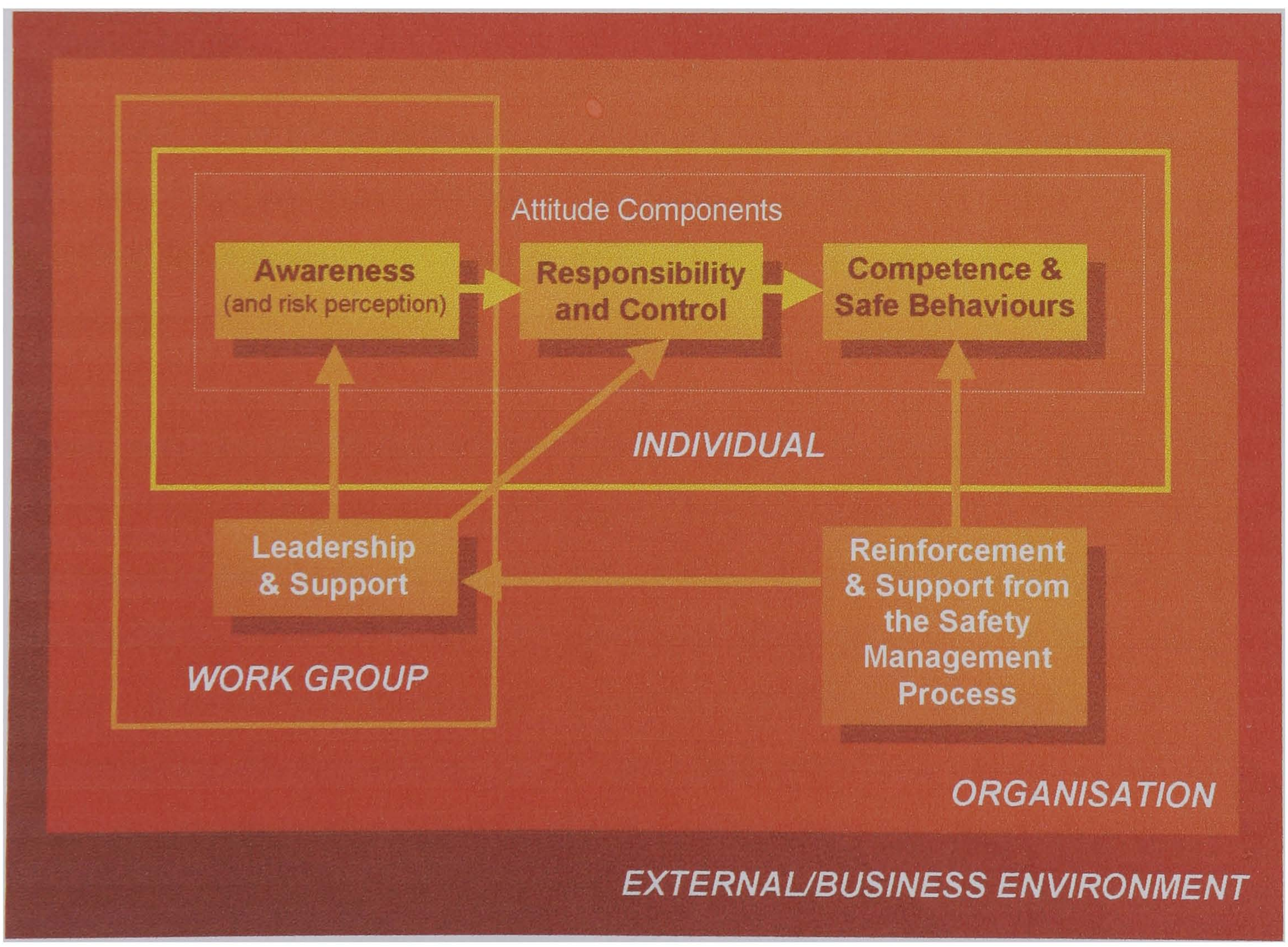

Figure 3.2
Organisation safety systems model underpinning culture (Cox and Cheyne, 1998)

The model illustrates how safety culture might best be thought of as the product of the various parts of the system, and is not resident in any one part, as suggested by the ACSNI Human Factors Study Group (HSC, 1993). For example, Simard and Marchand's (1994) study of first-line supervisor behaviour suggests that, while participatory supervisor behaviour was related to safety performance, it was not an independent determining factor, but part of a more complex system involving organisational safety programmes. In the same vein, the manner in which senior managers illustrate commitment and support (Cox and Cox, 1996) is very important for both the work group and the individual in such a system.

The representation shows how individual and organisational variables, taken together with vital promotional activities, are seen as essential in developing and maintaining a positive safety culture, and thus should be considered together to provide a complete picture of organisational safety culture. The individual's attitudes regarding their own role are highlighted in the model, showing how these might influence personal compliance and safe behaviours, and be influenced by the social norms of the work group, consistent with Ajzen's (1991) theory of planned behaviour. Like the elements in the INSAG (IAEA, 1991) model, shown in Figure 3.1, all of the above are placed in the business context (Ott, 1989) and external, societal, environment, which further influences how organisational culture for safety develops.

Booth and Lee (1995) also observed that a positive safety culture implies that the whole is more than the sum of the parts. The interaction of the various individual components and processes results in a synergistic effect, especially where all the people involved share similar perceptions and adopt the same positive attitudes to safety - a collective commitment. They also state that in organisations with a poor safety culture, the converse is true, and the resulting whole is less than the sum of its parts. An example of this situation is where there is a strong commitment to safety in only one department. In this situation, the commitment to safety of some individuals is strangled by the cynicism of others.

Just as organisational culture could be said to have sub-systems and sub-cultures, the same can be said of safety culture. In this respect, the offshore environment provides an example of the potential for many different sub-cultures to exist on one installation, given the numbers of contractors involved in the industry (Mearns et al., 1997). These sub-cultures may have particular superstitions and beliefs associated with them and these in turn may dictate behaviour within that sub-culture. In terms of cultural maintenance it may be, therefore, more useful to talk of 'cultural alignment'. Cultural alignment describes a mechanism which is essentially designed to influence and align sub-cultures with the overall, or 'dominant', organisational safety culture (Thom, 1997). As a process, alignment might involve the identification of major differences between sub and organisational cultures and then, depending on the nature of those differences, the promotion of appropriate organisational values and practices throughout the subcultures.

From a systems point of view, it is important to note the way in which the various elements of a safety culture interact and inter-depend. As noted at the beginning of this chapter, an all too common failing of past safety performance measures has been the concentration on just one aspect of the system output. Commonly, this is the analysis of accident and incident statistics. While in itself not harmful, the ignorance of other performance indicators leads to few actual safety performance improvements, which was one of the drivers of current interest in cultural approaches, as discussed above (Cox and Cox, 1996).

However, just as with the concepts of organisational culture and organisational climate, definitions, conceptualisations and models of safety culture are linked throughout the literature with the concept of safety climate.

3.2.2 Safety Climate

Just as in the more general culture field (see Denison, 1996), the concepts of safety culture and safety climate have become almost interchangeable in the literature (Cox and Flin, 1998). The ACSNI human factors group acknowledges this and states that:

"the term safety culture has emerged with a meaning that appears to be very similar to climate" (HSC, 1993; pg 23).

Independent definitions of the safety climate concept have, however, been offered. Niskanen (1994), for example, describes climate as:

"...a set of attributes that can be perceived about particular work organisations...and which may be induced by the policies and practices that those organisations impose upon their workers and supervisors" (pg 241)

Despite specific definitions of safety climate, the possible differences between the culture and climate concepts in safety research seem insufficient to support their independence (Cox and Flin, 1998). Lee (1993) has argued that, if there is only one basic concept, safety culture is a more appropriate name than safety climate because it highlights the social system is independent of the people who comprise it and consists of all that has been acquired and then passed on.

On the other hand, Mearns et al. (1997) suggest that safety climate is the more appropriate term for the output from more common questionnaire based surveys. These, they argue, are only capable of sensing surface features discerned from the workforce's attitudes and perceptions at a given point in time - a snapshot of the prevailing state of safety (Mearns and Flin, 1999). These views mirror, once again, Denison's (1996) assertion that methodology is one of the main differences between organisational culture and climate. They are also consistent with the standpoint taken in this thesis and outlined in Chapter 2, that climate is a temporal measure of culture, focusing perceptions, values and attitudes at a particular time. Safety climate, as a manifestation of safety culture, is the focus of assessment in this research.

3.2.3 Safety Attitudes

The important role that employee attitudes play in relation to safety culture has been widely discussed. Pidgeon (1991) has indicated that a good safety culture has three main components: (1) norms and rules for effectively handling hazards, (2) positive attitudes towards safety, and (3) the capacity for reflection on safety practice (reflexivity). These, with the addition of senior management commitment, have subsequently been described as idealised organisational objectives (Pidgeon, 1998). The measurement of employee attitudes towards safety and their perceptions of workplace hazards can thus provide some indication of whether these objectives are being met and, in turn, the nature of an organisation's safety climate and underpinning safety culture. Williamson et al. (1997) have endorsed this view, suggesting that the perceptions and attitudes of workers are important factors in understanding safety climate. In the same vein, Cox and Cox (1991) have argued that employee attitudes, themselves, are one of the most important indices of safety culture and climate since these attitudes are often framed as a result of all other contributory features of the working environment. This was discussed in relation to organisational culture in Chapter 2. Lee (1995) has also proposed that attitudes towards safety are one of the basic components of a safety culture. Attitudes to safety and their relationship with safety culture can, therefore, be seen in the same light as organisational attitudes are in relation to organisational culture. Safety attitudes can be considered as a component of safety climate, which is, in turn, a manifestation of safety culture. Much research into the assessment and quantification of culture and climate for safety has centred on the use of attitude surveys and these are discussed, together with other approaches, in the following section on safety culture assessment.

3.3 Assessment of Safety Culture and Climate

Reichers and Schneider (1990) argue that there are three phases in the development of a theoretical perspective: (1) introduction and elaboration, (2) evaluation and augmentation, and (3) consolidation and accommodation. If this model were applied to the field of organisational culture, it could be assumed that the phase of introduction was in the 1970s and elaboration in the 1980s. Since then, to judge by the books and papers that have emerged, there has been plenty of augmentation, but with relatively little evaluation (Hawkins, 1997). Cox and Flin (1998) suggest that the safety culture field may be at an earlier stage of development. There is, therefore, a requirement for descriptive work as an empirical basis for theory building and testing; the introduction and elaboration, and evaluation and augmentation stages of development. As in the field of organisational culture assessment both qualitative and quantitative methods have been employed in the safety arena. The qualitative methodologies are often used to identify characteristics associated with good, or positive, safety cultures, while more quantitative studies tend to focus on surveys of employee perceptions and attitudes. Much recent research has focused on the latter method in the development of assessment tools.

3.3.1 Qualitative studies

These studies, in the safety field, are often of (i) organisations that have suffered major accidents (sometimes described as 'crisis-prone' organisations); and (ii) organisations with a relatively good safety performance as measured by comparatively low accident rates (judged 'safe' organisations).

Indicators to the characteristics of a 'good' safety culture may be identified by studying organisations which have experienced a major accident, disaster or crisis. If features of 'crisis-prone' organisations can be identified, then the elimination of these features could provide the basis for the improvement of safety performance and safety culture. After studying several crisis-prone organisations, Smith (1995) identified the following characteristics:

- safety is not seen as a primary function or responsibility;
- there is a lack of clarity over the responsibility for safety in the organisation;
- structure, systems and job roles prevent common ownership of safety issues;
- there is little or no learning from near-miss events;
- there is a feeling of invulnerability among senior managers; and
- multiple weak links exist within the organisation as managers recruit in their own image.

In many cases, the absence of key senior management attributes is seen to be a defining characteristic of a 'bad' or 'poor' safety culture (Cox and Flin, 1998). Turner carried out early work in this field including a study of organisations who had experienced a major accident (Turner, 1978; Turner and Pidgeon, 1997). He proposed that the critical features present during the incubation period of a major accident were:

- rigid perceptions;
- decoy problems;
- organisational exclusivity;

- information difficulties;
- violations; and
- failure to recognise emergent danger.

Reason (1997) has endorsed these findings and described the latent, or organisational, conditions present in any complex system and contribute to accidents. These conditions comprise the full range of organisational processes, including designing, constructing, operating, maintaining, communicating, selecting, training, supervising and managing. However, it is difficult to know for sure if these types of characteristics help cause accidents or are developed as a reaction to a major incident (Cox and Flin, 1998).

Studies of 'safe' organisations - those with good safety performance - provide another perspective for qualitative studies. For example, comparative studies, such as those described below, between high and low accident plants in a variety of industrial settings have revealed some relevant results and form the basis of industry guidelines, for example the ACSNI human factors group report (HSC, 1993).

High reliability organisations (HRO) are mandated to do everything possible to avoid certain negative outcomes (Klein et al., 1995). HROs have low accident rates, not because they are immune to catastrophe, but because much effort is dedicated to avoiding them. La Porte (1996) and Roberts (1993) and the research team at the University of California at Berkeley have examined organisations with practically 'error free' records, including power plants, aircraft carriers and air traffic control centres. Factors deemed critical for the design and maintenance of such safe operations include:

- safety as a primary goal;
- decentralised authority;
- systems redundancy;
- organisational learning; and
- senior management commitment.

In a similar exercise, the US Nuclear Regulatory Commission (reported in Booth, 1996) found that safety performance in organisations was influenced by the following broad factors:

- effective communication, leading to commonly understood goals and the means to achieve them
- good organisational learning, where organisations are tuned to identify and respond to change;
- an organisational focus on safety; the attention devoted by the organisation to workplace health and safety; and
- external factors, including the impact of regulators and the financial climate.

The themes identified in high reliability organisations mirror those found in more general examinations of industrial organisations. The Confederation of British Industry (CBI) (1990), in a survey on how companies manage health and safety, highlighted the following organisational characteristics as important in managing safety:

- leadership and commitment;
- line management safety roles and responsibilities;
- employee involvement;
- open communication; and
- demonstration of care and concern.

Lee (1993; 1995) has summarised the key characteristics of low accident plants based on the evidence of these and other studies (shown in Table 3.1). Characteristics include having effective communication at all levels; showing evidence of organisational learning; a strong focus on safety and senior management commitment; effective and participative leadership; quality safety training which incorporates skills training; clean and comfortable (relative to the task) work environments; high levels of job satisfaction; and a workforce composition which recruits, rewards and (thus) retains employees who work safely and have lower turnover and absenteeism (as distinct from higher productivity). This list reflects evidence from both the 'safe' and 'unsafe' (crisis prone) organisations and provides a comprehensive summary of qualitative studies.

Table 3.1
Characteristics of low accident plants (adapted from Lee, 1993)

Low accident characteristics	
1	A high level of communication between and within levels of the organisation; less formal and more frequent exchanges; safety matters are discussed; managers do more walkabouts
2	Good organisational learning, where organisations are tuned to identify necessary changes
3	A strong focus on safety by the organisation and its members
4	A senior management that is committed to safety, giving it high priority, devoting resources to it and actively promoting it
5	A management leadership style that is co-operative, participative and humanistic, as distinct from autocratic and adversarial
6	High level of quality training, not only specifically on safety, but also with safety aspects emphasised in skills training
7	Clean and comfortable (relative to the task) working conditions; good housekeeping
8	High job satisfaction, with favourable perceptions of the fairness of promotion, layoff and employee benefits as well as task satisfaction
9	A workforce composition that often includes employees who are recruited or retained because they work safety and have lower turnover and absenteeism, as distinct from higher productivity

The relative absence of accidents, or the presence of a major one, does not, however, prove that the organisation is a 'safe', or 'unsafe' one, or has a 'good or 'bad' culture for safety. Many 'safe' organisations may have a record of concealed accidents and safety breaches (Sagan, 1993) and their low accident rates might be a reflection of low reporting. Nevertheless Cox and Flin (1998) suggest that it may be possible, with caution, to extract some more evidence about features of a 'good', or appropriate for the particular organisation, safety culture from these findings.

3.3.2 Quantitative Surveys

Many approaches to safety culture (and related safety climate) assessment consider attitudes and their potential impact on behaviours as a central theme. A variety of studies have used attitude and perception measurement techniques in relation to safety issues in different organisational settings. Bailey and Petersen (1989) suggest that a properly structured survey instrument is an effective tool for assessing organisational safety culture. The literature cited here concentrates on culture and climate assessment and survey measurement instruments and their findings, which are summarised alphabetically in Table 3.2. As already pointed out, the terms culture and climate have been used interchangeably in the study of organisations.

The same is true of research within the safety arena (Mearns and Flin, 1999). The terms used in the studies discussed below, although mostly focusing on climate, are those used by their authors.

Much early safety climate research was based around the use of large-scale questionnaire surveys. Zohar (1980) developed one of the first questionnaires in this area. His study was survey based and involved asking around 400 Israeli factory workers to what extent they agreed or disagreed with a series of attitude and perception statements, using a 5-point Likert response scale. Eight safety climate factors resulted from an exploratory analysis of the 49 items in a pilot sample of 120 workers. These included safety training, management attitude towards safety, effects of safety behaviour on promotion, the level of risk at the workplace, effects of required work pace on safety, the status of the safety officer, effects of safe behaviour on social status; and the status of the safety committee. The results from 20 factories involved in various manufacturing activities were compared to independent ratings of safety. Correlations were found between climate ratings and these evaluations with the highest importance accorded to management attitudes and the relevance of safety in the production process.

A number of replication studies, based on Zohar's work, have since been carried out in various industries in a number of countries. Brown and Holmes (1986) assessed an American sample with ten items selected, for statistical reasons, from Zohar's total scale. Their initial data did not fit Zohar's eight factor solution. In its place they identified a three factor solution using fewer items; risk perception, management concern and management action. The results of this study showed that, while the structure of climate did not vary between pre and post trauma (accident) groups, relationships were found between the climate scores for members of these two groups. Dedobbeleer and Béland (1991), in turn, applied nine items from Brown and Holmes' questionnaire to Canadian construction workers, reducing the solution to two factors; management commitment to safety and workers' involvement in safety. Dedobbeleer and Béland (1991) suggest that these are the two primary factors which should be included in any safety climate measure. The failure to replicate a similar structure in the construction industry suggests that this measure of climate may be context dependent.

Cooper and Phillips (1994) returned to the 40-item Zohar scale, modifying some of them and adding new ones up to a total of 50 items, and applied it to a British sample. Principal component factor analysis of this study produced seven factors, similar to those derived by Zohar (1980). Differences in climate scores were detected in this study, before and after a goal-setting intervention. Similarly, Isla Díaz and Díaz Cabrera (1997) applied a broad range of Zohar's (1980) original items to a sample of Spanish airport workers. They found six climate factors which differentiated between three groups (airport authority, fuel company and ground handling) in the same pattern as differences in expert ratings of those groups' compliance.

Brown and Holmes (1986) and Dedobbeleer and Béland's (1991) questionnaires were short and presented more general items, whereas Zohar's (1980), Cooper and Phillips' (1994) and Isla Díaz and Díaz Cabrera's (1997) surveys included more specific safety questions. All of these studies were based on Zohar's (1980) questionnaire with their main focus on the number and structure of factors involved in the description of safety climate. Some attempt to link safety climate with performance and/or accident measures was made, and there is some evidence that that link exists. On a methodological note, it is not surprising that fewer factors are derived from a smaller item bank (Kline, 1994), and the topic covered by the reduced data sets are obviously very different from Zohar's (1980) original. Further attempts have been made to elaborate the relationship between these items and individual behaviours (Hofman and Stetzer, 1996a). Although in that study climate has been described by a single scale based on Dedobbeleer and Béland's (1991) work, evidence was found of the influence of safety climate on impression formation, and in a related study (Hofman and Stetzer, 1996b) related to accidents. The shorter of the questionnaires instruments discussed here, although statistically derived, can be criticised in terms of their coverage of relevant issues in terms of the definitions of safety culture discussed above, and, to a degree, in the range of climate issues they cover.

Table 3.2
Summary of cited safety culture and climate studies

Author(s)	Sample	Format	Dimensions	Reliability	Validity
Alexander et al. (1995)	UK oil production organisation (n= 558)	40 item questionnaire with 5-point Likert response scale; individual interviews	Exploratory factor analysis produced six factors: Overt Management Commitment, Personal Need for Safety, Appreciation of Risk, Attributions of Blame, Conflict and Control, Supportive Environment	Cronbach's alpha for the six factors ranged from .64 to .87	Relationships found between aggregate interview and questionnaire responses. No differences between accident groups
Brown and Holmes (1986)	10 US manufacturing and produce companies (n= 425)	40 items (reduced to10) from Zohar (1980) with 5-point response scale	Confirmatory factor analysis, maximum likelihood estimation highlighted three dimensions: Management concerns in worker well-being; Management safety activities; Employee risk perception.	Invariate factor structure found for two random groups	Links found to pre and post trauma (accident) groups
Budworth (1997)	Three chemical sites	32 items (in sites A and C) and 22 items (in site B) with a 5-point response scale	Five pre-determined areas: Management commitment to safety, Supervisor support, Support for safety systems, General attitudes towards safety, Attitude towards safety representatives	No formal measure, although similar positive and negative were included to gauge consistency	Not reported
Carroll (1998)	US Nuclear power plant (n= 115)	45 items with a 4-point Likert response scale	Items reported individually together with a series of individual and group interviews	Not reported	Links found between open interviews and questionnaire responses
Cooper and Philips (1994)	UK packaging and production plant (n= 374))	50 items based on Zohar's (1980) survey	Seven dimensions derived from principal components analysis: Management attitudes toward safety; Perceived level of risk; Effects of workpace; Management actions toward safety; Safety officer and committee; Importance of safety training; Social status and promotion. Second order factor analysis produced two factors	Cronbach's alpha ranges from 0.5 to 0.9	Changes in climate measure related to the introduction of a goal-setting and feedback intervention
Cox and Cheyne (2000)	UK/US offshore oil production sector	43 item survey with a 5-point Likert response scale, structured interviews and systems checklist	Nine survey factors resulting from confirmatory factor analysis: Management commitment, Communication, Safety Rules; Priority of safety, Supportive environment, Involvement, Personal appreciation or risk, Responsibility and Work Environment	Cronbach's alpha for the survey scales ranges from .58 to .81. Significant test-retest correlations.	Checklist and survey results showed a similar pattern
Cox and Cox (1991)	European Compressed gas manufacturer (n= 630) (Cox and Cox, 1991) Food manufacturing company (n= 3329) (Cox et al., 1998)	16 item questionnaire with 5-point Likert response scale	Five factors derived from principal components analysis: Personal scepticism, Responsibility for safety, Safeness of the work environment, Arrangements for safety, and Personal immunity. Subsequent confirmatory analysis (Cox et al, 1998) confirmed three factors: Safety training, Safety management and Individual responsibility	Significant test-retest scores on all but one item. Cronbach's alpha ranging from .69 to .91	Attitude measures related to supervisor training (Cox, 1988) and systems audits (Cheyne and Cox, 1995)

(Continued on next page)

Table 3.2: Continued

Author(s)	Sample	Format	Dimensions	Reliability	Validity
Coyle et al. (1995)	Clerical and service organisations (n= 880)	26 item questionnaire with a 7-point response scale	Exploratory factor analysis of organisation 1 (n = 340) produced seven factors: Maintenance and management issues, Company policy, Accountability, Training and management attitudes; Work environment; Policy/procedures and Personal authority. A similar analysis in organisation 2 (n = 540) produced three factors: Work environment, personal authority, Training and enforcement policy	Not reported	Not reported
Dedobbeleer and Béland (1991)	Nine non-resident US construction sites (n= 272)	9 items based on Brown and Holmes (1986) study	Two factors derived from a confirmatory factor analysis: Management commitment and Workers involvement	-	Not reported
Donald and Canter (1994)	Ten UK chemical processing sites (n = 701)	167 items	Theoretically derived scales: Self, Workmates, Supervisors, Managers, Safety representatives, Satisfaction, Knowledge, Action, Passive safety behaviour, Active safety behaviour.		All scales (except safety representatives) correlated with self-reported accidents.
Harvey et al. (1999)	Two UK nuclear plants (n= 1000)	60 items with a 6-point response scale	Exploratory analysis revealed seven factors for managers and workforce, six shared: Management communication, Commitment and involvement, Risk taking, Risk awareness, Satisfaction and Complacency. The final factor was different in each group, with Responsibility appearing for industrial staff and Good versus poor management for management.	Cronbach's alpha values ranged between .6 and .88 (Harvey et al., in press)	Differences found between managerial and industrial staff.
Hofman and Stetzer (1996b)	Chemical sector (n= 204)	Based on Dedobbeleer and Béland's study. 9 items with a 5-point response scale	Used as a global measure of safety climate	Cronbach's alpha .79 for the climate scale (Hofman and Stetzer, 1996a)	Significant relationships between climate and unsafe behaviour and accidents.
HSE (1997)	Mining, chemical food and manufacturing industries (n= 3850)	74 items for managers, 83 for supervisors and 80 for general workforce, all with 5-point response scales.	10 dimensions: Organisational commitment and communication, Line management commitment, Supervisors' role, Personal role, Workmates' influence, Competence, Risk taking behaviour and possible influences, Obstacles to safe behaviour, Permit to work, and Reporting of accidents and near misses.		None
Isla Díaz and Díaz Cabrera (1997)	Three aviation companies: ground handling; fuel company and airport authority (n= 78/39/49)	33 safety climate items with a two point response scale and 29 attitude items.	Exploratory factor analysis produced six climate factors: Company policy towards safety, Emphasis on productivity versus safety, Group attitude towards safety, Specific strategies for prevention, Safety level perceived in the airport; Safety level perceived on the job.	Internal consistency for the single climate scale (33 items) was .93	Expert ratings of safety level (including a measure of accidents) show the same company pattern as climate dimensions

(Continued on next page)

Table 3.2: Continued

Author(s)	Sample	Format	Dimensions	Reliability	Validity
Janssens et al. (1995)	Manufacturing (US, France and Argentina) (n= 330/241/152)	13 items with a 5-point Likert response scale	Confirmatory factor analysis endorsed four factors: Management's overall concern; Production as a priority, Safety as a priority and Perceived safety level	Relatively high item to factor coefficients suggest consistent scales	Cultural differences found in the explicative model
Lee (1998)	UK Nuclear reprocessing plant (n= 5269)	172 items with a 5-point response scale	The 19 factors accounting for most of the variance were extracted falling into seven general domains: Safety procedures, Risks, Permit to work system, Job satisfaction, Safety rules, Training, Participation, Control of safety and Design of plant	Not reported explicitly although alternative analysis approaches support findings	16 of the 19 factors discriminate between accident and non-accident groups
Mearns, et al. (1998)	Offshore oil and gas production installations (n= 722)	52 attitude items with a 5-point response scale plus work climate, safety satisfaction and risk perception scales	Exploratory analysis uncovered ten factors: Speaking up about safety, Attitude to violations, Supervisor commitment to safety, Attitude to rules and regulations, OIM commitment to safety, Safety regulation, Cost versus safety, Personal responsibility for safety, Safety systems, Over confidence in own safety	Reliability coefficients ranged from .21 to .85	Differences between non-accident and accident groups for all except OIM commitment to safety, Over-confidence in own safety and Safety regulation
Merry (1998)	US Nuclear organisation	33 items covering 11 characteristics with a Likert response scale	Based on 11 world class performance characteristics: Visible leadership, Safety role of line management, Business importance of safety, Supportive culture, Involvement, Organisational learning, Measurement of safety performance, Mutual trust and confidence, Openness of communication and Absence of production conflict	Not reported	Comparison with a 'world class' organisation showed expected differences
Niskanen (1994)	Road Administration (n= 2452)	25 items for workforce and 18 for supervisors (10 common items) with a 5-point response scale	Exploratory analysis for the workforce sample (n= 1890) revealed four factors: Attitude towards safety in the organisation, Changes in work demands, Appreciation of the work, Safety as part of productive work. Analysis of the supervisor sample (n= 562) produced slightly different factors: Changes in job demands, Attitude towards safety in the organisation, Value of the work, Safety as part of productive work.	Not reported	Some items (not factors) differentiate between low and high accident workplaces and the factor structure varies between supervisors and workers.
Ostrom et al. (1993)	Nuclear laboratory (n= 4000)	88 items with a 5-point response scale	13 pre-determined scales relating to: Safety awareness, Teamwork, Pride and commitment, Excellence, Honesty, Training, Customer relations, Communication, Leadership and supervision, Procedure compliance, Safety effectiveness, Facilities, Innovation.	Cronbach's alpha for entire survey was .96. Item-scale total correlations ranged from .63 to .83	Links made between some responses and accident statistics, but no systematic analysis

(Continued on next page)

Table 3.2: Continued

Author(s)	Sample	Format	Dimensions	Reliability	Validity
Rundmo (1992)	Eight Norwegian offshore oil platforms from five oil companies (n= 915)	72 item questionnaire covering work task, risk source, job stress, work conditions, safety measures and individual characteristics plus items on strain.	In addition to the predetermined dimensions of work conditions, safety measures, individual characteristics and psychological strain, Exploratory analysis revealed three risk factors: Subjective evaluations of safety, Ordinary occupational accidents and Post accident measures; and two job stress factors: Time independence and Participation and co-operation	Cronbach's alpha measure of internal reliability ranged from .68 for individual characteristics to .9 for safety measures	Structural modelling showed all dimensions were related to self-reported accidents
Williamson et al (1997)	Seven workplaces including heavy and light manufacturing and outdoor workers (n= 660)	27 items with a visual analogue scale (True/ False or Always/ Never as anchors) and 5-point Likert response scale	Exploratory analysis revealed a five factor solution: Personal motivation, Positive safety practice, Risk justification, Fatalism, and Optimism. A short uni-dimensional scale was also developed	Internal consistency for the five factors ranged from .39 to .86, for the single scale (17 items) .61	Four factors showed significant differences for those who perceived risks at work and also for those who had suffered accidents. The short scale also differentiated between these groups
Zohar (1980)	20 Israeli factories from metal fabrication, food processing, chemical, and textile manufacture sectors (n= 380)	40 items with a 5 point Likert scale (disagree to agree)	Eight dimensions derived from exploratory factor analysis in four factories: Importance of safety training; Management attitudes towards safety; Effects of safe conduct on promotion; Work place risk; Effects of required work pace; Status of safety officer; Effects of safe conduct on social status; Status of safety committee	Not reported	Independent ratings of the organisations involved agree with rankings from the climate survey
Zohar (2000)	53 work groups in a metal processing plant (n= 534)	10 items (derived from pilot) with a 5-point response scale varying from 'completely agree' to 'completely disagree'	Two safety climate factors derived by exploratory analysis: (Supervisory) Action, and Expectation. Other measures taken included Job Risk, Role Overload, Microaccidents and Lost time Accidents.	Cronbach's alpha measures of internal reliability were 0.93 and 0.91.	Group climate scores significantly related to 'microaccident' records, Expectation related to lost time accidents

Several other researchers have employed climate and culture surveys in a variety of organisations. Cox and Cox (1991) developed an attitude survey of safety issues for use in a multinational organisation within the industrial gas manufacturing sector. This questionnaire has since been used in a variety of organisational settings, including food manufacturing and transport (Cheyne and Cox, 1994). Responses to the questionnaire items were found to improve after a supervisor training intervention (Cox, 1988) and were represented by the five factors, including personal scepticism, responsibility for safety, the safeness of the work environment, arrangements for safety, and personal immunity.

These dimensions have been developed further into a series of models illustrating individual attitudes to and perceptions of safety issues (Cheyne et al., 1999; Cox et al., 1998). Confirmatory factor analysis produced three factors; management actions; individual actions; and safety training. Subsequent modelling of the data uncovered differing relationships between the management actions dimension and appraisals of organisational commitment to safety for different employment levels in a food manufacturing organisation (Cox et al., 1998) and differences in structure in three industrial sectors (Cheyne et al., 1999). Coyle et al.'s (1995) study of safety climate in two Australian organisations, in the clerical and service sector, also found that climate factors were not stable across organisations. Exploratory analysis found six factors in one organisation and three in the other. Although no detail was given of how the researchers decided on the number of factors to be retained in the final solutions and not all the items are included in the second solution, this study does provide further evidence for the context dependency of safety climate. Janssens et al. (1995), however, found that three units of a multinational organisation, each in a different county (US, France and Argentina) had relatively minor differences in factor structure but did show cultural differences when it came to the structural relationships between those factors.

Williamson et al., (1997) developed a 67 item questionnaire based on much of the previous research described above from a study of workers in a variety of jobs in seven different workplaces. The five factors derived from the study was similar to those uncovered in earlier research, especially that of Cox and Cox (1991), suggesting that it may be possible to identify 'core' dimensions relating employee attitudes to safety. This similarity may not be surprising since, as with much research in this field, its assessment is based on a similar premise as the research that it is held to resemble. Furthermore, this study found that there was little variation in intensity of views between respondents on a large proportion of the items. This suggests one of two processes at work. Either there is a set of well-known beliefs about safety issues which need to be understood in detail in the manufacturing and production industries surveyed, or the instrument used in the study is not sensitive, or perhaps diverse enough, to differentiate between respondents in different industrial settings. Williamson et al. (1997) suggest that the consensus shown across these items might reflect workers' views about safety in general and that safety climate may be composed of these views as well as more specific perceptions of individual work environments. Mearns and Flin (1999) suggest that this may be explained by the fact that shared attitudes and beliefs are indicative of a shared safety culture across Australian workers. The differences in perceptions of day to day safety issues, on the other hand, might reflect climates in different organisations.

Donald et al. (1991) identified three facets of safety attitudes: people or organisational roles; aspects of an individual's safety behaviour; and safety activity using the 'Safety Attitude Questionnaire' developed by the Safety Research Unit at the universities of Surrey and Liverpool. This questionnaire has been used in profiling employee attitudes to safety and studies have been conducted in over 60 organisations throughout Europe (Donald, 1995; Donald and Canter, 1994). Negative correlations have been found between attitude dimensions from this questionnaire and accident rates (Donald and Canter, 1994). The instrument has also been used as the basis for interventions, including the setting up of safety teams, introduction of written action plans and an enhanced profile for management action. These interventions have been linked, in turn, to improvements in attitude scores, accident rates and absenteeism.

The growing popularity of assessing employee attitudes to safety is reflected in recent work conducted by HSE (HSE, 1997; Byrom, 1998; Byrom and Corbridge, 1997). This work has sought to develop an attitudinal indicator of safety climate, initially in conjunction with the mining industry but also extending over a number of chemical and manufacturing industries. The analysis of this instrument produced ten dimensions assessing attitudes to safety, including organisational commitment and communication, line management commitment, supervisors' role, personal role, workmates' influence, competence, risk taking behaviour and possible influences, obstacles to safe behaviour, permit to work, and the reporting of accidents and near misses. The assessment tool differentiates between managers, first line supervisors and general workforce to produce profiles of each of dimensions. The differentiation between work groups has been explored in greater detail in a recent study of group level climate (Zohar, 2000). Zohar's (2000) study found evidence that safety climate exists as a group level, as well as organisational level, construct. Work groups were found to develop homogenous views of supervisor practices and these views differed between the groups. In addition, climate scores were related to unit safety records in the months following the assessment.

As well as general industrial studies of safety culture and climate, several researchers have focused on high hazard environments. As discussed earlier, the nuclear industry was one of the first to become involved in the evaluation of safety culture. Both ACSNI (HSC, 1993) and INSAG (IAEA, 1991) have included safety culture prompt lists to help organisations identify their culture. Interest in safety culture and climate has been extended to more quantitative approaches and recent work (Lee, 1997; 1998) has continued in this vein and dealt specifically with the role of attitudes in nuclear plant safety culture. Lee's study (1998) involved a 172 item questionnaire, derived from focus discussion groups at a UK nuclear facility. These items were subjected to a factor analysis and produced 19 factors, or dimensions, grouped around 9 general areas. These general areas included safety procedures, risks, permit to work, job satisfaction, safety rules, training, participation/ownership, control of safety, and design.

Work carried out in the same organisation (Harvey et al, 1999) has suggested that a number of different cultures are at work in the nuclear sector. Specifically, it was found that basic conceptualisations of safety differed between management and staff at two plants in their study. Different factor structures emerged for managerial and industrial staff. The two work groups shared management communication, commitment and involvement, risk taking, risk awareness, satisfaction and complacency dimensions but the final factor was different in each group, with responsibility appearing for industrial staff and good versus poor management for managerial staff. Harvey et al (1999) suggest that these differences may be a function of how the individual views the organisation from their position in it and their experience of it, and that this may be the case in a wide range of organisations not just in the nuclear arena. Indeed, differences consistent with those found by Harvey et al. (1999) have been discovered in the construction industry (Niskanen, 1994). This study found differences between supervisors and workers relating to factors dealing with supervision, individual responsibility, changes in work demands and the value placed on work.

Similar nuclear sector research has been carried out in various installations in the United States (US). Ostrom et al. (1993) assessed the safety culture of an engineering laboratory using their Safety Norm Survey. This survey focused on 13 dimensions similar to many of those already mentioned and including, amongst others, commitment, communication, leadership, training, compliance and work environment. Similarly, Merry (1998) used an attitude and perception survey based on 11 characteristics believed to be distinguishing of world class safety performance, including leadership, role of line management, importance of safety, supportive culture, involvement, organisational learning, safety performance, mutual trust, communication and production conflict. These characteristics were used to compare the safety cultures of two divisions of one organisation, and differences were highlighted in several of the dimensions. Carroll (1998) also used a questionnaire survey as the basis of a cultural investigation in the engineering department of a nuclear facility. The questionnaire was used in conjunction with group and individual interviews to produce a number of management recommendations. Carroll (1998) notes that one of the more important aspects of the investigation may be the conducting of the survey itself that could constitute an intervention in its own right.

Like the nuclear sector, safety in the offshore oils exploration and production sector has been the focus of much attention as the result of a disaster. A number of studies have been carried out in this area and each has used a self or group administered questionnaire as the major data collection method. In the Norwegian sector of the North Sea, Rundmo (1992) found that perceived risks, job stress, work conditions, safety measures and individual characteristics were all related to self-reported accidents. Mearns and colleagues (1997) have used a similar survey of risk perception on offshore installations to tap into some aspects of safety climate with one of their scales. The questionnaire was used to characterise the climates on each of the installations and some evidence was found for safety sub-cultures existing between different levels of employee and different occupational groups which accounted for differing safety attitudes. Budworth (1997) has also found some evidence for the existence of sub-cultures in different departments within the chemical sector. However it has also been noted by Mearns, et al. (1998) that operatives from different organisations showed few differences in the intensity of their attitudes of and perceptions to safety. One suggested reason for this was the potential existence of a general sectoral culture.

In a study of safety culture one organisation in the UK sector of the North Sea, a factor analysis (Alexander et al., 1995) was applied to uncover the underlying dimension structure of a safety survey. Six dimensions were uncovered: Management commitment, Need for safety, Appreciation of risk, Supportive environment, Attributions of blame and Conflict and control. The survey was used in conjunction with a number of individual interviews that addressed the notion of safety culture directly and differences were found between those employed in different locations, onshore and offshore.

The organisation involved in the Alexander et al. (1995) study also participated in a wider study of climate assessment in the offshore sector conducted by Cox and Cheyne (1998; 2000) and culminating in the production of the Safety Climate Assessment Toolkit. This instrument was designed to gauge the safety climate/culture in offshore installations (Cox and Cheyne, 1998). It utilises data from three independent sources to build an overall profile of the prevailing climate for safety. Once again employee attitudes to safety were gathered using an attitude questionnaire, but opinions on safety systems and practices were also gathered in interviews and/or focus discussion groups. Behavioural indicators based on individuals' behaviour, safety systems and work practices, provided the final source of data from which the profile of safety climate can be developed. Other researchers into safety culture and climate have recognised the importance of taking multiple measurements. Merry (1998) acknowledges the merit of triangulation of methods since culture may be difficult to evaluate through reliance on one method. A similar multiple methods approach to the assessment of safety climate and culture has been developed by AEA Technology (Dalling, 1997), centring on three areas; management factors, enabling factors and individual factors. Like Cox and Cheyne's (1998) toolkit this 'Safety Culture Assessment Tool' uses three methods, questionnaires, interviews and checklists in an endeavour to provide a holistic profile of safety culture to assist organisations in the better targeting of resources.

3.3.3 Conclusions on Culture and Climate Assessment

Almost all of the more recent studies and instruments described above are based around self-report questionnaires; even when a multiple methods approach is taken one of the key elements is a questionnaire, or climate, survey. Most questionnaire surveys, while conducted at the individual level, are analysed and reported at the group or organisational level. As James (1982) noted, characterising the unit of theory for climate as the individual does not mean that culture or climate perceptions cannot be aggregated, as they have been, to describe larger units. Joyce and Slocum (1982) note that agreement amongst individuals is what distinguishes organisational and psychological, or individual, climate and this can be achieved through the use of questionnaires.

The main focus in many studies, for example in the nuclear industry, has, from the start, been on safety culture, although the empirical studies of culture examined here do not seem to differ substantially from other climate studies described. This echoes Denison's (1996) assertions about the differences between studies of organisational culture and climate which may relate to the same basic phenomenon. On the other hand, Moran and Volkwein (1992) suggest that climate operates on a more accessible level than culture, is more readily changed and, therefore, the more appropriate level at which to target short-term interventions aimed at producing positive organisational change.

3.3.3.1 Common themes

An interesting aspect of the studies, both qualitative and quantitative, described above, is the similarity of areas covered by them. When recent safety culture and climate research is considered in its entirety, a number of common themes become apparent. This suggests that, like organisational culture in general, values, attitudes and behaviours can be assessed in similar terms (Rousseau, 1990). Flin et al. (2000), in their review of safety climate assessment, hold that the evidence for universal factors is, however, inconclusive, but that there may be a set of fundamental climate factors common to many organisations. Possible common themes discernible from the research reviewed here, and summarised in Tables 3.1 and 3.2 are described below.

Safety Systems, Procedures and Policy

Views on the efficacy and necessity of rules, systems and procedures, the appropriateness of policy, and the development of all of these are included in this theme. These issues have been identified in most of the studies described above and focus on issues such as permit to work (Lee, 1998) and safe practices (Williamson et al., 1997).

Management Commitment/Actions

Perceptions of management's overt commitment to health and safety issues and their visible actions to enhance and improve safety performance are generally the focus of this theme. This is one of the 'core' dimensions, or primary factors, suggested by Dedobbeleer and Béland (1991) and reinforced by Flin et al. (2000), and also found at the supervisory level (Zohar, 2000). Management Commitment was also a strong feature of the qualitative studies summarised in Table 3.1.

Priority of Safety

The priority assigned to safety and the relative status of health and safety issues within the organisation is labelled priority of safety. Isla Díaz and Díaz Cabrera (1997), for example, identified the emphasis placed on productivity versus safety as the second most important dimension in their study.

Safety Training

This theme relates to the development, availability, effectiveness and priority accorded to organisational and individual safety training. Since featuring in Zohar's (1980) study this theme has appeared, not only in replications of that study (Cooper and Phillips, 1994), but also in studies derived from different premises (for example, Cox et al., 1998; Lee, 1998).

Communication

This includes the nature and efficiency of health and safety communications within the organisation, the appropriateness of information sharing, and the dissemination of safety decisions. The importance of open communication was highlighted in many of the qualitative studies of high reliability and crisis prone organisations (CBI, 1990; Lee, 1993), has been included as an aspect of safety culture (HSE, 1997; Ostrom et al., 1993) in some qualitative studies, and in addition to climate in others (Hofman and Stetzer, 1996a)

Involvement/Participation

The extent to which safety is a focus for everyone and all are involved in the monitoring and improvement of safety performance characterises involvement in many of the studies described above. This is the other of Dedobbeleer and Béland's (1991) primary safety climate factors and has been included in several of the studies shown in Table 3.2 (for example, Lee, 1998; Rundmo, 1992).

Individual Actions/Responsibility

This refers to the importance of ensuring safe working and realising that safety is an individual, as well as organisational, responsibility. This theme has been included on its own in some studies (Cox and Cox, 1991; Mearns et al., 1998) and items incorporated into differently named dimensions in others. Individual responsibility items were included in Alexander et al.'s (1995) 'attributions of blame' dimension, and were the essence of Niskanen's (1994) 'safety as part of productive work' factor and HSE's (1997) 'personal role' factor.

Risk

Perceptions of the types of risk associated with individual's roles and present in their work environment feature as a major dimension of safety climate in several studies (Brown and Holmes, 1986; Dedobbeleer and Béland, 1991; Isla Díaz and Díaz Cabrera, 1997; Zohar, 1980).

Work Environment

This theme includes perceptions of the nature of the physical environment, including ambient conditions, housekeeping issues. Like perceptions of risk, evaluations of the work environment have been included in several climate assessments (for example, Cox and Cox, 1991; Coyle et al., 1995).

Perhaps not surprisingly, given the important role of early conceptualisations of safety culture, these dimensions can be mapped onto the models of safety culture proposed by INSAG (IAEA, 1991) and Cox and Cheyne (1998) shown in Figures 3.1 and 3.2. Dimensions like Safety Systems, Procedures and Policy, Management Commitment/Actions, Priority of Safety and Safety Training represent organisational and management levels, while the individual level can be characterised by dimensions like Individual Actions/Responsibility. The list also includes working environment factors, both at the social, or work group (Communication and Involvement), and physical (Risk, Work Environment) levels. These groupings relate closely to the influences on the individual in the HSE's (HSE, 1989) Individual-Job-Organisation integrated approach to safety management. This approach advocates achieving improvement using the 'individual in their job in their organisation' framework. Cox and Cox (1996) stress that, while each of the HSE's components are important, more challenging is understanding and describing the nature of the inter-relationships between them. In addition to the content and structure of safety culture and climate, studies have also focused on relating measures of climate with objective assessments of safety performance, as well as differences between organisations and sub-groups within those organisations.

3.3.3.2 Outcome Measures

Data from safety climate studies often support relationships between safety climate (as assessed) and a range of safety performance outcome measures. Zohar (1980) found significant correlations between judges' rankings of factories and overall safety climate scores. Isla Díaz and Díaz Cabrera (1997) found a similar pattern in a replication study, but relationships were not tested statistically. Climate has also been linked with behaviour, both self-reported and as measured by accidents and incidents. Safety climate scores aggregated across teams were found to correlate significantly with the teams' level of unsafe behaviours ($r = -0.66$) and accident rate ($r = -0.61$) (Hofmann and Stetzer, 1996b). Donald and Canter (1994) also found significant correlations with all of their safety climate scales (except safety representatives) and accidents, and Rundmo (1994) found relationships between all safety dimensions in the study and self-reported accidents in a structural model of his data. Zohar's (2000) study of group level climate also showed relationships between two safety climate sub-scales and his measure of 'microaccidents'.

As well as examining the relation of climate with behaviours, other studies have compared safety climate for accident and non-accident groups. Brown and Holmes (1986) found significant differences between these two groups on all three dimensions. Cooper and Phillips (1994) found significant differences for four accident groups on five of their seven scales. Similarly, Williamson et al. (1997) reported differences between accident and non-accident groups for two of five dimensions, Mearns et al. (1998) for seven of 10 dimensions and Lee (1998) for 16 of 19 dimensions. Only Alexander et al. (1994) found no significant differences between the two groups on any of their safety culture dimensions, although differences were found between scale scores at different organisational locations.

3.3.3.3 Safety Culture and Sub-Cultures

The final point to emerge from a comparison of safety culture and climate studies is the apparent confusion surrounding the level at which culture (as reflected by climate measures) is shared. On the surface there seems to be conflicting evidence on the pervasiveness of common cultures. Some research suggests that a common safety culture exists across several organisations (Mearns et al., 1998; Williamson et al., 1997). This possibility stems from early multiple organisation studies (Zohar, 1980) and is in line with Schein's (1999) assertion that culture might be shared across an industry, but may be contrary to views that commercial context influences organisational culture (Ott, 1989). On the other hand differences have been uncovered between occupational levels (that is, management and workforce) within some organisations. Such differences have been found both in terms of the interpretations (intensity of attitudes) (Alexander et al., 1994; Mearns et al, 1997) and in terms of the structure (Cox et al., 1998; Harvey et al., 1999; Niskanen, 1994) of attitudes and climate. These differences reflect Trice and Beyer's (1993) suggestion that organisational hierarchy gives rise to subcultures.

This, apparently conflicting, evidence can, however, be reconciled. One possible explanation is that, while there may be general levels of agreement across organisations, differences between organisational sub-groups might also be consistent, showing a similar pattern for each organisation with hierarchies giving rise to similar subcultures. This would explain the agreement found by Williamson et al. (1997) for example, but also allows for differing sub-group structures found by Cox et al. (1998). Indeed Harvey et al.'s (1999) study in the nuclear sector and Niskanen' (1994) in the construction industry, suggest that more than one structure can exist in most organisations. The potential structure of sub-groups attitudes and perceptions is, however, often not considered when exploring the dimensionality of survey instruments, usually due to sample size constraints.

3.4 MODELLING SAFETY CLIMATE

Many of the studies discussed in the previous sections have been exploited to determine the nature of, and relationships between underlying dimensions describing attitudes to safety and their effects on outcome measures, such as accident experiences (Brown and Holmes, 1986; Donald et al., 1991; Williamson et al, 1997). However it is becoming increasingly apparent that the measurement of attitudes, although suitable, is not in itself sufficient for planning appropriate strategies for the improvement and development of a more positive safety culture. This may be the case if, for example, a number of measured variables are involved, some of which may be indirectly influencing the outcome measure. Structural equation modelling (SEM) techniques, described in detail in the next Chapters, can be utilised to produce explicative models of such data. It is applicable where models are constructed in an attempt to explain how several variables may be related to a target (or outcome) variable, and how strong these relationships are, while taking the influence of other variables in the model into account.

Several explicative models dealing with safety issues have been developed. These models have been used to explain employee readiness to take part in safety improvement programmes (Goldberg et al., 1991), and the role of personality and cognitive variables (Hansen, 1989), and affectivity (Iverson and Erwin, 1997), as predictors of accidents. In the offshore oils and gas production sector models have been constructed to explain accidents, safety satisfaction and risk perception (Fleming et al, 1998; Flin et al., 1996). Each of these studies has focused on particular outcomes and in most cases these have included occupational accidents or safe/unsafe behaviours. Other studies of safety climate have also employed structural or 'causal' models. Clarke (1994) described train drivers' attitudes to safety in a causal model highlighting the precursors of unsafe acts. Similarly Neal and Griffin (1998) constructed a structural model looking at the influences of climate on behaviour. These two studies, however, only touched on culture and climate with one or two of their measures, although they did attempt to link climate with safe behaviour.

Three recent studies have concentrated specifically on the architecture of safety climate and safety attitudes, and have developed models based on the inter-relationships between safety climate variables before relating these variables to outcome measures. Janssens et al. (1995) have explored the structure of employee perceptions of safety priority, management concern and perceived levels of safety in three units of a multinational organisation. This research examined the proposal that management concern for employees would be positively related to the extent to which safety is a priority and, in turn, perceived safety levels. Linked to this was the hypothesis that emphasis on production would decrease perceived levels of safety. Janssens et al. (1995) found that their data supported this model although there were national cultural differences. Management concern had a weaker influence in the French unit compared to the US unit and in the Argentinean unit management concern had a stronger influence than in the US and production as a priority had a weaker influence on safety as a priority.

Tomás and Oliver (1995) developed another such model to examine the attitudes and perceptions influencing safe behaviours, in terms of organisational and individual variables, in a sample of Spanish workers from a broad range of industries. They found that both attitudes towards organisational safety issues and perceptions of hazards in the working environment had a direct influence on self-reported safe behaviours. Similarly, Cox et al. (1998) modelled employee attitudes to safety in terms of three factors: management actions for safety, the quality of safety training, and the individual's personal actions for safety. This study found that attitudes with regards to management actions for safety showed the strongest relationship to overall appraisals of organisational commitment to safety, which was the main indicator of safety climate in that study.

3.4.1 Theoretical Model of Safety Dimensions

It should be possible to build up a theoretical model of relationships between the dimensions, or groups of dimensions, identified in the survey of research above. A model of the architecture of safety climate, illustrating the relationships between employee attitudes dimensions can be constructed based on previous models developed in the safety field and the theoretical models discussed earlier. A potential model, involving four groups of dimensions, is illustrated in Figure 3.3.

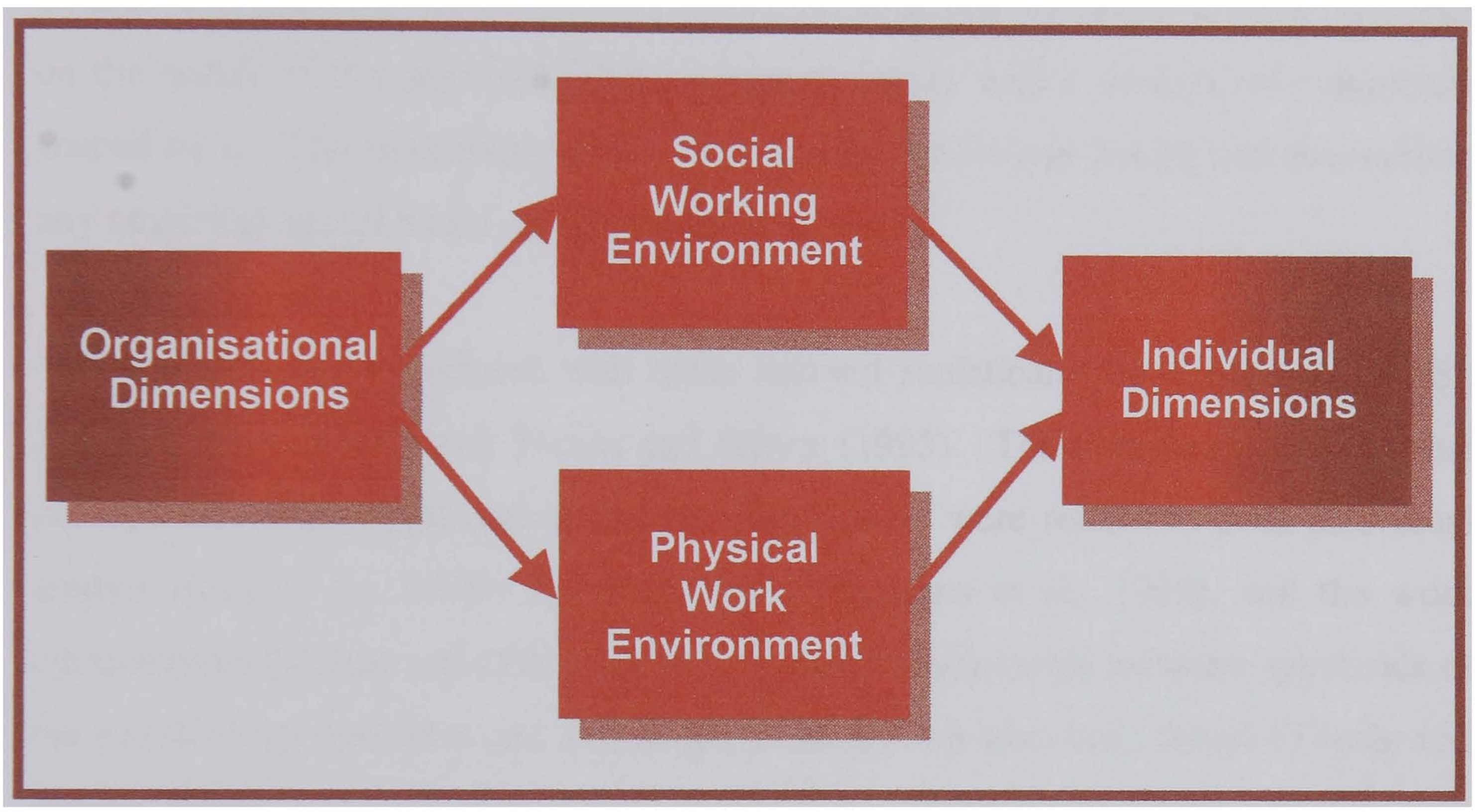

Figure 3.3
Theoretical model of safety attitude dimensions

This proposed model follows the broad hypothesis; that is, attitudes to organisational variables will effect environmental (both physical and social) evaluations which will, in turn, have some bearing on individual dimensions. This is in line with INSAG's (IAEA, 1991) representation of culture, with the addition in this case of environmental variables moderating the link between organisation and management and the individual, as suggested by Cox and Cheyne (1998). The model is also congruent with those derived statistically by Cox et al. (1998), Janssens et al. (1995) and Tomás and Oliver (1995). These models proposed that perceptions of the organisation and its management were related to both individual actions (Cox et al., 1998) and perceptions (Janssens et al., 1995), and the work environment (Tomás and

Specifically, this proposed model follows the broad hypothesis; that organisational variables will effect environmental (both physical and social) evaluations which will, in turn, have some bearing on individual dimensions. This is in line with INSAG's (IAEA, 1991) representation of culture, with the addition in this case of environmental variables moderating the link between organisation and management and the individual, as suggested by Cox and Cheyne (1998). Although the direction of the arrows shown in Figure 3.3 suggests a simple one-way relationship between the groups, it could be argued that each of the elements has a mutual influence on the others. The physical working environment, for example, might have some influence on the nature of the organisational response to safety issues, and not be completely shaped by it. This possibility should be borne in mind when testing and interpreting any empirical model based on this theoretical one.

The model is also congruent with those derived statistically by Cox et al. (1998), Janssens et al. (1995) and Tomás and Oliver (1995). These models proposed that perceptions of the organisation and its management were related to both individual actions (Cox et al., 1998) and perceptions (Janssens et al., 1995), and the work environment (Tomás and Oliver, 1995). A direct relationship between appraisals of the physical environment and individual variables has also been found (Tomás and Oliver, 1995).

3.4.2 Hypotheses

A main focus of this research is the description of the structure of safety climate within the manufacturing sector. Accordingly it will test *Hypothesis 1* that safety climate in the participating organisations can be described in terms of the four elements shown in the model illustrated above in Figure 3.3. Given the influential role accorded to business environment and organisational context in the models of culture described above (Cox and Cheyne, 1998; IAEA, 1991; Ott, 1989), variations in the dimensions, and/or relationships between them, might be expected across different organisations operating in different contexts. This position has been endorsed by studies that fail to replicated similar structures between organisations (Coyle et al., 1995; Dedobeleer and Béland, 1992). Other safety research has, however, provided evidence for the existence of sector wide cultures in terms of the interpretation of climate (Mearns et al, 1998; Williamson et al., 1997). One of the basic aims of this research is, therefore, to examine differences between organisations operating in the same and different sectors in order to gauge the extent to which structures might be shared at sectoral and organisational levels. This gives rise to *Hypothesis 2* that a similar climate structure exists across organisations operating in similar commercial environments.

Previous research in the safety field (Cox et al., 1998; Harvey et al., 1999; Mearns et al., 1997; Niskanen, 1994) suggests that, as well as similarities and differences in structure across organisations, there may also be variations in both structure and intensity of attitudes between different employment levels within an organisation. This possibility, and how the potential existence of general sectoral and specific organisational sub-cultures might be reconciled, is explored in the testing of *Hypothesis 3* that different employment groups within the same organisation will exhibit different climate structures. The next chapter goes on to examine how these hypotheses might be tested empirically.

3.5 SUMMARY

This chapter has reviewed the concepts of safety culture and safety climate and presented a systems based approach to their description, highlighting the importance of individuals' attitudes and perceptions in cultural definitions. A number of studies and instruments aimed at assessing safety culture and climate have been reviewed and their common themes identified. A broad theoretical model, to facilitate the implementation of improvement strategies, of the relationships between these themes has been suggested. The next chapter describes the methodological approach to testing such a model.

CHAPTER FOUR

Methodology

The previous chapter provided a summary of current theories and conceptualisations, the purpose of this chapter is to describe the steps undertaken in the conduct of the research, and to justify their use. The detailed research procedure is described in Chapters 5 and 6.

4.1 INTRODUCTION

The discussions of culture and climate in the previous sections have provided some general background and introduction to appropriate assessment domains in relation to safety culture and safety climate. It is now generally agreed that cultural approaches to safety are both suitable and beneficial, and that, taken in support of sound safety technology and systems, a good safety culture can provide the impetus for continual improvement (Cox and Cox, 1996). Much of the work dedicated to both the nature and construction of safety culture and climate, described in Chapter 3, will form the basis of the research process described here.

In organisational settings, research is primarily conducted in order to solve problematic issues in a particular sphere of the business (Sekaran, 1992). According to Dane (1990), the nature of such research aims to do at least one of the following:

- Explore whether or not a phenomenon exists;
- Examine a phenomenon more fully;
- Identify relationships that allow speculation about one variable given what we know about another; and
- Examine a cause-effect relationship between phenomena.

In addition to these goals applied research usually involves an attempt to provide a solution to the problematic issue under consideration. This is sometimes referred to as action research (Lewin, 1946) which is conducted to solve a particular social or organisational problem. The research process employed here is described below.

4.2 RESEARCH PROCESS

Figure 4.1 shows the various stages involved in the applied research process as proposed by Sekeran (1992) and adapted to describe this research.

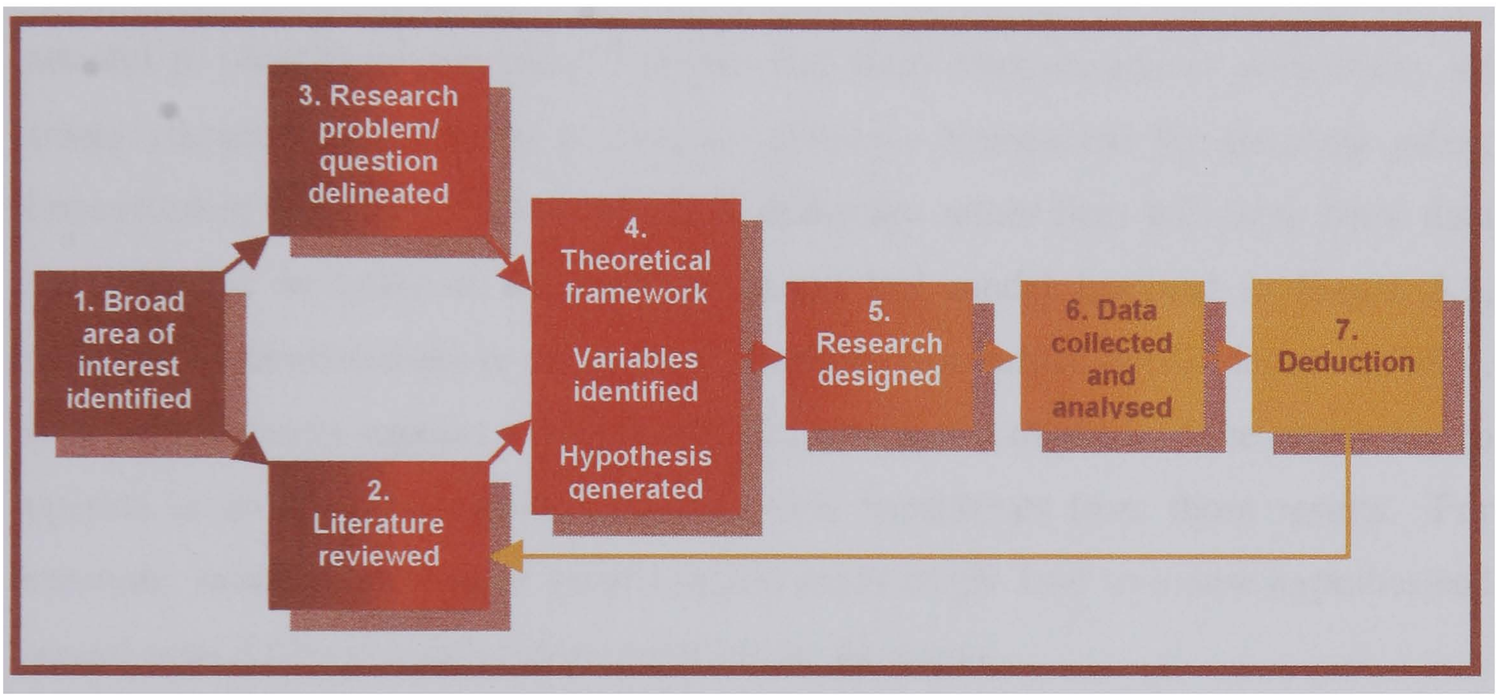

Figure 4.1
Applied research process (after Sekeran, 1992)

Despite the above description of discrete stages, it is not always possible to divide the process up in such a way. Bechhofer (1974) suggests that:

> "The research process is not a clear cut sequence of procedures following a neat pattern, but a messy interaction between the conceptual and empirical world, deduction and induction occurring at the same time" (pg 73)

The pattern of research outlined in Figure 4.1, however, can be mapped onto the research described in this thesis. The broad area of interest and the literature review, in boxes 1 and 2, have been dealt with in the discussion of culture and climate and safety culture and climate in Chapters 2 and 3. The research question (box 3) was defined by this examination of the literature, and by the participant organisations, and was outlined towards the end of Chapter 3. The theoretical framework and general hypothesis (box 4) were detailed at the end of the last chapter. The research design (box 5) is outlined in this chapter and described in detail in the next chapter. The data collection and analysis (box 6) for each organisation is covered in Chapters 6, 7, 8 and 9. The remainder of this chapter focuses on the justification, and nature, of the collection and analysis methods used in the research.

4.2.1 The Nature of the Current Research

The research described here is not only an examination of the phenomena of safety culture through the assessment of climate in a manufacturing setting, but also an attempt to identify relationships between the main components, or dimensions, of safety climate. In doing so it aims to provide a framework for targeting safety improvement strategies. The research is deductive rather than inductive since data are collected in order to illustrate the theoretical model outlined in Figure 3.3, although research activity is rarely purely deductive or inductive (Kidder et al, 1986). Even when results support a hypothesis, inconsistencies might lead the researcher to operate in an inductive manner, deriving new hypotheses from those results. For example, initial modelling of results in this study might lead to a new hypothesised model with different relationships between the elements.

4.3 RATIONALE

The research in this thesis is based on links with three large multi-national corporations, two manufacturing organisations and one involved in the supply of construction materials. The units under investigation are located in the United Kingdom (UK) and Western Europe. At the time of the research, all three organisations were involved in continuous safety improvements and were interested in describing their safety climate to allow them to:

- Benchmark employee attitudes and perceptions;
- Examine differences between manufacturing units, or plants, and between employment categories; and
- Gain an insight into the structure of those attitudes in order to uncover problem areas and better target improvement initiatives.

The participating organisations are described below.

4.3.1 Organisation A

The principal participating organisation is involved in the production of coated abrasives, healthcare equipment, recording media and adhesive tapes. Eight plants were involved in the studies, all of which are in the UK, one of the organisations largest subsidiaries outside the US. The management structure was the same in each of the plants with employees organised into work teams reporting to a supervisor or first line manager who, in turn, reported to the plant management team. A shift system operates in each of the plants. A central group headquarters, co-ordinating UK operations, supported plant operations.

All employees, at each level, were the target of the research. Each of the units operated in a similar manufacturing environment with manual handling and hazardous chemicals the main hazards present. As part of the organisation's move towards the creation of empowered teams, at the time of the study two of the plants had recently embarked on behavioural based safety programmes, encouraging team members to participate in safety observations and help reduce lost time accidents.

4.3.2 Organisation B

The second organisation was also in the manufacturing sector and is involved in paper goods production. The group has over 40 manufacturing units operating in Europe and the US and focuses on speciality and high value paper production. One division, based in the UK and France, took part in this research. Four plants were involved in the studies, three in the UK and one in France. Employees are involved in all aspects of the manufacturing process, as well as distribution, and are divided into general workforce, supervisors/first line managers and general plant management. The plants operate on a 24 hour basis and staff follow a rotating shift pattern. The main hazards present in these plants were manual handling, repetitive strain injury and forklift truck operations.

4.3.3 Organisation C

The third participating organisation is involved in the supply of construction materials, specifically quarried products. The company has a long history in this area spanning 80 years and operates a group headquarters and 250 sites in the UK. 14 of those sites were involved in the climate survey. The units in organisation C are smaller that the other participating organisations and the management structure is, therefore, less hierarchical, with, typically, one site manager and one or two supervisors in each unit. The sites operate a 5 day/8 hour work pattern with some opportunity for overtime, and the main hazards present in these working environments are plant vehicle operations, noise and manual handling.

The research methodology employed here was selected to suit the needs of those organisations, and the justifications for that methodology are detailed below.

4.4 METHODOLOGICAL JUSTIFICATION

Justification for methods chosen can be summarised as follows:

- The commissioners[1] of the research in both organisations were anxious that all employees should be given the opportunity to take part;
- Relatively little time was to be afforded to individuals for taking part in the study, usually during team or safety briefing meetings;
- Previous employee surveys had been well received by the workforce; and
- Previous research into safety culture and climate employed mainly quantitative techniques with some success (described in Chapter 3).

Dane (1990) suggests that survey techniques, including questionnaire methods, are some of the most established in the researcher's repertoire and those with which people are most familiar. Remenyi et al. (1998) point out that, in applied business and management research, evidence for the purposes of testing empirical generalisations is collected by means of such a technique or measuring instrument (Oppenheim, 1966). This is well established as a deductive research methodology (Remenyi et al, 1998); the most commonly used method of data collection in field research (Stone, 1978). This has been the case in much of the safety culture and climate research reviewed in Chapter 3. There it was noted that studies of climate, both in organisations generally, and related specifically to safety, have been typified by the use of quantitative survey techniques (Denison, 1996).

[1] In each participating organisation the research was commissioned by group level safety managers

James and Jones (1974) describe three different approaches to the assessment of organisational climate and, in doing so, offer commentary on its different (conceptual) loci. First, is the 'multiple measurement-organisational attribute approach' which regards organisational climate exclusively as a set of organisational attributes (or main effects), measurable by a variety of methods; for example organisational structure or organisational systems measured by propriety audit systems. Second, there is the 'perceptual-organisational attribute approach', which views organisational climate as a set of perceptual variables which are still seen as organisational effects, for example views of the organisation's commitment, safety performance, etc. Finally, there is the 'perceptual measurement-individual attribute approach', which captures organisational climate through perceptions of individual attributes, for example individuals' feelings and attitudes towards organisational issues, etc. The last of these is the most common approach taken using a questionnaire survey method, and, as discussed in Chapter 2, provide an indicator of climate.

Glendon and McKenna (1995) suggest that typical measures of safety culture and climate involve the surveying of workforce attitudes and the extraction of key elements from those surveys. Quantitative surveys are, in light of the research discussed in Chapter 3, an established and, to some extent, proven method for studying safety climate. In addition questionnaire studies have many advantages, including the ability to approach large numbers of subjects in a short time (a prerequisite in this case) and responses appearing in a standard format making analysis easier (Dane, 1990). Despite the fact that this research focuses on safety climate, the debate on which technique to use cannot, however, rest there. Safety climate is being viewed here as an indicator of organisational safety culture and as such the suitability of quantitative techniques for the study of culture needs to be discussed in detail.

Schein (1999) highlights three reasons why culture surveys do not in fact measure culture as:

1. The researcher does not know what to ask;
2. Asking about shared processes is ineffective; and
3. What employees complain about may be unchangeable.

The first of these issues is perhaps the easiest to deal with. Schein (1999) argues that culture covers all aspects of what an organisation learns over its history and to design a questionnaire that covers all possible external and internal dimensions would necessitate several hundred questions with no way of knowing which dimensions are the important ones in a particular organisation. The broader concept of organisational culture is considered to be a learned phenomenon, which varies from one population group to another (Schien, 1985; Smircich, 1983). Furnham (1997) explains some of this variation in terms of the societal, environmental and historical influences on the organisation or group, for example the evolution of an organisation might have some effect on its culture. This can also be the case for the organisation's safety culture, consistent with the models in Figures 3.1 and 3.2 presented in Chapter 3 (IAEA, 1991; Cox and Cheyne, 1998). The approach taken here aims to overcome these factors by basing the design of the survey instrument on the views of a sample of the organisations' members.

The second of Schien 's (1999) points is not so straightforward. He suggests that it is not easy for anyone to access shared tacit assumptions, so the use of questionnaires is based on faulty logic in the first place. Culture, as a group phenomenon, is far easier to study in groups by asking broad questions about different areas of organisational functioning and examining consensus among the members of the group. Some attempt can be made, however, to gauge consensus by calculating levels of agreement in responses. As noted earlier, agreement is what is held to distinguish individual and organisational climate (Joyce and Slocum, 1982), and examining agreement within groups will highlight areas of consensus. This type of examination has already been used to suggest that common, or sector wide cultures for safety might exist (Williamson et al., 1997; Mearns et al., 1998)

Schein's (1999) third criticism, that the things employees complain about may not be changeable, might be less a function of the data collection model and more a specific organisational problem. Survey methods do, however, have some value in identifying whether the espoused values are being met or not, and the data can show areas where they are not being met. Schien (1999) notes that if the organisation cannot or will not make the changes that the employees expect, the end result could well be a drop in morale as employees discover that what they hoped for is not happening. One solution to this problem is implementation of a thorough feedback and follow-up process (Cox and Cox, 1996), where problem areas are investigated and respondents informed of the process and outcomes. The commissioners of this research were committed to using its results to encourage just such a purpose (see Section 4.2).

Drawbacks can, to a degree, be minimised in the design and analysis of the survey. A thorough design process, taken with the advantages of using a large-scale questionnaire method, help justify its use in this case. The stages involved in the design and analysis of such an instrument and outlined in the next section.

4.5 THE NATURE OF A QUANTITATIVE INSTRUMENT

Surveys are concerned with the planned collection of data for the purpose of describing or predicting actions or for assessing relationships between certain variables (Oppenheim, 1992). The function of the questionnaire within a survey is one of measurement, in this case the measurement of attitudes to safety issues. As noted above, the design of the measurement instrument is crucial. The success of the instrument in addressing the research question is dependent on the ability to accurately and reliably operationalise unobserved constructs (Hinkin, 1995). Cox and Cox (1996) suggest that attitude measurement using a survey instrument, in an applied setting can be characterised as a five-step process. This process is illustrated in Table 4.1.

4.5.1 Initial discussions

The design of the measurement instrument is centred on core issues to which individual questions, or items, are related (Dane, 1990). These issues are often the product of both literature review and qualitative research within the organisation. Some broad issues for this research have been identified from the literature discussed in the opening chapters, however, further clarification is needed to ensure that the researcher knows what to ask and the questionnaire items are appropriate to the organisational context (Schein, 1999). This clarification can be obtained through consultation with members of the target population (in this case, members of the organisation) in order to generate survey items.

Table 4.1
Attitude measurement: a five stage process (from Cox and Cox, 1996)

Stage	Process
1 Initial discussion framing issues and planning design	Focus groups or representative discussions with a sample of respondents.
2 Pilot study/development	Development of attitude statements and pilot questionnaire instrument. Distribution to a small sample, reliability studies and subsequent refinement.
3 Distribution and data collection	Refined questionnaire distribution to test population and data collection
4 Data analysis	Data coding and analysis using computer-based statistical packages.
5 Feedback	Feedback in one or more of several forms including written, verbal and formal presentations

In item generation the primary concern is content validity which may be seen as the minimum psychometric requirement for measurement adequacy (Schriesheim, et al. 1993). Items and areas of interest can be identified in two ways; using a deductive, or 'classification from above', approach, or an inductive, or 'classification from below' approach (Hunt, 1991). The first approach requires an understanding of the theoretical area and items are developed from that understanding. The second approach involves asking a sample of respondents to provide descriptions of how they feel in relation to an organisational issue using qualitative techniques such as interviews, brainstorming and focus groups (Remenyi et al., 1998). Responses from this approach are classified into categories by means of content analysis (Holsti, 1969).

Once the items and/or areas to be studied have been identified it is possible to define the concepts to be measured and the manner in which they will be measured. At this point the first draft of the survey instrument can be designed.

4.5.2 Pilot and Development Work

This design stage culminates in the production of the final questionnaire for use with the target population. The first task to be approached is the exact nature of the survey items that reflect the concepts identified in the previous stage. Oppenheim

(1992) lists a number of basic rules to be followed when wording questionnaire items, including:

- Avoid double-barrelled questions, that is, questions with two possible meanings;
- Keep questions relatively short;
- Avoid double negatives;
- Use simple words;
- Beware of alternative usage; and
- Beware of 'leading' questions.

At this stage the use of reverse-scored (or negatively worded) items should be considered as recommended in the measurement literature (Pedhazur and Schmelkin, 1991). Such items are employed in an attempt to attenuate response pattern bias (Idaszak and Drasgow, 1987), although their use has been shown to reduce the validity of questionnaire responses in some cases (Schriesheim and Hill, 1981) and may introduce systematic error to a scale (Jackson, et al., 1993). An examination of studies using negative items (Hinkin, 1995), however, did not reveal any patterns of problems in the subsequent analysis of these items.

When the items have been compiled they should be subjected to a sorting process which serves as a first pre-test. This permits the detection of redundant and inconsistent items (Hinkin, 1995). The sorting task requires intellectual ability rather than work experience in this instance and it may, therefore, be appropriate to use students and/or experts for this task (Schriesheim and Hinkin, 1990).

The nature of the response mechanism is the next issue to be tackled. It is possible to give respondents the opportunity to make a free response to each item, or, as is most popular in the case in large scale attitude surveys, to include a numerical scale to quantify responses (Remenyi et al., 1998). One of the most common ways of measuring attitudes, used in many of the studies discussed in Chapter 3, is to present the respondent with a statement reflecting a favourable or unfavourable attitudes and ask them to what extent they agree with it on a numerical scale. This scale can range from, for example, 'strongly agree' to 'strongly disagree'. Likert (1932), who suggested the use of several such items to form a scale measuring a particular attitude, first proposed this method.

A primary concern of Likert scales is making sure that all items measure the same thing, or the scale is uni-dimensional (Oppenheim, 1992). Typically Likert scales comprise a minimum of three questions and a maximum of around 30 (Remenyi et al., 1998), although too many items can lead to problems of respondent fatigue and response bias (Anastasi, 1976). In terms of questionnaire construction, the use of Likert scales means that a pool of items need to be constructed to form a scale for each of the issues under consideration. Finally, the use of this technique is based on the assumption that the scales have the properties of interval scales, that is that the differences in the numbers can be interpreted meaningfully. In practice this means that we should be able to say that the conceptual distance between any two points on the scale is the same, and without making this assumption many statistical procedures would not be appropriate for the data collected in this manner.

In addition to 'closed' Likert scale items it is also possible to collect more qualitative data by the addition of open-ended questions. The inclusion of at least one item of this type provides supporting evidence for the more quantitative data (Cox and Cox, 1996) while ensuring response times are not greatly increased. Wherever possible qualitative open response data will be used to support questionnaire findings.

After questions have been worded, scales constructed and the layout of the questionnaire have been defined a series of further pilot studies should be conducted to detect possible shortcomings in the design and administration of the instrument (Emory and Cooper, 1991). These pilot studies provide the opportunity to asses the clarity of the instruction and questions, the face validity, or relevance, of the items, the quality of the data obtained and the time taken to administer the questionnaire. As well as these issues, pilot studies also help assess the reliability of the items through the comparison and correlation of two sets of responses from the same individuals over a period of time. Test-retest assessments of stability are only appropriate in those situations where the attribute being measured is not expected to change over time (Stone, 1978) and the time period between responses is long enough to rule out memory bias (Dane, 1990). A further reliability concern, that of consistency of the items in a scale, can be addressed when the underlying structure of the items has been established (described in the Data Analysis section). The result of the pilot studies will be a refined questionnaire with simple questions which have been judged relatively valid and reliable.

4.5.3 Data Collection

There are numerous methods of data collection; those most commonly used in questionnaire based studies fall into two categories:

- the interview, including
    - the personal interview, and
    - the telephone interview; and
- the self-administered questionnaire, including
    - the direct mail questionnaire,
    - the computer administered questionnaire; and
    - the group administered questionnaire.

Oppenheim (1992) contrasts the interview schedule versus the self-administered questionnaire and points out that, although each interviewer may work to a standardized questionnaire, information bias may occur in multi-researcher studies. The advantages of interviewer based studies however include the flexibility effect and the possibility of supporting responses. The chief advantage of direct mail, or self-administered questionnaires is that they are light on resources; however, the main disadvantage is the paucity of response (typically 40-60%). Response rate in this research, however, might be expected to higher since the survey is sponsored by the organisations who will encourage their members to complete and return questionnaires.

Several other aspects of administration need to be considered at this stage, including the nature of distribution to respondents and the issue of confidentiality of responses. Schein (1999) notes that having to give employees an anonymous survey surrounded by all kinds of procedures to ensure that no one is identified says more about the deep assumptions of the organisation's culture than any statistical analysis of the responses. He suggests that the need to keep things anonymous, the potential threat of punishment if an employee gives negative information, and the secrecy surrounding the whole project has implications for an assessment of organisational culture. On the other hand assurances of confidentiality may allow some employees to be more open in their responses; if even one additional response is encouraged by the promise of anonymity then it may be worthwhile. In any event each respondent should be notified of the time by which the survey should be completed and how it should be returned (Remenyi et al., 1998). In an applied setting, many of these issues are influenced, if not decided, by the commissioning organisation.

4.5.4 Data Analysis

After the collection of data the analysis should be planned to ensure the research question is answered. The design of the qualitative instrument described in the preceding sections will lend itself to detailed statistical analysis after the responses have been coded. There are several levels of analysis to which the data can be subjected, each providing different types of information. Initially the data are described. Descriptive statistics, such as those describing central tendency and spread, convey summary information about data sets containing large numbers of responses (Clegg, 1982). A further level of statistical analysis that questionnaire data might be subjected to is an exploration of their underlying structure, or in terms of Likert scaling, an examination of the dimensionality of the measurement instrument. This is achieved by the use of factor analytical techniques which are described in detail later (Section 4.6).

When the structure of the measurement instrument has been identified, and the internal consistency of scales examined, a further level of analysis can be carried out. Inferential statistics can be calculated to examine differences and similarities between the scores of different sub-samples, on each of the scales produced in the factor analytic analysis. These differences and similarities can be examined using techniques such as t-tests, one-way analysis of variance (ANOVA), and multivariate analysis of variance (MANOVA) in order to compare group means uncover any differences in attitudes.

4.5.5 Feedback

The final stage in Cox and Cox's (1996) attitude measurement process involves the provision of feedback to those who have taken part in the survey. This may take the form of formal presentation or written summaries, but it is important to keep participants informed of the use their responses will be put to (Remenyi, et al., 1998) and, wherever possible notify them of the results. In applied research the feedback process needs to be managed carefully both to avoid false expectations being raised as a result of the research outcomes (Schein, 1999) and also to afford the commissioners of the research an opportunity to investigate, plan and communicate responses to the survey results. In this case all three participating organisations decided from the outset that the feedback process would form an integral part of the survey. The importance of demonstrating to employees that an interest is being taken was first noted in the Hawthorne studies (Mayo, 1933; Roethlisberger and Dixon, 1939) where it was found to have a positive effect on work performance. The fact that the survey was being conducted in the first place illustrated that the organisations took views on safety issues seriously and it is important to let respondents know the outcome of their participation.

An important phase in the application of a survey instrument is the examination of its underlying structure. This relates to several of the measurement stages described above; the areas of interest outlined in the initial discussions can be verified, Likert scales can be constructed to reflect these areas, the data can be described in term of underlying dimensions, and these can be used to provide meaningful feedback.

4.6 DESCRIBING THE INSTRUMENT'S STRUCTURE

The most common approach to identifying hypothetical or latent constructs from a set of self-report or behavioural data has been the use of factor analytic techniques (Ferguson and Cox, 1993). Factor analysis consists of a number of techniques that aim to simplify complex sets of data. Analysis is usually applied to correlations between variables (Kline, 1994) in an attempt to reduce those variables to a more manageable number of latent, or underlying, constructs. Factor analytical techniques can be divided into two broad varieties, exploratory and confirmatory, both of which are employed in this research and described in detail below.

4.6.1 Exploratory Factor Analysis

As the name suggests, an exploratory approach is appropriate if there is no, or a weak, theoretical structure to the instrument and it is necessary to separate continuous variables into groups that measure single dimensions of a multi-dimensional concept (Ferguson and Cox, 1993; Kline, 1994). It is appropriate in this research since there is only an outline structure, provided by the review of instruments in Chapter 3 and potentially by the initial discussions framing the development of the instrument, which needs to be explored. This outline structure is important, however, since Comrey (1978) suggests that a theoretically driven structure should be proposed to ensure that exploratory factor analysis is used in a scientific manner. Ferguson and Cox (1993) advocate the use of simple indicators, such as a variable/factor 'hit' score in order to evaluate the original theoretical structure at a crude level. A more rigorous hypothesis testing procedure is offered by confirmatory factor analysis (discussed later).

A number of stages have to be followed in the practical application of exploratory factor analysis. Kim and Mueller (1994) propose that these stages include data preparation, factor extraction and factor rotation. There are a number of alternative strategies for the completion of each stage and these are described below together with the approach taken in this research.

4.6.1.1 Preparation

Ferguson and Cox (1993) suggest that the pre-analysis stage of exploratory factor analysis is one of the most important, but often most overlooked. It is vital if the analysis is to be technically adequate and the results not misleading (Cattell, 1978). In order to provide reliable and stable factors the sample from which the data is obtained must not only be fully representative, but also of sufficient size. Various absolute minimum sample sizes have been suggested, ranging from 100 (Kline, 1994) to 300 (Guadagnoli and Velicer, 1988), with general consensus being the larger the sample the more stable the solution.

Missing data can, however, have an effect on the data set to be analysed. There are at least two options for the treatment of missing data; an estimation can be made to replace the blank variables, or the cases which include missing data can be deleted from the analysis (Rummel, 1970). The most common way of replacing missing variables is by the insertion of the variable average value, referred to as mean substitution. Inserting the average value will, however, lower the correlations and covariances of the variable, and therefore underestimate its true value (Rummel, 1970). Removal of cases where missing values occur is a simpler approach but may result in a drastic reduction in cases if missing data is spread throughout the data set (Rummel, 1970). Before a decision can be made on the manner in which to treat missing data, their frequency and spread should be established. If missing data is concentrated in relatively few cases and the loss of these does not adversely affect the representativeness of the sample, then removal may be the most expedient option.

Related to the appropriate sample size are other heuristics that should be considered before analysis. Firstly the ratio of subjects to variables needs to be examined. For algebraic reasons it is essential that there are more subjects than variables (Kline, 1994) and claims have been made for minimum ratios between 2:1 (Kline, 1994) and 10:1 (Nunally, 1978). It has been claimed, however, that the subject to variable ratio is less important than the second heuristic, the subject to factor ratio, which should be more than 20:1 (Arrindal and van der Ende, 1985). The final heuristic is related to the other two and deals with the relative proportion of variables to factors. Cattell (1978) has suggested that the minimum values for this ratio should be between 2:1 and 6:1. With all these rules the larger the ratio the more stable the factor solution is held to be. In an exploratory analysis it may be difficult to ensure that the second and third rules are satisfied. In this case, however, there is a broad outline of potential factors, which will allow these ratios to be checked.

In addition to taking steps to ensure the stability of the factor solution, the data set, and the correlation matrix derived from it, should be appropriate for the application of exploratory factor analysis. Exploratory techniques require that the variables to be used conform to a normal distribution (Ferguson and Cox, 1993). This can be ascertained by examination of skew (describing the symmetry of the distribution) and kurtosis (describing how peaked the distribution is). Muthen and Kaplan (1985) have argued that some degree of skew and kurtosis is acceptable if neither exceed a value of +/- 2. Ferguson and Cox (1993) suggest that if more that 25% of variables exceed this value then those variables should be transformed. On the other hand, if 25% or less of the variables are affected it is believed that the factor solution will not be adversely affected. Muthen and Kaplan (1985), however, argue that transformation is not necessary when there are many low correlations in the initial matrix. If transformation is appropriate then logs, square roots and reciprocals can be used.

The final pre-analysis consideration is the appropriateness for analysis of the correlation matrix. Dzuiban and Shirkey (1974) propose that if correlation among the variables cannot be demonstrated then the results of the factor analysis are not interpretable. They suggest that two statistics should be examined; the Kaiser-Meyer- Olkin (KMO) test of sampling adequacy and the Bartlett test of sphericity (BS), based on chi-square (Dzuiban and Shirkey, 1974). The KMO indicates whether associations between variables in the matrix can be accounted for by a smaller set of factors and a minimum value of 0.5 is required. The BS tests the null hypothesis that no relationships exist between the variables and a significant result indicates that there are relationships to be examined. Once the sample, data and correlation matrix have been examined and found to be appropriate, factors can be extracted.

4.6.1.2 Extraction

The purpose of extraction is to identify and retain factors which are necessary to adequately reproduce the initial correlation matrix and this forms the second major step in the exploratory factor analysis process (Kim and Meuller, 1994). At this stage the extraction method and number of factor to be extracted are considered. There are a number of algorithms available to allow the extraction of factors and these are based on either an identification of principal components, dealing with variance, or common factor analysis which is concerned with the covariance of the initial matrix (Ferguson and Cox, 1993). The various extraction methods are discussed in detail by Kim and Meuller (1994), although in practical terms the different methods of condensation give remarkably similar results (Kline, 1994). The most common practice, recommended by Ferguson and Cox (1993) and Kline (1994), is to apply principal components analysis, which tends to produce a large general factor and a series of smaller bipolar factors in the initial solution. Principal components is used in this research for the initial extraction of factors.

Attaining a simple structure depends on the number of factors which are extracted and subsequently rotated. The most widely used method of arriving at a solution to this is the Kaiser 1 (K1) rule. This rule extracts as many factors as there are eigenvalues greater than one. An eigenvalue is the sum of squares of the factor loadings for each factor and it reflects the proportion of variance explained by each factor. Although popular, it has been argued (Cattell, 1978; Zwick and Velicer, 1886) that this rule leads to over-factoring, that is it retains more factors than optimally required. This can be overcome by examination of the scree test (Cattel, 1966). Kline (1994) suggests that most factor analysts agree that the scree test is one of the best solutions to selecting the correct number of factors. This test involves plotting eigenvalues against factor numbers. The plot is then examined and where a break is apparent is the number of factors to be extracted. Some Monte Carlo studies indicate that this method is superior in locating major factors (Linn, 1968; Tucker et al, 1969). One objection is that the scree test is objective and may contain more than one break in gradient. Kline (1994) suggests that it is sensible to compare the scree test with results from the K1 rule and both are employed in this research. When the correct number of factors have been extracted the structure should be rotated to simplify interpretation.

4.6.1.3 Rotation

The aim of rotating the factor structure is so that each variable should have a high loading on one factor and zero, or low, loadings on the others (Kim and Meuller, 1994). The initial solution, especially if arrived at using principal components analysis, will comprise one large general factor and smaller bipolar ones which will be difficult to interpret. Rotation moves the factors through Euclidean space until a simple structure is achieved. Mathematical rotation of factors can be either orthogonal or oblique. Orthogonal rotation attempts to achieve a simple structure by assuming that the factors are independent while oblique rotation allows for a degree of correlation among the factors (Kline, 1994). Gorsuch (1983) recommends that an orthogonal rotation be used as default option, although Ferguson and Cox (1993) make further recommendations. They suggest that an orthogonal rotation be applied if a single analysis of primary factors is required. Oblique rotation, on the other hand, is useful if a series of higher order analyses are required, and degrees of relatedness (delta value) need to be specified when using this rotation. An orthogonal rotation seems appropriate in this case since the primary order of sub-scales is of interest in this research, although it can be argued that the factors are all related to safety issues and an oblique rotation is suitable. It is not uncommon, however, for both types of rotation to produce similar results (Gorsuch, 1983), and both types of rotation will be used and their results compared. Of the orthogonal procedures, Varimax rotation is recommended by most factor analysts (Kline, 1994), since it produces factor loadings which are either high or near to zero, a crucial feature of a simple factor structure. Direct Oblimin is the most commonly used of the oblique rotational procedures and Ferguson and Cox (1993) recommend that several oblique analyses are completed specifying different degrees of factor correlation (delta values).

The final consideration in achieving a simple structure is the magnitude of loading that is acceptable for variables to define a factor. Factor loadings represent the correlations of the variables with the overall factor. Kline (1994) suggests that a factor loading of 0.3 (indicating that 9% of variable variance is accounted for by the factor) is large enough to indicate salience. Ferguson and Cox (1993), however, advocate a loading of 0.4 or more for a variable to define a factor. Cross-loading (that is high loadings on two or more factors) variables indicate that items are related to more that one factor. If it is important that factors are distinct, Ferguson and Cox (1993) suggest that cross-loading variables be removed unless the difference in magnitude of the loadings is greater than 0.2. In that case the item can be said to load on the factor for which it has the highest loading.

4.6.1.4 Additional Issues

The procedures described above provide a model with distinct factors in a simple structure. Two further practical issues remain. The first relates to the internal consistency of the scales produced by the analysis. The most commonly accepted measure of internal reliability is Cronbach's Alpha (Price and Meuller, 1986). A value of 0.7 and above is recommended for this coefficient (Nunnally, 1978) to denote that a scale is internally consistent.

The second issue concerns the naming of factors. This is important since the name attached to a factor will effect how it is conceptualised and how links to other variables are theorised (Ferguson and Cox, 1993). The broad theoretical hypothesis outlined in Chapter 3, taken together with the results of the initial discussions framing the research, will guide factor naming in this case. Rummel (1970), however, lists a number of considerations which will be taken into account when naming the factors in this research. These include:

- Items that do not load on a factor may be important in describing what the factor is not;
- Items with high loadings may help distinguish the factor;
- Reversing loading may help to interpret the factor; and
- Attaching adjectives to variable aids the description of a factor.

Exploratory analysis will be used in the manner described above to uncover the structure in one sample in this research. Subsequent comparison of that structure will be achieved using a confirmatory approach.

4.6.2 Confirmatory Factor Analysis

In confirmatory factor analysis the researcher postulates a model (a particular set of linkages between the observed variables and their underlying latent variables or factors) and then tests this model statistically, examining the degree to which it fits with the available data. In its confirmatory approach, factor analysis is concerned with implementing a theorist's hypothesis about how a domain of variables may be structured based on an established model. Many psychologists believe that confirmatory factor analysis is, in principle, superior to the exploratory method because it tests hypotheses, which is fundamental to the scientific method (Kline, 1994). This analysis does only test the appropriateness of the proposed factor structure model and not an infinity of possible models which may also fit the data; the proposed model, therefore, needs a sound rationale. In this research confirmatory factor analysis will be used to determine factor congruence (Ferguson and Cox, 1993) both by confirming the results of the exploratory analysis in the original sample (congruence by method) and across different organisations (congruence by sample), and will be conducted using structural equation modelling.

Structural equation modelling (SEM) is a multivariate statistical methodology which takes a confirmatory approach to the analysis of a structural theory (Byrne, 1994). This technique attempts to identify explicative relationships between variables. These relationships are represented by a series of simultaneous structural equations, which can also be modelled pictorially. SEM offers a comprehensive statistical approach to testing hypotheses about relationships among observed and latent variables (Hoyle, 1995). General structural equation models comprise two components: the measurement model and the structural model. The measurement model is that part of the general model where latent variables, or factors, are prescribed. The structural model deals with relationships between the latent variables (Kline, 1994). Confirmatory factor analysis makes use of only the measurement model. Structural models of latent variables are also employed in this research and are outlined later (Section 4.6.3).

Long (1983) has outlined the four stages involved in a confirmatory factor analysis using SEM. These cover the specification of the model, its identification, model estimation and finally the assessment of model fit. The procedures involved in each of these stages are described below, together with their application to the research described in this thesis.

4.6.2.1 Specification

SEM begins with the specification of the model to be estimated. This is the exercise of formally stating the model and no analysis can take place until a model of relationships among variables has been specified (Hoyle, 1995). The set of variables within a given model includes both measured variables and latent variables, or factors. Latent variables are often central in research in behavioural and social sciences (MacCallum, 1995). In the general class of models, measured variables typically serve as approximate measures, or indicators, of latent variables, as in exploratory factor analysis. In a structural equation model it is desirable for each latent variable to be represented by several distinct indicators. Similar to exploratory analysis, the latent variable is defined as whatever its multiple indicators have in common with each other. Without multiple indicators we rely on single error-perturbed measurement variables to represent constructs of interest. This approach is problematic in that constructs are not well defined and estimates of effects among constructs are biased by the influence of error of measurement.

Given a set of measurement and latent variables, a model postulates a pattern of linear relationships among these variables. Within the model there exist two types of relationships: directional and non-directional (MacCallum, 1995). Directional relationships represent hypothesised linear directional influences of one variable on another. Non-directional relationships represent hypothesised correlational associations between variables, with no attempt to postulate direction of influence. Model specification requires that the researcher specify a pattern of directional and non-directional relationships among the variables of interest. In a confirmatory factor analysis it is the directional effects between measured and latent variables that is the focus of the model.

Each of these associations can be thought of as having a numerical value associated with it. Numerical values associated with directional effects are values of regression coefficients; that is, weights applied to variables in linear regression equations. These weights can be thought of as parameters of the model. A major objective in applications of SEM is to estimate the values of these parameters. Parameters are typically specified as either fixed or free (Hoyle, 1995). Fixed parameters are not estimated from the data and their value is usually set at zero (signifying that there is no relationship). Free parameters are estimated from the data and denote where a non-zero relationship is believed to exist.

Furthermore, each variable in the system can be designated as either an endogenous or an exogenous variable. An endogenous variable is one that receives a directional influence from some other variable in the system. An exogenous variable is one that does not receive a directional influence from any other variable in the system. Exogenous variables are typically associated with one another by non directional relationships, but such associations are not required, and exogenous variables typically exert directional influences on one or more endogenous variables

(MacCallum, 1995). In the case of confirmatory factor analysis, the measured variables are exogenous and the latent variables are endogenous. An important feature of an endogenous variable is that it is not viewed as being perfectly and completely accounted for by those exogenous variables hypothesised to exert directional influences on it. Therefore, each endogenous variable is defined as also being influenced by an error term, which represents that part of the endogenous variable that is not accounted for by the linear influences of the other variables in the system.

In this research the non-zero relationships between the measured and latent variables in the confirmatory model will be defined by the results of the exploratory factor analysis.

4.6.2.2 Identification

A fundamental consideration when specifying models in SEM is identification. Identification concerns the correspondence between the information to be estimated (the free parameters) and the information from which it is to be estimated (the observed variances and covariances). More specifically, identification concerns whether a single, unique value for each and every free parameter can be obtained from the observed data (Hoyle, 1995). If a value for each free parameter can be obtained through only one manipulation of the observed data, then the model is just identified and has zero degrees of freedom. If a value for one or more free parameters can be obtained in multiple ways from the observed data, then the model is overidentified and has degrees of freedom equal to the number of observed variances and covariances minus the number of free parameters. If a single, unique value cannot be obtained from the observed data for one or more free parameters, then the model is underidentified and cannot be estimated. The model must therefore be examined to determine if it is either just identified or overidentified before analysis can continue, although Byrne (1994) argues that a just identified model is of little scientific interest since it has no degrees of freedom and can never be rejected. Preliminary identification will be examined in this research by calculating the number of observable elements (variances and covariances) in the confirmatory model and subtracting the number of parameters to be estimated, this is referred to as the *t-rule* (Byrne, 1994).

4.6.2.3 Estimation

Once a model has been specified and identified, the next task is to obtain estimates of the free parameters from a set of observed data. Maximum likelihood estimation has been the most commonly used approach in SEM and is recommended as a preferred method when the data are multivariate normally distributed and the sample is large (Chou and Bentler, 1995). Although maximum likelihood is based on the assumption that variables are multivariate and normally distributed, there is growing evidence that it performs well under a variety of non-optimal conditions. These include ordinal variables, and even for a very low number of categories (Chou and Bentler, 1995; Coenders et al., 1997; Hoyle and Panter, 1995). Iterative methods of estimation involve a series of attempts to obtain estimates of free parameters that imply a covariance matrix like the observed one. The implied covariance matrix is the matrix that would result if values of fixed parameters and estimates of free parameters were substituted into structural equations, which, in turn, were used to derive a covariance matrix. Iteration begins with a set of start values, tentative values of free parameters from which an implied covariance matrix can be computed and compared to the observed covariance matrix (Hoyle, 1995). Start values either are supplied by the researcher or, more commonly, are supplied by computer software, as in this case.

After each iteration, the resultant implied covariance matrix is compared to the observed matrix. The comparison between the implied and observed covariance matrices results in a residual matrix. This residual matrix contains elements whose values are the differences between corresponding values in the implied and observed matrices. Iteration continues until it is not possible to update the parameter estimates and produce an implied covariance matrix whose elements are any closer in magnitude and direction to the corresponding elements in the observed covariance matrix. At this point the estimation procedure is said to have converged. Convergence problems are not uncommon with models that have many free parameters, with models estimated from ill-conditioned, that is non-normal, data. In this area, much of what was discussed as desirable sample and data characteristics for exploratory factor analysis also holds true for confirmatory analysis (Ferguson and Cox, 1993).

When the estimation procedure has converged on a solution, a single number is produced that summarises the degree of correspondence between the implied and observed covariance matrices. That number, sometimes referred to as the value of the fitting function (Hoyle, 1995), approaches zero as the implied covariance matrix more closely resembles the observed covariance matrix. A perfect match between the two matrices produces a value of the fitting function equal to zero. The value of the fitting function is the starting point for constructing indexes of model fit and assessing the model.

4.6.2.4 Assessment of Fit

A model is said to fit the observed data to the extent that the covariance matrix it implies is equivalent to the observed covariance matrix (that is, elements of the residual matrix are near zero). The question of fit is a statistical one that must take into account features of the data, the model, and the estimation method (Hoyle, 1995). For instance, the observed covariance matrix is treated as a population covariance matrix, yet that matrix suffers from sampling error, which increases as sample size decreases. Also, the more free parameters in a model the more likely the model is to fit the data because parameter estimates are derived from the data.

The most common index of fit is the chi-square (χ^2) statistic, which is derived directly from the value of the fitting function. It is the product of the value of the fitting function and the sample size minus one, $F(N-1)$. That product is distributed as χ^2 if the data are multivariate normal and the specified model is the correct one. A non-significant and small χ^2 value indicates that the observed data are not significantly different from the proposed model. A significant chi-square test would cast doubt on the model specification (Bollen and Long, 1993). This test, however, presents several problems, especially its dependence on sample size. As sample size increases nearly all models are evaluated as incorrect (Bentler and Bonnet, 1980). Hence other indices, based on different rationales that correct for this problem, have been developed. No single index seems sufficient for a correct assessment of fit (Hu and Bentler, 1995; Marsh et al., 1988) and researchers are advised to use a variety of indices from different families (Marsh et al., 1996; Tanaka, 1993).

Growing dissatisfaction with the χ^2 goodness-of-fit test has led to the generation of a growing number of adjunct fit indexes, descriptive indexes of fit that often are intuitively interpreted (Hoyle, 1995). Absolute fit indices directly assess how well a model reproduces the sample data. The goodness-of-fit index (GFI) performs better than any other absolute index (Hoyle and Panter, 1995; Marsh et al., 1988) and has been included in the results reported here. The GFI has only a small bias due to sample size compared with other absolute fit indices. Incremental fit indices measure the proportionate improvement in fit by comparing a target model with a restricted baseline model, usually a null model in which all the observed variables are independent. The Tucker-Lewis index, or non-normed fit index (NNFI), a type 2 incremental fit index, and the comparative fit index (CFI), a type 3 incremental fit index, have been included here, following recommendations by Marsh et al. (1996). A value of 0.9 for all of these indices has been proposed as a minimum for model acceptance (Bentler and Bonnet, 1980, Hoyle, 1995).

Finally, the Root Mean Square Error of Approximation (RMSEA), introduced by Steiger and Lind (1980) is also used as a fit index. This index is computed based on sample size and the noncentrality parameter and degrees of freedom for the target model (Browne and Cudeck, 1993; Steiger, 1990). MacCallum (1995) argues that the RMSEA is probably better than any other index where models are extremely parsimonious, because it measures the lack of fit per degree of freedom. A value of the RMSEA up to 0.05 would indicate a good model fit; a value of about 0.08 or less would indicate a reasonable error of approximation; and values greater than 0.1 indicate poor model fit (Browne and Cudeck, 1993).

All of the features associated with the measurement model, focussed on confirmatory factor analysis outlined above, are also important in the analysis of the structural component of the structural equation model

4.6.3 Structural Modelling

Structural modelling of the latent variables (described in the factor analytic stage of analysis by their individual predictors) can be employed to explore the patterns of relationships within the overall data set. The structural component part of the general model prescribes the hypothesised relationships between latent variables and observed variables which are not indicators of latent variables (Hoyle, 1995). Following the principles outlined above, such relationships can be either directional or non-directional, and each latent variable can be defined as either exogenous or endogenous. A multiple regression model can be used employing constructed factor scores and not latent variables but this approach has been found to have strong biases compared to latent variable models (Oliver et al., 1999). When the measurement model (which has been described above in relation to confirmatory analysis) and structural model components are combined, the result is a comprehensive statistical model that can be used to evaluate relations among variables that are free of measurement error (Hoyle, 1995). MacCallum (1995) points out, however, that observed variables included in the structural model are considered and specified to be free of error of measurement. Therefore, the presence of such error in the measurements will contaminate estimates of model parameters. Thus it is generally advantageous to employ latent variables with multiple indicators, rather than computing observed variable for use in a path analysis.

The processes involved in structural modelling are identical to those involved in assessing the measurement model, including specification, identification, estimation and assessment of model fit. Structural models with latent variables included in this research will include the measurement model used in confirmatory analysis with the addition of relationships specified between the latent variables in line with the theoretical model described in Chapter 3.

4.6.3.1 Model Modification

In addition to the general goodness of fit tests of the adequacy of a given model described above, tests on the statistical necessity of sets of parameters that might be added to a model, or deleted from the model, are also frequently needed in structural equation modelling. The chi-square difference test (D test), based upon separate estimation of two nested models, and calculating the difference between the associated goodness of fit chi-square statistics and their degrees of freedom, has, historically, provided this information. However, there are two equivalent test procedures, known as Lagrange Multiplier (LM) and Wald (W) tests, which can also be used. The LM test evaluates the effect of adding parameters (or relationships) to a restricted model (that is, reducing restrictions on the model). The W test evaluates the effect of dropping parameters from a more complete model (that is, adding restrictions to the model).

The use of improvement indices in the modelling process, such as the LM test, has recently come under a great deal of scrutiny (MacCallum, 1995; Maruyama, 1998). It can be argued that model modification is a substantial shift from the original confirmatory intent of latent variable approaches (Cliff, 1983), and that modification should only be carried out to help plan for the next study. MacCallum (1995) suggests that generating new models based on modification indices is only appropriate when modifications are substantively meaningful and theoretically justifiable. If this is not the case then modifications may be capitalising on the chance characteristics of the particular sample involved, and generalisation beyond that sample may be unstable (MacCallum et al., 1992). Accordingly, in this research modification will be made to models only when theoretically justifiable.

4.6.3.2 Multisample Analyses

In the typical application of structural modelling it is presumed that all the individuals whose data are being analysed represent a random sample of observations from a single population (Bentler, 1995). In cases where data has been gathered from individuals belonging to certain groups, it may be appropriate to inquire whether multiple populations rather than a single population are involved, and multiple structural models rather than a single model. Hypotheses on multiple populations can be evaluated when data on the same variables exist in several samples, using a mutisample analysis. Byrne (1994) suggests that researchers test for evidence of multigroup invariance in order to answer one of five questions. First, do the items comprising a particular measuring instrument operate equivalently across different populations? Second, is the factorial structure of an instrument equivalent across populations? Third, are certain paths in a specified structure invariant across populations? Fourth, are the latent means of particular constructs in a model different across populations? Finally, does the factorial structure of a measuring instrument replicate across independent samples of the same population? These questions relate to the issue of cross-validation. In this thesis multisample analyses are employed to test, where possible, the invariance of factor structures across groups and the invariance of structural models across samples.

Multisample analysis is done by fitting an ordinary model in each sample or sub-sample, but in a single run simultaneously for all groups. This is done while taking into account that some parameters are the same in each of the samples, for example the factor loadings in the measurement model, or the factor relationships in a structural model. This type of analysis produces a single chi-square goodness of fit statistic, which evaluates the joint hypothesis that groups have equal loadings and/or relationships. Practically, multisample analysis involves the assessment of a baseline model where no constraints of invariance are imposed, and then a series of models where constraints are imposed on the equality of factor loadings and factor relationships between groups. Constrained models are then compared with the baseline model to evaluate whether or not constraints have been properly imposed. The LM test in a multisample analysis indicates which of the constraints of equality should be released in order to improve model fit, and therefore give an indication of where loadings and/or relationships are not the same in each sample.

4.6.3.3 Appropriateness of Structural Modelling

The use of structural equation modelling can be justified in this research for several reasons. First an underlying theoretical order identified in the review of previous studies (in Chapters 2 and 3) may be present among the factors. Furthermore, modelling with latent variables tests the relationships among factors free of measurement error. This feature is especially important if scale reliabilities are adequate but not extremely high. Including latent variables, and not simply observed factors calculated from the scales of predictors also allows the relationships among predictors (if any exist) to be accounted for within the model. Finally, a multisample structural model can analyse data from several samples simultaneously and helps to verify that a model reproduces the sample data of each group to within sampling accuracy (Bentler, 1995), allowing similarities and differences in structure between groups and organisations to be explored.

4.7 SUMMARY

Consideration of the research question, the needs of the commissioning organisations and previous research in this area has lead to a quantitative survey methodology being considered the most appropriate means of gathering data. Sound construction and analysis of the quantitative instrument are essential if any confidence is to be placed in its results, and these have been described in this chapter. Details of the development of the research instrument for application in the first of the participating organisations are given in the next chapter.

CHAPTER FIVE

Survey Instrument Development

This chapter describes the practical steps involved in developing the survey measurement instrument used to address the research question in Organisation A. It follows the initial stages of attitude measurement (Cox and Cox, 1996) outlined in the previous chapter and deals specifically with the discussions framing the phenomenon for examination, the instrument design and pilot testing. Chapter 6 details the application of this instrument in Organisation A covering the remaining stages in the attitude measurement process in that organisation.

5.1 EXPLORATORY DISCUSSIONS

In Organisation A initial discussions took place with a group of ten individuals working at both plant and divisional level. All the group members were engaged in safety management in the organisation and were, at the time, either safety managers or safety officers. The organisation operates a policy of placing all types of employees in these positions as part of individual career progression and development. As a result of this, those involved in the discussions had extensive knowledge of the organisation's operations.

The discussions took the form of a focus group. Focus group methodology, also referred to as group interview, uniquely combines elements of group dynamics and qualitative research methods to yield information (Dilorio et al., 1994) on a wide variety of issues. Focus discussion groups are a well established research technique and are particularly useful for:

- gaining information on a new field of enquiry;

- generating hypotheses based on participants' insights;
- developing survey methods; and
- evaluating research.

Focus groups are a form of group interview in which a 'moderator' facilitates discussion among group members, ensuring that the group focuses on the topic of interest. The technique is characterised by the use of the group interaction to produce data and insights that would be less accessible without the interaction found in a group (Morgan, 1988). As a group interview, focus groups sit between the two principal methods of qualitative data collection. That is, individual interviews and participant observation in groups. A further advantage of this type of data collection method is that issues may be raised that had not previously occurred to the researcher, and that may not have been covered using a set of items derived by previous research in the field (for example that outlined in Chapter 3).

The focus group borrows from individual interviewing in that the moderator directs the discussion to a greater or lesser extent and thus exerts some control over the data collected. There are a number of ways in which a moderator may structure the discussion group. At the least structured end of the spectrum, the moderator may simply present the topic to be discussed and leave it to the group to take it forward. A higher level of structure may involve a lengthier introduction followed by a series of questions.

The group in Organisation A was given an brief introduction to the topic and then asked to describe what they felt to be the elements of the organisation's safety culture which should be targeted to achieve improvements in safety performance. Members of the group first wrote down their ideas and then discussed each ides in turn. From their discussion the group identified six main elements related to safety that could be enhanced in order to help improve organisational performance. These were: management commitment, communication, personal responsibility, safety training, involvement and safety systems. These elements were mapped by the group and are shown in Figure 5.1.

Figure 5.1
Map of cultural components

Management commitment was described as including visible leadership and involvement in safety issues, as well as the priority the organisation afforded safety matters. Allied to this was the need for open and extensive communication of safety issues to all members of the organisation. The personal responsibility of individual workers was also identified as crucial to improving culture and performance and included acting safely and dealing with dangerous situations. Promoting involvement in safety activities and ensuring all employees are included, as well as targeted and appropriate safety training were seen as important ways of engaging individuals in safety. Finally transparent safety systems, including clear documentation, were thought necessary to promote safe working and enhance safety performance.

These six elements are similar to the common themes, identified in Chapter 3, from previous safety culture and climate studies. The only themes not initially suggested by the group were risk and work environment. The organisation was, however, interested in the working and hazard environment at each of the manufacturing units involved in the study. They recognised that each of the plants was different and the individual environments could influence safety activity and performance. They decided, therefore, to include assessments of the work and risk environment in the survey. With all the areas of interest identified by the initial discussions, a preliminary survey instrument could be developed to assess them.

5.2 SURVEY INSTRUMENT DEVELOPMENT

Development of the initial survey instrument was based on the areas identified by Organisation A and items for inclusion were drawn from previous work on the assessment of safety culture and climate. All parts of the instrument development process were completed in consultation with the sponsoring organisation.

The first part of the questionnaire was designed to ask respondents for basic demographic information, including occupation, plant, department and shift patterns, but not names or any other identifying feature. The information requested here was to allow comparison of responses from different plants and levels. There was no need to identify completed questionnaires and anonymity was guaranteed to encourage as many individuals as possible to respond.

The next area to be included was that dealing with the work environment. The second section included four items developed by Tomás and Oliver (1995) on basic environmental work conditions; lighting levels, ventilation, working space, and humidity. In addition to this, the sponsoring organisation was keen to get some idea of the suitability of working hours and suggested the inclusion of an item on overtime. Respondents indicated to what extent they agreed that these aspects of their working environment were satisfactory on a five point, Likert style, scale (from 1 'strongly disagree' to 5 'strongly agree'). The items in this section are detailed in Table 5.1.

Table 5.1
Working environment items

Item
1. The light levels in my workplace are adequate
2. The ventilation in my workplace is adequate
3. The space requirements for doing the task in my workplace are adequate
4. The humidity levels in my workplace are adequate
5. The level of overtime I do is adequate for me

In addition to the Likert response items regarding the work environment a workplace hazard checklist was included to gauge individual appraisals of their hazard environment. This checklist was based on i) a similar checklist developed by Tomás and Oliver, (1995), ii) a hazard listing proposed by Cox (1992), and iii) additional hazards and amendments suggested by a group of safety practitioners from the sponsoring organisation. The initial hazard checklist included 23 common hazards, for example forklift vehicle movements, using compressed gasses, slipping and tripping, working with hazardous substances, electrical hazards, etc. The full list is shown in Table 5.2.

Table 5.2
Hazard checklist items

	Hazards
1	Slipping and tripping
2	Objects falling onto personnel
3	Workplace design and layout
4	Working with hazardous chemicals
5	Working with irritant substances
6	Actions leading to repetitive strain injuries.
7	Explosion from hazardous/flammable gases
8	Ultra violet light, lasers and/or radio frequencies
9	Electrical hazards
10	Use of sharp hand tools
11	Entanglement and trapping in machinery
12	Fire potential of combustible or flammable materials
13	Use of compressed gas cylinders
14	Forklift truck operation
15	Loading and unloading of vehicles
16	Safe storage and stacking of goods
17	Manual handling of heavy goods
18	Compressed air hazards
19	Failure of pressure vessels
20	Contact with hot objects and surfaces
21	Noise
22	Working with visual display units
23	Conditions leading to hand or body vibration

Respondents were asked to rate the perceived frequency (on a scale of 0, where the hazard is never present, to 3, where the hazard is often present), the consequences (using a three point scale, 1 = slight, 2 = moderate and 3 = severe), and the existing control measures (1=adequate and 2 = inadequate) of each of these hazards. The frequency, consequence and control ratings were multiplied together to give a score for each hazard. Individual hazard scores could be added together to give an overall hazard rating varying between 0 and 414, as well as examined on an aggregate, hazard by hazard, basis for each plant.

The main section of the survey instrument contained statements about safety issues at organisational, group and individual levels, and was designed to assess the six areas defined by the group discussion described above. These statements were based on a combination of those used in previous studies by Cox and Cheyne (2000), Cox and Cox (1991) and Tomás and Oliver (1995) with the addition of some statements to suit the study sector proposed by representatives of the participating organisation. Items for each of the six areas, management commitment, communication, personal responsibility, safety training, involvement and safety systems, are shown in Table 5.3 together with their original source.

Once the items had been identified, members of the initial discussion group sorted them into the six categories, confirming their suitability for measuring the general areas. Questionnaire respondents were asked to endorse these statements using a five point Likert-type scale as used in work environment section of the questionnaire. A mixture of positively and negatively worded items was presented in this section and all 32 items were included in the draft survey instrument in random order.

The final section in the draft questionnaire presented an activity checklist in order to gain more information about individual's level of participation in safety activities. This checklist was proposed and developed by members of the sponsoring organisation and respondents were asked to indicate the frequency (if appropriate) of their involvement in 13 different safety activities; for example, being involved in site open days, or taking part in job safety analyses. These activities are shown in full in Table 5.4.

Table 5.3
Safety attitude items

Item	Source
Management Commitment	
1 Health and safety has a very high priority here	Cox and Cheyne (2000)
2 Safety jobs always get done	Tomás and Oliver (1995)
3 Management listen to safety concerns	Tomás and Oliver (1995)
4 Management are prepared to discipline workers who act unsafely	Organisation A
5 Levels of safety performance have improved here	Organisation A
6 There is a process of continual improvement in this company	Organisation A
7 Management takes the lead on safety issues	Tomás and Oliver (1995)
8 Supervisors actively support safety	Tomás and Oliver (1995)
9 The company is only interested in safety after an accident occurs	Cox and Cheyne (2000)
Communication	
10 There are good communications here about issues which affect me	Cox and Cheyne (2000)
11 I am informed of the outcomes of health and safety meetings	Cox and Cheyne (2000)
12 Relevant health and safety issues are communicated	Tomás and Oliver (1995)
13 Accidents and incidents are always reported	Cox and Cox (1991)
14 Safety issues are included in communication meetings	Cox and Cheyne (2000)
Individual Responsibility	
15 I can influence health and safety performance here	Organisation A
16 I look out for the safety of my colleagues	Cox and Cox (1991)
17 I feel that safety issues are an important part of my job	Tomás and Oliver (1995)
18 Safe working is a condition of my employment here	Organisation A
Involvement	
19 Everyone plays an active part in safety matters	Organisation A
20 Only a few people are involved in health and safety activities	Organisation A
21 I am often involved in the review of safety issues	Cox and Cheyne (2000)
22 My colleagues and I help each other work safely	Organisation A
23 Everyone on my site wants to achieve high levels of safety performance	Organisation A
Safety Training	
24 Safety training has a high priority here	Organisation A
25 I have been shown how to do my job safely	Tomás and Oliver (1995)
26 What is learnt from accidents is used to improve training	Organisation A
27 The safety training I received is not detailed enough for my job	Tomás and Oliver (1995)
Safety Systems	
28 The company makes an effort to prevent accidents happening	Cox and Cheyne (2000)
29 It is sometimes necessary to take shortcuts to get work done	Tomás and Oliver (1995)
30 On my site we have defined safety improvement objectives	Organisation A
31 As long as there are no accidents, unsafe behaviour is tolerated	Cox and Cheyne (2000)
32 Minor accidents are tolerated as part of the job	Organisation A

Respondents were particularly asked to indicate if they had taken part in any of the activities, listed in Table 5.4, in the last 12 months (where a score of 2 was assigned) or in the last 5 years (where a score of 1 was assigned). Like the hazard checklist described above, separate activity scores could be added together to give an overall safety activity rating for each individual, varying between 0 and 26, and examined on an aggregate, activity by activity, basis for each plant.

Table 5.4
Safety activities

Activity
1. Seen a safety video
2. Helped with site open day
3. Shown visitors around my job
4. Taken part in job safety analysis
5. Attended a safety committee meeting
6. Discussed safety at crew briefing
7. Took part in fire evacuation practice
8. Took part in safety promotion or competition
9. Conducted a safety inspection or audit
10. Took part in a risk assessment
11. Organised a safety activity
12. Attended a safety improvement meeting
13. Raised a suggestion to improve safety

The four sections detailed above were combined with an open question asking respondents for 'any other comments about safety issues' to form the initial pilot questionnaire.

5.2.1 Potential structure of safety attitudes

As mentioned above, the nine areas (six originally identified by the discussion group plus work environment, workplace hazards and safety activities) established by the sponsoring organisation discussion group fit into the same broad categories identified from previous safety culture and climate research, and detailed in Chapter 3. The identification of these areas within the study organisation allows the theoretical model shown in Figure 3.3, dealing with the relationships between Organisational, Social Working Environment, Physical Work Environment and Individual dimensions, to be elaborated upon. Figure 5.2 reproduces the previous figure and includes the nine areas identified in Organisation A.

Management Commitment, Safety Systems and Safety Training can be considered as being influenced at the organisational level, while Individual Responsibility and levels of Safety Activity can be considered as individual dimensions. The Hazard and Working Environments relate to the physical environment in the workplace, while Communication and Involvement are areas that are more related to group processes and the social situation at work. From this brief description it is obvious that these specific areas are related to each other. The pattern of relationships proposed in Figure 5.2 will be examined in more detail, in the first instance, in Organisation A, using the survey instrument, the refinement of which is described below.

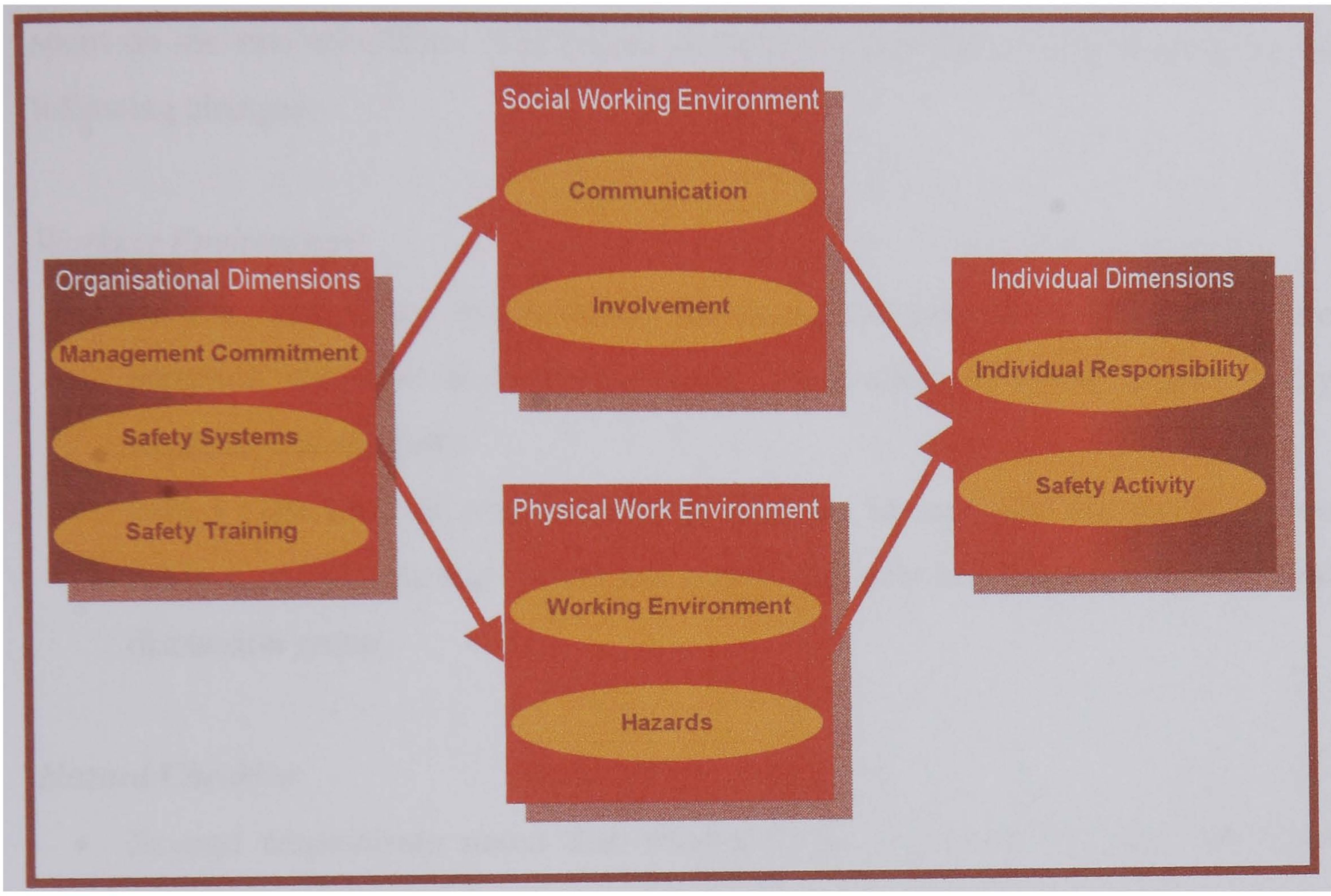

Figure 5.2
Theoretical model of safety issues in Organisation A

5.3 PILOT STUDIES

The pilot questionnaire was subjected to two initial studies; one tested the face validity of the items in particular and the survey as a whole, the other study was concerned with the reliability of the survey items.

5.3.1 Face Validity

The pilot attitude questionnaire was distributed to a number of Organisation A personnel in two locations, one was a manufacturing unit not participating in the main study, the other was group headquarters. These personnel were asked not only to complete the questionnaire but also to comment on the general content, clarity of instructions, any specific items they felt to be unclear, and the questionnaire completion time. 16 completed questionnaires were returned.

The main objective of this pilot study was to test the face validity of the items in the questionnaire with an appropriate group. Overall the pilot group felt that the instructions were clear and simple, and that the questionnaire covered the main areas of safety concerns. On average the survey took 20 minutes to complete, with most time spent on the two checklists. Comments restricted to individual items resulted in the following changes:

Working Environment

- Item 2 'The space requirements for doing the task in my workplace are adequate' was reworded and changed to 'Space allocated for doing tasks in my workplace is adequate'.
- Item 5 'The level of overtime I do is adequate for me' was highlighted as not really appropriate to this section and was deleted after consultation with the initial discussion group

Hazard Checklist

- Several respondents noted that forklift trucks were not the only hazardous vehicles in the working environment and item 14 'Forklift truck operation' was changed to 'Operations of forklift trucks and similar vehicles'

Safety Attitudes

- Item 2 'Safety jobs always get done' was clarified by changing to 'Safety specific jobs always get done'
- Item 3 'Management listen to safety concerns' was considered ambiguous and made more personal by changing to 'My manager listens to my concerns about health and safety'
- Item 5 'Levels of safety performance have improved here' was made more specific by adding a time frame and changes to 'Levels of safety performance have improved here over the last two years'
- Item 17 'I feel that safety issues are an important part of my job' was 'strongly agreed' with by all respondents and some commented that this item may only elicit a socially desirable response. This item was deleted.

- Item 21 'I am often involved in the review of safety issues' was described as 'unrealistic' by many respondents who felt that employees would regard this as referring to formal procedures and uniformly disagree with the statement. This item was deleted after discussion with members of original discussion group.

Safety Activity Checklist

- Almost all respondents considered item 7 'Took part in fire evacuation practice' redundant since everyone takes part in such an exercise on a regular basis. This item was, therefore, deleted.

This first pilot study resulted in a revised questionnaire (shown in Appendix 1), which was tested on another population in the next pilot study.

5.3.2 Test-retest reliability

The second pilot study involved distribution of the questionnaire to 35 employees in a manufacturing plant not involved in the main study. The questionnaire was distributed on two separate occasions, in order to assess the stability of the questionnaire items. The administrations of the questionnaire were separated by a three-week period, during which time no major incidents or accidents occurred and no safety related initiatives were carried out at the plant. Respondents were asked to provide a code word on each questionnaire to assure their anonymity while allowing their two responses to be matched. The retest aspect of the study was explained at the end of the questionnaire and the code word asked for on the last page to minimise attempts to remember patterns of response.

Thirty-three completed questionnaires were returned from the first distribution and 31 from the second. One of the retest responses could not be matched with a return from the first administration since no code was given. This resulted in 30 completed questionnaires at both times. Of these 30, two were female, two were managers and four were first line supervisors, in similar proportions to the entire plant population. Test-retest reliability was estimated from these data with correlations (Dane, 1990). The correlation between the two administrations provided an estimate of reliability.

The four items form the work environment section of the questionnaire are shown in Table 5.5, together with their mean score at each administration and the test-retest correlation. The mean scores for each of the items are very close and each of the correlation coefficients is significant at the 0.01 level, indicating that the items are relatively stable across time.

Table 5.5
Work environment test-retest coefficients

Item	Mean Time1	Mean Time 2	Test-retest correlation
1. The light levels in my workplace are adequate	3.77	3.67	0.487**
2. The ventilation in my workplace is adequate	3.47	3.37	0.606**
3. Space allocated for doing tasks in my workplace is adequate	3.7	3.73	0.895**
4. The humidity levels in my workplace are adequate	3.43	3.4	0.792**

** Significant at 0.01 level

For the second part of the questionnaire, a hazard score was computed for each respondent by combining the individual hazard ratings in the checklist. The hazard scores were then compared between the two questionnaire administrations, again based on 30 respondents. The mean hazard score at time 1 was 47.77 and 41.97 at time 2. The correlation coefficient providing the reliability estimate of the hazard checklist was 0.981 ($p<0.01$), indicating that it is a reliable individual estimation of the hazard environment.

Each of the 30 items in the safety attitude section of the questionnaire is shown in Table 5.6, in random order as presented in the survey instrument. Mean scores and test-retest correlation coefficients are also included. A comparison on the mean scores from each administration highlights the overall stability of this section with all but four of the retest items within a 0.2 range of the original scores, and all scores within a 0.5 range of the original. Twenty-eight of the correlation coefficients for the safety attitude section were significant at the 0.01 level. Those with the lowest coefficients, Items 13 (Relevant health and safety issues are communicated) and 34 (Accidents and incidents are always reported), were significant at the 0.05 level. The lower correlations between scores on these items might be explained by a reporting problem (cancellation of team briefing and, hence, lack of feedback) being experienced by one team. This problem existed at the time of the pilot study, before and after both administration times, and the five respondents in this team may have become increasingly dissatisfied with that situation.

Table 5.6

Safety attitude test-retest coefficients

Item	Mean Time1	Mean Time 2	Test-retest correlation
1. Health and safety have a very high priority at XXX	3.67	3.8	0.869**
2. Safety specific jobs always get done	3.87	3.8	0.782**
3. My line manager listens to my concerns about health and safety	3.7	3.57	0.568**
4. As long as there are no accidents unsafe behaviour is tolerated	2.53	2.5	0.577**
5. I look out for the safety of my colleagues	4.27	4.37	0.556**
6. The company makes an effort to prevent accidents happening	4.07	4.17	0.731**
7. Safety issues are included in communications meetings	3.45	3.63	0.651**
8. I have been shown how to do my job safely	4.07	3.9	0.544**
9. Management are prepared to discipline workers who act unsafely	3.83	3.8	0.738**
10. There are good communications here about safety issues which affect me	3.6	3.47	0.615**
11. It is sometimes necessary to take unsafe shortcuts to get the work done	2.67	2.53	0.521**
12. Relevant health and safety issues are communicated	3.83	3.38	0.457*
13. Everyone plays an active role in safety matters	3.5	3.43	0.638**
14. The safety training I receive is not detailed enough for my job	2.6	2.73	0.689**
15. I am informed of the outcomes of health and safety meetings	3.3	3.37	0.598**
16. Everyone on my site want to achieve the highest levels of safety performance	3.5	3.6	0.586**
17. Levels of safety performance have improved here over the last two years	3.37	3.67	0.654**
18. I can influence health and safety performance here	3.69	3.62	0.818**
19. Only a few people who work here are involved in health and safety activities	3.47	3.13	0.632**
20. Safety training has a high priority within XXX	3.6	3.77	0.735**
21. Minor/trivial accidents are tolerated as part of the job	2.47	2.37	0.511**
22. There is a process of continual safety improvement in the company	3.8	3.7	0.739**
23. Management takes the lead on safety issues	3.45	3.59	0.624**
24. What is learnt from accidents is used to improve safety training	3.63	3.23	0.774**
25. Safe working is a condition of my employment here	4.03	3.93	0.513**
26. On my site we have defined safety improvement objectives	3.43	3.47	0.703**
27. Supervisors actively support safety	3.87	3.8	0.478**
28. My colleagues and I help each other work safely	3.7	3.7	0.586**
29. Accidents and incidents are always reported	4.03	3.87	0.444*
30. The company is only interested in safety after an accident occurs	2.43	2.4	0.697**

* Significant at 0.05 level ** Significant at 0.01 level

In the final section, an activity score was computed for all 30 respondents by combining the individual activity responses in the checklist, similar to the hazard checklist. Activity scores were then compared between the two administrations. The mean activity score at time 1 was 34.57 and 34.67 at time 2. The correlation coefficient providing the reliability estimate of the activity checklist was 0.809 ($p<0.01$), indicating similar levels of activity at the two administration times.

A note of caution needs to be made here regarding multiple tests for statistical significance using the same data set. Results may be subject to Familywise Type 1 error (see Keppel et al., 1992) since 36 individual tests were conducted on the survey data. Using the 0.05 level of significance, one in twenty of the tests might be expected to return a significant result by chance. One or two of the results might be due to chance, although there is no way of telling which, this possibility should be borne in mind when interpreting the results.

Despite this note of caution, the test-retest reliability pilot study showed similar mean scores from the two questionnaire administrations and confirmed the stability of all sections of the revised survey instrument, suggesting that the questionnaire shown in Appendix 1 is suitable for use in the main study of Organisation A.

5.4 SUMMARY

This chapter has outlined the development of the measurement instrument that is the focus of the research described in this thesis. Initial discussions with the sponsoring organisation resulted in the identification of nine areas to be included in the survey. These topics were similar to those established by previous research and an outline structure was anticipated based on the architecture proposed in Chapter 3. Items were developed to capture these areas and an initial instrument developed. This initial instrument was refined as a result of pilot studies. Details of its use and the results obtained in Organisation A are given in the next chapter.

CHAPTER SIX

Structure of Attitudes to Safety in a Manufacturing Organisation (Organisation A)

This chapter details the structure of attitudes to safety and the prevailing climate for health and safety in the principal sponsoring organisation. It describes the data collection process and the survey results, including an exploratory analysis of the attitude scales and an examination of the questionnaire's structure. Chapter 7 outlines a similar process within Organisation B.

6.1 Data Collection

Data were collected during a series of team briefings at the participating plants. A brief introduction to the survey was given, stressing the importance of involving everyone and getting their views, and the complete confidentiality of the process. Respondents were given an envelope in which to return the questionnaire to the plant safety officer, who then forwarded them for analysis. Questionnaire distribution was omitted from briefings at one plant due to the absence of the safety officer and the survey was distributed to all employees individually. Respondents were told to take time during their working day to complete the survey.

Very few of the returned questionnaires were sealed in the supplied envelopes, suggesting an organisation that fosters openness. This lends weight to Schein's (1999) observation that the assurance of confidentiality in an organisational survey to encourage response is, in itself, telling of the organisation's culture

6.1.1 Sample

The study reported in this chapter is based on a questionnaire survey of the total population of employees in a manufacturing organisation with factories throughout the UK. A total of 708 valid questionnaires (66% response rate) were obtained from the survey: 4% were managers and 11% were line supervisors, in line with the general proportions in the organisation at the time (5.2% managers and 10.3% first line supervisors).

Almost all respondents' work organisation followed a three shift pattern, with the exception of some management and administration teams. Eight separate plants from organisation A were involved in this study and a cross-tabulation of job function and plant is shown in Table 6.1 together with the total number of responses. The plants varied in size and the 66% overall response rate was mirrored in each of them; plant response rates varied from 56% (plant three) to 70% (plant four). The response rate in the plant where questionnaires were distributed individually (plant six) was 64%, similar to the overall rate.

Table 6.1

Job function by plant in Organisation A

Job Function	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8
Managers	8.5%	2.1%	12%	2.3%	2.8%	3%	7.3%	4.8%
Supervisors	8.5%	5.2%	4%	15.9%	14%	6.2%	4.8%	15.2%
Workforce	83%	92.7%	84%	81.8%	83.2%	90.8%	87.9%	80%
Total response*	35	95	25	88	179	65	41	164

*excludes 16 not-specified

Data from the entire survey were initially subjected to a descriptive analysis, described in the next section.

6.2 DESCRIPTIVE RESULTS

The first section of the questionnaire contained four work environment items; these are shown in Table 6.2 with their mean items scores and standard deviations.

Table 6.2
Work environment items mean scores

Item	Mean	Standard Deviation
1. The light levels in my workplace are adequate	3.63	0.95
2. The ventilation in my workplace is adequate	2.56	1.2
3. Space allocated for doing tasks in my workplace is adequate	3.01	1.21
4. The humidity levels in my workplace are adequate	2.75	1.14

The work environment item scores show that, in general, respondents' views on ventilation and humidity are below the scale mid-point (3) indicating dissatisfaction with those aspects of their environment. Cronbach's Alpha measure of internal consistency for these items as a scale was 0.69, approaching the 0.7 acceptable level proposed by Nunally (1978).

Section 2 of the questionnaire listed workplace hazards. Table 6.3 shows each hazard together with the mean 'perceived risk' (presence of hazard (0-3) x severity of its consequences (1-3) x adequacy of control measures (1-2), giving a possible scale ranging from 0 to 18) across all respondents.

Table 6.3
Mean 'perceived risk' for each hazard

Hazards	Mean 'Perceived Risk'
21. Noise	4.76
6. Actions leading to repetitive strain injuries.	4.66
17. Manual handling of heavy goods	3.95
3. Workplace design and layout	3.76
1. Slipping and tripping	3.74
4. Working with hazardous chemicals	3.73
5. Working with irritant substances	3.42
10. Use of sharp hand tools	3.38
12. Fire potential of combustible or flammable materials	3.13
22. Working with visual display units	3.05
14. Operations of forklift trucks & similar vehicles	3.05
16. Safe storage and stacking of goods	2.80
20. Contact with hot objects and surfaces	2.58
9. Electrical hazards	2.46
11. Entanglement and trapping in machinery	2.29
18. Compressed air hazards	2.04
7. Explosion from hazardous/flammable gases	1.86
2. Objects falling onto personnel	1.42
13. Use of compressed gas cylinders	1.30
15. Loading and unloading of vehicles	1.26
19. Failure of pressure vessels	0.87
23. Conditions leading to hand or body vibration	0.87
8. Ultra violet light, lasers and/or radio frequencies	0.81

Individual hazard scores were also combined to produce an overall hazard rating for each respondent. The mean hazard score for the entire organisation was 60.98 with a standard deviation of 46.4. The large standard deviation is not surprising given the method of computing the overall hazard score, for example the presence of one additional hazard can increase the overall score by up to 18.

The third part of the questionnaire contained 30 attitude statements. These are shown with their mean item scores and standard deviations in Table 6.4. Without exception, responses to the attitude statements show views on the positive side of the mid-point (3) across the organisation.

Table 6.4
Attitude items mean scores

Item	Mean	Standard Deviation
1. Health and safety have a very high priority at XXX	4.06	0.929
2. Safety specific jobs always get done	3.37	1.005
3. My line manager listens to my concerns about health and safety	3.61	0.906
4. As long as there are no accidents unsafe behaviour is tolerated	2.38	1.145
5. I look out for the safety of my colleagues	4.08	0.668
6. The company makes an effort to prevent accidents happening	3.96	0.872
7. Safety issues are included in communications meetings	3.98	0.775
8. I have been shown how to do my job safely	3.68	0.909
9. Management are prepared to discipline workers who act unsafely	3.45	1.013
10. There are good communications here about safety issues which affect me	3.56	0.972
11. It is sometimes necessary to take unsafe shortcuts to get the work done	2.47	1.062
12. Relevant health and safety issues are communicated	3.69	0.773
13. Everyone plays an active role in safety matters	3.31	1.048
14. The safety training I receive is not detailed enough for my job	2.64	0.896
15. I am informed of the outcomes of health and safety meetings	3.27	1.031
16. Everyone wants to achieve the highest levels of safety performance	3.66	0.832
17. Levels of safety performance have improved here over the last two years	3.59	0.814
18. I can influence health and safety performance here	3.65	0.87
19. Only a few people are involved in health and safety activities	2.95	1.036
20. Safety training has a high priority within XXX	3.78	0.921
21. Minor/trivial accidents are tolerated as part of the job	2.53	1.022
22. There is a process of continual safety improvement in the company	3.77	0.758
23. Management takes the lead on safety issues	3.24	0.925
24. What is learnt from accidents is used to improve safety training	3.71	0.781
25. Safe working is a condition of my employment here	3.97	0.692
26. On my site we have defined safety improvement objectives	3.62	0.773
27. Supervisors actively support safety	3.69	0.827
28. My colleagues and I help each other work safely	3.82	0.727
29. Accidents and incidents are always reported	3.02	1.065
30. The company is only interested in safety after an accident occurs	2.49	1.036

The fourth section of the questionnaire dealt with individuals' safety activities over the past 12 months and five years. Table 6.5 shows the percentage of total respondents who had taken part in the specified activities in each of the two time slots. Individual scores were also combined to give each respondent an overall activity score. The mean activity score for the organisation as a whole was 8.47 with a standard deviation of 5.34.

Table 6.5
Percentage of respondents taking part in safety activities

Activity	In the past 12 months	In the past 5 years
1 Seen a safety video	66.53%	14.69%
2 Helped with a site open day	27.40%	1.55%
3 Shown visitors around my job	24.15%	26.13%
4 Taken part in a job safety analysis	31.07%	18.36%
5 Attended a safety committee meeting	23.05%	17.23%
6 Discussed safety at crew briefing	24.44%	37.57%
7 Took part in a safety promotion or competition	30.37%	10.88%
8 Conducted a safety inspection or audit	25.38%	19.49%
9 Took part in a risk assessment	19.93%	11.72%
10 Organised a safety activity	11.72%	6.64%
11 Attended a safety improvement meeting	21.76%	12.57%
12 Raised a suggestion to improve safety	29.66%	20.48%

Opportunity was provided at the end of the questionnaire for employees to make any additional comments about safety issues (see questionnaire in Appendix 1). 304 comments were made (42.9% of the total sample). The comments were subjected to content analysis (see Dane, 1990; Holsti, 1969) involving two raters. The first rater derived a series of general subject areas and then allocated each comment to one. The second rater then matched the comments with the areas determined by the first. Raters agreed on the categorisation of all but three of the comments, the final placing of which were confirmed by a third judge. The resulting general areas are shown in Table 6.6 with their frequency. The majority of comments were negative, the figure in brackets denotes the number of positive comments made in each of the areas.

Table 6.6
Open response categories

General Area	Number of comments
Safety Systems/Equipment	76 (2)
Management Actions	74 (4)
Individual Responsibility	56 (10)
Involvement	45 (7)
Training	22 (2)
Priority of Safety	12 (0)
Work Environment	12 (0)
Miscellaneous	7

Once the data from the questionnaire had been described, the underlying structure of the Likert attitude scales was assessed, before further analysis was carried out.

6.3 EXPLORATORY FACTOR ANALYSIS

The 30 attitude statements in the third section of the survey instrument were subjected to an exploratory factor analysis to examine the dimensionality of this part of the instrument. This analysis follows the practices described earlier in Chapter 4.

6.3.1 Pre-analysis Checks

Initial processing of the data included consideration of missing data, sample size and an examination of the appropriateness of the data and the initial correlation matrix for this analysis. 64 cases from the data set had one or more missing data points (9% of the total sample); two of these were managers and six were supervisors, reflecting the ratio in the whole sample. The loss of these data did not, therefore, adversely affect the representativeness of the sample and they were removed before further analysis. This left a sample size of 634 cases giving a subject to variable ratio in the order of 21:1, a subject to potential factor[2] ratio in the order of 100:1, and a variable to potential factor ratio in the region of 5:1. All of these ratios are within the guidelines discussed in Chapter 4 and summarised by Kline (1994), indicating that the data were appropriate for factor analysis.

Item skew and kurtosis were also examined to ensure the data were suitable. None of the item skew statistics, and only two of the item kurtosis statistics, exceeded Muthen and Kaplan's (1995) +/- 2 value. With only 6% of the variables not

[2] Six theoretical factors were identified during initial discussions with Organisation A.

conforming to standards of univariate normality the factor solution will not be affected (Ferguson and Cox, 1993) and so no data transformation was necessary. The final pre-analysis check concerned the appropriateness of the initial item correlation matrix. The KMO value for this matrix was 0.947, and the Bartlett test of sphericity yielded a significant chi-square approximate of 7690.1 (433 degrees of freedom), confirming that the data could be accounted for by a smaller set of factors.

6.3.2 Extraction

The next step in the factor analytic process is the determination of the number of factors to be extracted. This was achieved in the first instance by examination of the eigenvalue scree plot (shown in Figure 6.1). Six judges examined this plot for a break in its gradient. All of the judges perceived the break at the fifth component (judging from right to left). This was confirmed by the K1 rule, since 5 of the eigenvalues had value greater than 1.

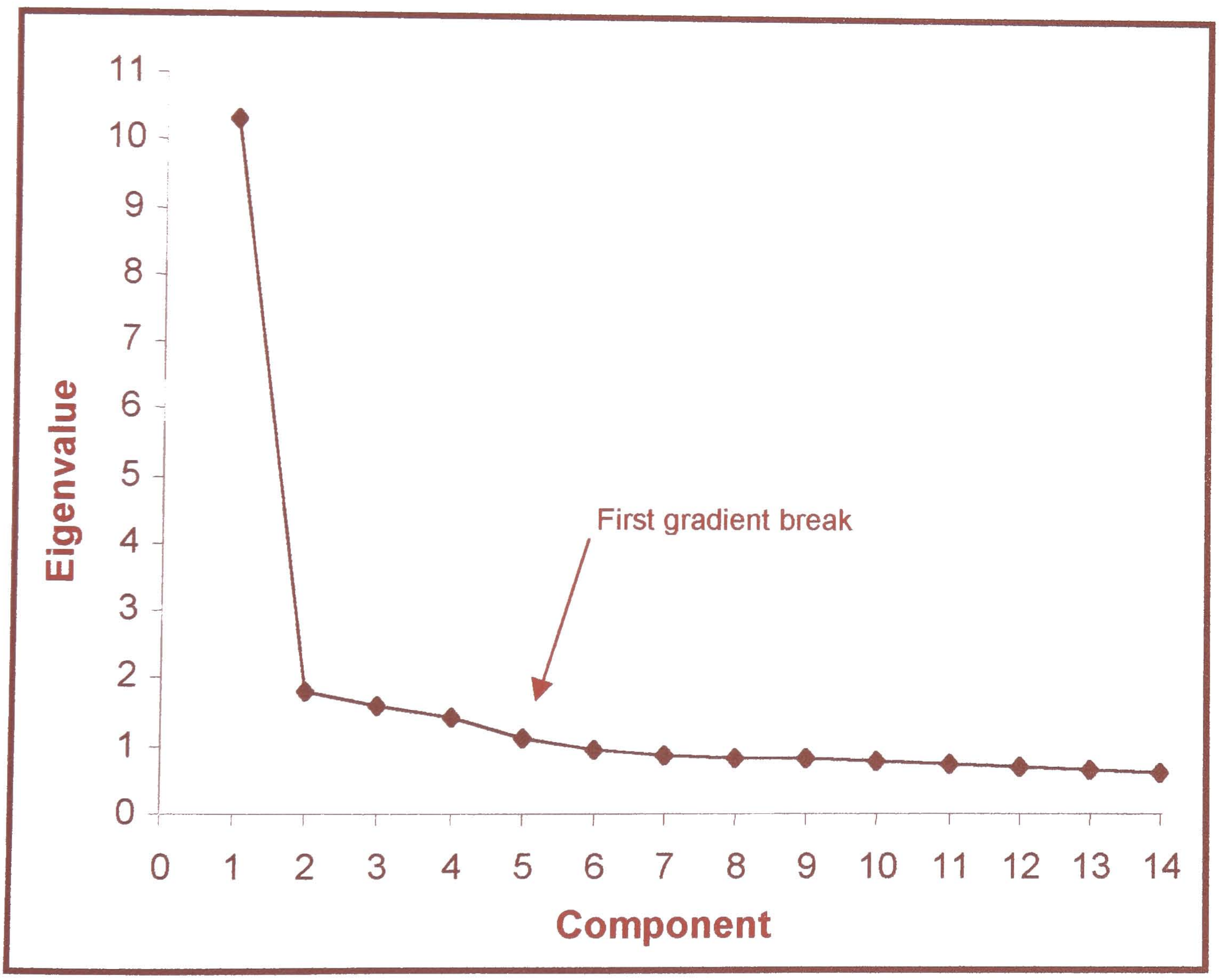

Figure 6.1
Exploratory factor analysis scree plot

6.3.3 Factor Structure

A simple factor structure was first achieved using a varimax orthogonal rotation of the five extracted factors, which account for 56% of the original variable variance. Table 6.7 shows the factor structure, detailing the items and their loadings. Only loadings over 0.4 are shown, except in the cases of items 14 and 9 where the loadings are almost at this level on one factor and close to zero for the others. Only one of the items (10) cross-loads on two factors, but the difference in the magnitude of the loadings is greater than 0.2 (Ferguson and Cox, 1993) and the item can, therefore, be considered to define Factor 2 alone.

Table 6.7
Attitude items factor loadings

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
22. There is a process of continual safety improvement in the company	0.776				
1. Health and safety have a very high priority at XXX	0.775				
6. The company makes an effort to prevent accidents happening	0.715				
17. Levels of safety performance have improved here over the last two years	0.691				
20. Safety training has a high priority within XXX	0.687				
27. Supervisors actively support safety	0.632				
24. What is learnt from accidents is used to improve safety training	0.630				
26. On my site we have defined safety improvement objectives	0.619				
2. Safety specific jobs always get done	0.607				
23. Management takes the lead on safety issues	0.6				
3. My line manager listens to my concerns about health & safety	0.592				
30. The company is only interested in safety after an accident occurs	-0.575				
14. The safety training I receive is not detailed enough for my job	-0.399				
9. Management are prepared to discipline workers who act unsafely	0.388				
12. Relevant health and safety issues are communicated		0.745			
15. I am informed of the outcomes of health and safety meetings		0.697			
10. There are good communications here about safety issues which affect me	0.401	0.681			
7. Safety issues are included in communications meetings		0.67			
8. I have been shown how to do my job safely		0.565			
13. Everyone plays an active role in safety matters			0.713		
29. Accidents and incidents are always reported			0.669		
16. Everyone on my site wants to achieve the highest levels of safety performance			0.651		
28. My colleagues and I help each other work safely			0.637		
19. Only a few people who work here are involved in health and safety activities			-0.406		
11. It is sometimes necessary to take unsafe shortcuts to get the work done				0.731	
4. As long as there are no accidents unsafe behaviour is tolerated				0.671	
21. Minor/trivial accidents are tolerated as part of the job				0.649	
5. I look out for the safety of my colleagues					0.795
25. Safe working is a condition of my employment here					0.674
18. I can influence health and safety performance here					0.569

In addition to the orthogonal rotation a series of oblique factor rotations were performed using direct oblimin. The rotations were completed each specifying a different degree of relatedness; δ (delta) values of 0, -1 and -2 were used (where a δ of 0 indicates the highest degree of correlation). In each case the rotated factor matrix was identical to that found using the orthogonal rotation, in line with Gorsush's (1983) suggestion. The factors shown in Table 6.7 are, therefore, a reasonably robust description of the structure of the attitude section of the questionnaire, and can be used in the description of Organisation A results.

The five factors identified by the exploratory analysis do not reflect entirely the six theoretical factors identified during discussions with the participating organisation, and detailed in Chapter 5. Table 6.8 shows each of the 30 attitude items, as they appeared in random order in the survey instrument, together with their theoretical, or proposed, factor, the actual factor they defined and an indication of how the two match.

As a result of the exploratory analysis, seven (23%) of the 30 items did not correspond with their original theoretical position. Three of these items related to the Safety Training theoretical factor, which seems, in this organisation, to be closely related to Management Commitment, where these items now load. Of the remaining four, Item 29 'Accidents and incidents are always reported' loaded with the Involvement items, and Item 8 'I have been shown how to do my job safety' loaded with the Communication items. The proposed Safety Systems factor contained the final two items to load on unexpected factors. Item 6 'The company makes an effort to prevent accidents happening' and Item 26 'On my site we have defined safety improvement objectives' both loaded with the Management Commitment items. The remaining three Safety Systems items loaded together.

6.3.4 Factor Naming

In order to ensure that the factors were labelled coherently the items comprising them were examined by the original discussion group from Organisation A. This group considered each of the items and the new factors they defined. Agreement was reached that the Communication, Involvement and Individual Responsibility names were still appropriate for the new factors. The reduced Safety Systems factor, however, no longer reflected that name and the group members felt that the items grouped here (Items 4, 11 and 21) reflected standards of behaviour that would be tolerated in the organisation. This factor was, therefore, renamed 'Safety Standards'. The Management Commitment theoretical factor had also expanded and it was felt that this should be renamed Safety Management.

Table 6.8

Theoretical factor/observed factor matches

Item	Proposed Factor	Actual Factor	Match
1. Health and safety have a very high priority at XXX	M.C.	M.C	✔
2. Safety specific jobs always get done	M.C.	M.C.	✔
3. My line manager listens to my concerns about health and safety	M.C.	M.C.	✔
4. As long as there are no accidents unsafe behaviour is tolerated	S.S.	S.St.	-
5. I look out for the safety of my colleagues	I.R.	I.R.	✔
6. The company makes an effort to prevent accidents happening	S.S.	M.C	✘
7. Safety issues are included in communications meetings	C.	C.	✔
8. I have been shown how to do my job safely	S.T.	C.	✘
9. Management are prepared to discipline workers who act unsafely	M.C.	M.C.	✔
10. There are good communications here about safety issues which affect me	C.	C.	✔
11. It is sometimes necessary to take unsafe shortcuts to get the work done	S.S.	S.St.	-
12. Relevant health and safety issues are communicated	C.	C.	✔
13. Everyone plays an active role in safety matters	I.	I.	✔
14. The safety training I receive is not detailed enough for my job	S.T.	M.C.	✘
15. I am informed of the outcomes of health and safety meetings	C.	C.	✔
16. Everyone wants to achieve the highest levels of safety performance	I.	I.	✔
17. Levels of safety performance have improved here over the last two years	M.C.	M.C.	✔
18. I can influence health and safety performance here	I.R.	I.R.	✔
19. Only a few people who work here are involved in health & safety activities	I.	I.	✔
20. Safety training has a high priority within XXX	S.T.	M.C.	✘
21. Minor/trivial accidents are tolerated as part of the job	S.S.	S.St.	-
22. There is a process of continual safety improvement in the company	M.C.	M.C.	✔
23. Management takes the lead on safety issues	M.C.	M.C.	✔
24. What is learnt from accidents is used to improve safety training	S.T.	M.C.	✘
25. Safe working is a condition of my employment here	I.R.	I.R.	✔
26. On my site we have defined safety improvement objectives	S.S.	M.C.	✘
27. Supervisors actively support safety	M.C.	M.C.	✔
28. My colleagues and I help each other work safely	I.	I.	✔
29. Accidents and incidents are always reported	C.	I.	✘
30. The company is only interested in safety after an accident occurs	M.C.	M.C.	✔

Key: M.C. = Management Commitment, C = Communication, I.R. = Individual Responsibility, I. = Involvement, S.T. = Safety Training, S.S. = Safety Systems, S.St. = Safety Standards

6.3.5 Internal Consistency

The internal consistency of each of the scales derived from the factor structure was assessed using Cronbach's Alpha coefficients. The alpha coefficient for each scale is shown in Table 6.9

Table 6.9
Attitude scale internal consistency

Factor Scale	Coefficient Alpha
Safety Management	0.89
Communication	0.79
Involvement	0.69
Safety Standards	0.61
Individual Responsibility	0.58

The alpha value for the scale relating to Individual Responsibility suggests that it may not be reliable. This should be borne in mind when dealing with the analysis of the scale and the results of any such analysis should be treated with caution.

6.4 PLANT DIFFERENCES

Multivariate analysis of variance (MANOVA) and one-way analysis of variance (ANOVA) were employed to examine mean differences between plants in each of the scales and measures described above. Three one-way analyses of variance were computed, with plant as the grouping variable and workplace hazards, physical work environment and safety activities as dependent variables. A Scheffé test was used for pairwise comparisons between the scale means for the four plants.

MANOVA was applied to test whether the mean differences among plants (groups) on a combination of safety attitude dimensions were likely to have occurred by chance. MANOVA is recommended for use in situations in which there is more than one dependent variable and these are correlated (Weinfurt, 1995). In this case the scales derived from the attitude component of the survey instrument represented several oblique dimensions included as part of a general construct. In this study, MANOVA has several advantages over a series of ANOVAs on several dependent variables. First, it offers protection against inflated type I error due to multiple tests of correlated dependent variables. Also, it provides a multivariate analysis of effects by taking into account the correlation between dependent variables (Stevens, 1986; Tabachnik and Fidell, 1989). Several multivariate statistics are available in statistical packages to test significance of effects. Wilk's Lambda and Pillai's criterion have been selected. Wilk's Lambda is the most commonly reported test, and Pillai's criterion is the test of choice when the design involves groups of unequal numbers, as in this case with unequal plant sample sizes.

MANOVA was used to test for the effects of plant on each of the safety attitude dimensions. A Box test was first employed, showing that there were statistically significant differences between the variance-covariance matrices across the different plants (Box's M= 240.3, F= 2.189, p<0.001), in such circumstances Pillai's criterion performs better. However, both Wilk's Lambda (Λ) and Pillai's criterion shown statistically significant differences between the plants [Wilk's Λ= 0.710, F= 5.994, p<0.001; Pillai's criterion = 0.320, F= 5.777, p<0.001]. Several one-way ANOVAs were then performed, one for each attitude dimension. Summary statistics for these analyses are shown in Table 6.10.

Table 6.10

One-way ANOVA for the five safety climate dimensions

Dependent variable	F	prob.
Safety Management	19.436	0.001
Communication	14.640	0.001
Individual Responsibility	7.027	0.001
Safety Standards	5.407	0.001
Involvement	13.537	0.001

Degrees of freedom for between sums of squares - 7; degrees of freedom for the error source - 682;

All effects were statistically significant and post-hoc comparisons (Scheffé tests) were performed for each effect. Means for each group can be seen in Table 6.11, with statistical differences shown by emboldened entries.

Table 6.11

Safety variable means for the eight plants involved in the study

	Plant							
Dependent variable	**One**	**Two**	**Three**	**Four**	**Five**	**Six**	**Seven**	**Eight**
Safety Management	53.77	**44.73**	54.52	**47.75**	52.53	55.58	51.15	53.58
Communication	18.65	**15.57**	19.65	17.78	18.59	19.85	17.24	18.86
Individual Responsibility	11.67	**10.71**	11.45	11.68	11.88	11.81	11.82	12.08
Safety Standards	10.51	**9.48**	10.30	10.77	11.01	11.48	10.36	10.91
Involvement	17.23	**14.19**	17.16	16.91	16.54	17.67	16.61	17.87
Work Environment	12.76	11.97	13.29	11.57	11.53	**13.53**	11.91	11.58
Workplace Hazards	49	68.47	41.2	64.92	69.37	**35.82**	67.73	58.39
Safety Activities	7.37	6.95	7.68	5.85	9.67	7.87	6.97	**10.42**

Emboldened groups differ significantly from the others (Scheffé tests, p < 0.01)

Respondents working in plant two had the least positive score on all of the safety attitude variables. They assessed safety management, communication, individual responsibility, safety standards, and involvement lower than any other group. They assessed work environment and workplace hazards and safety activities on a par with other plants. On the other hand, respondents in plants six and eight assessed the attitude dimensions most positively. Plant six reported the highest levels of safety management, communication and safety standards. They also assessed the work environment and workplace hazards better than any other plant. Plant eight had the most positive views on personal responsibility and involvement and the highest level of safety activities. The pattern of differences is interesting when we consider plant accident statistics for the last full year before the survey was conducted (1996). Table 6.12 shows the frequency of recordable incidents. This figure is calculated by multiplying the total number of recordable incidents in a plant by 200,000 and dividing the resulting number by the total number of hours worked in that plant.

Table 6.12
Organisation A accident frequency by plant

	Plant							
	One	**Two**	**Three**	**Four**	**Five**	**Six**	**Seven**	**Eight**
Accident Frequency	3.70	**3.72**	0	0.3	0.57	0.74	2.91	3.07

The poorest performing plant in terms of accident frequency (plant two) is also the plant with the poorest perceptions of safety issues (as shown in Table 6.11). The converse is not, however, true, although one of the best plants (plant six) does have a relatively low accident frequency. The other good performer in terms of the survey (plant eight) is the third worst plant in terms of accident frequency, however the positive views of employees there may have been influenced by the introduction of a behavioural safety programme at the beginning of that year (late 1995).

As well as this examination the intensity of attitudes and perceptions, the structural relationship of the factors and measures was examined.

6.5 *STRUCTURAL MODEL OF ATTITUDES IN ORGANISATION A*

An a priori model was specified from the theoretical model presented in Figure 5.2 using the factors and measures derived from the exploratory analysis of the survey instrument shown above, including the measures of work environment, workplace hazards and safety activities. Given the small sample sizes of the individual plants (only two had samples of more than 100 respondents) a multisample analysis of the structure of attitudes in each plant was not possible. The model set out in Figure 6.2 was, therefore, tested in the total sample, combining all responses from all eight plants. It proposes that Safety Standards and Safety Management (as organisational dimensions) will influence Involvement and Communication (social environmental dimensions) and Workplace Hazards and Work Environment (work environment dimensions), both of which will affect Individual responsibility and levels of Safety Activity (the individual dimensions). The model uses latent variables and all of the constituent items in the safety attitude and physical work environment scales were included in the analysis, although for simplicity they are not shown in Figure 6.2[3].

The proposed model requires 80 free parameters to be estimated (36 error variances associated with observed variables, 6 factor variances and 38 regression coefficients signifying relationships between variables and factors) and had 666 observed variances and covariances. This results in an overidentified model with 586 degrees of freedom. The raw data, once again excluding missing cases, is multivariate normally distributed and maximum likelihood estimation was employed to estimate the free parameters. Overall fit measures for this model and modified models tested following LM test suggestions are shown in Table 6.13.

Table 6.13

Goodness of fit indices for the a priori model and modifications

Model	χ^2	d.f.	prob.	CFI	GFI	NNFI	RMSEA	χ^2 difference
1	1553.86	586	<0.001	0.875	0.871	0.865	0.052	-
2	1537.58	586	<0.001	0.877	0.872	0.868	0.051	16.28
3	1530.92	585	<0.001	0.878	0.873	0.868	0.050	22.94

[3] Figure 6.2 follows the convention of denoting latent variables with ellipses and observed variables with squares.

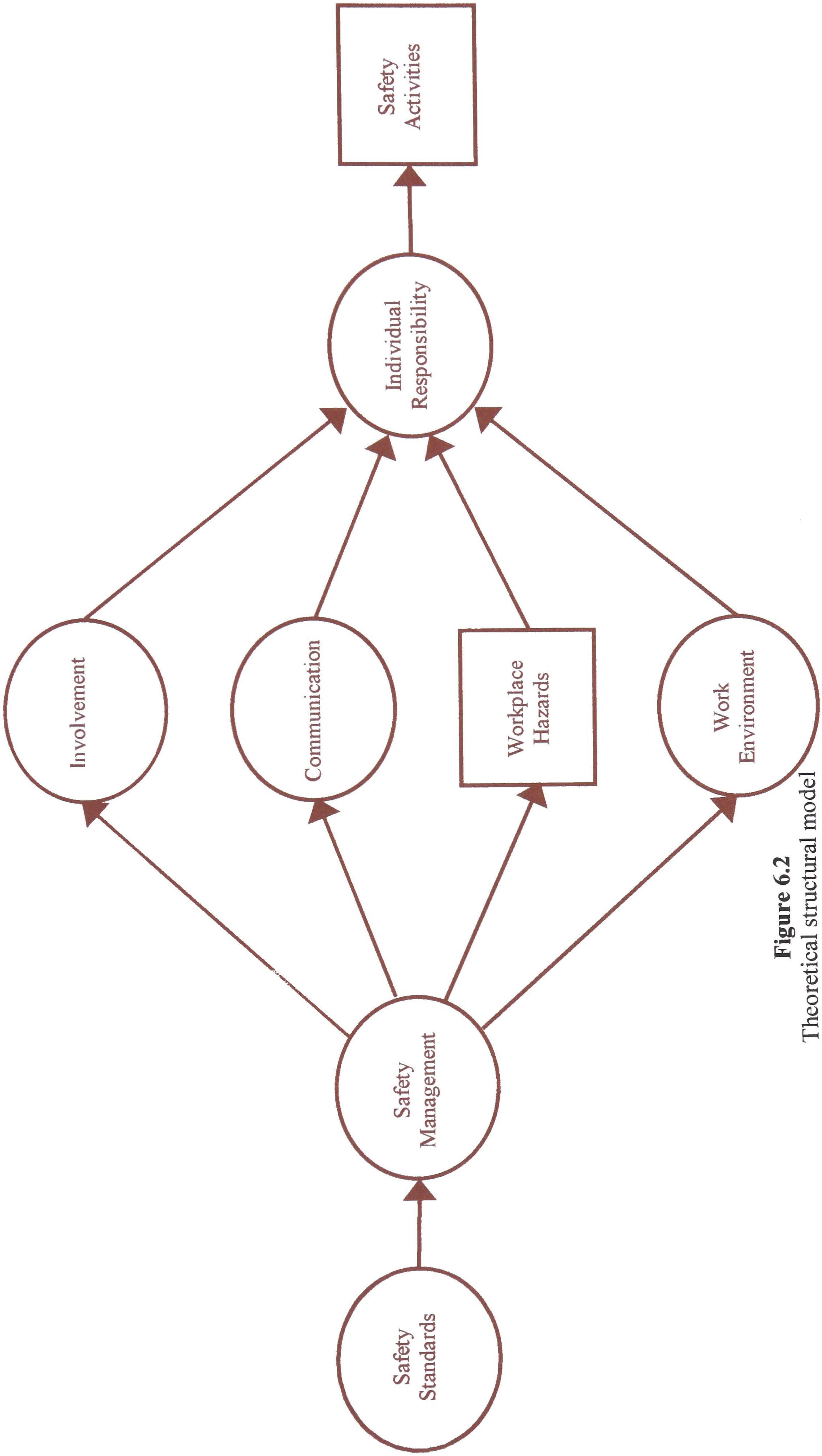

Figure 6.2
Theoretical structural model

The a priori model (Model 1, outlined in Figure 6.2) failed to provide the best fit for the data. The LM test suggested modifications to the model that not only improve fit, but are also in line with the theoretical model. Model 2 introduced effects between safety standards and goals and personal involvement as suggested by the LM test, and removed the effect between work environment and individual responsibility, which was not significant. This model remained overidentified with 586 degrees of freedom. Model 3 introduced the effect of work environment on workplace hazards, as suggested by the LM test, reducing the degrees of freedom to 585. The best fitting model was Model 3, which may be considered a good representation of the data. The χ^2 difference between Models 1 and 3 was significant indicating that Model 3 was the better representation. No other changes, either in variables that define factors (the measurement model outlined in the exploratory analysis) or in the relationships between factors (the structural model) were statistically significant. Furthermore, based on the results of the LM test, no other theoretically based modifications would make a significant improvement to model fit.

The χ^2 statistic for each of the models was significant, although this is not uncommon in cases with a large sample size. Other indices were also, therefore, examined. The CFI and GFI for Model 3 were very close to 0.9 and the RMSEA is 0.05 indicating a good model fit. Given the high number of degrees of freedom, the RMSEA is probably the most reliable indicator in this case (MacCallum, 1995). The significant interrelationships between the dimensions estimated in the final model are shown in Figure 6.3.

In addition to the direct effects (shown in Figure 6.3) there are several significant indirect effects, that is effects mediated by other variables, between variables illustrated in the model. The indirect effects on workplace hazard appraisals of safety management (β = -0.044) and of safety standards (β = -0.273) were statistically significant ($p<0.01$). The indirect effects on safety activities of all other variables were statistically significant ($p<0.01$): workplace hazards (β = 0.118), safety standards (β = 0.261), communication (β = 0.283), involvement (β = 0.173), work environment (β = -0.014), and safety management (β = 0.320).

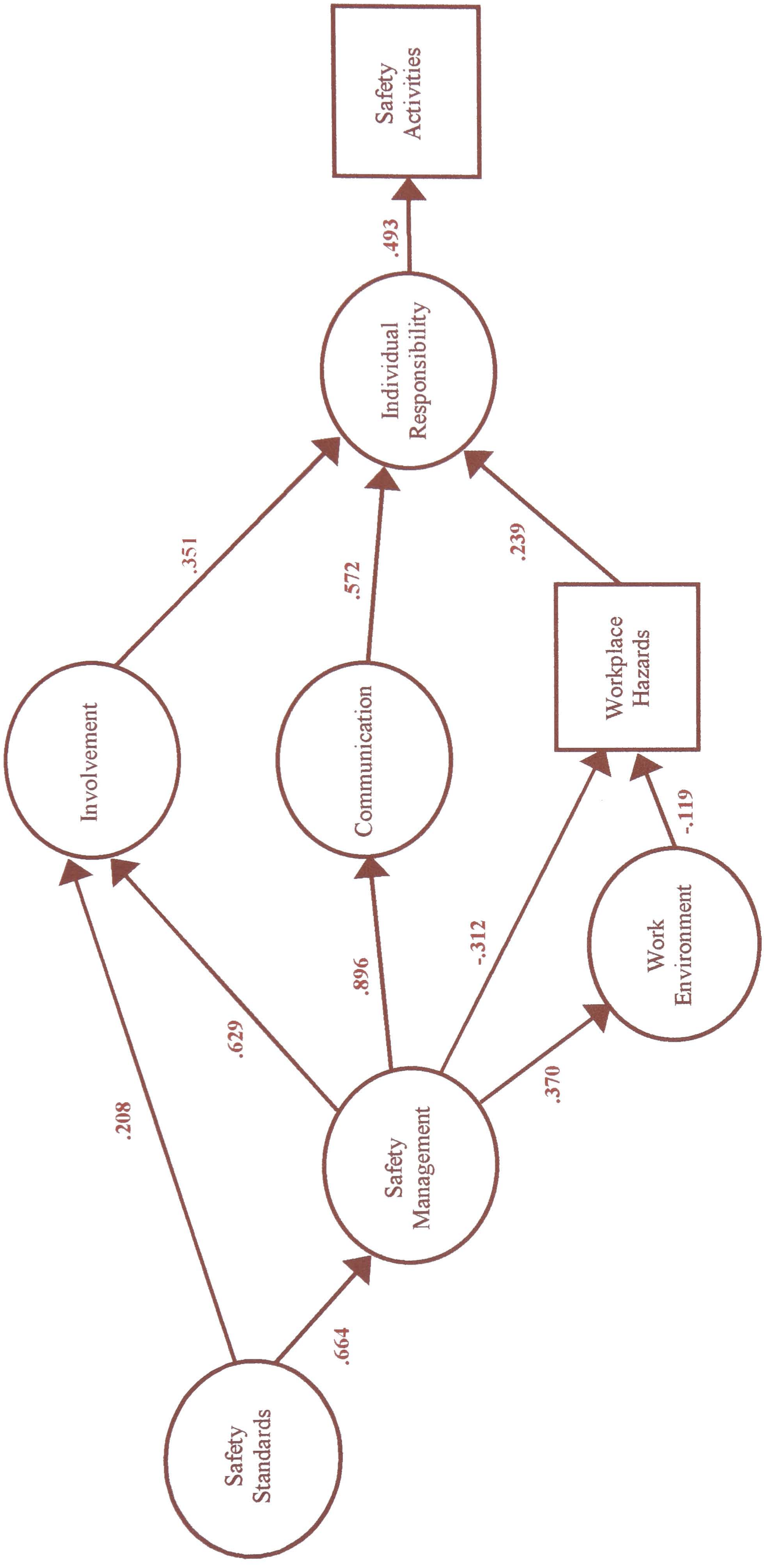

Figure 6.3
Revised structural model

The indirect effect of safety management on individual responsibility was statistically significant ($\beta = 0.649$, $p<0.01$), as well as the indirect effect of the work environment factor ($\beta = -0.029$, $p<0.05$). No other indirect effects were statistically significant.

Most of the a priori structural effects (paths) were statistically significant giving support to the theoretical model and *Hypothesis 1*. The only path statistically non-significant (between Work Environment and Individual Responsibility) was dropped during the modification process. The inclusion, however, of a new significant path between work environment and workplace hazards allows evaluations of the working environment to play a mediating role as suggested in the theoretical model.

6.6 FEEDBACK

The final stage in the Organisation A safety survey involved the feedback of results at several levels. The descriptive results (outlined in Section 6.2) were summarised in a series of bar graphs and distributed to each of the participating plants for presentation to those who had taken part. Plant differences and the structural model were presented to the group safety department and the safety engineers from each of the plants. Discussion within this group centred on how the behavioural safety programme being piloted in two of the plants would feed into the safety improvement process suggested by the model. It has been subsequently decided that the improvements in employee involvement and communication achieved through the behavioural safety programme should be extended to all plants operating in the UK, in an attempt to improve levels of activity. This programme is due to roll-out during 2000 and improvement will be evaluated after an 18 month period.

6.7 SUMMARY

This chapter has detailed the distribution and results obtained from the use of the survey instrument in Organisation A. Exploratory analysis of the attitude section of the questionnaire uncovered five factors relating to employees' attitudes to safety. These factors, together with measures of work environment, workplace hazards and levels of safety activity showed some correspondence with accident rates within that organisation. Structural equation modelling of the dimensions and measures from the questionnaire supported the general theoretical model presented in Figure 5.2, and thus supports Hypothesis 1 that safety climate can be described in terms of Organisational, Social Work Environment, Physical Work Environment and Individual dimensions. The next chapter describes the modification of the survey instrument and its application and results in another manufacturing organisation.

CHAPTER SEVEN

Structure of Attitudes to Safety in a second Manufacturing Organisation (Organisation B)

This chapter deals with the application and analysis of the survey instrument in a second manufacturing organisation. It describes the questionnaire adaptation, data collection process and the survey results, including confirmatory analysis of the attitude scales and an examination of the questionnaire's structure. Chapter 8 describes the same process within Organisation C.

7.1 QUESTIONNAIRE ADAPTATION

Before the survey instrument described in Chapter 5 could be applied in a second industrial setting its suitability had to be assessed by that organisation. The appropriateness of the questionnaire was examined in two stages. The first involved eliciting views from members of the organisation and the second was concerned with adapting the instrument in line with the organisation views.

7.1.1 Initial Discussions

The first stage in the adaptation process involved asking safety professionals within the organisation to write down what they felt was important in ensuring that their workplace, and the organisation as a whole, continued to operate safely and made improvements in safety performance. Thirteen individuals took part in this exercise and their responses were content analysed by two judges, one internal and the other external to the organisation. This analysis produced the seven themes shown in Table 7.1. On average participants highlighted three or four different aspects that they felt important for continued success.

Table 7.1
Important safety issues in Organisation B

Theme	Number of comments
Individual Awareness	11
Safety Systems	9
Management Actions	8
Involvement	7
Training	5
Housekeeping	5
Priority of Safety	2

7.1.2 Changes to the Survey Instrument

Once the important safety issues had been identified the second stage in the adaptation process involved the examination of the survey instrument against these issues. The safety engineer from each of the four participating plants scrutinised the survey instrument in light of the themes distinguished by their colleagues, and all agreed that it was appropriate for use in their organisation with the following minor changes:

- Items 1 and 20 were changed to refer to 'here' rather than naming the organisation, since site representative felt that this might help highlight any differences between the individual pants.
- Item 31 'All safe systems are up to date' was added in recognition of the emphasis placed on safety systems by those involved in the initial discussions.

The final instrument used in Organisation B is shown in Appendix 2, together with the briefing note that accompanied it. Since one of the participating plants was in France, the instrument was translated into French and then checked by a commercial translation service and the safety engineer in the French plant. The translated survey instrument is shown in Appendix 3.

7.2 DATA COLLECTION

Data were collected in this organisation in two ways. In two of the plants employees were given the questionnaire and briefing note during a series of team briefings. A very brief introduction to the survey was given, stressing the complete confidentiality of the process. At the other two plants employees were informed at their team briefings that a survey was taking place in the near future and given the same information as in the other plants. Questionnaires were then distributed to each individual between two and four weeks after the briefing. In both cases respondents were given an envelope in which to return the questionnaire to the plant safety officer, who then forwarded them for analysis.

7.2.1 Sample

The research reported in this chapter is based on a questionnaire survey of the total population of employees in a manufacturing organisation with factories in both the UK and France. A total of 915 valid questionnaires (63% response rate) were obtained from the survey: 6.4% were managers, 8% were line supervisors and 75.1% were regular employees (this excludes 10.5% who did not provide this information).

Respondents' work organisation followed three patterns: 56% of them worked varying shifts; 44.6% worked only days; and 0.4% worked only nights. Four separate plants were involved in this study: plant 1 returned 145 valid questionnaires (59% response rate), plant two provided 128 (61 % response rate), plant 3 returned 83 (52 % response rate, and plant 4 provided 559 (70% response rate) completed questionnaires. A cross-tabulation of response rate by job function and plant is shown in Table 7.2.

Table 7.2
Job function by plant in Organisation B

Job Function	**Plant 1**	**Plant 2**	**Plant 3**	**Plant 4**
Managers	14.1%	2%	4.2%	6.9%
Supervisors	9.6%	16.2%	13.9%	6%
Workforce	76.3%	81.8%	81.9%	87.1%

As in Organisation A, data from the survey were first subjected to descriptive analysis.

7.3 DESCRIPTIVE RESULTS

The first section of the questionnaire contained four work environment items; these are shown in Table 7.3 with their mean items scores and standard deviations. The work environment item scores show that, like Organisation A, respondents' views on ventilation and humidity were below the scale mid-point (3), and evaluations of space requirements were exactly on the mid-point. Cronbach's Alpha measure of internal consistency for these items as a scale was 0.67, approaching the 0.7 acceptable level.

Table 7.3
Work environment items mean scores in Organisation B

Item	Mean	Standard Deviation
1. The light levels in my workplace are adequate	3.50	1.03
2. The ventilation in my workplace is adequate	2.81	1.24
3. Space allocated for doing tasks in my workplace is adequate	3.00	1.19
4. The humidity levels in my workplace are adequate	2.84	1.13

The second section of the questionnaire listed a number of workplace hazards and elicited the views of respondents as to: i) whether the hazard was present; ii) the severity of it's consequences; and iii) the adequacy of existing precautions and control measures. Table 7.4 shows each hazard together with the mean 'perceived risk' (presence of hazard (0-3) x severity of its consequences (1-3) x adequacy of control measures (1-2), giving a possible scale ranging from 0 to 18) across all respondents.

Table 7.4
Mean 'perceived risk' for each hazard in Organisation B

Hazards	Mean 'Perceived Risk'
21. Noise	5.85
1. Slipping and tripping	5.01
6. Actions leading to repetitive strain injuries	4.84
14. Operations of forklift trucks and similar vehicles	4.77
17. Manual handling of heavy goods	4.68
20. Contact with hot objects and surfaces	4.17
3. Workplace design and layout	4.08
11. Entanglement and trapping in machinery	3.81
16. Safe storage and stacking of goods	3.73
10. Use of sharp hand tools	3.70
22. Working with visual display units	3.19
12. Fire potential of combustible or flammable	3.14
9. Electrical hazards	2.90
4. Working with hazardous chemicals	2.71
15. Loading and unloading of vehicles	2.53
5. Working with irritant substances	2.26
2. Objects falling onto personnel	2.01
18. Compressed air hazards	1.67
7. Explosion from hazardous/flammable materials	1.37
23. Conditions leading to hand or body vibration	1.27
13. Use of compressed gas cylinders	1.24
19. Failure of pressure vessels	1.06
8. Ultra violet light, lasers and/or radio frequencies	0.73

Individual hazard scores were also combined to produce an overall hazard rating for each respondent. The mean hazard score for the entire organisation was 74.06 with a standard deviation of 46.5.

The third part of the questionnaire contained 31 attitude statements. These are shown with their mean item scores and standard deviations in Table 7.5. Without exception, responses to the attitude statements show views on the positive side of the mid-point (3) across the organisation.

Table 7.5
Attitude items mean scores in Organisation B

Item	Mean	Standard Deviation
1. Health and safety have a very high priority here	4.09	0.94
2. Safety specific jobs always get done	3.10	1.016
3. My line manager listens to my concerns about health and safety	3.70	0.904
4. As long as there are no accidents unsafe behaviour is tolerated	2.36	1.19
5. I look out for the safety of my colleagues	4.29	0.648
6. The company makes an effort to prevent accidents happening	4.09	0.744
7. Safety issues are included in communications meetings	3.95	0.814
8. I have been shown how to do my job safely	3.78	0.876
9. Management are prepared to discipline workers who act unsafely	3.80	0.977
10. There are good communications here about safety issues which affect me	3.63	0.887
11. It is sometimes necessary to take unsafe shortcuts to get the work done	2.64	1.21
12. Relevant health and safety issues are communicated	3.77	0.754
13. Everyone plays an active role in safety matters	3.54	1.095
14. The safety training I receive is not detailed enough for my job	3.52	0.927
15. I am informed of the outcomes of health and safety meetings	3.30	1.093
16. Everyone wants to achieve the highest levels of safety performance	3.61	0.902
17. Levels of safety performance have improved here over the last two years	3.26	1.043
18. I can influence health and safety performance here	3.77	0.835
19. Only a few people are involved in health & safety activities	2.80	1.127
20. Safety training has a high priority here	3.80	0.857
21. Minor/trivial accidents are tolerated as part of the job	2.36	1.006
22. There is a process of continual safety improvement in the company	3.94	0.659
23. Management takes the lead on safety issues	3.45	0.915
24. What is learnt from accidents is used to improve safety training	3.84	0.771
25. Safe working is a condition of my employment here	4.06	0.657
26. On my site we have defined safety improvement objectives	3.69	0.768
27. Supervisors actively support safety	3.71	0.869
28. My colleagues and I help each other work safely	3.94	0.670
29. Accidents and incidents are always reported	3.13	1.087
30. The company is only interested in safety after an accident occurs	2.41	1.077
31. All safe systems are up to date	3.78	1.014

Section 4 of the questionnaire dealt with individuals' safety activities over the past five years. Respondents indicated if they had taken part in a range of activities either in the past 12 months or in the past five years. Table 7.6 shows the percentage of respondents who had taken part in the specified activities in each of the two time slots. Individual scores were also combined to give each respondent an overall activity score. The mean activity score for the organisation as a whole was 9.79 with a standard deviation of 5.77.

Table 7.6
Percentage of Organisation B respondents taking part in safety activities

Activity	In the past 12 months	In the past 5 years
1 Seen a safety video	66.62%	24.43%
2 Helped with site open day	18.46%	1.84%
3 Shown visitors around my job	23.86%	13.56%
4 Taken part in job safety analysis	30.37%	15.63%
5 Attended a safety committee meeting	18.17%	14.52%
6 Discussed safety at crew briefing	34.69%	25.78%
7 Taken part in safety promotion or competition	34.34%	6.73%
8 Conducted a safety inspection or audit	29.83%	21.05%
9 Took part in a risk assessment	24.03%	11.31%
10 Organised a safety activity	8.13%	7.34%
11 Attended a safety improvement meeting	22.85%	13.63%
12 Raised a suggestion to improve safety	34.76%	23.91%

As with the questionnaire used in Organisation A, opportunity was provided for respondents to make additional comments about safety issues in their workplace. 242 comments were made in this space (25.6% of the total sample). The comments were once again subjected to content analysis involving two raters and using the same procedure as that described in Chapter 6 (Section 6.2). These comments have been summarised in six general areas and these are shown in Table 7.7. Once again the vast majority of comments were negative in nature; the number of positive comments relating to each of the areas is shown in brackets together with the total.

The next stage in the analysis of data from Organisation B involved examining the structure of the attitude scales, using a confirmatory approach.

Table 7.7
Open responses in Organisation B

General Area	Number of comments
Individual Responsibility and Awareness	64 (14)
Safety Systems/Equipment	71 (3)
Training and Involvement	51 (5)
Priority of Safety	22 (0)
Health Related	16 (0)
Miscellaneous	18 (1)

7.4 CONFIRMATORY FACTOR ANALYSIS

The 30 attitude statements[4] in the third section of the survey instrument were subjected to confirmatory factor analysis to examine the dimensionality of this part of the instrument in comparison with the structure found in Organisation A. This analysis followed the confirmatory practices described earlier in Chapter 4.

7.4.1 Pre-analysis checks

As with exploratory analysis, initial processing of the data included an examination of missing data, sample size and the appropriateness of the data for factor analysis. 73 cases from the data set had one or more missing attitude data points (8% of the total sample). Five of these were managers and nine were supervisors in line with the original sample ratio. In addition the missing data was in approximately the same ratios as the samples from each plant, with Plant 1 losing 18 cases, Plant 2 losing 12, Plant 3 losing 1 and Plant 4 losing 42. This left a sample size of 842 cases giving a subject to variable ratio in the order of 28:1, a subject to factor ratio in the order of 168:1, and a variable to factor ratio of 6:1 for the total sample. All of these ratios are within the guidelines discussed in Chapter 4 and summarised by Kline (1994) and Ferguson and Cox (1993), indicating that the data in the total sample were appropriate for factor analysis. In this organisation, the sample sizes of at least three of the plants were large enough to consider individually. The breakdown of how the suitability ratios stood for each of the plants is shown in Table 7.8.

Structural equation modelling (SEM) was used to examine the factorial validity of the five factor model, found in Organisation A, across the different plants. While the subject to variable ratio and the total sample size in Plant 3 were slightly less than

[4] The additional questionnaire item, added by Organisation B, was not included in this analysis, since it was not part of the structure found in Organisation A.

recommended (Arnindal and van der Ende, 1985) for factor analysis, it was included in the multi-group analysis to compare structures, although Plant 3 specific differences must be interpreted with caution. In addition to sample characteristics, the raw data were within the acceptable parameters of multivariate normal distribution.

Table 7.8
Appropriateness of plant samples for factor analysis

Ratio	Plant 1	Plant 2	Plant 3	Plant 4
Subject:Variable	4:1	4:1	3:1	17:1
Subject:Factor	25:1	23:1	16:1	103:1
Variable:Factor	6:1	6:1	6:1	6:1
Sample	127	116	82	517

7.4.2 Multi-group Confirmatory Factor Analysis

As described in Chapter 4, a confirmatory measurement model tests assumptions, relating the indicators (observed variables) to the hypothetical latent variables (or factors). In this study data were gathered from four different plants all belonging to the same parent organisation. In this case each of the plants had almost sufficient sample sizes to allow evaluation of their individual factor structures. Differences in factorial structure across plants might occur, because of, for example, national and regional differences (one of the plants is situated in France). The stability of the dimensions must, therefore, whenever possible, be established across plants. If such a measurement, or confirmatory, model does not obtain satisfactory fit, then there is no point in proceeding with any other statistical tests, including any other structural model containing these latent variables, until their proper measurement is achieved. A fundamental concern in any multiple group comparison is ensuring construct compatibility, or measurement equivalence, when looking for between group differences (Little, 1997). If the structure is not stable across plants, mean and structural differences may be due to different factors arising for the different plants. In other words, mean differences and other parameter comparisons can be computed, only when the underlying structure has been clearly shown as general. Further comparisons are appropriate only when the architecture of safety attitudes is stable across plants.

A sequence of confirmatory multi-group models, employing maximum likelihood estimation, was used in order to test the factorial invariance across plants. Each of these models is overidentified, since the degrees of freedom are additive in a multi-group analysis (Byrne, 1994). As a first step, the five-factor model was tested for every group (plant), with no cross-group constraints. The five-factor model found in Organisation A fitted the data well giving support to the idea that the responses to the 30 observed variables could be collapsed into five theoretical factors. The fit indices for this model (Model 1) are shown in Table 7.9.

Table 7.9
Multi-group goodness of fit indices for the confirmatory factor analyses

Model	χ^2	d.f.	prob.	CFI	χ^2 difference
1	2834.6	1580	<0.001	0.84	-
2	2968.6	1655	<0.001	0.82	134
3	2213.5	1648	<0.001	0.92	621.1

As a more restrictive test for factor invariance, a multisample confirmatory factor analysis was employed, constraining all factor loadings to be the equal across groups. This model tests for equal weight of the indicators to define their factors across the four plants. The constrained multi-group analysis (Model 2), however, resulted in a poorer fitting solution. Seven constraints among the 75 imposed were released, following LM test suggestion. This modified model resulted in a satisfactory fit to the data. The better fitting model was achieved releasing just seven constraints involving factor loadings among two groups (plants 1 and 4). It can be concluded after this analysis that the dimensionality (structure) of the safety attitude section of the survey seems stable across plants. Moreover, most of the factor loadings are almost the same across groups, indicating that fundamental factoral partial invariance has been achieved.

7.4.3 Total Sample Confirmatory Analysis

The five factor model was then tested for the overall sample to provide better estimates of factor loadings which in turn became reliability estimates of the observed variables and provided a further indication of factors' internal consistency (Bollen, 1989). This measurement model showed a satisfactory model fit (χ^2= 1209.747, d.f.= 395, p<0.001, CFI= 0.886, GFI= 0.905, RMSEA = 0.051) and was used as the basis for the description of attitudes to safety in this study. Factor loadings for each item on the appropriate factor are shown in Table 7.10. The loadings shown in Table 7.10 were all large and statistically significant ($p<0.001$), indicating satisfactory reliabilities of the items. Moreover, on examination of the factor loadings, it can be concluded that the five latent variables (or factors) presented very similar reliabilities, hence the internal consistency of the factors seems adequate, although the personal responsibility factor did have less consistent indicators (with lower loadings).

Table 7.10

Standardised total sample factor loadings for the five-factor model

Item	Factor 1 Safety Mgt.	2 Comm.	3 Inv.	4 Safety Stds.	5 Ind. Res.
1. Health and safety have a very high priority here	0.709				
2. Safety specific jobs always get done	0.555				
3. My line manager listens to my concerns about health and safety	0.536				
6. The company makes an effort to prevent accidents happening	0.636				
9. Management are prepared to discipline workers who act unsafely	0.509				
14. The safety training I receive is not detailed enough for my job	0.446				
17. Levels of safety performance have improved here over the last two years	0.328				
20. Safety training has a high priority here	0.734				
22. There is a process of continual safety improvement in the company	0.661				
23. Management takes the lead on safety issues	0.475				
24. What is learnt from accidents is used to improve safety training	0.507				
26. On my site we have defined safety improvement objectives	0.482				
27. Supervisors actively support safety	0.660				
30. The company is only interested in safety after an accident occurs	0.614				
7. Safety issues are included in communications meetings		0.633			
8. I have been shown how to do my job safely		0.545			
10. There are good communications here about safety issues which affect me		0.816			
12. Relevant health and safety issues are communicated		0.642			
15. I am informed of the outcomes of health and safety meetings		0.487			
13. Everyone plays an active role in safety matters			0.495		
16. Everyone on my site wants to achieve the highest levels of safety performance			0.559		
19. Only a few people who work here are involved in health and safety activities			0.462		
28. My colleagues and I help each other work safely			0.510		
29. Accidents and incidents are always reported			0.455		
4. As long as there are no accidents unsafe behaviour is tolerated				0.666	
11. It is sometimes necessary to take unsafe shortcuts to get the work done				0.587	
21. Minor/trivial accidents are tolerated as part of the job				0.684	
5. I look out for the safety of my colleagues					0.400
18. I can influence health and safety performance here					0.513
25. Safe working is a condition of my employment here					0.519

All factor loadings are statistically significant ($p< 0.01$)

7.4.4 Internal Consistency

The internal consistency of each of the scales derived from the factor structure was assessed using Cronbach's Alpha coefficients. The alpha coefficient for each scale is shown in Table 7.11. As in Organisation A, the alpha coefficient for the scale relating to Individual Responsibility suggests, like the less consistent factor loadings, that it may not be reliable.

Table 7.11

Attitude scale internal consistency in Organisation B

Factor Scale	Coefficient Alpha
Safety Management	0.86
Communication	0.75
Involvement	0.61
Safety Standards	0.68
Individual Responsibility	0.47

7.5 PLANT DIFFERENCES

Once the measurement model had been properly established, further comparisons between groups were considered. In particular, whether or not plants differed in their average perceptions of safety climate as measured by the attitude survey was examined. MANOVA and one-way ANOVA tests were performed on the measured safety attitude variables, although, as already noted, the Individual Responsibility scale had a low internal reliability coefficient and results for this scale should be interpreted with caution.

MANOVA was used to test for the effects of plant on each safety attitude dimensions. A Box test was first employed, showing that there were statistically significant differences between the variance-covariance matrices across the different plants (Box's M= 102.7, F= 2.234, $p<0.001$), in such circumstances Pillai's criterion performs better. However, both Wilk's Lambda (Λ) and Pillai's criterion shown statistically significant differences between the plants (groups) [Wilk's Λ= 0.854, F= 8.328, $p<0.001$; Pillai's criterion = 0.151, F= 8.138, $p<0.001$].

Several one-way ANOVAs were then performed, one for each attitude dimension. Summary statistics for these analyses are shown in Table 7.12. All effects were statistically significant and post-hoc comparisons (Scheffé tests) were performed. Means for each group are shown in Table 7.13.

Table 7.12
One-way ANOVA for the safety climate dimensions in Organisation B

Dependent variable	F	Prob.
Safety Management	7.961	0.001
Communication	11.568	0.001
Individual Responsibility	5.205	0.001
Safety Standards and Goals	10.755	0.001
Personal Involvement	8.804	0.001

Degrees of freedom for between sums of squares - 3; degrees of freedom for the error source - 772;

Respondents working in Plant 1 had the most positive score on most of the safety attitude variables. They assessed safety management, safety standards and goals, and personal involvement more positively than any other group. They also assessed communication and individual responsibility on a par with Plants 3 and 4. Physical work environment and workplace hazards were assessed as positively as they were in Plants 2 and 3. Plant 1 also displayed the highest level of safety activities.

Table 7.13
Safety variable means for the four plants in Organisation B

	Plant			
Dependent variable	**One**	**Two**	**Three**	**Four**
Safety Management	**53.91**	49.40	50.71	51.18
Communication	19.01	**16.50**	18.40	18.44
Individual Responsibility	12.10	**11.22**	12.12	12.05
Safety Standards	**11.29**	9.31	10.25	10.60
Involvement	**18.24**	17.47	17.19	17.14
Work Environment	12.34	12.50	13.06	**11.82**
Workplace Hazards	64.33	58.53	60.56	**78.18**
Safety Activities	**11.58**	7.41	8.69	9.24

Emboldened groups differ significantly from the others (Scheffé tests, $p < 0.01$)

On the other hand, respondents in Plant 2 assessed the attitude dimensions more negatively than the other plants. They reported the lowest levels of communication and individual responsibility. They also assessed safety management, safety standards and goals, and personal involvement similarly to Plants 3 and 4. However, respondents in Plant 2 did not report their plant as hazardous or problematic in terms of the physical work environment. Respondents in Plant 4 negatively assessed physical work environment and level of workplace hazards, while they reported lower levels of safety management, safety standards and goals and personal involvement, and high levels of communication and individual responsibility. In summary, Plant 2 presented the poorest picture in terms of the variables derived from the attitude questionnaire, whereas Plant 4 reported more hazards and poorer working conditions than any other plant. Plant 3 occupied an intermediate position between Plant 1 (with good standards) and Plant 2 (poor attitudes) and Plant 4 (high level of hazards).

7.6 STRUCTURAL MODEL OF ATTITUDES IN ORGANISATION B

The theoretical model, shown in Figure 6.2, was used as the a priori model for Organisation B and was tested in the total sample, combining all responses from all plants. This model was, as before, overidentified with 586 degrees of freedom. Overall fit measures for this model and modified models tested following LM test suggestions are shown in Table 7.14.

Table 7.14

Goodness of fit indices for Organisation B model and modifications

Model	χ^2	d.f.	Prob.	CFI	GFI	NNFI	RMSEA	χ^2 difference
1	1809.35	586	<0.001	0.855	0.883	0.844	0.051	-
2	1759.96	585	<0.001	0.860	0.885	0.850	0.050	49.39
3	1752.71	584	<0.001	0.861	0.886	0.850	0.050	56.64

The a priori model (outlined in Figure 6.2) fitted the data relatively well. In this model all of the constituent items in the safety attitude and physical work environment scales were included in the analysis. The LM test, however, suggested modifications which would bring the model in line with that found in Organisation A (and shown in Figure 6.3). Model 2, therefore, introduced effects between safety standards and involvement and between work environment and workplace hazards, as well as dropping the relationship between work environment and individual responsibility. This resulted in a model with 585 degrees of freedom, which provided a better fit for the data. As a result of a further LM test in Model 2, however, Model 3 introduced direct effects between work environment and safety activities. This modification was still in line with the theoretical model and reduced the degrees of freedom in the model to 584.

The χ^2 difference (D test) between Models 1 and 3 was significant indicating that Model 3 was the best representation of the data. No other changes between factors were statistically significant and, based on the results of the LM test, no other theoretically based modifications would make a significant improvement to model fit. The CFI and GFI for Model 3 were very close to 0.9 and the RMSEA is 0.05 indicating a good model fit. As with the model in Organisation A, given the high number of degrees of freedom, the RMSEA is probably the most reliable indicator in this case (MacCallum, 1995). The interrelationships estimated in the final model between the dimensions for Organisation B are shown in Figure 7.1.

As well as the direct effects (shown in Figure 7.1) there are several significant indirect effects between factors and variables. The indirect effects on workplace hazard appraisals of safety management (β = -0.076) and of safety standards (β = -0.245) were both statistically significant ($p<0.01$). The indirect effects on safety activities of all other variables were statistically significant ($p<0.01$): workplace hazards (β = 0.122), safety standards (β = 0.281), communication (β = 0.173), personal involvement (β = 0.194), work environment (β = -0.032), and safety management (β = 0.262). The indirect effect of safety management on individual responsibility was statistically significant (β = 0.657, $p<0.01$), as well as the indirect effect of work environment (β = -0.084, $p<0.01$). No other indirect effects were statistically significant.

As with Organisation A, all but one of the a priori structural effects were statistically significant giving more support to the theoretical model and *Hypothesis 1* that safety climate can be described in terms of four main elements: Organisational, Social Work Environment, Physical Work Environment and Individual dimensions. The addition, in Organisation B, of a new direct path between work environment and safety activities, while not detailed in the a priori structure, is still consistent with the general four-element model illustrated in Figure 5.2.

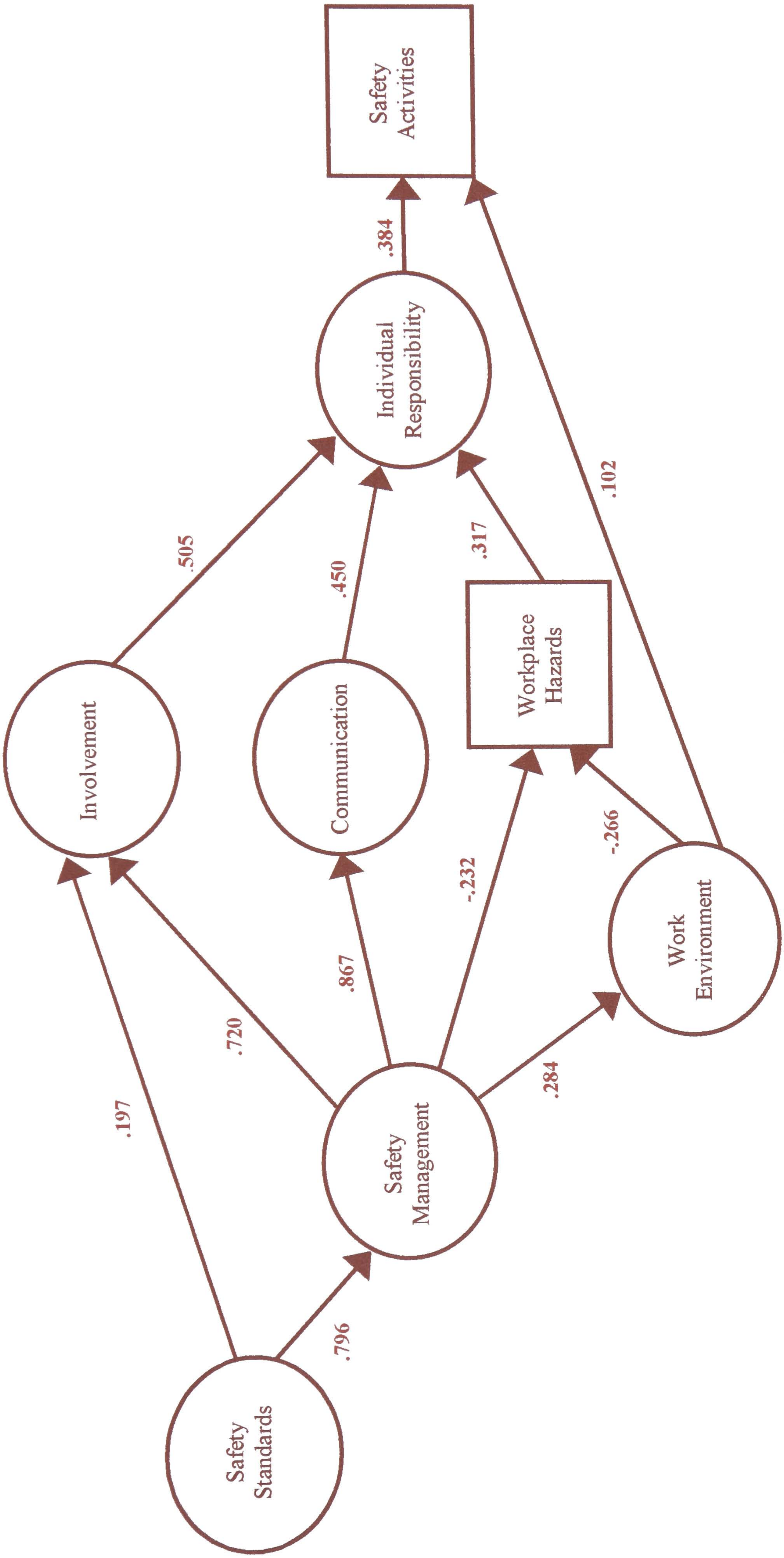

Figure 7.1
Revised structural model in Organisation B

7.7 FEEDBACK

The final stage in the Organisation B safety survey involved the feedback of results at several levels within the organisation. As in Organisation A, the descriptive results were summarised in a series of reports for each of the participating plants, including a summary sheet for display on plant notice boards. Comparative results between plants were reported to the group safety department, who distributed the results to the member of the group safety committee. The structural model was explained to the safety committee where it was decided to set up safety improvement teams in each plant in an attempt to improve employee involvement and promote responsibility. Members of these teams would exchange views with, and visit other plants in the division.

7.8 SUMMARY

This chapter has detailed the distribution and results obtained from the use of the survey instrument in Organisation B. Confirmatory factor analyses of the attitude section of the questionnaire, at individual plant and whole organisation levels, endorsed the five employee attitudes to safety factors found in Organisation A. Structural equation modelling of these dimensions and other measures from the questionnaire supported the model described in Figure 6.3, and lends further support to *Hypothesis 1*. The next chapter describes the modification of the survey instrument and its application and results in an organisation involved in the supply of construction materials.

CHAPTER EIGHT

Structure of Attitudes to Safety in a Construction Supply Organisation (Organisation C)

This chapter deals with the final application and analysis of the survey instrument. It describes questionnaire adaptation, data collection process and analysis in an organisation operating in a different environment from the other participating organisations, namely the supply of construction materials. Once again, the survey results, including confirmatory analysis of the attitude scales and an examination of the questionnaire's structure are described. Chapter 9 details the comparison of organisational models.

8.1 QUESTIONNAIRE ADAPTATION

The suitability of the survey instrument was assessed by a third participating organisation. In this organisation the questionnaire was first examined by representatives from participating work sites in a pilot study and then adapted by members of the group safety advisory committee in line with the views of those representatives and consistent with current safety issues.

8.1.1 Pilot Study

The first stage in the adaptation process involved asking two representatives from each site to complete the questionnaire described in Chapter 5 and used in Organisation A (shown in Appendix 1). As in the original instrument development those involved in this study were asked not only to complete the questionnaire but also to comment on the general content, clarity of instructions, and any specific items they felt to be unclear.

Twenty-five questionnaires were completed, including at least one from each participating site. In general terms this group agreed that the instructions were adequate and that the questionnaire covered the main safety issues in their work place. Specific comments related to the following aspects of the instrument:

- In the hazard checklist it was noted that forklift truck operations were not a common hazard in this environment;
- In the safety attitudes section of the questionnaire 22 respondents indicated that they had no idea if item 24 'What is learned from accidents is used to improve safety training' was the case;
- A number of safety activities were highlighted as inappropriate for inclusion for this organisation, specifically those relating to visitors and open days, and job safety analysis with which most respondents were not familiar.

8.1.2 Changes to the Survey Instrument

The second stage in the adaptation process involved customising the survey instrument to take account of the issues raised in the pilot study and the views of the group safety advisory committee. This committee comprised the organisation's group safety manager as well as a selection of safety advisors from individual work sites. This committee scrutinised the survey instrument and suggested the following changes to make the questionnaire suitable for their organisation:

Work Hazard Checklist

- Item 3 'Workplace design and layout' was clarified and changed to 'Problems with workplace design and layout', and
- Item 14 'Operations of forklift trucks and similar vehicles' was reworded to the more appropriate 'Mobile plant operation on site'.

Safety Attitudes

- Item 16 'Everyone on my site wants to achieve the highest levels of safety performance' was considered too broad and perhaps difficult for employees to respond to. It was changed, therefore, to 'People on my site want to achieve the highest levels of safety performance';

- Item 24 'What is learned from accidents is used to improve safety training' was deleted following the results of the pilot study; and
- Item 28 'My colleagues and I help each other work safely' was changed to 'My colleagues and I help each other to keep safe' to avoid the suggestion that employees may need help to do their jobs correctly.

Safety Activity Checklist

- Items 2 'Helped with a site open day', 3 'Shown visitors around my job', and 4 'Taken part in a job safety analysis' were deleted from the checklist as a result of the pilot study;
- Items 7 'Taken part in a safety promotion or competition' and 10 'Organised a safety activity' were also deleted since there were no such programmes in place in the organisation;
- Six items, reflecting activities common to the organisation, were added to the checklist: 'Attended a safety training course', 'Participated in an accident investigation', 'Helped develop a safety procedure', 'Involved in the selection of PPE', 'Reported a near miss' and 'Tried to prevent a colleague doing something unsafe'; and
- 'Never' was added as a response category in this section.

This process resulted in a revised questionnaire for use in Organisation C, which is shown in Appendix 4.

8.2 DATA COLLECTION

Data were collected in this organisation as part of the group safety audit. The group safety team took full responsibility for the production, distribution and processing of the survey. At each of the sites employees were given the questionnaire during a team briefings. An introduction to the site audit was given and included information on the survey, which assured attendees of the confidentiality of the process. Questionnaires were then distributed and individuals were given 30 minutes to complete and return the survey to the group safety team. The group safety team then coded the questionnaires and produced a descriptive report for each site. A complete data file was forwarded for an organisational analysis.

8.2.1 Sample

The research reported in this chapter is based on a questionnaire survey of the total population of employees in 14 work sites of an organisation supplying construction materials based in the UK. A total of 398 valid questionnaires (83% response rate) were obtained from the survey: 3.7% were managers, 7.3% were line supervisors and 51.4% were regular employees (this excludes 38.4% who did not provide this information).

Only 31% of respondents specified at which of the 14 sites they worked. This was probably due to the fact that responses could be identified by those collecting the completed questionnaires at the site team briefing and therefore attributed to that plant, rather than any attempt by employees to remain anonymous. Since so many of the responses could not be attributed to a specific plant in the data file, no plant level analyses could be carried out for this organisation. However, as in the other participating organisations, data from the survey were first subjected to an overall descriptive analysis.

8.3 DESCRIPTIVE RESULTS

The first section of the questionnaire contained four work environment items; these are shown in Table 8.1 with their mean items scores and standard deviations. The work environment item scores show that, unlike the two previous organisations, respondents' views on all aspects of their working environment were above the scale mid-point (3). Only item 2 'The ventilation in my workplace is adequate' was close to the mid-point. Cronbach's Alpha measure of internal consistency for these items as a scale was 0.72, above the acceptable level.

Table 8.1
Work environment items mean scores in Organisation C

Item	Mean	Standard Deviation
1. The light levels in my workplace are adequate	3.22	1.15
2. The ventilation in my workplace is adequate	3.04	1.23
3. Space allocated for doing tasks in my workplace is adequate	3.30	1.13
4. The humidity levels in my workplace are adequate	3.22	1.02

The second section of the questionnaire listed a number of workplace hazards and elicited the views of respondents as to: i) whether the hazard was present; ii) the severity of it's consequences; and iii) the adequacy of existing precautions and control measures. Table 8.2 shows each hazard together with the mean 'perceived risk' (presence of hazard (0-3) x severity of its consequences (1-3) x adequacy of control measures (1-2), giving a possible scale ranging from 0 to 18) across all respondents.

Table 8.2

Mean 'perceived risk' for each hazard in Organisation C

Hazards	Mean 'Perceived Risk'
21 Noise	5.91
1 Slipping and tripping	4.81
17 Manual handling of heavy goods	4.69
14 Mobile plant operation on site	4.42
6 Actions leading to repetitive strain injuries.	4.37
3 Problems with workplace design and layout	3.47
4 Working with hazardous chemicals	3.08
16 Safe storage and stacking of goods	3.00
5 Working with irritant substances	2.98
9 Electrical hazards	2.96
20 Contact with hot objects and surfaces	2.64
22 Working with visual display units	2.63
18 Compressed air hazards	2.50
15 Loading and unloading of vehicles	2.45
11 Entanglement and trapping in machinery	2.41
10 Use of sharp hand tools	2.25
12 Fire potential of combustible or flammable materials	2.13
23 Conditions leading to hand or body vibration	2.10
2 Objects falling onto personnel	2.00
13 Use of compressed gas cylinders	1.78
7 Explosion from hazardous/flammable gases	1.31
19 Failure of pressure vessels	0.94
8 Ultra violet light, lasers and/or radio frequencies	0.74

When individual hazard scores were combined to produce an overall hazard rating for each respondent the mean hazard score for the entire organisation was 65.57 with a standard deviation of 49.8.

The mean scores and standard deviations from the 29 attitude statements in the third part of the questionnaire are shown with in Table 8.3. Responses to the attitude statements show views on the positive side of the mid-point (3) across the organisation for all but item 19, which indicated that, on average, respondents agreed with this statement that only a few people were involved with health and safety activities at their site.

Table 8.3

Attitude items mean scores in Organisation C

Item	Mean	Standard Deviation
1. Health and safety have a very high priority at XXX	3.62	1.07
2. Safety specific jobs always get done	3.29	1.08
3. My line manager listens to my concerns about health and safety	3.82	0.82
4. As long as there are no accidents unsafe behaviour is tolerated	2.50	1.27
5. I look out for the safety of my colleagues	4.27	0.58
6. The company makes an effort to prevent accidents happening	3.91	0.80
7. Safety issues are included in communications meetings	3.78	0.86
8. I have been shown how to do my job safely	3.84	0.85
9. Management are prepared to discipline workers who act unsafely	3.82	0.91
10. There are good communications here about safety issues which affect me	3.46	0.98
11. It is sometimes necessary to take unsafe shortcuts to get the work done	2.53	1.18
12. Relevant health and safety issues are communicated	3.65	0.84
13. Everyone plays an active role in safety matters	3.37	0.98
14. The safety training I receive is not detailed enough for my job	2.60	0.94
15. I am informed of the outcomes of health and safety meetings	3.33	1.07
16. People on my site want to achieve the highest levels of safety performance	3.50	0.91
17. Levels of safety performance have improved here over the last two years	3.51	0.98
18. I can influence health and safety performance here	3.65	0.87
19. Only a few people are involved in health and safety activities	3.15	1.06
20. Safety training has a high priority at XXX	3.50	0.96
21. Minor/trivial accidents are tolerated as part of the job	2.62	1.02
22. There is a process of continual safety improvement in the company	3.64	0.81
23. Management takes the lead on safety issues	3.32	0.94
24. Safe working is a condition of my employment here	3.97	0.72
25. On my site we have defined safety improvement objectives	3.46	0.96
26. Supervisors actively support safety	3.72	0.80
27. My colleagues and I help each to keep safe	3.87	0.70
28. Accidents and incidents are always reported	3.29	1.04
29. The company is only interested in safety after an accident occurs	2.58	1.08

The fourth section of the questionnaire dealt with individuals' safety activities over the past 12 months and five years. Table 8.4 shows the percentage of total respondents who had taken part in the specified activities in each of the two time slots. The mean activity score for the organisation as a whole, when individual scores were combined to give each respondent an overall activity score, was 9.46 with a standard deviation of 5.77.

Table 8.4

Percentage of Organisation C respondents taking part in safety activities

Activity	In the past 12 months	In the past 5 years
1 Seen a safety video	10.29%	78.36%
2 Attended a safety training course	8.18%	62.80%
3 Participated in an accident investigation	7.39%	21.90%
4 Helped develop a safety procedure	11.08%	21.64%
5 Attended a safety committee meeting	12.14%	21.11%
6 Discussed safety at crew briefing	24.27%	36.15%
7 Took part in a safety inspection or audit	14.25%	23.22%
8 Took part in a risk assessment	14.51%	26.12%
9 Involved in the selection of PPE	13.19%	15.83%
10 Attended a safety improvement meeting	7.92%	25.07%
11 Raised a suggestion to improve safety	22.96%	43.01%
12 Reported a near miss	16.36%	39.05%
13 Tried to prevent a colleague doing something unsafe	25.33%	36.15%

As with the questionnaires used in the other participating organisations, opportunity was provided at the end for respondents to make additional comments about safety issues in their workplace. 143 comments were made in this space (36% of the total sample). The comments were once again subjected to content analysis using the same procedure as that described in Chapter 6 (Section 6.2). These comments have been summarised in seven general areas and these are shown in Table 8.5. Once again the vast majority of comments were negative in nature; the number of positive comments relating to each of the areas is shown in brackets together with the total.

Table 8.5

Open responses in Organisation C

General Area	Number of comments
Management Action	38 (8)
Work Environment	33 (0)
Training	22 (6)
Equipment	18 (1)
Individual Responsibility	13 (3)
Communications	10 (0)
Miscellaneous	8 (0)

In addition to the survey data in this organisation, the group average ratings from the site safety audits were also made available.

8.3.1 Group Safety Audit

The purpose of the audit was to give each site an objective measurement of their health and safety performance compared to legal requirements, and their own declared policy standards. At an organisational level, adverse audit grades were designed to raise the profile of need for support. Audits were scheduled by the group safety manager for once every two years and were carried out by two competent auditors assigned from other organisation sites.

The audit protocol covered ten areas including: policy and management, substances, noise, electricity, work equipment, workplace, manual handling, general provisions, contractors and visitors, and accident management. These areas were assessed against a number of criteria and given an overall grade. An explanation of the grading system is shown in Table 8.6.

Table 8.6
Organisation C group audit grade descriptions

Grade	Description
5	An exemplary level of health and safety performance, which sets new standards for the industry.
4	A higher level of health and safety performance than would be considered normal for the industry.
3	An acceptable level of health and safety performance, which achieves broad legal compliance, and is consistent with organisational policy.
2	A level of health and safety performance where there is either a minor breach in related legislation that can be resolved in the short term, or policy standards have not been met.
1	An unacceptable level of health and safety performance where remedial action is essential, and should be completed in a reasonable time scale.
0	A totally unacceptable level of health and safety performance where immediate action is necessary.

The results of ten of the 14 participating sites, which had been audited using this protocol, were made available for comparison with the survey results. Table 8.7 details the organisational average audit grading for each of the ten areas covered by the organisational safety audit.

Table 8.7
Overall audit grades in Organisation C

Audit Area	Average Grade
Electricity	1.4
Noise	1.5
Substances	1.7
Manual Handling	1.8
Work Equipment	2
General Provisions	2
Contractors and Visitors	2.1
Policy and Management	2.2
Workplace	2.6
Accident Management	2.9

The hazards perceived as carrying the most risk from the questionnaire were Noise, Slipping and tripping and Manual handling of heavy goods. Interestingly Noise and Manual Handling were identified among the areas for improvement in the group health and safety audit. The audit did not, however, highlight so many problems with the Workplace, contrary to the perceptions of survey respondents with regard to Slipping and tripping and Problems with workplace design and layout.

The next stage in the analysis of data from Organisation C involved a confirmatory analysis of the structure of the attitude scales in Section 2 of the questionnaire.

8.4 Confirmatory Factor Analysis

The 29 attitude statements in the third section of the survey instrument were subjected to confirmatory factor analysis to examine the dimensionality of this part of the instrument in comparison with the structure found in Organisations A and B. Once again this analysis followed the confirmatory practices described earlier in Chapter 4.

8.4.1 Pre-analysis checks

Initial processing of the data included an examination of missing data, sample size and the appropriateness of the data for factor analysis. 12 cases from the data set had one or more missing attitude data points (3% of the total sample). One was a manager, two were supervisors and five were regular employees. This, including the four missing cases that did not specify employment level, was in line with the original sample ratio. This left a sample size of 386 cases giving a subject to variable ratio in the order of 13:1, a subject to factor ratio in the order of 77:1, and a variable to factor ratio of almost 6:1. All of these ratios are within the acceptable levels described in Chapter 4, indicating that the data were appropriate for factor analysis.

8.4.2 Factor Structure

The five factor model found to fit the data in Organisations A and B was tested using the data from Organisation C[5] and once more employing a maximum likelihood estimation. This measurement model was, as in the other organisations, overidentified with 367 degrees of freedom. Overall fit measures for the proposed five factor measurement model (Model 1) and a modified model, tested as a result of LM test suggestions, (Model 2) are shown in Table 8.8.

Table 8.8

Goodness of fit indices for Organisation C factor structure and modification

Model	χ^2	d.f.	Prob.	CFI	GFI	NNFI	RMSEA	χ^2 difference
1	1172.72	367	<0.001	0.836	0.829	0.818	0.064	-
2	943.87	367	<0.001	0.882	0.857	0.870	0.054	228.85

The a priori measurement model (Model 1) failed to fit the data well in this organisation, with indices of fit closer to 0.8 than 0.9. The LM test, however, suggested three modifications to factor/variable relationships that would change the χ^2 statistic significantly. Model 2, therefore, proposed that item 6 'The company makes an effort to prevent accidents happening' and item 29 'The company is only interested in health and safety after an accident occurs' loaded on Factor 4 (Safety

[5] The model was constructed omitting one item from the first factor, which was not included in this questionnaire

Standards) rather than Factor 1 (Safety Management), and that item 26 'Supervisors actively support safety' loaded on Factor 3 (Involvement) rather than Factor 1 (Safety Management). The movement of items 6 and 29 made theoretical sense since, in terms of the four element model shown in Figure 5.2, they were remaining within the 'Organisational Dimensions' element of the general model. The new factor where item 26 loaded was not, however, as theoretically obvious, and might be considered as peculiar to the sample from this organisation (MacCallum et al., 1992). No other changes to the structure were suggested by the LM test as statistically significant.

The large χ^2 difference between the two models suggested that Model 2 was the better representation of the data. The CFI, GFI and NNFI for measurement model 2 were close to 0.9, indicating a good model fit. Factor loadings for each item on the appropriate factor are shown in Table 8.9. The loadings shown in Table 8.9 were all large and statistically significant ($p<0.001$), indicating satisfactory reliabilities.

8.4.3 Factor Naming

In order to ensure that the factors were still labelled coherently, given the change in structure, the group safety advisory committee in Organisation C examined the items comprising them. Like the process followed in Organisation A, this group considered each of the items and the factors they defined. In this case, however, the discussion group did not know the previous names attached to the factors. The group agreed that Factor 2 referred to communication systems, Factor 3 to worker participation and involvement and Factor 5 to personal responsibility for safety, and settled on the labels used in the previous structure. The expanded Factor 4 was thought to relate to organisational principles and the group agreed that it should be named 'Organisational Safety Standards'. The largest factor (Factor 1) was the topic of most discussion within the group and it was finally agreed to label this 'Management Action' since many of the items included within it referred to direct actions taken by company management.

Table 8.9
Standardised factor loadings in Organisation C

Item	Factor 1 Safety Mgt.	2 Comm.	3 Inv.	4 Safety Stds.	5 Ind. Res.
1. Health and safety have a very high priority at (this site)	0.819				
2. Safety specific jobs always get done	0.772				
3. My line manager listens to my concerns about health and safety	0.623				
9. Management are prepared to discipline workers who act unsafely	0.583				
14. The safety training I receive is not detailed enough for my job	0.494				
17. Levels of safety performance have improved here over the last two years	0.672				
20. Safety training has a high priority at (this site)	0.754				
22. There is a process of continual safety improvement in the company	0.816				
23. Management takes the lead on safety issues	0.754				
25. On my site we have defined safety improvement objectives	0.687				
7. Safety issues are included in communications meetings		0.613			
8. I have been shown how to do my job safely		0.610			
10. There are good communications here about safety issues which affect me		0.855			
12. Relevant health and safety issues are communicated		0.760			
15. I am informed of the outcomes of health and safety meetings		0.516			
13. Everyone plays an active role in safety matters			0.723		
16. People on my site wants to achieve the highest levels of safety performance			0.585		
19. Only a few people who work here are involved in health and safety activities			0.572		
26. Supervisors actively support safety			0.745		
27. My colleagues and I help each other to keep safe			0.711		
28. Accidents and incidents are always reported			0.537		
4. As long as there are no accidents unsafe behaviour is tolerated				0.516	
6. The company makes an effort to prevent accidents happening				0.715	
11. It is sometimes necessary to take unsafe shortcuts to get the work done				0.507	
21. Minor/trivial accidents are tolerated as part of the job				0.595	
29. The company is only interested in safety after an accident occurs				0.816	
5. I look out for the safety of my colleagues					0.682
18. I can influence health and safety performance here					0.671
24. Safe working is a condition of my employment here					0.784

All factor loadings are statistically significant ($p < 0.01$)

8.4.4 Internal Consistency

The internal consistency of each of the scales derived from the factor structure was assessed using Cronbach's Alpha coefficients. The alpha coefficient for each scale is shown in Table 8.10. Unlike the coefficients in the other participating organisations, all of the alpha coefficients are above the acceptable (0.7) level.

Table 8.10
Attitude scale internal consistency in Organisation C

Factor Scale	Coefficient Alpha
Management Action	0.90
Communication	0.79
Involvement	0.77
Organisational Safety Standards	0.80
Individual Responsibility	0.75

No between plants comparisons were possible due to the small number of respondents who identified their work site. The next stage of analysis in this organisation, therefore, involves the construction of a full structural model of attitudes to safety.

8.5 Structural Model of Attitudes in Organisation C

The new factor structure in Organisation C was still consistent with the general theoretical model described in Chapter 3 and illustrated in Figure 5.2. The more specific model, shown in Figure 6.2, was, therefore, used as the a priori model for Organisation C, with 'Organisational Safety Standards' replacing 'Safety Standards' and 'Management Actions' replacing 'Safety Management' in that model. This model was, as in the other organisations, overidentified with 552 degrees of freedom. Overall fit measures for this model and modified models tested following LM test and W test suggestions are shown in Table 8.11.

Table 8.11
Goodness of fit indices for Organisation C structural model and modifications

Model	χ^2	d.f.	Prob.	CFI	GFI	NNFI	RMSEA	χ^2 difference
1	1436.61	552	<0.001	0.846	0.831	0.834	0.060	-
2	1388.03	552	<0.001	0.854	0.849	0.842	0.059	48.58
3	1380.43	551	<0.001	0.860	0.851	0.844	0.057	56.18

The a priori model (outlined in Figure 6.2) did not fit the data well. The LM and W tests, however, suggested modifications which would bring the model more in line with that found in Organisation A (and shown in Figure 6.3). Model 2, therefore, introduced effects between organisational safety standards and involvement and between work environment and workplace hazards, as well as dropping the relationships between work environment and individual responsibility and between management action and workplace hazards. This resulted in a model with the same degrees of freedom (552), which provided a better fit for the data. As a result of a further LM test suggestion, however, Model 3 introduced direct effects between organisational safety standards and workplace hazards, reducing the degrees of freedom in the model to 521. The introduction of this final path was, as in the other modification cases, consistent with the theoretical four element model and provided another direct path from 'Organisational Dimensions' to 'Physical Working Environment'.

The χ^2 difference between Models 1 and 3 was significant indicating that Model 3 was the best representation of the data. No other changes between factor and variable relationships were statistically significant and, based on the results of the LM or W tests, no other theoretically based modifications would make a significant improvement to model fit. The CFI and GFI for Model 3 were close to 0.9, although the RMSEA is 0.057. The standardised interrelationships estimated in the final model between the dimensions and observed variables for Organisation C are shown in Figure 8.1.

As well as the direct effects (shown in Figure 8.1) there are several significant indirect effects between factors and variables. The indirect effects on workplace hazard appraisals of management action (β = -0.193) and of organisational safety standards (β = -0.139) were statistically significant ($p<0.01$). The indirect effects on safety activities of all other variables were statistically significant ($p<0.01$): workplace hazards (β = 0.121), organisational safety standards (β = 0.129), communication (β = 0.157), involvement (β = 0.178), work environment (β = -0.046), and management action (β = 0.136). The indirect effect of management action on individual responsibility was statistically significant (β = 0.307, $p<0.01$), as well as the indirect effect of work environment (β = -0.103, $p<0.01$). No other indirect effects were statistically significant.

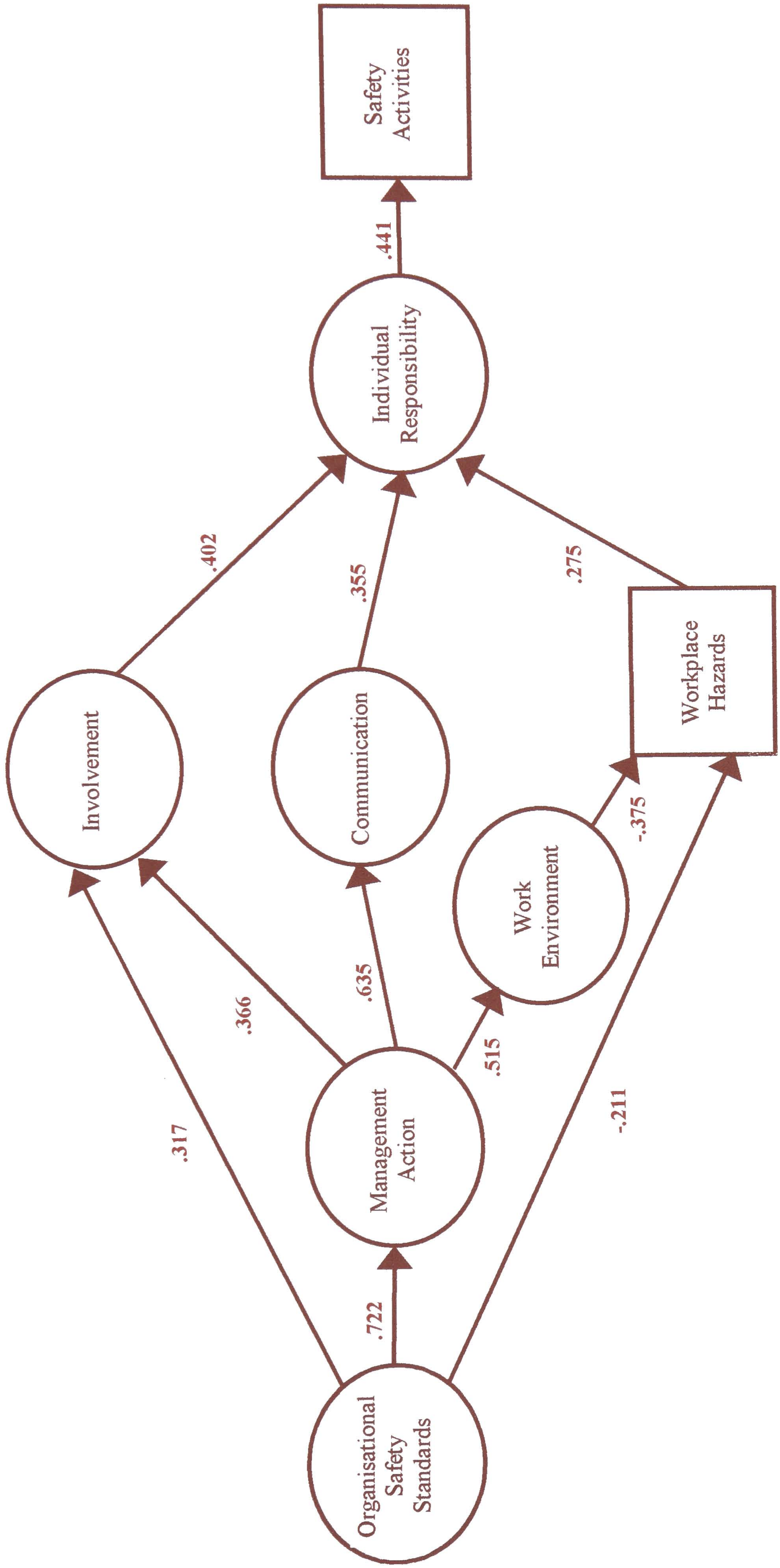

Figure 8.1
Revised structural model in Organisation C

Unlike Organisations A and B where only one proposed path was not significant, two of the a priori structural effects from the theoretical model shown in Figure 6.2 were not statistically significant in Organisation C structural model. There were two main structural path differences between the model in this organisation and those described in Chapters 6 and 7. Management actions had no direct effect on workplace hazards but organisational safety standards did have a direct effect on workplace hazards. Although the direct relationships, and indeed the factor structure, are not the same the model in Organisation C still supports the general theoretical model and is consistent with the four-element model illustrated in Figure 5.2.

8.6 FEEDBACK

Feedback in Organisation C was co-ordinated by the Group Safety Manager. Individual descriptive reports were prepared by the organisation and incorporated into site audit reports, which were discussed with all participants at team briefings. The group safety department did not produce comparative results between sites since their main aim was to give each site a benchmark on which to judge future performance. The structural model derived from Organisation C data was explained to the group safety committee, who felt that the paths shown endorsed their current policy of developing new communication forums at all levels throughout the organisation. The committee planned to re-assess each of the sites involved after approximately two years.

8.7 SUMMARY

This chapter has detailed the adaptation, distribution and results obtained from the use of the survey instrument in Organisation C. Comparison of survey results with summary results from the organisation's group health and safety audit provided some evidence on the accuracy of employee workplace hazard perceptions, although a plant-by-plant comparison of the data was not possible. Confirmatory factor analyses of the attitude section of the questionnaire, endorsed five employee attitudes to safety factors, although these were not identical to those found in Organisations A and B. Structural equation modelling of these dimensions and other measures from the questionnaire produced a model that, while not the same as the models found in the other participating organisation, did support the general model proposed in Figure 5.2, and lends further support to *Hypothesis 1*. The next chapter describes the detailed comparison of the models found in Organisations A and B, as well as an investigation of the structure of attitudes at different employment levels in those organisations.

CHAPTER NINE

A General Model of Employee Attitudes to Safety

This chapter focuses on comparison of models from the different participating organisations and from different work groups within those organisations. A detailed comparison of the explicative models of employee attitudes to and perceptions of safety issues in each of the organisations described in the preceding chapters is described here, as well as an examination of the differences between the structures of managers', first line supervisors' and employees' attitudes to safety. The following chapter presents a discussion of individual organisations' results in addition to one of the comparisons detailed in this chapter.

9.1 INTRODUCTION

In addition to the general model of safety climate derived in Chapter 3, the examination of previous research in the field of safety culture and climate in that chapter also gave rise to a second hypothesis. *Hypothesis 2* stated that a similar climate structure exists across organisations operating in similar commercial environments (Mearns et al, 1998; Williamson et al., 1997). One of the aims of this research was to examine similarities and differences between organisations operating in the same and different sectors, and by doing so gauge the extent to which structures might be shared in the sectors under study. Comparison of the results from the three organisations described in the preceding chapters will, therefore, provide an indication of those elements of safety climate that might be common to one sector, or specific to a particular organisation.

The exploration of the shared nature of safety culture and climate is also pertinent to the more detailed examination of similarities and differences between employment levels within an organisation or industrial sector. Other researchers (Cox et al., 1998; Harvey et al., 1999; Mearns et al., 1997; Niskanen, 1994) have suggested that that variations between hierarchical levels exist within organisations, giving rise to a third hypothesis that different employment groups within the same organisation will exhibit different attitudes and, consequently, different climate structures. The remainder of this chapter examines how the evidence for these two hypotheses and compares climate structures empirically where possible.

9.2 COMPARISON OF SAFETY CLIMATE IN TWO ORGANISATIONS

The individual analyses of the structure of safety climate in the three participating organisations, described in Chapters 6, 7 and 8, have produced factor structures and explicative models which all endorse hypothesis 1. These structures, since they are described in similar terms, can be compared and tested for generalisation across samples. Generalisation has several meanings in this context. As a starting point, the overall model should fit the data well across all samples. This does not imply equal parameter estimates (that is relationships between variables and factors, and between factors), but an overall similar structure. However, a fundamental concern in any cross-groups comparison is ensuring construct compatibility, or measurement equivalence. Further comparisons are adequate only when the underlying factors across samples (or organisations) are reasonably stable (Byrne, 1994).

An initial examination of the factor structures from the three organisations highlights an identical structure for organisations A and B, but a slightly different pattern in Organisation C. The same is true when the explicative, or structural, model of relationships between latent variables is considered; Organisations A and B exhibit a very similar structure, while Organisation C is different in at least two structural paths. A more detailed comparison between the results from Organisations A and B was thus possible, given the similarities in their structures. As discussed in Chapter 4, hypotheses on multiple populations can be evaluated when data on the same variables exist in several samples, using a mutisample analysis (Bentler, 1995). There is already evidence that the factor structure in Organisation C is quite different to that found in the other organisations and so the multisample analysis will focus on testing for invariance between Organisations A and B.

In this section, multigroup invariance is examined. Specifically the equivalence of the factorial structure and the invariance of structural paths in the two organisations were studied. This detailed comparison was achieved in three parts. First, the factor structures of the attitude and work environment variables were examined in a multisample confirmatory analysis. Next, differences in intensity of attitudes between the organisations were tested using t-tests to compare factor means. Finally, invariance in the structural models was scrutinised using a multisample structural analysis.

9.2.1 Multisample Confirmatory Factor Analysis

As in the other multisample analyses reported in this thesis, a sequence of confirmatory multi-group models, employing maximum likelihood estimation, was used in order to test the factorial invariance between attitude and work environment items in Organisation A and Organisation B. Each of the models in the sequence is overidentified, since the degrees of freedom are additive in a multi-group analysis (Byrne, 1994). As a first step, the overall measurement model was estimated in both samples with no constraints. Goodness-of-fit indices for this multigroup model (Model 1) are shown in Table 9.1.

Table 9.1
Goodness of fit indices for multisample measurement models

Model	χ^2	d.f.	Prob.	CFI	GFI	NNFI	RMSEA	χ^2 difference
1	2768.92	1024	<0.001	0.886	0.892	0.875	0.035	-
2	2827.57	1052	<0.001	0.884	0.890	0.876	0.035	58.65
3	2794.58	1046	<0.001	0.886	0.892	0.878	0.034	25.66

Although Model 1 has a statistically significant χ^2 statistic, the CFI is very close to 0.9; and, given that the model is extremely parsimonious (1024 degrees of freedom involves a huge reduction in the complexity of the original data), the model fit can be considered sufficient. Model 1 shows that the basic structure of the model fits the data in both samples (already evident from the exploratory analysis of Organisation A and the confirmatory result in Organisation B) and sets a baseline model against which to test for more refined cross-group equalities. A second model (Model 2) proposed equal factor loadings across the two groups, testing for measurement equivalence across samples (that is, that the constructs are defined in the same operational way in each organisation). Either a statistical or a modelling rationale can be used for evaluating the cross-group restrictions. With a statistical rationale, Models 2 and 1 chi-square differences are calculated, which leads to a chi-square test with degrees of freedom equal to their differences in degrees of freedom (the D test) (Bentler, 1995). If the test is non-significant then the statistical evidences indicates no cross-groups differences. The χ^2 difference between models 1 and 2 is 58.65 and the difference in degrees of freedom is 28, indicating that the test is significant. However, χ^2 statistic may be an overly sensitive index because of the model complexity and large sample size (Marsh et al. 1988). In this case, results from χ^2 test should be complemented using a modelling rationale that involves comparisons of the practical fit indices described above. A precise criterion for comparison among fit indices has not yet been established, but McGaw and Jöreskog (1971) concluded that a difference in fit of around .022 was negligible, and the most parsimonious model should be selected. Differences between models 1 and 2, in terms of practical fit, are small thus giving support to the measurement equivalence across samples.

The third model (Model 3) is the result of a more statistical approach. This model uses the LM test to look for cross sample constraints (that is equal relationships) that were not correctly imposed in the earlier models. As was suggested by the assessment of fit of Model 2, only a few relations differ between the two samples. Six of the 36 factor loadings in Model 2 were identified by the LM test as incorrectly imposed constraints. These included the strength of the relationship between indicators 6, 22, 23 and 27 and the safety management factor, indicator 11 and the safety standards factor, and indicator 32 with the work environment factor. The χ^2 difference in fit between Model 3 and the baseline model (Model 1) is not significant, suggesting that Model 3 is as good a representation of the data as model 1, while allowing most of the factor loadings to be constrained as equal across the two samples.

Table 9.2 presents the multisample measurement model described by Model 3, with both the unstandardised and standardised values. Apart from the six unconstrained indicators, all the other paths were constrained to equality and these constrains were tenable. Thus, unstandardised values for those factor loadings are equal in table 9.2 and comparison of samples was made with unstandardised coefficients[6]. This must be borne in mind when examining standardised values, because constrained ones may look different, although this does not imply that they are statistically different.

Among the indicators that were different across the samples, four of them belong to the safety management factor. This factor may then be considered stable in spite of these cross group inequalities because of the large number (ten) of other indicators available. The strength and sense of the relationships are similar, as it is shown in table 9.2. For example, variable 6 is a highly reliable indicator in Organisation A, with unstandardised value of 0.907 (standardised value of 0.730), as it is in sample 2 (unstandardised loading of 0.743, and standardised value of 0.634). Although statistically significant, the size of the difference between both samples can be considered minor. As in this example, no other difference across samples makes an important difference in the interpretability of the substantive model; all indicators, even those that are not equal across samples, are reliable and significant.

9.2.2 Mean Organisational Differences

Once the factor structure of the two organisations had been evaluated, further comparison between the central tendencies of the two samples was considered. t-tests were used to compare the means of both samples on the variables under study. Specifically, t-tests were performed on the scores of the hazard and activity checklist, the measure of work environment and the five factors measured in the attitude scale - safety management, communication, responsibility, safety standards and goals, and personal involvement. Bonferroni adjustment was used in order to avoid the inflation of type-I error (Hays, 1994).

[6] Differences in standardised coefficients may be due to differences in standard deviations of the variables across the samples even though the strength of the relations are the same (Bollen, 1989).

Table 9.2
Factor loadings for the multisample measurement model

Item	Unstandardised		Standardised	
	Org A	Org B	Org A	Org B
Safety management				
1. Health and safety have a very high priority here	1.00	-	.739	.690
2. Safety specific jobs always get done	.935	-	.631	.577
3. Management listens to my safety concerns	.798	-	.617	.554
6. The company makes an effort is made to prevent accidents happening	.907	.743	.730	.634
9. Management are prepared to discipline workers who act unsafely	.748	-	.490	.491
14. The safety training I receive is not detailed enough for my job	.601	-	.444	.417
17. Levels of safety performance have improved over the last two years	.585	-	.500	.353
20. Safety training has a high priority here	.978	-	.730	.730
22. There is a process of continual safety improvement in the company	.779	.648	.735	.659
23. Management takes the lead on safety issues	.830	.687	.591	.477
24. What is learnt from accidents is used to improve safety training	.665	-	.614	.537
26. On my site we have defined safety improvement objectives	.593	-	.504	.488
27. Supervisors actively support safety	.796	.902	.670	.659
30. The company is only interested in safety after an accident occurs	1.04	-	.666	.614
Communication				
7. Safety issues are included in communications meetings	1.00	-	.646	.594
8. I have been shown how to do my job safely	1.04	-	.603	.565
10. There are good communications here about safety issues	1.54	-	.816	.822
12. Relevant health and safety issues are communicated	1.05	-	.713	.650
15. I am informed of the outcomes of health and safety meetings	1.10	-	.545	.480
Involvement				
13. Everyone plays an active role in safety issues	1.00	-	.601	.515
16. Everyone on my site wants to achieve the highest levels of safety performance	.901	-	.687	.567
19. Only a few people who work here are involved in health and safety activities	.848	-	.508	.432
28. My colleagues and I help each other work safely	.609	-	.525	.516
29. Accidents and incidents are always reported	.867	-	.512	.453
Safety Standards				
4. As long as there are no accidents unsafe behaviour is tolerated	1.00	-	.644	.665
11. It is sometimes necessary to take unsafe shortcuts to get work done	.669	.899	.470	.587
21. Minor/trivial accidents are tolerated as part of the job	.874	-	.631	.686
Individual Responsibility				
5. I look out for the safety of my colleagues	1.00	-	.495	.401
18. I can influence health and safety performance here	1.70	-	.608	.526
25. Safe working is a condition of my employment here	1.27	-	.597	.503
Work Environment				
1. The light levels in my workplace are adequate	1.00	-	.352	.371
2. The ventilation in my workplace is adequate	3.09	2.48	.848	.765
3. Space allocated for doing tasks in my workplace is adequate	1.26	-	.349	.402
4. The humidity levels in my workplace are adequate	2.44	-	.724	.829

All factor loadings are statistically significant ($p< 0.01$)

There were differences between the means of two of the safety attitude factors, individual responsibility ($t= -4.9$, d.f.= 1420, $p< 0.01$) and involvement ($t= -4.03$, d.f.= 1420, $p< 0.01$). There were also statistically significant differences in the perceived level of workplace hazards (t= -4.62, d.f.= 1420, p< 0.01) and between the means of the reported level of safety activities (t= -4.08, d.f.= 1420, p< 0.01). Respondents in Organisation B scored more positively in these constructs, with the exception of reporting higher levels of workplace hazards. However, they assessed safety management, communication, safety standards and goals and workplace environment on a par with Organisation A (that is, there were no differences among the means of these constructs). All the means for the two organisations are summarised in Table 9.3.

Table 9.3

Safety variable means for Organisations A and B

Dependent variable	Org. A	Org. B
Safety Management	51.63	51.84
Communication	18.24	18.46
Involvement	**16.78**	**17.45**
Safety Standards	10.71	10.65
Individual Responsibility	**11.74**	**12.14**
Work Environment	12.06	12.15
Workplace Hazards	**60.98**	**74.06**
Safety Activities	**8.47**	**9.8**

Emboldened variables differ significantly across samples (p < 0.01)

9.2.3 Multisample Structural Model

The final stage in the comparison of Organisations A and B data involved an examination of their structural models. A simple inspection of the structural models derived from these two organisations revealed that both exhibited similar strengths and directions of paths with the exception of an additional path between work environment and safety activities in Organisation B. A more detailed comparison was achieved through the examination of a multisample structural model. The similar analysis of the measurement model (described above) showed that there was partial factor invariance between the two organisations. A sequence of multi-group structural models, involving the same latent variables and employing maximum likelihood estimation, was used in order to test the structural invariance between Organisations A and B. As a first step, the overall structural model was estimated in both samples with no relationships constrained to equality. The final structural model in Organisation B (shown in Figure 7.1) was used as a starting point for this analysis, since it includes the same paths as that found in Organisation A with one additional path. This one difference should be identified in the sequence of multisample models. Goodness-of-fit indices for this multigroup model (Model 1) are shown in Table 9.4, together with subsequent nested multisample models.

Table 9.4

Goodness of fit indices for multisample structural models

Model	χ^2	d.f.	Prob.	CFI	GFI	NNFI	RMSEA	χ^2 difference
1	3283.41	1168	<0.001	0.869	0.880	0.859	0.036	-
2	3304.67	1180	<0.001	0.867	0.879	0.860	0.036	21.25
3	3289.95	1177	<0.001	0.869	0.880	0.860	0.036	6.53

Once more Model 1 is extremely parsimonious (1168 degrees of freedom) and the CFI is close to 0.9, although the χ^2 statistic is statistically significant. Given the large sample involved model fit can be considered sufficient, based on evaluation of the descriptive indices. Model 1 provides a baseline structural model against which to test for equalities between the two organisations. Model 2 proposed, therefore, that equal structural relationships existed between the latent and observed variabled in the structural model. A comparison of fit measures between the two models shows that the χ^2 difference is 21.25 and the difference in degrees of freedom is 12, indicating that the test is significant. Differences between Models 1 and 2 in terms of practical fit are, however, small, giving support to structural equivalence across the two samples.

Model 3 deleted non-correctly imposed constraints (or equal relationships) as a result of the LM test suggestions. As expected from the closeness in fit of Models 1 and 2, only a few relations differ significantly across the two organisations. Three of the twelve structural relationships are statistically different across the two samples. The main conclusion that can be drawn is that the model holds for both samples with minor differences between them. Figure 9.1 details the relationships among the constructs (factors and observed variables that are not indicators of an underlying factor) in the two samples according to the final estimates in Model 3. The standardised relationships for Organisation B are show in brackets alongside those for Organisation A.

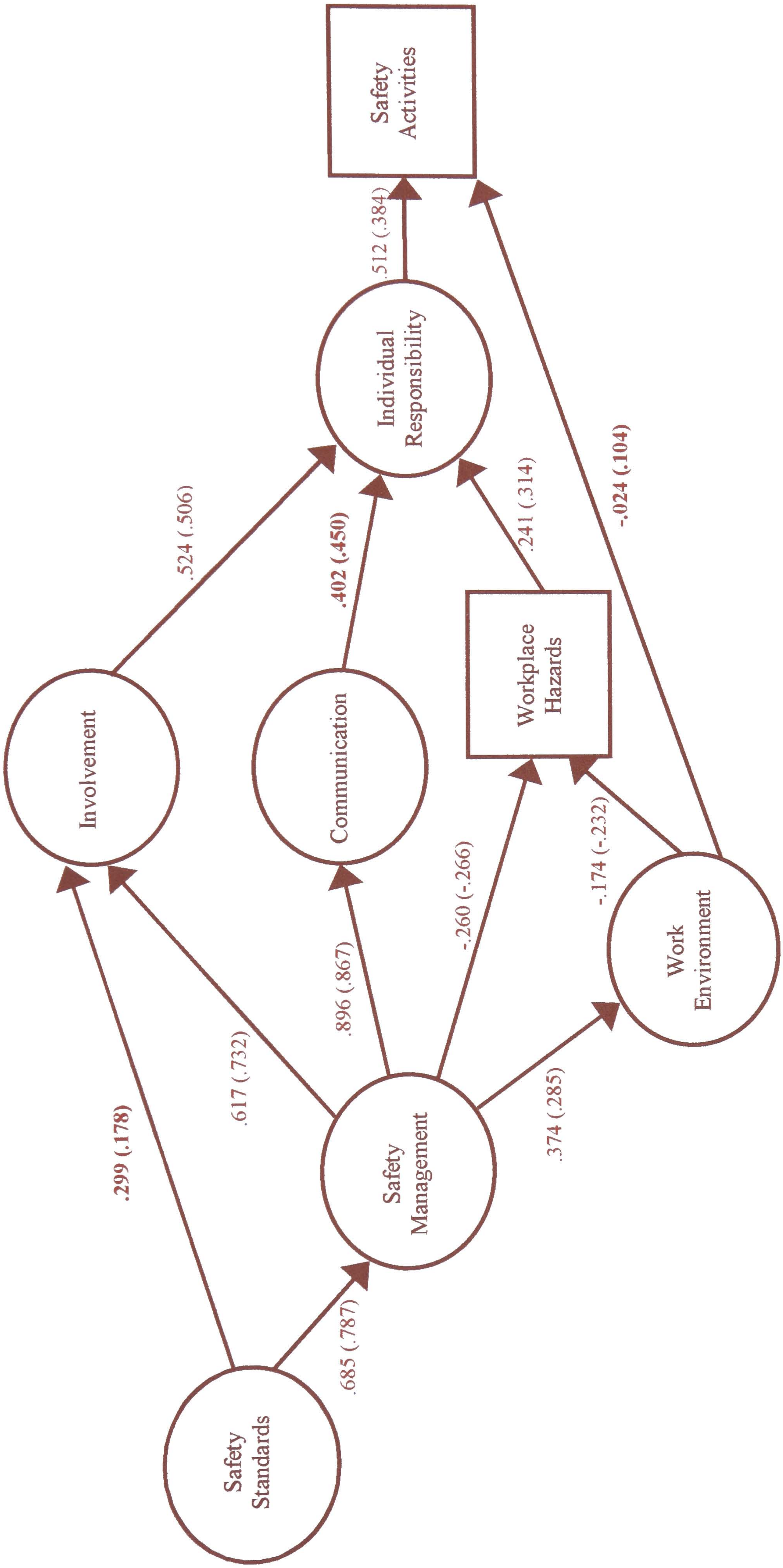

Figure 9.1
Multisample structural model in Organisations A and B

Overall, most of the a priori structural effects were statistically significant giving support to the theoretical model. The only relationship statistically non-significant was the effect of work environment on safety activities in Organisation A, as predicted from the simple examination of that organisation's structural model. Most of the other estimated effects among the constructs were equal across the two organisations giving support to an overall cross-validation of the theoretical model. Statistical differences between the samples included: the effect of safety standards on involvement, which resulted slightly higher in Organisation A; the effect of communication on individual responsibility, this time slightly higher in Organisation B; and, the effect of work environment on safety activities, which was statistically different from zero in Organisation B, but not Organisation A.

In summary, the models from Organisations A and B were very similar, both in terms of the definition of the factors (measurement model) and the relationships between the factors (structural relations) with minor differences arising from the multisample analysis. Coupled with this, the intensity of attitudes and perceptions in the two organisations differed in only four of the eight measured variables. These similarities allow the data from both organisations to be combined, in order to assess differences between groups at different employment levels.

9.3 Structure of Attitudes by Employment Level

The third hypothesis, that different employment groups within the same organisation will exhibit different climate structures is difficult to test within either Organisation A or Organisation B, given the small number of respondents who identified themselves as either managers or first line supervisors in each sample. This hypothesis can be tested, however, if the samples from the two organisations are combined. The combination of data can be justified given the similar working environments and management structures of the two organisations, as well as the similarities in their factor structures and explicative models.

In this section, multigroup invariance between three employment groups is examined. Specifically the equivalence of the factorial structure and the invariance of structural paths in three sub-samples (managers, supervisors and employees) were studied. This comparison was, once again, achieved in three parts. First, the factor structures of the attitude and work environment variables (the measurement models) were examined for each of the groups. Next, differences in intensity of attitudes between the three groups were tested using one way ANOVA to compare factor means. Finally, invariance in the structural models was scrutinised using a multisample structural analysis.

9.3.1 Multisample Confirmatory Factor Analysis

In the combined sample, the sub-sample sizes were large enough to consider examining their factor structures individually. The breakdown of how the suitability ratios stood for each of the groups is shown in Table 9.5.

Table 9.5
Appropriateness of employment level samples

Ratio	Managers	Supervisors	Employees
Subject:Variable	3:1	4:1	32:1
Subject:Factor	25:1	29:1	193:1
Variable:Factor	6:1	6:1	6:1
Sample	97	123	967

Structural equation modelling (SEM) was used to examine the factorial validity of the five-factor model, found in Organisations A and B, across the different employment groups. While the subject to variable ratio and the total sample size for managers were just below those recommended (Arnindal and van der Ende, 1985) for factor analysis, it was included in the multi-group analysis to compare structures. In addition to these sample characteristics, the raw data were within the acceptable parameters of multivariate normal distribution. As in the analysis described in the previous section, a sequence of nested confirmatory multi-group models, employing maximum likelihood estimation, was used in order to test the factorial invariance in attitude and work environment items. As a first step, the overall measurement model was estimated in all three sub-samples with no constraints. Goodness-of-fit indices for this multigroup model (Model 1) are shown in Table 9.6.

Table 9.6

Goodness of fit indices for employment level measurement models

Model	χ^2	d.f.	Prob.	CFI	GFI	NNFI	RMSEA	χ^2 difference
1	3311.51	1536	<0.001	0.854	0.869	0.841	0.031	-
2	3386.48	1592	<0.001	0.853	0.867	0.844	0.031	74.97
3	3344.14	1046	<0.001	0.855	0.869	0.845	0.031	32.64

Although Model 1 has a statistically significant χ^2 statistic, given that the CFI is close to 0.9; and it is extremely parsimonious (1536 degrees of freedom), the model fit can be considered sufficient. Model 1 shows that the basic structure of the model fits the data in all three samples and sets a baseline model against which to test for cross-group equalities. A second model (Model 2) proposed equal factor loadings across the three groups, testing for measurement equivalence across samples. The χ^2 difference between Models 1 and 2 is 74.97 and the difference in degrees of freedom is 56, indicating that the test is significant. In terms of practical fit indices, however, differences between the models are small, giving support to the measurement equivalence across the three samples.

The third model (Model 3) used the results of the LM test to examine for cross sample constraints that were not correctly imposed in Model 2. Only a few relations differ between the three samples. The only constraints that were indicated as incorrect by the LM test were six of the 36 factor loadings, including the strength of the relationship between indicators 14, 23 and 26 and the safety management factor, indicator 10 and the communications factor, indicator 25 and the individual responsibility factor, and indicator 28 with the involvement factor. The χ^2 difference in fit between Model 3 and the baseline model (Model 1) is not significant, suggesting that Model 3 is as good a representation of the data as Model 1, while allowing most factor loadings to be constrained. Table 9.7 presents the multisample measurement model described by Model 3, with both the unstandardised and standardised values. Apart from the six unconstrained indicators, all the other paths were constrained to equality and these constrains were tenable. Thus, unstandardised values for those factor loadings are equal in table 9.7 and comparison of the three samples was made with unstandardised coefficients, as with the comparison of Organisations A and B measurement models.

Table 9.7
Factor loadings for the employment level measurement model

Item	Unstandardised			Standardised		
	E	S	M	E	S	M
Safety management						
1. Health and safety have a very high priority here	1.00	-	-	.695	.677	.650
2. Safety specific jobs always get done	.955	-	-	.601	.409	.556
3. Management listens to my safety concerns	.783	-	-	.571	.469	.524
6. The company makes an effort is made to prevent accidents happening	.780	-	-	.645	.643	.672
9. Management are prepared to discipline workers who act unsafely	.810	-	-	.582	.466	.532
14. The safety training I receive is not detailed enough for my job	.666	.530	.375*	.462	.290	.273
17. Levels of safety performance have improved over the last two years	.530	-	-	.352	.351	.285
20. Safety training has a high priority here	.979	-	-	.721	.680	.705
22. There is a process of continual safety improvement in the company	.730	-	-	.691	.593	.688
23. Management takes the lead on safety issues	.697	.921	1.02	.477	.534	.691
24. What is learnt from accidents is used to improve safety training	.678	-	-	.560	.487	.555
26. On my site we have defined safety improvement objectives	.575	.881	.367	.487	.555	.334
27. Supervisors actively support safety	.886	-	-	.657	.624	.584
30. The company is only interested in safety after an accident occurs	1.01	-	-	.609	.541	.721
Communication						
7. Safety issues are included in communications meetings	1.00	-	-	.608	.504	.621
8. I have been shown how to do my job safely	1.04	-	-	.582	.452	.527
10. There are good communications here about safety issues	1.61	1.45	1.34	.843	.704	.809
12. Relevant health and safety issues are communicated	1.03	-	-	.672	.466	.766
15. I am informed of the outcomes of health and safety meetings	1.04	-	-	.483	.351	.482
Involvement						
13. Everyone plays an active role in safety issues	1.00	-	-	.562	.540	.431
16. Everyone on my site wants to achieve the highest levels of safety performance	.862	-	-	.596	.628	.558
19. Only a few people who work here are involved in health and safety activities	.891	-	-	.470	.388	.398
28. My colleagues and I help each other work safely	.579	.716	.775	.519	.588	.576
29. Accidents and incidents are always reported	.781	-	-	.448	.376	.405
Safety Standards						
4. As long as there are no accidents unsafe behaviour is tolerated	1.00	-	-	.650	.688	.671
11. It is sometimes necessary to take unsafe shortcuts to get work done	.789	-	-	.524	.520	.534
21. Minor/trivial accidents are tolerated as part of the job	.830	-	-	.634	.638	.631
Individual Responsibility						
5. I look out for the safety of my colleagues	1.00	-	-	.452	.571	.588
18. I can influence health and safety performance here	1.36	-	-	.468	.699	.631
25. Safe working is a condition of my employment here	1.23	1.07	.786	.530	.555	.506
Work Environment						
1. The light levels in my workplace are adequate	1.00	-	-	.331	.382	.385
2. The ventilation in my workplace is adequate	2.86	-	-	.780	.803	.856
3. Space allocated for doing tasks in my workplace is adequate	1.14	-	-	.326	.345	.365
4. The humidity levels in my workplace are adequate	2.59	-	-	.769	.803	.811

E = Employees, S= Supervisors, M = Managers
All factor loadings are statistically significant at $p< 0.01$, except * which are significant at $p> 0.05$

Among the indicators that were different across the samples, three of them belong to the safety management factor. This factor may then be considered stable in spite of these cross group inequalities because of the large number (eleven) of other, equally constrained, indicators available. The strength and sense of all relationships are similar, as it is shown in table 9.7. For example, variable 25 is a reliable indicator in the employee sample, with unstandardised value of 1.23 (standardised value of 0.530), as it is in the supervisor sample (unstandardised loading of 1.07, and standardised value of 0.555), and in the managers sample (unstandardised loading of 0.786, and standardised value of 0.506). As in this example, no other difference across samples makes an important difference in the interpretability of the substantive model; all indicators, even those that are not equal across samples, are reliable and significant. Only the loadings for item 14 (The safety training I receive is not detailed enough for my job) showed a marked difference between samples, with the loading in the manager sample only significant at the 0.05 level.

9.3.2 Mean Group Differences

Further comparison between the central tendencies of the three samples was considered once their factor structure had been evaluated. In particular, whether or not samples differed in their average perceptions of safety climate as measured by the attitude survey and checklists was examined. Several one-way ANOVAs were performed, one for each variable. All effects were statistically significant and post-hoc comparisons (Scheffé tests) were performed. Means for each group are shown in Table 9.8.

Table 9.8

Safety variable means for employment level samples

Dependent variable	Employees	Supervisors	Managers
Safety Management	**50.90**	54.59	56.13
Communication	**18.09**	19.48	20.19
Involvement	17.08	17.82	**18.18**
Safety Standards	**10.54**	11.54	11.93
Individual Responsibility	**11.87**	12.52	12.77
Work Environment	**12.01**	**13.02**	**13.98**
Workplace Hazards	**77.18**	68.47	56.52
Safety Activities	**7.79**	**12.84**	**14.75**

Emboldened groups differ significantly from the others (Scheffé tests, $p < 0.01$)

The one way ANOVA tests showed differences between the means in all of measured variables. Respondents in the employee sample systematically scored less positively than those in the manager sample in all constructs. Supervisors assessed all variables except involvement, work environment and safety activities on a par with managers, and all except involvement more positively than employees. In general managers have the most positive views, followed by supervisors, and employees who had the least positive views.

Potential interactions between the effects of employment level and organisation (detailed in Section 9.2.2) were investigated using a series of two-way ANOVAs. The main effects already described in Tables 9.3 and 9.8 were found to be significant but none of the interactions between organisation and employment status were statistically significant, suggesting that the intensity of attitudes and perceptions are relatively consistent for employees, managers and supervisors across the two organisations.

9.3.3 Employment Level Structural Model

The final stage in the comparison of the employment level data involved an examination of the structural model derived from each sub-sample. As with the comparison of Organisations A and B models, a detailed comparison was achieved through the examination of a multisample structural model. The analysis of the measurement model in the three samples (described above) showed that there was partial factor invariance between them. A sequence of multi-group structural models, involving the same latent variables and employing maximum likelihood estimation, was used in order to test the structural invariance between employees, supervisors and managers. As a first step, the overall structural model was estimated in all three samples with no constraints. The final structural model in Organisation A (shown in Figure 6.3) was used as a starting point for this analysis, since it includes the paths relevant to both organisations. Goodness-of-fit indices for this multigroup model (Model 1) are shown in Table 9.9, together with subsequent nested multisample models.

Table 9.9
Goodness of fit indices for employment level structural models

Model	χ^2	d.f.	Prob.	CFI	GFI	NNFI	RMSEA	χ^2 difference
1	3826.01	1755	<0.001	0.847	0.871	0.834	0.032	-
2	3892.92	1777	<0.001	0.843	0.869	0.832	0.032	66.92
3	3849.13	1769	<0.001	0.846	0.870	0.834	0.036	23.12

Model 1 is extremely parsimonious (1755 degrees of freedom) and the CFI is close to 0.9, although the χ^2 statistic is statistically significant, and model fit can be considered sufficient. Model 1 provides a baseline structural model against which to test for cross-groups equalities. Model 2, therefore, proposed equal structural relationships. The χ^2 difference between models 1 and 2 is 66.92, with 22 degrees of freedom, a significant D-test. Differences between Models 1 and 2, in terms of practical fit, are, however, small, giving support to structural equivalence across the two samples.

The LM test suggested that four of the eleven structural relationships are statistically different across the three samples. Model 3 deleted the constraints on relationships between safety management and workplace hazards, and between individual responsibility and involvement, communication and workplace hazards. A comparison of fit measures between Models 1 and 3 shows that the χ^2 difference is 23.12 and the difference in degrees of freedom is 14, indicating that this D-test is not significant and Model 3 is as good a representation of the multisample data as the totally unconstrained Model 1.

The main conclusion that can be drawn from these nested models is that baseline model holds for all samples with only a few structural differences. Figure 9.2 details the relationships among the constructs (factors and observed variables that are not indicators of an underlying factor) in the three samples according to the final standardised estimates in Model 3. A separate explicative model is shown for each of the three sub-samples, detailing only those paths that were found to be significant.

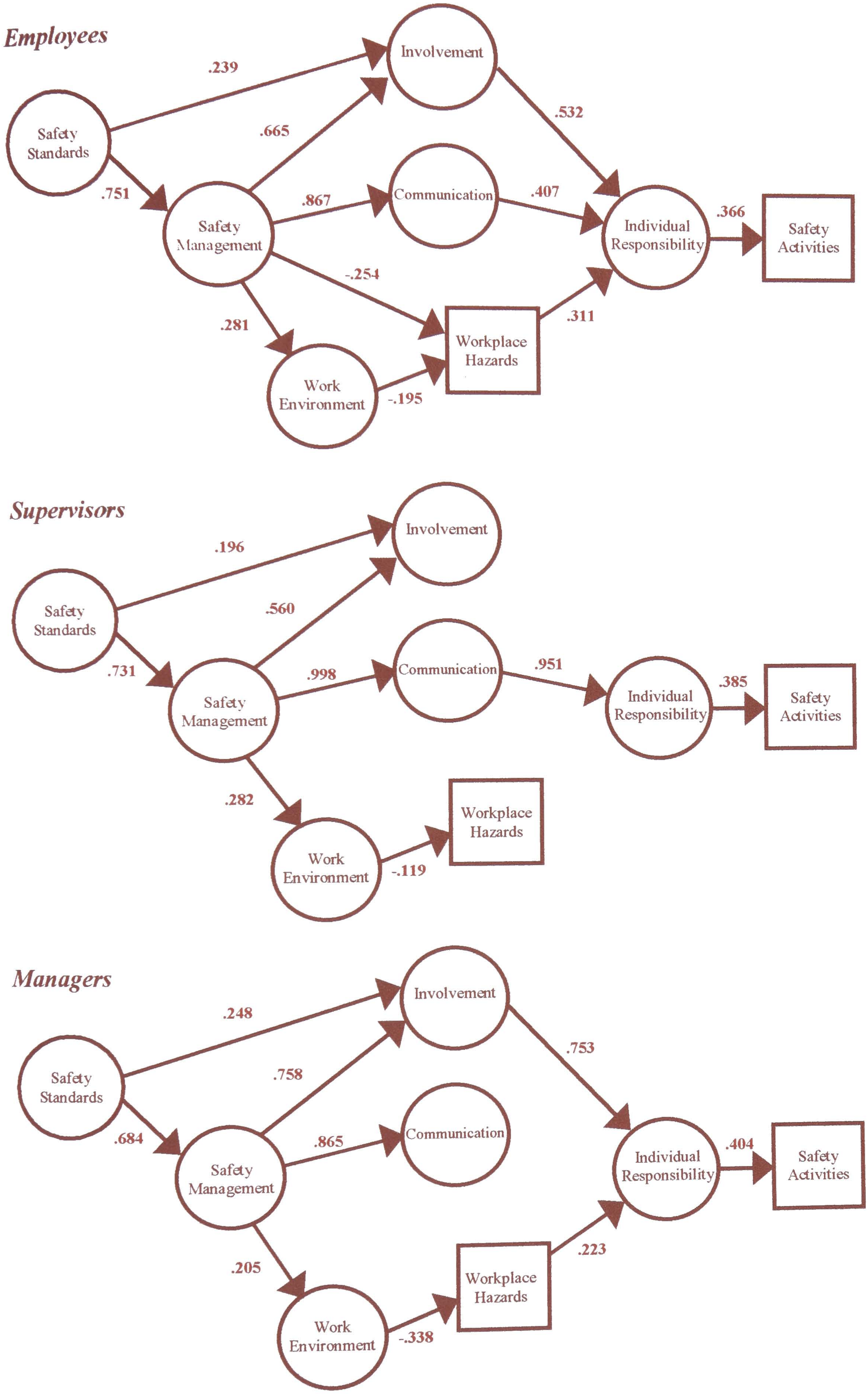

Figure 9.2
Structural models for three employment levels

All of the a priori structural effects were statistically significant in the employee model giving support to the theoretical model. The supervisor model showed a very different picture, with three of the unconstrained paths not significant. In that model the only path to individual responsibility and safety activities was through communication. Finally, the structural model describing the manager sample data produced other differences. In this case two of the unconstrained paths were not significant, with no direct path from communication to individual responsibility or from safety management to workplace hazards. The remaining seven estimated effects among the constructs were equal across the three samples. Statistical differences between the samples included:

- the effect of workplace hazards on personal responsibility, which was slightly higher in the employee sample than the manager sample and not different from zero in the supervisor sample;
- the effect of communication on individual responsibility, higher for supervisors than for employees and not significant for managers;
- the effect of involvement on individual responsibility, higher for employees than for manager and not significant for supervisors; and
- the effect of workplace hazards on personal responsibility, which was statistically different from zero in the employee sample but not in the others.

In summary, the measurement models (or factor structures) were very similar for the three samples. In terms of the relationships between the factors (the structural relations), however, the models from the three employment level samples illustrated quite different positions. This, taken with the range of differences in the intensity of attitudes and perceptions across all eight measured variables, suggests that, while managers, supervisors and employees agreed on the definition of factors, their perceptions of these factors and how they interrelate were quite different.

9.4 SUMMARY

This chapter has described the comparison of data from Organisations A and B and the examination of employment group differences, using a series of multisample structural models. Comparison of data from the two manufacturing organisations showed very few differences in factor structures, intensity of attitudes and perceptions, or factor interrelationships. This similarity, coupled with the differences in structure from Organisation C, gives support to *Hypothesis 2* that similar climate structure exists across organisations operating in similar commercial, and therefore physical, environments. The examination of combined data from the three different employment groups showed not only differences in intensity of attitudes but also different structural patterns of relationships between factors. The comparison of employment group data supports *Hypothesis 3* that different employment groups will exhibit different climate structures. The next chapter discusses the results from the each of the participating organisations as well as those presented in this chapter.

CHAPTER TEN

Discussion of Results

This chapter discusses the results from each of the participating organisations as well as the comparisons of results from these organisations and the employment levels within them. It includes a detailed examination of each of the hypotheses outlined at the end of Chapter 3 in light of these results, and how the results relate to the previous research that framed those hypotheses. The final chapter in this thesis details the implications of the finding and the wider conclusions that can be drawn from them.

10.1 ORGANISATIONAL RESULTS

This section examines the results from each of the three participating organisations (detailed in Chapters 6, 7 and 8) in turn. Comparisons between organisation and employment level models (presented in Chapter 9) are dealt with in subsequent sections.

10.1.1 Organisation A

The descriptive results from Organisation A show a generally positive picture. On average, all attitude items reflected positive views and everyone reported being involved in some kind of safety activity. Overall hazard scores were well below the mid-point (mean = 60.98, mid-point of total possible hazard score = 207) and individual perceived risk ratings for each hazard were all relatively low. The relative ranking of workplace hazards (shown in Table 6.3) broadly reflect those that were present in the working environment. The occurrence of 'Noise' at the top of this list, however, was considered unusual by the organisation, since although noise was recognised as a hazard in a few areas of the working environment, it was controlled by the use of isolation chambers and protective equipment. The only area of the questionnaire that produced negative views was that relating to the work environment. Two of the items in this section (relating to ventilation and humidity) showed average scores below the scale mid-point. This result was endorsed to a degree by the open responses of 12 respondents (from several different locations) who highlighted the working environment in general as problematic.

10.1.1.1 Attitude Survey Structure

The factor structure resulting from the analysis of Organisation A data did not reflect entirely the proposed safety attitude dimensions that resulted from the review of previous research in Chapter 3 and the initial discussions within the organisation. Several items loaded on unexpected factors as a result of the exploratory analysis. Most of the safety training, and some of the safety systems, were seen by the participants in this organisation as part of a broad safety management dimension. This dimension seems to play a similar role to that of 'Organisational Influence' in Tomás and Oliver's (1995) study, in that it reflects a wider range of organisational issues than only the commitment of management. The amalgamation of the safety training items into this wider dimension is not, however, consistent with many other studies (for example Cox et al., 1998; Lee, 1998) which established training as an independent dimension of their study organisations' safety climates. Cox et al. (1998) did propose, however, that changes in the structure of questionnaires, like the ones they noted compared to previous studies (Cox and Cox, 1991), suggested that such structures were context dependent. It may be then that safety training is perceived as a distinct function in the food manufacturing (Cox et al., 1998) and nuclear (Lee, 1998) sectors but seen as more of a general management responsibility in this organisation. This possibility is supported by the placing of item 8 'I have been shown how to do my job safely' with the communication dimension and not with the other training items. The position of this item suggests a difference between views of formal training (perceived as part of a management role) and 'on the job training' (seen in this case, as part of the communication process). In a final change to the proposed structure, the communication process does not, as anticipated by the initial discussion group, involve the reporting of accidents and incidents (item 29). Respondents perceived this activity as more in terms of getting involved in safety issues by reporting incidents.

10.1.1.2 Plant Differences

The mean survey scores for the eight plants in Organisation A were almost all on the positive side of the scale mid-point. In the attitude scales, only the involvement score in plant 2 showed a negative average (mean = 14.19, mid-point = 15). On the other hand, evaluations of the work environment were below the mid-point (12) in five of the eight plants, reflecting the low overall scores in two of the individual items. The pattern of differences between plants broadly reflects that shown by plant accident rates for the previous year. It would seem from this that the survey provides alternative indicators of plant safety performance and could potentially supply another metric against which achievements can be gauged (Cox and Cox, 1996). If climate scores can be used in this way they provide a shift in focus from negative measures (number of accidents or incidents) to more positive evaluations of attitudes to, and perceptions of safety issues and avoids reliance on one or two particular measures of safety performance (Nichols, 1975).

The potential relationship between safety culture (and by extension safety climate) and performance is implicit in early definitions and use of the term (for example, Cullen, 1990; HSC, 1993). Some studies have found evidence of such a relationship. Donald and Canter (1994) found significant relationships between almost all of their climate scores and individual self-reported accident rates. If, however, the social and cultural context in which accidents occur (Nichols, 1975) is important, it may also be appropriate to examine aggregate accident rates and climate scores at group or operational unit level. Aggregate rates have been found to correlate with team climate scores in other settings (Hoffman and Stetzer, 1996b). The association between accident rates and climate scores illustrated by this research is, however, more analogous to Zohar's (1980) and Isla Díaz and Díaz Cabrera's (1997) comparisons of entire factories' climate scores with performance assessments, since it gives a general picture for each of the eight plants.

10.1.1.3 Structural Model

The data from Organisation A supported the broad hypothesis (*Hypothesis 1*) that organisational variables (safety management and safety standards) would influence environmental (physical work environment and workplace hazards appraisal) and social, or group process, (communication and involvement) variables which, in turn, would influence individual precursors to safe behaviour (individual responsibility and level of safety activity). The only changes noted from the detailed theoretical model (shown in Figure 6.2) were the lack of direct relationship between evaluations of the work environment and individual responsibility and the addition of relationships between (i) safety standards and involvement, and (ii) physical work environment and workplace hazards. These changes suggest that the better perceptions of acceptable standards are the easier workers will find involvement in safety issues to be. In this model perceptions of the work environment would appear to have no direct effect on individual responsibility, as suggested in the a priori model. An indirect effect is provided, however, by higher appraisals of the work environment being related to lower evaluations of workplace hazards which, in turn, are related to individual responsibility. This unhypothesised relationship in the final model does, however, make theoretical sense, with, as might be expected, workers reporting a more satisfactory physical work environment also reporting relatively fewer and/or less severe workplace hazards in that same environment.

In terms of the architecture of employee attitudes to safety, a pivotal role is played, on one hand, by the strength of employees' attitudes with regard to safety management, and, on the other, by their views on individual levels of responsibility. The importance of these dimensions is further supported when the indirect paths in the model are considered. These findings are consistent, to an extent, with the earlier findings on the importance management commitment (Flin et al., 1996; Zohar, 1980), safety training (Cox et al, 1998), and the more general organisational involvement (Tomás and Oliver, 1995). Although, as noted by Cox and Flin (1998), many such variables may be derived from very similar starting points. The importance of individual responsibility differs from earlier findings of Cox et al. (1998) where personal actions for safety were not found to play a central role in the model of appraisal of commitment constructed in that study. However, in a model involving individual safety activity and responsibility, personal responsibility could reasonably be expected to take a more central role than in a model involving the appraisal of organisational commitment. The relationship between individual responsibility in this model indicates that individuals are aware of their responsibility towards safety and link this to safety activity. This relationship is consistent with recommendations from the IAEA (1991) who state that a key indicator of safety culture is an individual being able to state their responsibilities.

10.1.2 Organisation B

Organisation B descriptive results paint a universally positive picture of safety within this organisation. The mean results indicated that attitudes to safety and evaluations of the working environment were generally positive. Everyone reported being involved in at least two safety activities and the average hazard score (74.06) was below the mid-point (207) of the full potential range. As in Organisation A, the relative ranking of hazards broadly reflected those that were present in the workplace, with the exception of 'Noise' and 'Contact with hot objects'. Noise was, as in Organisation A, recognised as being present but thought of, by safety advisors, as adequately controlled. The appearance of 'Contact with hot objects', although not a common hazard in these workplaces, was thought to reflect concerns raised in one plant (plant 4) after a recent burn injury there, resulting from attempts at unauthorised machine maintenance. This was endorsed, to a degree, by the open responses on the subject of safety systems and equipment. On the whole, however, relatively fewer individuals made comments in this organisation (25.6%) than in Organisation A.

10.1.2.1 Attitude Survey Structure

The confirmatory analysis of the attitude data in Organisation B produced a measurement model with an identical structure to that found in Organisation A. Moreover, this structure fitted each of the four participating units, indicating a stable structure. In many multi-site studies, including Zohar's (1980), this possibility is not considered before a general structure is explored. In addition, the factor pattern found here provides evidence for cross-organisational invariance in the way that factors are defined. This is not consistent with Coyle et al.'s (1995) findings, although in that case it could be argued that the comparison was made between organisations from different sectors. A more detailed comparison of Organisation A and B factor structures is considered later in this chapter.

10.1.2.2 Plant Differences

The plant mean scores on each component of safety climate measure in Organisation B show that there are clear differences between locations within this organisation, although all plants had relatively positive views. Plant 1 exhibits the best attitudinal and safety activity scores, and acceptable scores on the physical work environment and workplace hazard components, relative to the other plants. Plant 2, however is the worst in terms of safety attitudes and plant 4 is the worst in terms of the physical work environment (the only of the survey scores below the mid-point) and workplace hazards. This further supports, to a degree, the assertion that attitudes to safety are good index of safety culture (Cox and Cox, 1991) given that they seem to reflect some good aspects of the working environment. The converse, however, is not true, where lower attitudinal scores would be expected to be accompanied by lower evaluations of the working environment. Given that all plants exhibited positive attitudes and perceptions, it may be more appropriate to characterise their prevailing cultures in different ways. Plant 1, for example might be characterised as having a collaborative, open culture where employees perceive a high degree of commitment, good communication and are involved in safety activities.

Plant differences can also be considered in terms of national differences. Plant 2 was located in France, and while the factor structure was not different, the intensity of attitudes towards communication and individual responsibility was lower than the other three, UK based, plants. These results are in line with Hofstede's (1980) findings on power distance between the managers and workforce being greater in Latin European countries, of which France is one. In Latin European countries high power distance between individuals is tolerated and hierarchies accepted. If this is the case in plant 2, it is perhaps not surprising that some respondents do not expect, for example, to be kept informed of safety issues, the responsibility for which they perceive of as being found higher up in the organisation.

Strategies for improvement, or alignment of climate in the organisation, in the four plants might take different approaches, given the differences in perceptions of the workforces. Managers in plant 2 might begin by focusing on improving attitudes to safety management, communication and involvement, in other words reducing the 'distance' between themselves and the rest of the workforce. Managers in plant 4, on the other hand, might decide to concentrate on improvements to the physical work environment. In that way levels of safety activity and individual responsibility may be improved, as illustrated by the structural model.

10.1.2.3 Structural Model

The structural model resulting from these data, which can be seen to describe the safety climate in the four constituent plants, again suggests that attitudes towards safety management and attitudes towards individual responsibility play a key role. The model highlights safety management as the most appropriate area to start any improvement programme and, in this respect, confirms previous findings of Cox et al. (1998) where management actions were highlighted as a prime area for intervention in their model. Only one additional path, between work environment and safety activities, significant at the 0.05 level, was found compared to the model found in Organisation A. This path suggests that the better the working environment the higher level of safety activities, or vice versa. This difference is perhaps not surprising given that the working environment is an obvious distinction that can be drawn between organisations and work sites. This is similar to explanation offered by Mearns and Flin (1999) for the differences in perceptions found by Williamson et al. (1997) in their study of Australian workers from a variety of different organisations. A more detailed examination of the similarities and differences between the structural paths in Organisation A and B is considered later in this chapter.

10.1.3 Organisation C

The mean responses for all the work environment items in Organisation C were on the positive side of the mid-point. This picture is not borne out, however, when the open response section of the questionnaire is examined. Here 33 respondents (almost 10% of the total sample) highlighted the working environment as problematic. It is possible that those who are not satisfied with their working environment are concentrated in one or two worksites. This could account for the generally positive responses to the four items on the one hand, and the specific problems reported by some respondents on the other. Unfortunately a site by site comparison was not possible in this organisation. Poor perceptions of the workplace were not, it seems, restricted to evaluations of the four working environment items. 'Problems with workplace design and layout' appeared quite high (in 6th place) in the ranking of hazards (shown in Table 8.2), although the similar 'workplace' element of the organisational safety audit was, on average the second best rated element. Other than workplace problems, the issues raised by the organisational safety audit were reflected, in broad terms, by respondents' mean hazard scores. Although not in the same order, noise, manual handling, chemicals and substances, and electrical hazards appear towards the top of both individual ratings and average safety audit scores. Overall hazard scores were, however, well below the mid-point (mean = 65.57, mid-point = 207), reflecting a reasonably positive position, while average ratings in the safety audit were all relatively low on the six-point descriptive scale (shown in Table 8.6). The similarities between the two sets of evaluations do provide further evidence of the validity of the hazard evaluation section of the questionnaire. The hazard evaluation results from the other two organisations (with the exception of noise) were also felt to reflect the main hazards present, although there were no objective ratings with which to compare these results.

In the attitude section of the survey the mean responses for all items, except item19 'Only a few people are involved in health and safety activities', were on the positive side of the mid-point. This result may be due to the methods of working employed in this organisation. Individuals work in small teams with little regular contact with managers. There may, therefore, be less opportunity for involving everyone in day to day safety activities. Self-reported safety activity levels are, however, relatively high. Every respondent reported being involved in at least two activities in the last five years in the final section of the questionnaire.

10.1.3.1 Attitude Survey Structure

The confirmatory factor analysis of Organisation C data failed to produce the same factor structure as found in the other two participating organisations. The movement of three of the 29 items to different factors suggests that management in this organisation might be seen as more autonomous and, at the same time, less hierarchical than the other organisations. Items 6 'The company makes an effort to prevent accidents happening' and 29 'The company is only interested in safety after an accident occurs' both refer to 'the company'. Their move from the former 'Safety Management' factor to the new 'Organisational Safety Standards' dimension suggests a divergence of perceptions between what managers and what the organisation can achieve and/or control. Managers might be seen as less aligned to the organisation in terms of what they do on a day to day basis in their own sites, but there is still an overarching organisational influence on safety. This division is in line with the HSE (1997) climate tool, which differentiates between organisational commitment and line management commitment. The distinction between these two dimensions may also be more apparent in this organisation given the size of the worksites involved. Small sites with one or two managers could easily be perceived as distant from the organisation as a whole, with their own specific roles and responsibilities separate from the organisation.

The size of the sites in Organisation C may also provide an explanation for the other item that moved to a new factor compared to the other two organisations. Item 26 'Supervisors actively support safety' is aligned with the involvement factor in this organisation, indicating that perhaps supervisors are considered more part of the workforce that a separate management layer. This could easily be the situation in smaller sites where there is less opportunity for a hierarchy to develop. This is not the case in studies of larger organisations where researchers have often found a supervisor specific dimension (for example, HSE, 1997; Mearns et al., 1998; Zohar, 2000). Although the changes in structure can be explained, the modifications made during the modelling process must be viewed with some caution. It may be that these changes have capitalised on chance characteristics of this sample (MacCallum et al., 1992) and this structure is only applicable to Organisation C and not others operating in the same, or similar, industrial sectors.

10.1.3.2 Structural Model

Like the factor structure, the structural model in Organisation C was quite different to that found in Organisations A and B. A more central role was played in this model by organisational safety standards, especially with the introduction of the direct path between this factor and workplace hazards. These differences can also be explained by the structure of the organisation in question. It could be that the organisation is seen as directly responsible, at least in part, for the hazards faced by the workforce, perhaps due to the very nature of its operations. The issues under the control of management also have an influence on the hazard environment but only through their influence on work environment conditions. The remainder of the model is similar to those in the other participating organisations in that the individual responsibility dimension also plays an important role here as a precursor to levels of safety activity.

10.1.4 Conclusions on Organisational Results

Several general conclusions can be drawn from the three organisational studies discussed above. In terms of the survey process, all three organisations found the questionnaire easy to administer and were satisfied with both the range of topics included and the levels of response in each or their plants. Feedback of results was also considered a success. Each of the participating organisations approached the results of the surveys, not only as valuable management information, but also as an opportunity to engage the workforce in safety issues. This was achieved through the use of feedback strategies that not only informed respondents of the survey results (Remenyi et al., 1998) but, in some cases, also involved those respondents in formulating improvement plans.

The analyses suggest that the survey instrument itself is both valid and reliable. The face validity of the questionnaire was checked by each of the organisations before conducting the survey. In each case the items were felt to reflect important safety issues. In addition to the initial test-retest analysis, comparison of organisational results with other performance measures also showed that the items and checklists in the survey were reliable. In Organisation A the worst performing plant in terms of accident rates was also the worst in terms of mean attitude dimension scores. Those other plants with better survey scores also tended to have lower accident rates. Furthermore, in Organisation C overall hazard ratings were very similar to the average organisational safety audit ratings.

The factors produced by exploratory and confirmatory analyses in the organisations confirmed, for the most part, the common themes identified in the review of qualitative and quantitative research. Safety training and safety systems were the only proposed dimensions not reflected in the factor structures, although the items involved were included in other factors in the same 'organisational dimensions' group. While the factor structures of Organisations A and B were very similar, the differences in Organisation C's structure supported Coyle et al.'s (1995) findings that organisations in different environments exhibited differing factor structures.

The relationships between these factors in all three organisations supported *Hypothesis 1*, that organisational variables influenced individual variables through work environment and group process variables. This was consistent with relationships found in previous studies (Cox, et al., 1998; Tomás and Oliver, 1995), with the addition of group process and work environment variables. The pattern of relationships was not, however, the same in each organisation. The next section discusses the results of the comparison of those structures.

10.2 GENERAL MODEL OF SAFETY CLIMATE

The main aim of comparison of data from the three organisations was to investigate the feasibility of developing a general climate framework. While the individual structures are useful for the targeting of improvement strategies in particular organisations, this type of model would be of greater use if it were possible to describe the characteristics of safety climate across a broad sector or sectors, and allow more general strategies to be recommended. Work in this area built, therefore, on the meta-analyses suggested by Cox and Flin (1998) and focused on deriving models from data gathered from different organisations. It was proposed by *Hypothesis 2* that differences in structure might arise given differences in physical and/or commercial environments. For example, the nature of capital intensive versus labour intensive industries (Cox et al, 1998). The nature of such differences will, however, provide further indication as to the most effective focus for continuous improvement strategies.

A preliminary comparison of all three organisations indicated that, as already suggested, Organisation C, had quite a different factor structure from the others. With different measurement and subsequent structural models, it was obvious that the structure developed in the construction supply organisation was different from those developed in the manufacturing sector. A detailed comparison between Organisations A and B was examined, therefore, in an attempt to develop a general model in the manufacturing sector.

10.2.1 Factor Structures

The measurement models from both organisations were compared first to test for equivalence of factor structures. Six of the 34 variables were statistically different across the two samples, although all indicators were reliable and significant. Four of the 'non-equal' items were from the largest, safety management factor. The number of remaining 'equal' items (ten) in this factor suggests, however, that it is stable. Items 6 'The company makes an effort to prevent accidents happening' and 22 'There is a process of continual improvement in the company' both refer to 'the company' in general. The other two unequal items in this factor, Items 23 'Management take the lead on safety issues' and 27 'Supervisors actively support safety' both refer more to line management issues. While all four of these unequal items are reliable indicators of the factor in both organisations, their standardised loadings are slightly lower in Organisation B. This might suggest that respondents in Organisation A view safety management as a relatively more coherent dimension and those in Organisation B may be more inclined to differentiate between organisational and line management issues. This is similar to the more pronounced factor structure differences produced from the confirmatory analysis of Organisation C. It should be pointed out, however, that these four items still define the safety management factor in Organisation B, and do not relate to other factors, as in Organisation C.

The only other item in the attitude section that was not equal across organisations was item 11 'It is sometimes necessary to take unsafe shortcuts to get work done'. This item related to the safety standards factor and was, like the other unequal items, significant and reliable in both samples. The standardised factor loading for this item was slightly higher in Organisation B. This suggests that the conflict between safety and production is relatively more important in defining appropriate safety standards in this organisation. The sixth unequal item in the measurement model, 'The ventilation in my workplace is adequate' related to the work environment measure and its standardised loading was slightly higher in Organisation A. In general, however, the multisample measurement model suggests cross-organisational equality and provides little evidence for different structures in the two organisations.

As well as a comparison of factor structures, the mean scores on each of the factors and measures were compared between organisations. Only four of the eight measures differed statistically between the two samples. Two of the differences related to attitude factors and suggested that respondents in Organisation B viewed involvement and individual responsibility more positively than those in Organisation A. The more positive views on involvement are consistent with the significantly higher levels of safety activity also found in Organisation B, and suggest that this organisation may more actively promote safety activities. On the other hand, the more positive views may be a result of increased activity due to perceptions of the hazard environment, which were also significantly higher in Organisation B. It could be argued that presence of, and thus greater exposure to, more hazards encourage greater responsibility and involvement from the workforce and, consequently, a higher level of safety activity. There were no differences between the means of the other four measures, suggesting that, in addition to the structure being almost identical in the two organisations, the intensity of views was relatively similar. The structural relationships between the factors and measures were examined in detail to provide a full picture of the extent of the similarities and differences between the two organisations.

10.2.2 Structural Model

The structural models from Organisations A and B were, like their measurement models, very similar. The multisample analysis involving both organisations highlighted only three statistical differences from a total of 12 structural relationships in the model. One of these relationships, that between work environment and safety activities, was only found in Organisation B and was, therefore, not expected to be equal across the two samples. This difference does suggest that a good working environment directly enhances safety activity in Organisation B. It could be that housekeeping is an important way of getting employees involved in this organisation. The individual levels of activity for Organisation B (shown in Table 7.6) support this and indicate that over 40% of respondents reported taking part in a safety inspection or audit in the five years before the survey was conducted, slightly higher than in Organisation A.

The other two unequal structural relationships were significant in both samples. The effect of safety standards on involvement was higher in Organisation A, indicating that higher standards are associated more with involvement in safety issues than in

Organisation B. It could be that employees in Organisation A feel that in order for standards of behaviour to be maintained they need to be more involved in safety. This may also be the case in Organisation B, but to a lesser extent. In this sense the role of involvement is consistent with Dedobbeleer and Béland's (1991) claim that it is one of the core safety climate factors. The final unequal relationship was that between communication and individual responsibility, which was slightly higher in Organisation B, but again significant in both samples. This structural relationship indicates that the more positive the perceptions of communication were, the more individual responsibility was taken. This slight difference in this relationship is consistent with the differences in intensity of attitudes between the two organisations described above. There was no difference in appraisals of communication but Organisation B did have significantly higher levels of individual responsibility. It could be that the same perceptions of communication affect levels of responsibility to different degrees in each organisation, resulting in the different responsibility scores. The role of communication, while important in this model, is less prominent than suggested by some authors. Weir (1991), for example, suggests that failures in communications systems contribute to almost all transport catastrophes. Although there is no evidence from the multisample model to support this assertion, it does seem that communication plays an important part in encouraging responsibility and subsequent activity.

The similarities illustrated by the multisample analyses allow a core general model to be derived for the industrial sector to which Organisations A and B belong. Figure 10.1 details the common manufacturing organisations' relationships, and provides a baseline against which similar organisations can evaluate their safety climate.

The general four-element model (as illustrated in Figure 5.2) provides a broad framework for the interpretation of safety climate. It not only provides the basis for the more detailed model shown in Figure 10.1, but is also equally appropriate for the description of the model produced in Organisation C. Furthermore, although it is perhaps more extensive, the four-element model can be considered consistent with the nature of relationships in models derived from previous research. The model proposed by Cox et al. (1998) involved relationships between organisational and individual dimensions, but no environmental variables were included. Similarly

Tomás and Oliver's (1995) model involving organisational, work environment and individual variables would fit with three of the four elements in the theoretical model.

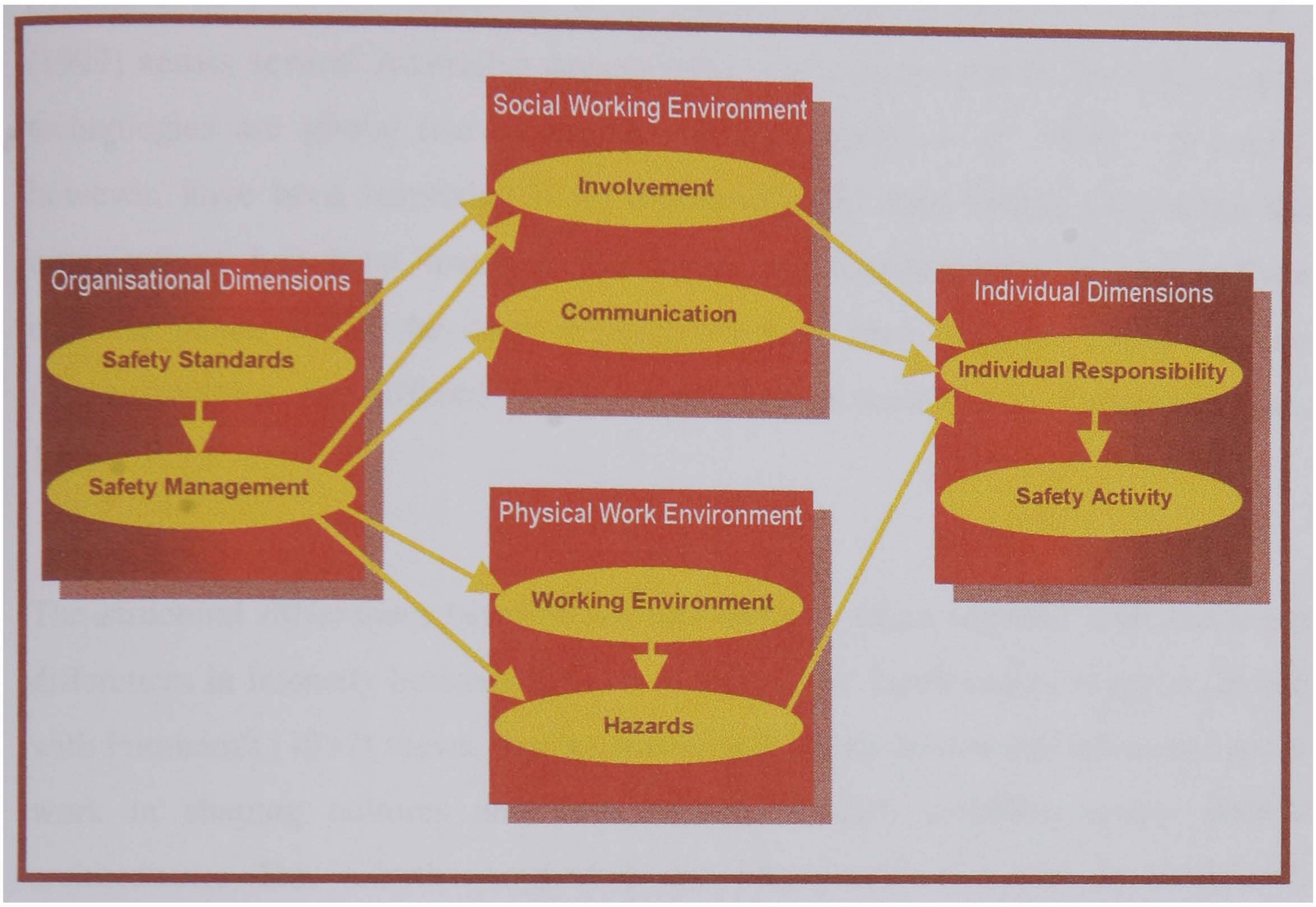

Figure 10.1
Four-element model of safety issues in the manufacturing sector

The grouping of dimensions and measures into elements means that this model allows many different factors to be included in its framework. This applies equally to:

- models which have already been constructed, for example, Tomás and Oliver's (1995) measure of tension could be included within the individual dimension;
- models constructed using the survey instrument described in this thesis but producing variant factor structures, for example that produced in Organisation C; and
- models constructed using 'core dimensions' such as those identified in Chapter 3 and by recent reviews in the safety arena (for example, Flin et al., 2000; Guldenmund, 2000)

In summary, the results of the multisample analysis provided some evidence of a sector wide safety culture based on these two organisations, lending weight to Mearns et al.'s (1998) suggestion in the offshore industry and Williamson et al.'s (1997) across several Australian organisations. It may be that in this case similar technologies are giving rise to similar cultures (Klein, et al., 1995). It would, however, have been surprising if no differences had been found, even when the organisations had been matched for sector and manufacturing process. Even different plants within the same organisation have been found to exhibit similar factor structures, but different relationships between those factors (Janssens, et al., 1995).

The structural differences between the two models, taken together with the mean differences in intensity between the two organisations' factor scores suggests, in line with Furnham's (1997) views, that organisational and environmental influences are at work in shaping cultures and their related climates including safety attitude architectures. This is further supported when Organisation C results are considered. These data from another industrial sector not only produced a different factor structure but also two main differences in the structural model. Even without confirmation of the construction supply organisational model in a similar organisation, the results from Organisation C still supports *Hypothesis 2*. These suggest, like the results in the other two participating organisations, that different environments, in terms of both sector and, to a lesser degree, organisation, produce different climate structures.

The utility of a model, such as the one presented here, is that it allows improvement programmes and initiatives to be targeted in one or two areas, depending on the desired outcomes. The model emerging from a comparison of Organisations A and B data could, therefore, identify managers, and their actions and commitment, as a key group in which to begin influencing and improving attitudes to safety and, in turn, levels of safety activity. Similarly a restructuring of safety communication systems and the foundation of employee participation programmes would also impact on safety climate and perhaps help develop a participative organisational culture for safety. Fostering such a culture could be particularly important if Petty et al.'s (1995) finding that a co-operative organisational culture improves performance can be extended to the safety domain. The model found in Organisation C suggests that similar improvement strategies could be applied in that organisation, since many of the paths were the same in that model. The use of such strategies in other organisations would depend on the specific model derived in them. The examination of work level specific models gives further direction on the complexities of safety climate and the subsequent targeting of improvement initiatives at different work levels within an organisation.

10.3 EMPLOYMENT LEVEL CLIMATES

The similarities between the two manufacturing organisations allowed their samples to be combined in order to explore *Hypothesis 3*, that different employee groups will exhibit different climate structures. This is particularly important if organisation-wide improvements are planned which target all employees at all levels. Not only does such a comparison highlight common ground, but it might also give managers and supervisors an appreciation of how other employees perceive elements of climate to be related.

10.3.1 Factor Structures

The measurement models from all three groups were compared first to test for equivalence of factor structures between managers, first-line supervisors and employees. Only six of the 34 variables were statistically different across the three samples, although all indicators were reliable and significant for each of the groups. As with the multisample analysis of Organisations A and B, the largest number of 'non-equal' items came from the safety management factor. Three of the 14 items in this factor were not equal across samples. The relationship between Item 14 'The safety training I receive is not detailed enough for my job' and the safety management factor was higher for employees than for supervisors and managers. If it is the case, as proposed earlier, that respondents in these organisations view safety training as a management responsibility, it may be that managers and supervisors perceive it as less related to overall safety management and more to their own particular skills. Item 26 'On my site we have defined safety objectives' showed a similar pattern, this time with the relationship for managers lower than those for supervisors and employees. Managers might consider this item to be less aligned to the overall management factor since it is something for which they feel personally responsible. The third unequal item, 28 'Management take the lead on safety issues', was more strongly related to this factor for managers than for the other two groups. It is perhaps not surprising that managers value their own input as a more important part of the safety management factor than the other groups.

The remaining three unequal items came from three different attitude dimensions. Item 10 'There are good communications here about safety issues' had a slightly lower relationship with the communication factor for supervisors than for the other two groups. It might seem from this that the quality of communication is not as important to the definition of this factor for those in the middle of the process, although, like the other unequal items, this is a reliable indicator for the supervisor group. The relationship between the involvement factor and Item 28 'My colleagues and I help each other work safely' is lower for employees than for the other two groups. This suggests that co-operation is less important in defining this factor for employees than for managers and supervisors, who might consider it part of their formal duties to encourage other to work safely. The final unequal item in the multisample measurement model relates to the individual responsibility factor. Item 25 'Safe working is a condition of my employment here' has a slightly lower relationship for managers than for the other groups. It could be that managers view this item as also related to responsibility for the general management of the workplace rather than just their own personal responsibility. In summary, there are some differences in the way the three groups define the attitude factors, and some evidence that managers, supervisors and employees conceptualise climate differently. The majority of items are, however, equal, suggesting cross-group equality in the measurement models and not the type of factor structure differences reported in the nuclear sector by Harvey et al. (1999), or the transport sector by Niskanen (1994).

The mean scores on each of the factors and measures were also compared across the three groups. All groups had positive views, all scoring above the scale mid-points and having relatively low hazard mean appraisals, although employee evaluations of the work environment were only just above the mid-point. There were, however, statistical differences on all eight of the measures. In seven of the eight measures the employee group had statistically lower scores than the other two groups. Only in terms of involvement were they on a par with supervisors but still had statistically lower views than managers. Supervisors assessed all variables, except involvement, work environment and safety activities, on a par with managers. In general terms managers have the most positive perceptions and workers the worst. Supervisors' views are more like managers than they are like employees. A similar comparison by Cox et al., (1998) found the converse, that managers and supervisors reported consistently lower perceptions on attitude dimensions. In that case the differences were attributed to high expectations being unmet. By the same reasoning the results reported here might indicate that managers, and to a lesser extent supervisors have similar expectations about safety, which are being met. Despite there being little difference in the factor structure of attitudes in the three groups, there is definite evidence that sub-climates have the potential to exist based on the intensity of attitudes and perceptions at the three work levels. A final comparison of structural relationships between the factors and measures was made in order to examine the full extent of the similarities and differences between the three work level groups.

10.3.2 Structural Model

The structural models derived from the three work level samples were, unlike their measurement models, quite different. The multisample analysis highlighted four statistical differences from a total of 11 structural relationships in the model. The relationship between involvement and individual responsibility was significant for both employees and managers but not for supervisors. A similar pattern was found between workplace hazards and individual responsibility, where there was a significant relationship for employees and managers but not for supervisors. In their model supervisors only related organisational dimensions with individual ones through the communication process. The relationship between communication and individual responsibility was not, however, itself consistent across the three groups. Whereas this relationship is significant for employees and supervisors it is not for managers. The final unequal relationship was that between perceptions of safety management and evaluations of workplace hazards, which was only significant for the employee group.

The greatest difference seems to be between the supervisor model and the models from the other two groups, although supervisors do share some common elements with each of the others. This result suggests that the nature of the supervisor's role in safety issues is quite different from the other two groups. It has been noted that the supervisor works differently form other levels in an organisation, for example, Trice and Beyer (1993) suggest that supervisors have little of no opportunity to interact as a group, unlike more senior managers and workers in general. The model is also contrary to Simard and Marchand's (1994) finding that supervisory participation was related to more general safety performance. Perhaps it is because supervisors in these organisations play a vital part in the communication process that they consider it to be of paramount influence on their levels of responsibility. The same conclusion cannot, however, be drawn for managers. Of all the relationships affecting their individual responsibility, only communication is unrelated. It may be that managers see themselves as in complete control of the communication process, and are therefore more influenced by the environment and co-operation with colleagues to take individual responsibility. On the other hand they may place less emphasis on responsibility and perceive good communications as a desirable ultimate outcome in themselves. The latter explanation is consistent with Harvey et al.'s (1999) study in the nuclear sector where responsibility featured as a factor for industrial staff but not for managers, for whom a good versus poor management factor took its place. The nature of organisational safety communications could fit within the remit of good management practices.

The final difference in structural relationships relates to the direct association between safety management and evaluations of workplace hazards. This relationship was only significant in the model derived from the employee sample. Managers and supervisors might have considered that the nature of workplace hazards was related to the nature of organisational operations and not, therefore, under the direct control of site management. Employees, on the other hand, could perceive a closer association between the organisation's goals and its local management, providing the direct link between safety management and the hazard environment.

The differences between the three work level samples are important if considered in light of early theories and definitions of safety culture and climate. An important aspect of the definitions outlined in Chapters 2 and 3 was the shared nature of culture (HSC, 1993; Schein, 1985; Uttal, 1983) and climate (Moran and Volkwein, 1992). The models derived from the employment level samples show that not all of safety climate's interrelationships are shared. The aspects of the models that are shared, and also equal in the statistical sense, relate mostly to the organisational dimensions and their relationships with the other variables. It could be argued that each of these levels has its own sub-climate and that which is shared between them helps define the organisation's overall climate. In the same vein, Martin and Siehl (1983) believe that organisational sub-cultures are defined in relation to overall cultural patterns, especially dominant values. The larger number of employees in the organisations could mean that their sub-climate perceptions have a greater influence on the overall climate. Indeed the employee model reflects the overall organisational models exactly. The influence of the other two groups should not, however, be underestimated, given the more prominent role that managers and supervisors play in defining safety procedures and policies may compensate for this.

The differentiation of safety sub-climates parallels many of the views of the nature of organisational culture outlined in Chapters 2 and 3. Organisational hierarchies have been held to provide the status differentials necessary to produce sub-cultures (Trice and Beyer, 1993). Furnham and Gunter (1993) specifically suggested that management and staff levels could give rise to differences in culture between those groups. Such cultural differences may be indicative of the power distance (Hofstede, 1980) perceived between the hierarchical levels in the organisation. The result of the cross group comparison described above provides evidence that this is also the case in terms of safety climate, and its related safety culture, as suggested for occupation specific safety sub-cultures in the offshore environment (Mearns et al., 1997). In the two organisations studied here there also seems to be evidence that the sub-climates are nested (Pidgeon, 1991) and overlapping when their shared relationships are considered.

The fact that managers and supervisors see things differently from the workforce is important in terms of promoting a positive, or appropriate, culture for safety. It has implications for the success of improvement programmes aimed at all employment levels. There was no single significant path to responsibility and activity that was consistent for all three groups. It may, therefore, be difficult to aim an improvement initiative at all three levels simultaneously. A more beneficial approach might be to attempt to 'align' managers and supervisors with the workforce (Thom, 1997) to give an appreciation of how workers view things, and reduce the power distance between the three groups if appropriate. This might be particularly important if individuals are being encouraged to take more responsibility for safety and not view safety issues as the preserve of managers.

The differences found between occupational level provide evidence for the existence of organisational sub-climates for safety relating to employee, supervisor and manager levels, and support *Hypothesis 3*. Sub-cultures were not apparent from the examination of measurement models of the three groups. The factor structures were almost completely equivalent in statistical terms, unlike the more pronounced differences found in similar comparisons in the transport (Niskanen, 1994) and nuclear (Harvey et al., 1999) sectors. Differences in the intensity of attitude and perception did, however, suggest that sub-climates might exist at occupational levels, similar to, but in a different direction from, those found by Cox et al. (1998). Examination of the structural model for each group provided further information on the presence sub-climates. Organisational hierarchies seem to encourage different structural relationships between the climate measures in the general model, suggesting different strategies might be appropriate for improving climate in different work levels.

10.4 CONCLUSIONS

The results of this research paint a complex picture of the nature of organisational safety climate. At one level the components of safety climate can be described in terms of organisational, group process, environmental and individual variables, for all of the participating organisations. Comparisons of results also suggest that a general model can be constructed for two of the organisations in the manufacturing sector. At another level, employment group comparisons show marked differences in the perceptions and structure of safety climate for employees, supervisors and managers. There are several possible explanations as to why such differences have arisen, but the overwhelming conclusion that can be drawn from their examination is that safety climate, like the safety culture it reflects, is best considered as a complex system (Cox and Cox, 1996). The implications of these results and general conclusions on the research are presented in the final chapter.

CHAPTER ELEVEN

Implications and Conclusions

This final chapter considers the utility of the concepts of safety culture and climate following the results of this research. The research methodology is critically reviewed here and suggestions made for enhancing it for future research. The implications of the results for identifying potential influences on organisational culture for safety and the associated safety climate are also discussed here. The chapter closes with a discussion of the directions future research into safety culture and climate may take in light of the finding presented in this thesis.

11.1 INTRODUCTION

The research described in this thesis involved studies of the structure of safety climate in three organisational settings. Safety culture and its associated safety climate are considered useful concepts, and there are moves within many companies to manipulate organisational safety culture in order to improve overall safety performance (Cox and Flin, 1998). The organisations involved in this research held such aspirations, and these provided the main impetus for their participation. They hoped that by assessing safety climate and through concomitant interventions, improvements in culture and, by association, performance would follow. The current research shows that it is possible to assess and produce explicative models of the structure of safety climate. These models were deemed appropriate to the organisations involved and were subsequently used to plan future, or endorse current, safety improvements. In practice it was not possible to evaluate the outcomes of the actions planned by the participating organisations. Given the enduring nature of culture (Schein, 1985) such results may not be seen for several months or years and, as such, are beyond the scope of this research. However, given these limitations, the studies described in the preceding chapters provide useful and relevant indications of safety climate in each of the organisations. The methodology employed here, however, could be improved upon for future studies.

11.2 CRITICAL REVIEW OF METHODOLOGY AND ANALYSIS

The research described in this thesis is based on data collected within an applied setting, using predominantly quantitative methods. There were a number of reasons for choosing this research methodology and these were discussed earlier in Chapter 4. The intent here is to review the success of the research, the validity of the findings, and discuss possible improvements to the research method. This section starts with a discussion of the efficacy of the data collection methods, focuses on the problems associated with fieldwork, and outlines the effects of the data collection procedures on the validity of the findings. The methods of data analysis and the interpretation of results are then examined. Finally, recommendations are made for the improvement of the research methodology.

11.2.1 Data Collection Methods

Although the main tools for collecting data were a paper-based questionnaire, structured group discussions were also used to inform the design of those questionnaires. The participants in the pilot discussions were selected by the participating organisation in question, often from a group of plant and organisation level safety professionals. While it can be argued that these individuals might have a clear insight into safety issues, it is also possible that issues they are not aware of could be excluded from the final survey instrument. The coverage of the questionnaire was examined in a series of pilot studies with a more general population of workers in an attempt to compensate for any issues missed by the original discussion groups. In addition an open response question was included, providing all respondents with the opportunity to raise further issues, and the nature of these issues were compared with the results of the quantitative analysis. The pilot studies also ensured that the question set and checklists used in the survey instrument were constructed in an appropriate way, and that there was no confusion over their meaning. Results from the pilot and main studies confirmed that items related, for the most part, to the themes they were designed to and that they provided consistent and reliable measures.

The distribution and collection of the survey instrument was, for the most part, conducted by the sponsoring organisations. Wherever possible the researcher was involved with the administration but organisational events did not always make this possible. In one organisation, however, there was no direct contact between the researcher and the worksites under study. It was difficult, therefore, to ensure that participants received the same type of information before they completed the questionnaire. A short script (similar to the covering memo shown in Appendix 2) was provided, in addition to the written instructions and/or covering letter in an attempt to overcome this problem.

The total working population was targeted in each of the study organisations. The participating organisations wanted to canvass opinion across all employees and so no explicit sampling technique was employed. As an inevitable result of a less than 100% response rate the research findings cannot be declared as fully representative of the organisations involved, although the relatively large response rates gave some degree of confidence in the results. In addition, the demographic make-up of each of the samples was very similar to that of the whole organisation.

11.2.2 Data Analysis

There were three distinct stages within the data analysis. First, descriptive statistics were calculated at the organisational level. This was followed by an examination of underlying factors and finally the construction of explicative models of the data. Interestingly the most basic, descriptive level of analysis was the one in which the participating organisations took most notice. This analysis afforded them an overall picture of prevailing attitudes and perceptions and made simple feedback of results possible. The categorisation of the open responses at the end of the questionnaire was the one part of the descriptive process where meaning and context could have been lost. This was addressed by the use of multiple raters in an attempt to eliminate bias and ensure comments related to their grouping. Copies of all comments made were also fed back to the organisation so that they were aware of the full extent of individuals' concerns.

One limitation of the explicative modelling techniques used in this research is their reliance on a relatively large sample size in order to construct reliable models. This is not an issue when the whole organisation is being considered but can be a problem when sub-samples, such as work groups or a particular level of employees, are being evaluated. The sample sizes of groups of employees precluded the examination of work level differences in each of the individual organisations. The problem of small numbers of managers and supervisors was, however, resolved here by the combination of groups from two very similar organisations in one sector. A similar comparison was, however, not possible for data from the third organisation.

A lack of comprehensive analysis of safety performance data was one important problem that the studies in this research faced. Attempts were made to compare the survey results with other measures of safety performance with limited success. Once again the problem here was one of primary contact with the participating units. While overall plant accident rates were made available in Organisation A and average safety audit results were supplied for Organisation C, a more thorough examination of the link between climate and performance may have been possible. This could have been achieved if group level accident and incident statistics had been available in Organisations A and B, or if individual plants could have been identified in Organisation C. However, given these limitations, it was possible to establish tentative links between the survey results and the objective data that was available.

11.2.3 How the Methodology Could be Improved

In order to improve the methodology used in this research the problem of client-researcher contact has to be considered further. If more extensive access to a participating organisation can be negotiated then several steps can be taken to improve the research methodology. Initially this might include the random selection of discussion group participants. This, coupled with rigorous pilot studies, should ensure that a survey instrument is devised or amended in line with current salient issues, which are relevant to a wider constituency of members of the organisation.

Two further actions can be taken to improve on the methods employed here. Once again depending on the nature of the relationship with the study organisation, efforts could be made at more thorough objective performance data gathering. This might involve follow-up investigations of accident rates or the application of a proprietary audit system with which to compare survey results. The final potential improvement concerns the maximising of responses from sub-groups to allow comparative explicative models to be constructed for each group. If time and organisational constraints allow it, members of these sub-groups, such as managers and supervisors, could be targeted personally in order to encourage responses. While the three improvements detailed above would enhance the methodology and analysis used in this research, it has, nonetheless, produced a set of valid and interesting results with implications for the safety climate and culture fields.

11.3 CURRENT RESEARCH

The main focus of this research has been the assessment of attitudes to, and perceptions of, safety climate. This assessment has concentrated on the more accessible layers of culture (Rousseau, 1990; Schein, 1985) in an attempt to define a general explicative structure. This explicative structure has been used by the participating organisations to plan and implement a number of improvement strategies, aimed at enhancing safety culture and, ultimately, safety performance. These included, amongst others, setting up improvement teams, initiating communication forums, and expanding behavioural participation programmes. Specifically the research has illustrated that safety climate might be thought of at the most basic level as comprising of four elements, which interrelate to produce an influence on individual actions (*Hypothesis 1*). Furthermore there was evidence which suggested that this structure varied depending on industrial sector (*Hypothesis 2*) and, more notably, on employment level (*Hypothesis 3*). In supporting these hypotheses the results were consistent, not only with a large body of safety climate and culture research (for example Cox et al., 1998; Harvey et al., 1999; Mearns et al, 1998; Zohar, 1980), but also with theories about the nature of organisational culture in general (for example Furnham, 1997; Hofstede, 1980; Schein, 1999). These similarities lend weight to the view that climate is a representation of culture (shown in Figure 2.3), and that safety culture is a subset of organisational culture (Booth and Lee, 1995). In addition to clarifying these relationships, the results allow a meta-framework of safety culture and climate to be developed for the manufacturing sector, providing a basis for ongoing improvement in safety in that sector.

11.3.1 Influences on the Development of Safety Culture

The research reported in this thesis has produced a series of results that clarify the nature of safety climate, and to a degree, safety culture. This clarification has been in terms of both the structure of, and the influences upon, the formation of safety climate. The four-element model detailed in the previous chapter describes the structure of climate in the participating organisations. Further conclusions can, however, be drawn about the possible influences, both from within the organisation and externally, on the formation of the safety climate that that model describes.

This research suggests that external influences on organisational safety culture come from at least two sources. Differences in intensity of attitude and perception between plants in different countries in Organisation B suggests, as Hofstede (1980) found for organisations in general, that national, or societal, culture is one such influence. The other external influence apparent from the studies reported here, is that of a common, industry wide culture (Schein, 1999). The comparison of the structure of attitudes and the explicative models form the three organisations showed the two organisations in the paper manufacturing sector are very similar with only a few differences. The third organisation, from a different sector, showed more marked differences, indicating that industrial sector might have some influence on climate. Although the involvement of only three organisations allows for limited conclusions to be drawn, it does provide a useful comparison across sectors and a starting point from which to begin constructing general models of safety climate. Although these have been labelled external influences, they are in fact related to the organisation's culture in as much as the organisation is part of both the society and the industrial sector in which it is located. These influences could also be described as factors over which the organisation has limited control and/or influence.

In addition to external influences, conditions within the organisation itself would be expected to affect its safety culture (Furnham, 1997). The minor differences that did arise between Organisations A and B centred on perceptions of the working environment, perhaps the most likely element to change between organisations, given different levels of resource, investment and corporate history. Figure 11.1 shows how these three factors might be represented as influences on safety climate and safety performance. This figure is based on Kopelman et al.'s (1990) flowchart model of culture in productivity and its subsequent modifications for safety issues (Cox, 1996; Mearns and Flin, 1999). It illustrates two of the many potential external influences on the organisation's safety culture and the role played by the four-element-model of safety climate in the path between these and the final result of safety performance. The two external influences discussed here are not unrelated and they, together with other influences not highlighted by this research, could work together to create an overall external influence on an organisation's safety culture.

Figure 11.1
Influences on the development of safety climate

The four-element model of safety climate (developed in Chapter 3 and elaborated in Chapter 10) is central to the model illustrated in Figure 11.1 in as much as it provides a description of how the organisation's safety culture is translated into the range of individual safe behaviours and resulting levels of safety performance. The organisation's safety culture is reflected by perceptions of organisational dimensions (such as safety management and safety standards) in the four-element model. These organisational dimensions, through the work and social environments that they help to create, effect individual variables. Individual dimensions, in turn, translate into safe behaviours, which have some baring on safety performance. This model implies that an attempt to improve safety performance by targeting culture and climate will be a complex route, with a number of influences and processes needing to be considered. Improvements focused on the more accessible element of culture may also have to take the influences on its deeper levels into account.

This model is further complicated when differences between employment level groups are considered. Different safety climate models were derived for each of these groups and it may be that three parallel models like that shown in Figure 11.1 also exist for managers, supervisors and employees. For example, national and societal differences might have a greater impact on workers' perceptions, while industry practices play more of a role in influencing how managers view, and deal with, safety issues. The existence of such parallel models is one of several possibilities that could be examined by future research in this area.

11.4 Current Trends and Future Research

The number of studies published recently on safety culture and climate, and more particularly their assessment, give some idea of the current interest in operationalising these concepts in an attempt to enhance safety performance. In response to the increasing desire to assess safety climate the HSE have produced a generic survey based instrument (HSE, 1997) for use in many different sectors. The same process reported in this thesis, involving the modelling of relationships between climate components, could be carried out for many different industrial sectors. In that way similarities and differences between sectors could be established and organisations within those sectors could plan initiatives accordingly. This type of benchmarking of sectoral culture would also lend itself to the achievement of HSC's Action Point 4 in their recent *Revitalising Health and Safety* report (HSC, 2000), which states:

> "The Health and Safety Commission will advise Ministers what steps can be taken to enable companies, if they wish, to check their health and safety management arrangements against an established 'yardstick'." (pg 22)

Specific models of climate for each industrial sector, similar to those described in this thesis, could provide such a yardstick. Organisations could then compare their own structures against those found in their particular sector. Comparisons between sectors and work groups could also be made on a larger scale than was possible here. Such comparisons would allow a range of potential influences to be identified.

In terms of more specific research suggested by the results, the most apparent future research relates to the validation of the model for the construction supply sector, derived from Organisation C. This model was based on only one company and may have capitalised on the chance characteristics of that organisation. In order for a more comprehensive model to be developed in this sector, at least one other similar organisation should be surveyed and an explicative model constructed. If the explicative model in this new study were similar to that already described then it would suggest that the model found in Organisation C is appropriate for the sector. If, on the other hand, the explicative model was similar to that found in the Organisations A and B that could suggest that Organisation C is different from what might be considered an industrial 'norm'. Finally, if the model found in this new research was different from all other previous models it could be that this sector does not have a unifying structure and a third organisation should be examined to confirm this. Similarly, employment level models could be examined further in different sectors, in order to investigate whether the differences found in this research are the same for managers, supervisors and workers in other organisations and industries.

One of the main reasons for the organisations' participation in this research was the opportunity it would give them to plan improvement initiatives based on the results of the climate assessment. One final piece of future research, suggested by the work described in this thesis, relates to the evaluation of these improvement strategies and how they might change attitudes and perceptions, and/or the relationships between variables. In terms of the utility of structural modelling, a post intervention comparison would provide useful data as to whether an intervention has had the desired effect on outcome measures, such as safety activity. There is scope for returning to some of the organisations involved in this research to conduct such a comparison, but, as with much applied research, this would have to be at the invitation of the organisation.

11.5 CONCLUSIONS

This research set out to examine the structure and relationships between components of safety climate as measured by individual attitudes to, and perceptions of, safety issues. The basic thesis was that safety climate, as a manifestation of safety culture, could be described in terms of the relationships between four elements; organisational, work environment, social working environment and individual variables. The nature of these associations was also examined in relation to different industrial sectors and different employment levels. The implications of the research findings described in this thesis can be summarised as follows:

- There appear to be a number of common elements involved in the description of safety climate. These were very similar across the three organisations involved, but not identical in their construction. The similarity of dimensions could be important for cross-organisation and cross-industry comparisons of safety climate.
- Safety climate in all three participating organisations can be described in terms of a four-element model. This model provides a summary way of describing climate while recognising that it is a complex system with several inter-relationships. The model describes how factors interrelate and how they directly, or indirectly, influence activity and behaviours.
- Notions of safety culture need to take into consideration the type of industry being described, and the nature of external influences upon the organisation to which the culture applies. Any attempt to construct a general model of climate and culture also needs to take these conditions into consideration.
- Attempts to improve or align safety culture within organisations must consider the possibility that sub-cultures exist associated with employment status and, potentially, work groups. It may be more productive to aim improvement initiatives at targets appropriate to each group comprising the organisation, than to develop universal initiatives for an entire company.

REFERENCES

Adams, G.B. and Ingersoll, V.H. (1989) Painting over old works: the culture of organisations in an age of technical rationality. In B.A. Turner, (ed) *Organisational Symbolism*, Berlin: Walther De Gruyter.

Alexander, M., Cox, S., and Cheyne, A. (1995) The concept of safety culture within a UK offshore organisation. Paper presented at *Understanding Risk Perception* conference. Robert Gordon University, Aberdeen, February.

Allen, R.F., and Dyer, F.J. (1980) A tool for tapping the organisational unconscious. *Personnel Journal*, 192-199.

Allport, G.W. (1935) Attitudes. In C.A. Murchison (Ed.) *A Handbook of Social Psychology (Vol. 2)* Worcester, MA: Clark University Press.

Anastasi, A. (1976) *Psychological Testing (4th ed.)*. New York: Macmillan.

Argyris, C. (1958) Some problems in conceptualizing organizational climate: A case study of a bank. *Administrative Science Quarterly*, **2**, 501-520

Arrindal, W.A. and van der Ende, J. (1985) An empirical test for the utility of the observations-to-variables ratio in factor and components analysis. *Applied Psychological Measurement*, **9**, 165-178.

Ashforth, B.E. (1985) Climate formation: issues and extensions. *Academy of Management Review*, **4**, 837-847.

Ajzen, I. (1982) On behaving in accordance with one's attitudes. In M.P. Zanna, E.T. Higgins, and C.P. Herman (Eds.) *Consistency in Social Behaviour.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Ajzen, I. (1991) The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes*, **50**, 179-211.

Bailey, C.W., and Petersen D. (1989) Using perception surveys to assess safety systems effectiveness. *Professional Safety*, **34**, 22-26.

Ballard, G.M. (1988) *Nuclear Safety after Three Mile Island and Chernobyl.* London: Elsevier

Barker, R. (1965) Explorations in ecological psychology. *American Psychologist,* **20**,1-14.

Bechhofer, F. (1974) Current approaches to empirical research: some central ideas. In J. Rex (ed.) *Approaches to Sociology: an Introduction to Major Trends in British Sociology.* London: Routledge and Kegan Paul.

Becker, H.S., and Geer, B. (1970) Participant observation and interviewing: A comparison. In W Filstead (ed.), *Qualitative methodology.* Chicago: Rand McNally, 133-142.

Bentler, P.M. (1995) *EQS Structural Equation Program Manual.* Encino, CA: Multivariate Software, Inc.

Bentler, P.M., and Bonnet, D.G. (1980) Significance tests and goodness-of-fit in the analysis of covariance structures. *Psychological Bulletin*, 88, 588-606.

Bentler, P.M., and Wu, E.J.C. (1995). *EQS for Macintosh user's guide.* Encino, CA: Multivariate Software, Inc.

Block, J. (1978) *The Q-sort method in personality assessment and psychiatric research.* Palo Alto, CA: Consulting Psychologists Press.

Bollen, K.A. (1989) *Structural equations with latent variables.* New York: Wiley.

Bollen, K.A., and Long, J.S. (1993) *Testing structural equation models.* Newbury Park, CA: Sage.

Booth, R.T. (1996) The promotion of a positive health and safety culture. In N Stanton (ed) *Human Factors in Nuclear Safety*, London: Taylor and Francis.

Booth, R.T., and Lee T.R. (1995). The role of human factors and safety culture in safety management. Proceedings of the Institution of Mechanical Engineers Part B - *Journal of Engineering Manufacture*, 1995, **209**, 393-400

Bright, K., and Cooper, C.L. (1993) Organizational culture and the management of quality. Journal of Management Psychology, 8(6), 21-27.

Broadbent, D.E. (1989). *Advisory Committee on the Safety of Nuclear Installations: Study Group on Human Factors. First Report of Training and Related Matters.* London: Health and Safety Commission.

Brown, A. (1995) *Organisational culture*, London: Pitman Publishing

Brown, A.D., and Starkey, K. (1994). The Effect of Organizational Culture on Communication and Information. *Journal of Management Studies*, 31:6, 807-828.

Brown, R.L., and Holmes, H. (1986) The Use of a Factor-Analytic Procedure for Assessing the Validity of an Employee Safety Climate Model. *Accident Analysis and Prevention*, **18**, 455-470.

Browne, M.W., and Cudeck, R. (1993) Alternative ways of assessing model fit. In K. A. Bollen and J. S. Long (Eds.), *Testing structural equation models*. Newbury Park, CA: Sage.

Budworth, N. (1997) The development and evaluation of a safety climate measure as a diagnostic tool in safety management. *Journal of the Institution of Occupational Safety and Health*, **1**, 19-29

Byrne, B.M. (1994). *Structural Equation Modelling with EQS and EQS/Windows*. Thousand Oaks: Sage

Byrom, N. (1998) Presenting a new tool to assess aspects of an organisation's health and safety culture. Paper presented at *Developing an Employee-Led Safety Culture* conference, London, June.

Byrom, N., and Corbridge, J. (1997) A tool to assess aspects of an organisation's health and safety climate. Paper presented at the *Safety Culture in the Energy Industries* conference, University of Aberdeen, September.

Caroll, J.S. (1998) Safety culture as an ongoing process: culture surveys as opportunities for enquiry. *Work and Stress*, **12**, 272-284.

Cattell, R. (1978) *The Scientific Use of Factor Analysis in the Behavioral and Life Sciences*. New York: Plenum Press.

CBI (1990) *Developing a Safety Culture - Business for Safety*. London: Confederation of British Industry

Cheyne, A., and Cox, S. (1994) A comparison of employee attitudes to safety. In A. Cheyne, S. Cox and K. Irving (eds) *Proceedings of the Fourth Annual Conference on Safety and Well-Being at work*, Loughborough: Centre for Hazard and Risk Management.

Cheyne, A., and Cox, S. (1995) Uncovering safety culture. *Work and Well-being: An Agenda for Europe Conference*, Nottingham, 7-9 December.

Cheyne, A., Tomás, J.M., Cox, S., and Oliver, A. (1999) Modelling employee attitudes to safety: a comparison across sectors. *European Psychologist*, **4**, 1-10.

Chou, C.P., and Bentler, P.M. (1995) Estimates and tests in structural equation modeling. In R. H. Hoyle (Ed.), *Structural Equation Modeling: Concepts, Issues and Applications*. Thousand Oaks, CA: Sage.

Clarke, S. (1994) Violations at work: implications for risk management. In A. Cheyne, S. Cox and K. Irving (eds), *Proceedings of the Fourth Annual Conference on Safety and Well-Being at Work.* Loughborough: Centre for Hazard and Risk Management.

Cliff, N. (1993) Some cautions concerning the application of causal modelling methods. *Multivariate Behavioural Research*, **18**, 115-159.

Clegg, F. (1982) *Simple Statistics*. Cambridge: Cambridge University Press.

Coenders, G., Satorra, A., and Saris, W.E. (1997) Alternative approaches to structural equation modeling of ordinal data: A Monte Carlo study. *Structural Equation Modeling*, 4, 261-282.

Comrey, A. (1978) Common methodological problems in factor analytical studies. *Journal of Clinical and Consulting Psychology*, **46**, 648-659.

Cooke, R.A., and Lafferty, J.C. (1984) *Level V Organizational Culture Inventory*. Plymouth, MI: Human Synergistics, Inc.

Cooke, R.A., and Lafferty, J.C. (1989) *Organizational Culture Inventory*. Plymouth, MI: Human Synergistics, Inc.

Cooke, R.A. and Rousseau, D.M. (1988) Behavioural norms and expectations: a quantitative approach to the assessment of organizational culture. *Group and Organization Studies*, **13**, 245-273.

Cooke, R.A., and Szumal, J.L. (1983) Measuring normative beliefs and shared behavioral expectations in organizations: the reliability and validity of the Organizational Culture Inventory. *Psychological Reports*, **72**, 1299-1339.

Cooper, M.D., and Philips, R.A. (1994) Validation of a safety climate measure. Paper presented at the *British Psychological Society: Annual Occupational Psychology Conference*, Birmingham, January.

Cox, S. (1988) *Employee attitudes to safety*. MPhil thesis, Nottingham University.

Cox, S. (1992) *Risk Assessment Toolkit* Loughborough: Loughborough University of Technology.

Cox, S.J. (1996) Maximising performance: the impact of positive safety cultures. Paper presented at *Maximising Performance: 5th OIM Conference,* The Robert Gordon University, 16 April, Aberdeen.

Cox, S., and Cheyne, A. (1998) *Measuring Safety Culture in Offshore Environments* Offshore Technology Report, Loughborough University.

Cox, S.J., and Cheyne, A., (2000), Assessing safety culture in offshore environments. *Safety Science*, **34**, 111-129.

Cox, S.J. and Cox, T.R. (1991). The structure of employee attitudes to safety: A European example. *Work and Stress*, 5, pp 93-106.

Cox, S.J. and Cox, T.R. (1996). *Safety, Systems and People.* Oxford: Butterworth-Heinemann.

Cox, S., and Flin, R. (1998) Safety culture: philosopher's stone or man of straw? *Work and Stress*, **12(3)**, 189-201.

Cox, S., Tomás, J.M., Cheyne, A. and Oliver, A. (1998) Safety culture: the prediction of commitment to safety in the manufacturing industry. *British Journal of Management*, **9**, S3-S11.

Coyle, I.R., Sleeman, S.D. and Adams, N. (1995) Safety climate. *Journal of Safety Research*, **26**, 247-254.

Cross Industry Safety Leadership Forum (1997) *Step Change in Safety*, London: Safety Leadership Forum

Cullen, Hon Lord (1990) *The Public Inquiry into the Piper Alpha Disaster*. London: HMSO

Dalling, I. (1997) Understanding and assessing safety culture. *International Conference on Safety Culture in the Energy Industries*, Aberdeen, September

Dane, F.C. (1990) *Research methods*. Pacific Grove, CA: Broks/Cole.

Dawson, S. (1992) *Analysing Organisations*. Basingstoke: Macmillan Press.

Deal, T.E., and Kennedy, A.A. (1982) *Corporate Cultures: The Rites and Rituals of Organisational Life*. Reading MA: Addison-Wesley.

Dedobbeleer, N., and Béland, F. (1991) A Safety Climate Measure for Construction Sites. *Journal of Safety Research*, **22**, 97-103.

Denison, D. (1984) Bringing corporate culture to the bottom line. *Organizational Dynamics*. 13(2): 4-22.

Denison, D.R. (1996) What is the difference between organizational culture and organisational climate? A native's point of view on a decade of paradigm wars. *Academy of Management Review*, **21**: 619-654.

Dilorio, C., Hockenberry-Eaton, M., Maibach, E. and Rivero, T. (1994) Focus groups: an interview method for nursing research. *Journal of Neuroscience Nursing*, **26**, 175-180.

Donald, I. (1995) Safety attitudes as a basis for promoting safety culture: An example of an intervention. *Work and Well-being: An Agenda for Europe Conference*, Nottingham, 7-9 December.

Donald, I., and Canter D. (1993). Psychological factors and the accident plateau. *Health and Safety Information Bulletin*, **215**, November pp. 5-12.

Donald, I., and Canter, D. (1994) Employee attitudes and safety in the chemical industry. *Journal of Loss Prevention in the Process Industries*. **7**: 203-208

Donald, I., Canter, D., Chalk, J., Hale, A., and Gerlings, P. (1991) Measuring safety culture and attitudes. *1st International Conference on Health, Safety and Environment*, 639-644. Den Haag: Society of Petroleum Engineers.

Dziuban, C., and Shirkey, E. (1974) When is a correlation matrix appropriate for factor analysis? Some decision rules. *Psychological Bulletin*, **81**, 358-361.

Emory, C.W., and Cooper, D.R. (1991) *Business Research Methods*. Burr Ridge, IL: Irwin.

Enz, C. (1986) *Power and shared values in the corporate culture*. Ann Arbor, MI: UMI.

Etzioni, A. (1961) *A Comparative Analysis of Complex Organisations*, London: Free Press.

Fennel, D. (1988). *Investigation into Kings Cross Underground Fire.* Department of Transport, HMSO.

Ferguson, E., and Cox, T. (1993) Exploratory factor analysis: a users' guide. *International Journal of Selection and Assessment*, **1**, 84-94.

Falcione, R.L., Sussman, L., and Herden, R.P. (1987) Communication climate in organizations. In F. Jablin, L. Putnam, K. Roberts and L. Porter (eds.) *Handbook of Organizational Communication.* London: Sage

Fishbein, M., and Ajzen, I. (1974) Attitudes to ward objects as predictors of single and multiple behavioral criteria. *Psychological Review*, **81**, 59-74.

Fleming, M., Flin, R., Mearns, K., and Gordon, R. (1998) Offshore workers' perceptions of risk: comparisons with quantitative data. *Risk Analysis*, **18**, 88-92

Flin, R., Mearns, K., Flemming, M., and Gordon, R. (1996) *Risk perception and safety in the offshore oil and gas industry. Health and Safety Executive Offshore Technology Report OTH 94 454.* Sudbury: HSE Books.

Flin, R., Mearns, K., O'Connor, P., and Bryden, R. (2000) Measuring safety climate; identifying the common features. *Safety Science*, **34**, 177-192.

Forehand, G.A., and Gilmer, B.V. (1964) Environmental variation in studies of organizational behavior. *Psychological Bulletin*, **62**, 228-240

Furnham, A. (1997) *The Psychology of Behaviour at Work.* Hove: Psychology Press.

Furnham, A., and Gunter, B. (1993) *Corporate Assessment.* London: Routledge

Glaser, S.R. (1983) *The Corporate Culture Survey.* Bryn Mawr, PA: Organizational Design and Development

Glaser, S.R., Zamanou, S., and Hacker, K. (1987) Measuring and interpreting organizational culture. *Management Communication Quarterly*, **1**, 173-198.

Glendon, A.I., and McKenna, E.F. (1995) *Human Safety and Risk Management.* London: Chapman and Hall.

Glick, W. (1985) Conceptualizing and measuring organization and psychological climate: Pitfalls in multilevel research, *Academy of Management* Review, **10**, 601-816.

Gold, K.A. (1982) Managing for success: a comparison of the private and public sectors. *Public Administration Review*, Nov-Dec, 568-575.

Goldberg, A.I., Dar-El, E.M., and Rubin, A.E. (1991) Threat perception and the readiness to participate in safety programs. *Journal of Organizational Behavior,* **12**, 109-122.

Gordon, G. (1985) The relationship of corporate culture to industry sector and corporate performance. In R. H. Kilman, M. J. Saxton and B. Serpa. (Eds.), *Gaining control of the corporate culture:* 103-125. San Francisco: Jossey-Bass.

Gordon, G., and DiTomaso, N. (1992) Predicting corporate performance from organizational culture. *Journal of Management Studies,* 29: 783-798.

Gorsuch, R. (1983) *Factor Analysis.* London: Lawrence Erlbaum Associates.

Griffiths, A. (1999) Organizational interventions: facing the limits of the natural science paradigm. *Scandinavian Journal of Work Environment Health.* **25**, 589-596

Guadangnoli, E., and Velicer, W. (1988) Relation of sample size to the stability of component patterns. *Psychological Bulletin*, **103**, 265-275.

Guion, R. (1973) A note on organizational climate. *Organizational Behavior and Human* Perform*ance,* **9**, 120-125.

Guldenmund, F.W. (2000) The nature of safety culture: a review of theory and research. *Safety Science,* **34**, 215-257

Hale, A.R. (1974) Motivation and propaganda. *Occupational Health*, **26**, 92-95.

Hampden-Turner, C. (1990) *Corporate Culture: From Vicious to Virtuous Circles.* London: Hutchinson

Handy, C.B. (1981) *Understanding Organizations (2nd ed.).* London: Penguin.

Hansen, C.P. (1989). A causal model of the relationship among accidents, biodata, personality and cognitive factors. *Journal of Applied Psychology,* **74**, 81-90.

Harvey, J., Bolam, H., and Gregory, D. (1999) How many safety cultures are there? *The Health and Safety Practitioner*, December, 8-12.

Harvey, J., Bolam, H., and Gregory, D. (in press) The effect of training to change safety culture in a highly regulated environment. *Personnel Review.*

Hatch, M.J. (1997) *Organizational Theory.* Oxford: Oxford University Press.

Hawkins, P. (1997) Organizational culture: sailing between evangelism and complexity. *Human Relations*, **50**, 417-440.

Hays, W.L. (1994). *Statistics.* Fort Worth, TX: Harcourt Brace College Publishers.

Hidden, A. (1989). *Investigation into the Clapham Junction Railway Accident.* London: HMSO.

Hinkin, T.R. (1995) A review of scale development practices in the study of organisations. *Journal of Management*, **21**, 967-988.

HSC (1993) *Organising for Safety* - Third Report of the Human Factors Study Group of ACSNI. Suffolk: HSE Books.

HSC (2000) *Revitalising Health and Safety: Strategy Statement.* London: Department of the Environment, Transport and the Regions.

HSE (1997) *Health and Safety Climate Tool Process Guidelines.* Sudbury HSE Books

Hofman, D.A., and Stetzer, A. (1996a) The role of safety climate and communication in accident interpretation: implications for learning from negative events, *Academy of Management Journal,* **41**, 644-657.

Hofman, D.A. and Stetzer, A. (1996b) A cross-level investigation of factors influencing unsafe behaviours and accidents. *Personnel Psychology,* **49**, 307-339.

Hofstede, G. (1980) *Culture's Consequences: International Differences in Work-related Values* Beverly Hills, CA: Sage.

Hofstede, G. (1991) *Cultures and Organizations: The Software of the Mind.* Maidenhead: McGraw-Hill.

Hofstede, G., Neuijen, B., Daval Ohayv, D., and Sanders, G. (1990) Measuring organizational cultures: a qualitative and quantitative study across twenty cases. *Administrative Science Quarterly*, **35**, 286-316.

Holsti, O.R. (1969) *Content Analysis for the Social Sciences and Humanities.* Reading, MA: Addison-Wesley.

Hoyle, R.H. (1995) The structural equation modeling approach: basic concepts and fundamental issues. In R. H. Hoyle (Ed.), *Structural Equation Modeling: Concepts, Issues and Applications.* Thousand Oaks, CA: Sage.

Hoyle, R.H. and Panter, A.T. (1995) Writing about structural equation models. In R. H. Hoyle (Ed.), *Structural Equation Modeling: Concepts, Issues and Applications.* Thousand Oaks, CA: Sage.

Hu, L., and Bentler, P.M. (1995) Evaluating model fit. In R. H. Hoyle (Ed.), *Structural Equation Modeling: Concepts, Issues and Applications*. Thousand Oaks, CA: Sage.

Hunt, S.D. (1991) *Modern Marketing Theory*. Cincinnati: South-Western Publishing.

Huse, E.F., and Cummings, T.G. (1989) *Organisational Development and Change (3rd ed)*. St Paul, MN: West Publishing Company.

IAEA (1991) International Nuclear Safety Advisory Group. Safety Series No 75-INSAG-4, IAEA, Vienna.

Idaszak, J.R., and Drasgow, F. (1987) A revision of the Job Diagnostic Survey: elimination of a measurement artifact. *Journal of Applied Psychology*, **72**, 69-74.

Isla Díaz, R., and Díaz Cabrera, D. (1997) Safety climate and attitude as evaluation measures of organizational safety. *Accident Analysis and Prevention*, **29**, 643-650.

Iverson, R.D., and Erwin, P.J. (1997) Predicting occupational injury: The role of affectivity. *Journal of Occupational and Organizational Psychology*, **70**, 113-128.

Jackson, P.R., Wall, T.D., Martin, R., and Davids, K. (1993) New measures of job control, cognitive demand, and production responsibility. *Journal of Applied Psychology*, **78**, 753-762.

James, L. (1982) Aggregation bias in estimates of perceptual agreement. *Journal of Applied Psychology*, **76,** 214-224.

James, L., and Jones. A. (1974) Organizational climate: A review of theory and research. *Psychological Bulletin*, **18**, 1096-1112.

Janssens, M., Brett, J.M. and Smith, F.J. (1995) Confirmatory cross-cultural research: testing the validity of a corporation-wide safety policy. *Academy of Management Journal*, **38(2)**, 364-382.

Jelineck, M., Smircich, L., and Hirsch, P. (1983) Introduction: a code of many colors. *Administrative Science Quarterly*, **28**, 331-338.

Joyce, W.F., and Slocum, J.W. (1979) Organizational climate: A review of theory and research. *Psychological Bulletin*, **81**: 1096-1112.

Kennedy, R., and Kirwan, B. (1995) The failure mechanisms of safety culture. In A. Carnino and G. Weimann (eds) *Proceeding of the International Topical Meeting on Safety Culture in Nuclear Installations.* Vienna, Nuclear Society of Austria.

Keppel, G., Saufley, W.H., and Tokunaga, H. (1992) *Introduction to Design and Analysis (2nd ed.).* New York: W.H. Freeman and Co.

Kidder, L.H., Judd, C.M., and Smith, E.R. (1986) *Research Methods in Social Relations (5th ed.).* New York: Holt, Rinehart and Winston.

Kilmann, R.H., and Saxton, M.J. (1983) *The Kilmann-Saxton Culture-Gap Survey.* Pittsburg, PA: Organisational Design Consultants.

Kilmann, R.H., Saxton, M.J., and Serpa, R. (1985) *Gaining Control of the Corporate Culture.* San Francisco: Jossey-Bass.

Kim, J., and Mueller, C.W. (1994) Factor analysis: statistical methods and practical issues. In M.S. Lewis-Beck (ed) *Factor Analysis and Related Techniques.* London: Sage.

Klein, R.L., Bigley, G.A., and Roberts, K.H. (1995) Organisational Culture in High Reliability Organisations: An Extension. *Human Relations*, **48**, 771-793

Kline, P. (1994) *An Easy Guide to Factor Analysis.* London: Routledge.

Kopleman, R.E., Brief, A.P., and Guzzo, R.A. (1990) The role of climate in productivity. In B. Schneider (ed.), *Organizational Climate and Culture.* San Francisco: Jossey-Bass, 282-318.

Krause, T.R. (1994) Continuous safety progress focuses on 'upstream' factors in analyses. *Occupational Health and Safety*, **63**, 81.

Kroeber, A.I., and Kluckhohn, C. (1952) *Culture: A critical review of concepts and definitions.* New York: Vintage Books.

La Porte, T. (1996) High reliability organisations: unlikely, demanding and at risk. *Journal of Contingencies and Crisis Management,* **4**, 60-71.

Leather, P.J. (1987) Safety and accidents in the construction industry: a work design perspective. *Work and Stress*, **1**, 167-174.

Lee, T.R. (1993) Psychological aspects of safety in the nuclear industry. Paper presented at *The Second Offshore Installation Management Conference: Managing Offshore Safety*, The Robert Gordon University, 29 April, Aberdeen.

Lee, T.R. (1995). The role of attitudes in the safety culture and how to change them. Paper presented at *Understanding Risk Perception Conference,* The Robert Gordon University, 2 February, Aberdeen.

Lee, T.R. (1997) How can we monitor the safety culture and improve it when necessary? Paper presented at the *International Conference on Safety Culture in the Energy Industries*, University of Aberdeen, September, Aberdeen.

Lee, T.R. (1998) Assessment of safety culture at a nuclear reprocessing plant, *Work and Stress*, **12**, 217-237.

Lewin, K. (1946) Action research and minority problems. *Journal of Social Issues*, **2**, 34-64.

Lewin, K. (1951) *Field theory in social science.* New York: Harper and Row.

Lewin, K., Lippit, R., and White, R. (1939) Patterns of aggressive behavior in experimentally created social climates. *Journal of Social Psychology.* 10: 271-299.

Likert, R. (1932) *A Technique for the Measurement of Attitudes.* New York: Columbia University Press.

Likert, R.L. (1961) *New patterns of management.* New York: McGraw-Hill.

Linn, R.L. (1968) A Monte Carlo approach to the number of factors problems. *Psychometrika*, **33**, 37-71.

Little, T.D. (1997) Mean and covariance structures (MACS) analyses of cross-cultural data: Practical and theoretical issues. *Multivariate Behavioural Research*, **32(1)**, 53-76.

Litwin, C., and Stringer, R. (1968) *Motivation* and *organisational climate.* Cambridge, MA: Harvard University Press.

Long, J.S. (1993) *Confirmatory Factor Analysis.* Beverly Hills, CA: Sage University Paper 33

Louis, M.R. (1983) Organizations as culture-bearing milieux. In L.R. Pondy, P.J. Frost, G. Morgan, & I.C. Dandridge (Eds.), *Organizational symbolism.* Greenwich, CT: JAI Press.

MacCallum, R.C. (1995) Model specification. In R H Hoyle (Ed.) *Structural Equation Modeling: Concepts, Issues and Applications.* Thousand Oaks, CA: Sage.

MacCallum, R.C., Roznowski, M., and Necowitz, L.B. (1992) Model modifications in covariance structure analysis: the problem of capitalization on chance. *Psychological Bulletin*, **111**, 490-504.

McGaw, B. and Jöreskog, K.G. (1971). Factorial invariance of ability measures in groups differing in intelligence and socioeconomic status. *British Journal of Mathematical and Statistical Psychology, 24,* 154-168.

Marsh, H.W., Balla, J R., and Hau, K. (1996) An evaluation of incremental fit indices: A clarification of mathematical and empirical properties. In G. A. Marcoulides and R. E. Schumacker (eds.), *Advanced structural equation modeling: Issues and techniques*. Mahwah, New Jersey: LEA.

Marsh, H.W., Balla, J.R., and McDonald, R.P. (1988) Goodness-of-fit indices in confirmatory factor analysis: The effect of sample size. *Psychological Bulletin,* **102**, 391-410.

Martin, J., and Siehl, C. (1983) Organizational culture and counterculture: An uneasy symbiosis. *Organizational Dynamics,* **12(2):** 52-64.

Martin, J., Sitkin, S., and Boehm, M. (1985) Founders and the elusiveness of a cultural legacy. In P. Frost, L. Moore, M. Louis, C. Lundberg, and J. Martin (eds.). *Organizational culture.* Beverly Hills, CA: Sage.

Maruyama, G.M. (1988) *Basics of Structural Equation Modeling*. Thousand Oaks, CA: Sage.

Mayo, E. (1933) *The Human Problems of Industrial Civilisation.* New York: Macmillan

Mearns, K.J., and Flin, R. (1999) Assessing the state of organizational safety – culture or climate? *Current Psychology*, **18**, 5-17.

Mearns, K., Flin, R., Fleming, M. and Gordon, R. (1997) Measuring safety climate in offshore installations. Paper presented at the *Safety Culture in the Energy Industries Conference*, University of Aberdeen, September.

Mearns, K., Flin, R., Gordon, R., and Fleming, M. (1998) Measuring safety climate in offshore installations. *Work and Stress*, **12**, 238-254.

Merry, M. (1998) Assessing the safety culture of an organization. *Nuclear Europe Worldscan*, **3-4**, 52-53.

Meyerson, D. (1991) Acknowledging and uncovering ambiguities. In P. Frost, L. Moore, M. Louis, C. Lundberg, and J. Martin (eds.), *Reframing Organizational Culture*. Beverly Hills, CA: Sage.

Ministerial Statement on the Sixewell B nuclear power station (1987) *Atom*, **367**, 36.

Moorhead, G., and Griffin, R.W. (1995) *Organizational Behavior (4th ed.)*. Boston: Houghton Mifflin Company.

Moran, E.T., and Volkwein, J.F. (1992) The cultural approach to the formation of organizational climate. *Human* Relations, **45**, 19-47.

Morgan, D.L. (1988) *Focus Groups as Qualitative Research*. London: Sage.

Morgan, G. (1986) *Images of Organization*. Beverly Hills: Sage.

Münch, R., and Smelster N.J. (1992) *Theory of Culture*. Berkeley: University of California Press.

Muthen, B., and Kaplan, D. (1985) A comparison of some methodologies for the factor analysis of non-normal Likert variables. *British Journal of Mathematical and Statistical Psychology*, **42**, 241-250.

Neal, A., and Griffin, M.A. (1988) *The impact of organizational climate on safety climate and individual behavior*. Paper presented at the International Association of Applied Psychology Congress, San Francisco, August.

Nichols, R. (1975) The sociology of accidents and the social production of injury. In G. Esland, G. Salaman and M.A. Speakman (eds) *People and Work*. Milton Keynes: The Open University Press.

Niedenthal, P.M., and Cantor, N. (1986) Affective responses as guides to category-based inferences. *Motivation and Emotion*, **10**, 217-232.

Niskanen, T. (1994) Safety climate in the road administration. *Safety Science*, **17**, 237-255.

Nunally, J. (1978) *Psychometric Theory*. New York: McGraw-Hill.

O'Reilly, C., Chatman, J., and Caldwell, D. (1991) People and organizational culture: a profile comparison approach to assessing person-environment fit. *Academy of Management Journal*, **34**, 487-516.

Oliver, A., Tomás, J.M., Hontangas, P.M., Cheyne, A., and Cox, S. (1999) Effectos del error de medida aleatorio en modelos de ecuaciones estructurales con y sin variables latentes [The effects of random measurement error on structural equation models with observed variables and models with latent variables]. *Psicológica*, **20**, 41-55.

Oppenheim, A.N. (1992) *Questionnaire Design, Interviewing and Attitude Measurement.* London: Pinter.

Ostrom, L., Wilhelmsen, C., and Kaplan, B. (1993) Assessing safety culture. *Nuclear Safety*, 34(2): 163-172.

Ott, J.S. (1989) *The Organizational Culture Perspective.* Chicago: Dorsey Press.

Ouchi, W.G. (1981) *Theory Z: How American business can meet the Japanese challenge.* Reading, MA: Addison-Wesley.

Parker, M. (1992) Post-modern organizations or postmodern organization theory? *Organizational Studies,* 12:1-17.

Pedhazur, E.J., and Schmelkin, L.P. (1991) *Measurement, design and analysis: An integrated approach.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Peters, T.J., and Waterman, R.H. (1982) *In Search of Excellence: Lessons from America's Best Run Companies.* New York: Harper and Row.

Pettigrew, A. (1979) On studying organizational cultures. *Administrative* Science *Quarterly*. **24**, 570-S81.

Pettigrew, A. (1990) Organizational climate and culture: Two constructs in search of a role. In B. Schneider (Rd.). *Organizational climate and culture.* 413-433. San Francisco: Jossey-Bass.

Petty, M.M., Beadles, N.A., Lowery, C.M, Chapman, D.F., and Connell, D.W. (1995) Relationships between organizational culture and organizational performance. *Psychological Reports*, **76**, 483-492.

Pidgeon, N. F. (1991) Safety culture and risk management in organizations. *Journal of Cross-Cultural Psychology*, **22**, 129-140.

Pidgeon, N. F. (1998) Safety culture: key theoretical issues. *Work and Stress*, **12**, 202-216.

Price, J.L. and Meuller, C.W. (1986) *Handbook of Organizational Measurement.* Marshfield, MA: Pitman Publishing.

Rajecki, D.W. (1990) *Attitudes*. Sunderland, MA: Sinauer Associates.

Reason, J. (1997) *Managing the Risks of Organizational Accidents*. Aldershot: Ashgate.

Reason, J (1998) Achieving a safety culture: theory and practice. *Work and Stress*, **12**, 293-306.

Reichers, A. E., and Schneider, B. (1990). Climate and Culture: An evolution of constructs. In B. Schneider, (ed.). *Organisational Climate and Culture*, San Francisco: Jossey-Bass.

Remenyi, D., Williams, B., Money, A., and Swartz, E. (1998) *Doing Research in Business and Management*. London: Sage.

Roberts, K. (1993) Some aspects of organisational cultures and strategies to manage them in reliability enhancing organisations. *Journal of Managerial Issues,* **5**, 165-181.

Robey, D. (1991) *Designing Organisations (3rd ed)*, Homewood, IL:Irwin

Rochlin, G.I., and von Meyer, A. (1994) Nuclear power operations: a cross-cultural perspective. *Annual Review of Energy and Environment*, **19**, 153-187.

Roethlisberger, F.J. and Dixon, W.J (1939) *Management and the Worker*, Cambridge, MA: Harvard University Press.

Rohner, R.P. (1984). Towards a conception of culture for cross-cultural psychology. *Journal of Cross-Cultural Psychology*, **15,** 111-138.

Rosenberg, M.J., and Hovland, C.I. (1960) Cognitive, affective and behavioural components of attitudes, in M.J. Rosenberg, C.I. Hovland, W.J. McGuire, R.P. Abelson and J.W. Brehm (eds), *Attitude Organization and Change: An Analysis of Consistency Among Components*. New Haven, Conn: Yale University Press.

Rousseau, D.M. (1988) The construction of climate in organizational research. In C. Cooper and I. Robertson (eds) *International Review of Industrial and Organizational Psychology 1988*. London: Wiley and Sons.

Rousseau, D.M. (1990) Assessing organizational culture: the case for multiple methods. In B. Schneider (ed.), *Organizational Climate and Culture*. San Francisco: Jossey-Bass.

Rummel, R.J. (1970) *Applied Factor Analysis*. Evanston: Northwestern University Press.

Rundmo, T. (1992) Risk perception and safety on offshore petroleum platforms. *Safety Science*, **15**, 39-68.

Ryan, A.M., and Schmitt, M.J. (1996) An assessment of organizational climate and P-E fit: a tool for organizational change, *International Journal of Organizational Analysis*, **4**, 75-95.

Rycraft, H.S. (1997) Developing a safety culture in a changing organisation. *International Conference on Safety Culture in the Energy Industries*, Aberdeen, September.

Sagan, S. (1993) *The Limits of Safety: Organisations, Accidents and Nuclear Weapons*. Princeton: Princeton University Press.

Sashkin, M., and Fulmer, R. (1985) *Measuring organizational excellence culture with a validated questionnaire.* Paper presented at the August meeting of the Academy of Management, San Diego, CA.

Schein, E.H. (1984) Coming to a new awareness of organizational culture. *Sloan Management Review*, **25**, 3-16.

Schein, E.H. (1985) *Organizational Culture and Leadership.* San Francisco: Jossey-Bass.

Schein, E.H. (1999) *The Corporate Culture Survival Guide.* San Francisco: Jossey-Bass.

Schneider, B. (1987) The people make the place. *Personnel Psychology*, **40**, 437-453.

Schneider, B. (1990) *Organisational Climate and Culture*, San Francisco: Jossey-Bass.

Schriesheim, C.A., and Hill, K. (1981) Controlling acquiescence response bias by item reversal: the effect on questionnaire validity. *Educational and Psychological Measurement*, **41**, 1101-1114.

Schriesheim, C.A., and Hinkin, T.R. (1990) Influence tactics used by subordinates: a theoretical and empirical analysis and refinement of the Kipnis, Schmidt and Wilkinson Subscales. *Journal of Applied Psychology*, **75**, 246-257.

Schriesheim, C.A., Powers, K.J., Scandura, T.A., Gardiner, C.C., and Lankau, M.J. (1993) Improving construct measurement in management research: Comments and a quantitative approach for assessing the theoretical content adequacy of paper-and-pencil survey-type instruments. *Journal of Management*, **19**, 385-417.

Sekaran, U. (1992) *Research Methods for Business: A Skill Building Approach (2nd ed.)*. New York: Wiley

Siehl, C., and Martin, J. (1990) Organizational culture: the key to financial performance? In B. Schneider (Ed.), *Organizational Climate and Culture*. San Francisco: Jossey-Bass.

Simard, M., and Marchand, A. (1994) The behaviour of first-line supervisors in accident prevention and effectiveness in occupational safety. *Safety Science*, **17**, 169-185.

Shipley, P. (1990) The analysis of organisations as a conceptual tool for ergonomics practitioners. In J.R. Wilson and E.N. Corlett (eds) *Evaluation of Human Work*. London: Taylor and Francis.

Smircich, L. (1983) Concepts of culture and organizational analysis. *Administrative Science Quarterly*, **28**, 339-358.

Smith, D. (1995) High reliability organisations: Exploring the cultural dynamics. *Human Factors in the Process Industries*, Manchester, 20-21 November.

Snyder, M., and Kendzierski, D. (1982) Acting on one's attitudes: Procedures for linking attitude and behavior. *Journal of Experimental Social Psychology*, **18**, 165-183.

Statement on Rail Safety by Lord Macdonald of Tradeston (1999, October 11) *House of Lords Hansard*. Retrieved December 15, 1999 from the World Wide Web: http://www.parliament.the-stationery-office.co.uk/pa/ld199697/ldhansrd/pdvn/lds99/text/91011-04.htm#91011-04_state0

Steiger, J.H. (1990) Structural model evaluation and modification: An interval estimation approach. *Multivariate Behavioral Research*, 25, 173-180.

Steiger, J.H., and Lind, J.C. (1980) *Statistically based tests for the number of common factors*. Presentation at the meeting of the Psychometric Society, Iowa City, IA.

Stevens, J., (1986) *Applied multivariate statistics for the social sciences.* Hillsdale, NJ: Erlbaum.

Stone, E. (1978) *Research Methods in Organizational Behavior.* Glenview, IL: Scott, Foresman.

Swartz, M., and Jordon, D. (1980) *Culture: an anthropological perspective.* New York: Wiley.

Tabachnik, B.G., and Fidell, L.S: (1989) *Using multivariate statistics.* New York: Harper Collins Pub.

Tagiuri, R. (1968) The concept of organizational climate. In R. Tagiuri and G. Litwin, (eds.). *Organizational climate: Exploration, of a concept.* Boston: Harvard Business School.

Tanaka, J. S. (1993). Multifaceted conceptions of fit in structural equation models. In K. A. Bollen and J. S. Long (eds.), *Testing structural equation models.* Newbury Park, CA: Sage.

Thom, G. (1997) SHAPE - The future of safety in the North Sea. *International Conference on Safety Culture in the Energy Industries*, Aberdeen, September

Toft, B., and Reynolds, S. (1994) Learning from Disasters: A Management Approach, Oxford: Butterworth-Heinemann.

Tomás, J.M., and Oliver, A. (1995) The perceived effect of safety climate on occupational accidents. *Work and Well-being: An Agenda for Europe Conference*, Nottingham, 7-9 December.

Trice, H.M., and Beyer, J.M. (1984) Studying organizational cultures through rites and ceremonials. *Academy of Management Review*, **9**, 653-669.

Trice, H.M., and Beyer, J.M. (1993) *The Culture of Work Organizations.* Englewood Cliffs, NJ: Prentice Hall

Trompenaars, F., and Hampden-Turner, C. (1997) *Riding the Waves of Culture: Understanding Cultural Diversity in Business.* London: Nicholas Brealey

Tucker, L.R, Koopman, R.F., and Linn, R.L. (1969) Estimation of factor analytic research procedures by means of simulated correlation matrices. *Psychometrika*, **34**, 421-459.

Turner, B.A. (1978) *Man-made Disasters*. London: Wykeham

Turner, B.A. (1991) The development of a safety culture. *Chemistry and Industry*, **1**, 241-243.

Turner, B.A., and Pidgeon N.F. (1997) *Man-made Disasters (2nd. ed)*. London: Butterworth-Heinemann.

Turner, B.A., Pidgeon, N.F., Blockley, D.I., and Toft, B. (1989) Safety culture: its position in future risk management. Paper to: *Second World Bank Workshop on Safety Control and Risk Management*, Karlstad, Sweden.

Uttal, B. (1983) The corporate culture vultures. *Fortune*, 17 October, 66-72.

Van Maanen, J., and Schein, E. (1979) Toward a theory of organizational socialization. *Research in Organizational Behavior,* **11**, 209-259.

Weick, K. (1985) The significance of corporate culture. In P. Frost, L. Moore, M. Louis, C. Lundberg, and J. Martin (eds.), *Organizational culture.* Beverly Hills, CA: Sage.

Weinfurt, K.P. (1995) Multivariate analysis of variance. In L. G. Grimm and P. R: Yarnold (Eds.), *Reading and understanding multivariate statistics.* Washington, DC: American Psychological Association.

Weir, D. (1991) Hazard management and transport. *ESRC Seminar Series on Institutional Design and Systems Failure*, London School of Economics.

Wicker, A.W. (1969) Attitudes versus actions: The relationship of verbal and overt behavioural responses to attitude objects. *Journal of Social Issues*, **25**, 41-78.

Williamson, A., Feyer, A., Cairns, D., and Biancotti, D. (1997) The development of a measure of safety climate: the role of safety perceptions and attitudes. *Safety Science,* **25**, 15-27.

Wunthow, R., and Witten, M. (1988) New directions in the study of culture. *Annual Review of Sociology*, **14**, 49-67.

Xenikou, A., and Furnham, A. (1996) A correlational and factor analytic study of four questionnaire measures of organizational culture. *Human Relations*, **49**, 349-371.

Zohar, D. (1980) Safety climate in industrial organisations: Theoretical and applied implications. *Journal of Applied Psychology*, **65**, 96-102.

Zohar, D. (2000) A group level model of safety climate: testing the effect of group climate on microaccidents in manufacturing jobs. *Journal of Applied Psychology*, **85**, 587-596.

Zwick, W., and Velicer, W. (1986) Comparison of five rules for determining the number of components to retain. *Psychological Bulletin*, **99**, 432-442.

APPENDIX 1

Organisation A Questionnaire

ATTITUDES TO SAFETY QUESTIONNAIRE

XXX is undertaking a number of initiatives aimed at raising health and safety standards. The company has asked Loughborough University to assist them in measuring the effectiveness of these at all levels in the company. To help us with this task we would like you to complete the following questionnaire.

Ther questionnaire is in four sections; section 1 considers the work environment, section 2 deals with the hazards you may encounter, section 3 asks about your attitudes to safety, and the final section deals with safety activities. Please try to answer all of these questions being as open and honest as you can. Do not put your name on the form.

Plant: ______________________
Department: ______________________
Manager/Supervisor/Employee/Safety Representative(please circle all that apply)
Date: ______________________

Section 1: Work Environment

Please circle the number representing the extent to which you agree with each statement about your work ing environment.

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
1. The light levels in my work place are adequate	1	2	3	4	5	6
2. The ventilation in my work place is adequate	1	2	3	4	5	6
3. Space allocated for doing tasks in my workplace is adequate	1	2	3	4	5	6
4. The humidity levels in my work place are adequate	1	2	3	4	5	6

Section 2: Work Hazards

We would like to know how you view the hazards which might be present when you do your job. In this section there are listed a number of hazards, please give a rating for each of the three columns on the right.

Hazards	Hazard is present 0= never 1= not often 2= sometimes 3= often	Consequences of the hazard 1= slight 2= moderate 3= severe	Existing prcautions and control measures are 1= adequate 2= inadequate
Slipping and tripping			
Objects falling onto personnel			
Workplace design and layout			
Working with hazardaous chemicals			
Working with irritant substances			
Actions leading to repetitive strain injuries.			
Explosion from hazardous/flammable gases			
Ultra violet light, lasers and/or radio frequencies			
Electrical hazards			
Use of sharp hand tools			
Entanglement and trapping in machinery			
Fire potential of combustible or flammable materials			
Use of compressed gas cylinders			
Operations of forklift trucks and similar vehicles			
Loading and unloading of vehicles			
Safe storage and stacking of goods			
Manual handling of heavy goods			
Compressed air hazards			
Failure of pressure vessels			
Contact with hot objects and surfaces			
Noise			
Working with visual display units			
Conditions leading to hand or body vibration			
Other (please describe)			

Section 3

Please circle the number representing the extent to which you agree with each statement.

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
1. Health and safety have a very high priority at XXX	1	2	3	4	5	6
2. Safety specific jobs always get done	1	2	3	4	5	6
3. My line manager listens to my concerns about health and safety	1	2	3	4	5	6
4. As long as there are no accidents unsafe behaviours are tolerated	1	2	3	4	5	6
5. I look out for the safety of my colleagues	1	2	3	4	5	6
6. The company makes an effort to prevent accidents happening	1	2	3	4	5	6
7. Safety issues are included in communications meetings	1	2	3	4	5	6
8. I have been shown how to do my job safely	1	2	3	4	5	6
9. Management are prepared to discipline workers who act unsafely	1	2	3	4	5	6
10. There are good communications here about safety issues which affect me	1	2	3	4	5	6

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
11. It is sometimes necessary to take unsafe shortcuts to get the work done	1	2	3	4	5	6
12. Relevant health and safety issues are communicated	1	2	3	4	5	6
13. Everyone plays an active role in safety matters	1	2	3	4	5	6
14. The safety training I receive is not detailed enough for my job	1	2	3	4	5	6
15. I am informed of the outcomes of health and safety meetings	1	2	3	4	5	6
16. Everyone on my site want to achieve the highest levels of safety performance	1	2	3	4	5	6
17. Levels of safety performance have improved here over the last two years	1	2	3	4	5	6
18. I can influence health and safety performance here	1	2	3	4	5	6
19. Only a few people who work here are involved in health and safety activities	1	2	3	4	5	6
20. Safety training has a high priority within XXX	1	2	3	4	5	6
21. Minor/trivial accidents are tolerated as part of the job	1	2	3	4	5	6

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
22. There is a process of continual safety improvement in the company	1	2	3	4	5	6
23. Management takes the lead on safety issues	1	2	3	4	5	6
24. What is learnt from accidents is used to improve safety trainning	1	2	3	4	5	6
25. Safe working is a condition of my employment here	1	2	3	4	5	6
26. On my site we have defined safety improvement objectives	1	2	3	4	5	6
27. Supervisors actively support safety	1	2	3	4	5	6
28. My colleagues and I help each other work safely	1	2	3	4	5	6
29. Accidents and incidents are always reported	1	2	3	4	5	6
30. The company is only interested in health and safety after an accident occurs	1	2	3	4	5	6

Section 4: Safety Activities

Please tick if you have taken part in any of the following activities (a) in the past 12 months, and (b) in the past 5 years at this unit.

Activity	In the past 12 months	In the past 5 years	Not appropriate for my job
Seen a safety video			
Helped with site open day			
Shown visitors around my job			
Taken part in job safety analysis			
Attended a safety committee meeting			
Discussed safety at crew briefing			
Taken part in safety promotion or competition			
Conducted a safety inspection or audit			
Took part in a risk assessment			
Organised a safety activity			
Attended a safety improvement meeting			
Raised a suggestion to improve safety			
Others (please list up to three):			

Do you have any other comments on health and safety issues in your workplace?

____

____

____

____

Thank you for completing this questionnaire.

APPENDIX 2

Organisation B Questionnaire

Memorandum - Note

Date	28 July 1997
To - A	All Employees
From - De	
Reference - Référence	
Subject - Objet	*DIVISIONAL SAFETY SURVEY 1997*

The Operations Board has asked Loughborough University to carry out an independent, impartial and confidential survey, as part of the annual safety audit.

To help with this task, please complete and return the enclosed questionnaire to your manager in the sealed envelope provided before 31 August. As you will see, confidentiality is assured, basic job information is only necessary to help interpret the results. Please take time to consider your response carefully. Try to answer all the questions being as open and honest as you can.

Completed questionnaires will be returned, unopened, to Loughborough University who will analyse the results. The results will be fed back to you on completion of the survey.

Thank you for your help and co-operation.

GENERAL MANAGER

DIVISIONAL SAFETY QUESTIONNAIRE

Unit: ______________________

Date: ______________________

Department: ______________________
(Production, please state whether Papermaking or Finishing)

Occupation: Manager / Supervisor / Employee / Safety Representative
(*Please delete those that do not apply)

Work Pattern: Shifts / Permanent Nights / Days
(*Please delete those that do not apply)

PLEASE DO NOT PUT YOUR NAME ON THIS FORM

Section 1: Work Environment

Please circle the number representing the extent to which you agree with each statement about your working environment.

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
1. The light levels in my work place are adequate	1	2	3	4	5	6
2. The ventilation in my work place is adequate	1	2	3	4	5	6
3. Space allocated for doing the task in my work place is adequate	1	2	3	4	5	6
4. The humidity levels in my work place are adequate	1	2	3	4	5	6

1

Section 2: Work Hazards

We would like to know how you view the hazards which might be present when you do your job. In this section there are listed a number of hazards, please give a rating for each of the three columns on the right.

Hazards	Hazard is present 0= never 1= not often 2= sometimes 3= often 4= N/A	Consequences of the hazard 1= slight 2= moderate 3= severe	Existing precautions and control measures are 1= adequate 2= inadequate
Slipping and tripping			
Objects falling onto personnel			
Workplace design and layout			
Working with hazardous chemicals			
Working with irritant substances			
Actions leading to repetitive strain injuries.			
Explosion from hazardous/flammable gases			
Ultra violet light, lasers and/or radio frequencies			
Electrical hazards			
Use of sharp hand tools			
Entanglement and trapping in machinery			
Fire potential of combustible or flammable materials			
Use of compressed gas cylinders			
Operations of forklift trucks and similar vehicles			
Loading and unloading of vehicles			
Safe storage and stacking of goods			
Manual handling of heavy goods			
Compressed air hazards			
Failure of pressure vessels			
Contact with hot objects and surfaces			
Noise			
Working with visual display units			
Conditions leading to hand or body vibration			
Other (please describe)			

2

Section 3: Safety Attitudes

Please circle the number representing the extent to which you agree with each statement.

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
1. Health and safety have a very high priority here	1	2	3	4	5	6
2. Safety specific jobs always get done	1	2	3	4	5	6
3. My line manager listens to my concerns about health and safety	1	2	3	4	5	6
4. As long as there are no accidents unsafe behaviours are tolerated	1	2	3	4	5	6
5. I look out for the safety of my colleagues	1	2	3	4	5	6
6. The company makes an effort to prevent accidents happening	1	2	3	4	5	6
7. Safety issues are included in communications meetings	1	2	3	4	5	6
8. I have been shown how to do my job safely	1	2	3	4	5	6
9. Management are prepared to discipline workers who act unsafely	1	2	3	4	5	6
10. There are good communications here about safety issues which affect me	1	2	3	4	5	6

3

Section 3: Safety Attitudes

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
11. It is sometimes necessary to take unsafe shortcuts to get the work done	1	2	3	4	5	6
12. Relevant health and safety issues are communicated	1	2	3	4	5	6
13. Everyone plays an active role in safety matters	1	2	3	4	5	6
14. The safety training I receive is not detailed enough for my job	1	2	3	4	5	6
15. I am informed of the outcomes of health and safety meetings	1	2	3	4	5	6
16. People on my site want to achieve the highest levels of safety performance	1	2	3	4	5	6
17. Levels of safety performance have improved here over the last two years	1	2	3	4	5	6
18. I can influence health and safety performance here	1	2	3	4	5	6
19. Only a few people who work here are involved in health and safety activities	1	2	3	4	5	6
20. Safety training has a high priority here	1	2	3	4	5	6
21. Minor/trivial accidents are tolerated as part of the job	1	2	3	4	5	6

4

Section 3: Safety Attitudes

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
22. There is a process of continual safety improvement in the company	1	2	3	4	5	6
23. Management takes the lead on safety issues	1	2	3	4	5	6
24. What is learnt from accidents is used to improve safety training	1	2	3	4	5	6
25. Safe working is a condition of my employment here	1	2	3	4	5	6
26. On my site we have defined safety improvement objectives	1	2	3	4	5	6
27. Supervisors actively support safety	1	2	3	4	5	6
28. My colleagues and I help each other work safely	1	2	3	4	5	6
29. Accidents and incidents are always reported	1	2	3	4	5	6
30. The company is only interested in health and safety after an accident occurs	1	2	3	4	5	6
31. All safe systems are up to date	1	2	3	4	5	6

5

Section 4: Safety Activities

Please tick if you have taken part in any of the following activities (a) in the past 12 months, and (b) in the past 5 years at this unit.

Activity	In the past 12 months	In the past 5 years	Not appropriate for my job
Seen a safety video			
Helped with site open day			
Shown visitors around my job			
Taken part in job safety analysis			
Attended a safety committee meeting			
Discussed safety at crew briefing			
Taken part in safety promotion or competition			
Conducted a safety inspection or audit			
Took part in a risk assessment			
Organised a safety activity			
Attended a safety improvement meeting			
Raised a suggestion to improve safety			
Others (please describe):			

Do you have any other comments on health and safety issues in your workplace?

Thank you for completing this questionnaire.

6

APPENDIX 3

Organisation B French Questionnaire

QUESTIONNAIRE CONCERNANAT LA SECURITE

Unité: ______________________

Date: ______________________

Service: ______________________
(Production, indiquez Fabrication du papier ou Finition)

Fonction: *Directeur / Superviseur / employé / représentant Sécurité
(*Barrez les mentions inutiles)

Horaire de travail: *Travail par équipes / Equipes de nuit / Travail de jour
(*Barrez les mentions inutiles)

N'INSCRIVEZ PAS VOTRE NOM SUR LE FORMULAIRE

Section 1: L'Environnement de Travail

Veuillez entourer d'un cercle le numéro indiquant dans quelle mesure vous êtes d'accord avec l'énoncé indiqué à gauche.

	Absolument pas d'accord	Pas d'accord	Ne suis ni en accord, ni en désaccord	D'accord	Tout à fait d'accord	Je ne comprends pas l'énoncé de la question
1. A mon poste de travail, les niveaux de lumière sont adéquats	1	2	3	4	5	6
2. A mon poste de travail, la ventilation est adéquate	1	2	3	4	5	6
3. A mon poste de travail, je dispose de suffisamment de place pour effectuer ma tâche	1	2	3	4	5	6
4. A mon poste de travail, les niveaux d'humidité sont adéquats	1	2	3	4	5	6

1

Section 2: Risques dans le Cadre du Travail

Nous souhaiterions avoir votre opinion au sujet des risques susceptibles d'être présents au moment où vous effectuez votre travail. Dans cette section, nous dressons la liste d'un certain nombre de risques: veuillez donner une évaluation dans chacune des trois colonnes de droite.

Hazards	Risque est présent 0= jamais 1= pas souvent 2= quelquefois 3= souvent 4= ne s'applique pas	Conséquences du risque 1= légères 2= modérées 3= graves	Les précautions existantes et les mesures de contrôle sont 1= adéquates 2 = inadéquates
Chute due à des surfaces glissantes ou à un faux pas			
Objets tombant sur le personnel			
Conception et aménagement du poste de travail			
Manipulation de produits chimiques dangereux			
Manipulation de substances irritantes			
Actions aboutissant à des blessures dues à des efforts répétés			
Explosion due aux gaz dangereux/inflammables			
Lumière ultraviolette, lasers et/ou radiofréquence			
Risques électriques			
Utilisation d'outils manuels tranchants			
Risque d'être pris, ou happé, dans la machine			
Risque d'incendie dû à des matières combustibles ou inflammables			
Utilisation de cylindres à gaz comprimé			
Manœuvres de chariots élévateurs à fourches et véhicules similaires			
Chargement et déchargement de véhicules			
Entreposage et empilement de marchandises en toute sécurité			
Manutention de marchandises lourdes			
Risques liés à l'air comprimé			
Défaillance de récipients sous pression			
Contact avec des surfaces et des objets chauds			
Bruit			
Travail avec des écrans de visualisation			
Condition provoquant des vibrations au niveau des mains ou du corps			
Autres (précisez)			

2

Section 3: Attitudes vis à vis la Securité

Veuillez entourer d'un cercle le numéro indiquant dans quelle mesure vous êtes d'accord avec l'énoncé indiqué à gauche.

	Absolument pas d'accord	Pas d'accord	Ne suis ni en accord, ni en désaccord	D'accord	Tout à fait d'accord	Je ne comprends pas l'énoncé de la question
1. Ici, les aspects santé et sécurité ont un degré de priorité élevé	1	2	3	4	5	6
2. Les travaux, concernant spécifiquement la sécurité, sont toujours effectués	1	2	3	4	5	
3. Mon supérieur est attentif à mes inquiétudes concernant la santé et la sécurité	1	2	3	4	5	6
4. Tant qu'il n'y a pas d'accidents, on va tolérer des pratiques peu sûres	1	2	3	4	5	6
5. Je fais attention à la sécurité de mes collègues	1	2	3	4	5	6
6. L'entreprise fait un effort pour empêcher que les accidents ne se produisent	1	2	3	4	5	6
7. Les questions de sécurité font partie des réunions de consultation	1	2	3	4	5	6
8. On m'a montré comment faire mon travail en toute sécurité	1	2	3	4	5	6
9. La Direction est prête à prendre des mesures disciplinaires à l'encontre des personnels ne respectant pas les mesures de sécurité	1	2	3	4	5	6
10. Il existe de bonnes communications, ici, au sujet des questions de sécurité qui me concernent directement	1	2	3	4	5	6

3

Section 3: Attitudes vis à vis la Securité

	Absolument pas d'accord	Pas d'accord	Ne suis ni en accord, ni en désaccord	D'accord	Tout à fait d'accord	Je ne comprends pas l'énoncé de la question
11. Il est quelquefois nécessaire de passer par des procédures peu sûres pour effectuer le travail	1	2	3	4	5	6
12. Les aspects pertinents concernant la santé et la sécurité sont communiqués au personnel	1	2	3	4	5	6
13. Chacun joue un rôle actif dans les questions relatives à la sécurité	1	2	3	4	5	6
14. La formation en matière de sécurité que je reçois n'est pas suffisamment détaillée pour mon travail	1	2	3	4	5	6
15. On m'informe des décisions prises lors des réunions portant sur la santé et la sécurité	1	2	3	4	5	6
16. Ici, les gens veulent parvenir aux niveaux de performance en matière de sécurité les plus élevés	1	2	3	4	5	6
17. Ici, les niveaux de performance concernant la sécurité se sont améliorés au cours de ces deux dernières années	1	2	3	4	5	6
18. J'ai la possibilité d'influencer la performance concernant les questions de santé et de sécurité	1	2	3	4	5	6
19. Seules quelques personnes travaillant ici sont impliquées dans les activités relatives à la santé et à la sécurité	1	2	3	4	5	6
20. Ici, la formation en matière de sécurité a un degré de priorité élevé	1	2	3	4	5	6
21. On tolère les petits accidents comme faisant partie du travail	1	2	3	4	5	6

4

Section 3: Attitudes vis à vis la Securité

	Absolument pas d'accord	Pas d'accord	Ne suis ni en accord, ni en désaccord	D'accord	Tout à fait d'accord	Je ne comprends pas l'énoncé de la question
22. Au sein de l'entreprise, il existe un processus d'amélioration constante de la sécurité	1	2	3	4	5	6
23. La Direction prend l'initiative en ce qui concerne les questions relatives à la sécurité	1	2	3	4	5	6
24. Les enseignements que l'on peut tirer des accidents servent à améliorer la formation en matière de sécurité	1	2	3	4	5	6
25. Une méthode de travail sûre est l'une des conditions de mon emploi, ici	1	2	3	4	5	6
26. Sur mon lieu de travail, nous avons défini des objectifs permettant d'améliorer la sécurité	1	2	3	4	5	6
27. Les superviseurs apportent un soutien actif aux questions de sécurité	1	2	3	4	5	6
28. Mes collègues et moi, nous nous aidons mutuellement à travailler en toute sécurité	1	2	3	4	5	6
29. Les accidents et incidents sont toujours signalés	1	2	3	4	5	6
30. L'entreprise s'intéresse uniquement aux aspects santé et sécurité, une fois qu'un accident s'est produit	1	2	3	4	5	6
31. Tous les systèmes de sécurité sont à jour	1	2	3	4	5	6

5

Section 4: Activités Relatives à la Sécurité

Veuillez cocher, si, dans le cadre de votre unité, vous avez participé à l'une des activités suivantes (a) au cours des 12 derniers mois, et (b) au cours des 5 dernières années.

Activité	Au cours des 12 derniers mois	Au cours des 5 dernières années	Ne s'applique pas à mon travail
Vu une vidéo concernant la sécurité			
Participé à la Journée Portes Ouvertes de l'entreprise			
Montré mon travail à des visiteurs			
Participé à une analyse de la sécurité du travail			
Participé à une réunion du comité chargé de la sécurité			
Discuté de la sécurité lors d'une réunion de l'équipe			
Participé à un concours ou une promotion concernant la sécurité			
Réalisé un audit ou une inspection concernant la sécurité			
Participé à une évaluation des risques			
Organisé une activité de sécurité			
Participé à une réunion relative à l'amélioration de la sécurité			
Soumis une suggestion visant à améliorer la sécurité			
Autres (indiquez):			

Avez-vous des autres commentaires à faire sur la santé et la sécurité?

____

____

____

____

____

____

____

Merci d'avoir répondu à ce questionnaire.

6

APPENDIX 4

Organisation C Questionnaire

ATTITUDES TO SAFETY QUESTIONNAIRE

XXX is undertaking a number of initiatives aimed at raising health and safety standards. Loughborough University is assisting with the development and with the measurement of the effectiveness of these at all levels in the company. To help us with this task, we would like you to complete the following questionnaire. The information you provide will be kept completely confidential.

The questionnaire is in four sections: Section 1 considers the work environment, Section 2 deals with the hazards you may encounter, Section 3 asks about your attitude to safety and the final section deals with safety activities. Please try to answer all of these questions, being as open and honest as you can. **Do not put your name on the form.**

Site: ____________________

Department: ____________________

Manager Supervisor Employee (Please circle all that apply)

Date: ____________________

Section 1: Work Environment

Please circle the number representing the extent to which you agree with each statement about your working environment

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
1. The light levels in my workplace are adequate	1	2	3	4	5	6
2. The ventilation in my workplace is adequate	1	2	3	4	5	6
3. The space requirements for doing the tasks in my workplace are adequate	1	2	3	4	5	6
4. The humidity levels in my workplace are adequate	1	2	3	4	5	6

Section 2: Work Hazards

We would like to know how you view the hazards which might be present when you do your job. In this section there are listed a number of hazards. Please give a rating for each of the three columns on the right.

Hazards	Hazard is present 0 = Never 1 = Not often 2 = Sometimes 3 = Often	Consequences of the hazard 1 = Slight 2 = Moderate 3 = Severe	Existing precautions and control measures are 1 = Adequate 2 = Inadequate
1. Slipping and tripping			
2. Objects falling onto personnel			
3. Problems with workplace design and layout			
4. Working with hazardous chemicals			
5. Working with irritant substances			
6. Actions leading to repetitive strain injuries			
7. Explosion from hazardous/flammable gases			
8. Ultra-violet light, lasers and/or radio frequencies			
9. Electrical hazards			
10. Use of sharp hand tools			
11. Entanglement and trapping in machinery			
12. Fire potential of combustible or flammable materials			
13. Use of compressed gas cylinders			
14. Mobile plant operation on site			
15. Loading and unloading of vehicles			
16. Safe storage and stacking of goods			
17. Manual handling of heavy goods			
18. Compressed air hazards			
19. Failure of pressure vessels			
20. Contact with hot objects and surfaces			
21. Noise			
22. Working with visual display units			
23. Conditions leading to hand or body vibration			
24. Others (Please describe)			
25.			

Section 3 Safety Attitudes

Please circle the number representing the extent to which you agree with each statement. Or circle 6 if you do not understand the statement

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
1. Health and safety have a high priority at (this site)	1	2	3	4	5	6
2. Safety specific jobs always get done	1	2	3	4	5	6
3. My line manager listens to my concerns about health and safety	1	2	3	4	5	6
4. As long as there are no accidents unsafe behaviours are tolerated	1	2	3	4	5	6
5. I look out for the safety of my colleagues	1	2	3	4	5	6
6. The company makes an effort to prevent accidents happening	1	2	3	4	5	6
7. Safety issues are included in communications meetings	1	2	3	4	5	6
8. I have been shown how to do my job safely	1	2	3	4	5	6
9. Management are prepared to discipline workers who act unsafely	1	2	3	4	5	6
10. There are good communications here about safety issues which affect me	1	2	3	4	5	6
11. It is sometimes necessary to take unsafe shortcuts to get the work done	1	2	3	4	5	6
12. Relevant health and safety issues are communicated	1	2	3	4	5	6
13. Everyone plays an active role in safety matters	1	2	3	4	5	6
14. The safety training I receive is not detailed enough for my job	1	2	3	4	5	6
15. I am informed of the outcomes of health and safety meetings	1	2	3	4	5	6
16. People on my site want to achieve the highest levels of safety performance	1	2	3	4	5	6
17. Levels of safety performance have improved here over the last two years	1	2	3	4	5	6
18. I can influence health and safety performance here	1	2	3	4	5	6
19. Only a few people who work here are involved in health and safety activities	1	2	3	4	5	6
20. Safety training has a high priority within (this site)	1	2	3	4	5	6
21. Minor or trivial accidents are tolerated as part of the job	1	2	3	4	5	6

3

	I strongly disagree	I disagree	I neither agree nor disagree	I agree	I strongly agree	I do not understand the statement
22. There is a process of continual safety improvement in the company	1	2	3	4	5	6
23. Management takes the lead on safety issues	1	2	3	4	5	6
24. Safe working is a condition of my employment here	1	2	3	4	5	6
25. On my site we have defined safety improvement objectives	1	2	3	4	5	6
26. Supervisors actively support safety	1	2	3	4	5	6
27. My colleagues and I help each other to keep safe	1	2	3	4	5	6
28. Accidents and incidents are always reported at this site	1	2	3	4	5	6
29. The company is only interested in health and safety after an accident occurs	1	2	3	4	5	6

Section 4: Safety Activities

Please tick if you have taken part in any of the following activities (a) In the past 12 months, (b) in the past 5 years or (c) Never at SSS. Alternatively, indicate if the activity s not appropriate for your job

Activity	In the past 12 months	In the past 5 years	Never	Not appropriate for my job
1. Seen a safety video				
2. Attended a safety training course				
3. Participated in an accident investigation				
4. Helped to develop a safety procedure				
5. Attended a safety committee meeting				
6. Discussed safety at a crew briefing				
7. Took part in a safety inspection or audit				
8. Took part in a risk assessment				
9. Involved in the selection of PPE				
10. Attended a safety improvement meeting				
11. Raised a suggestion to improve safety				
12. Reported a Near Miss				
13. Tried to prevent a colleague doing something unsafe				
14. Other				

Do you have any other comments about safety issues in your workplace?

Thank you very much for helping us with this survey

5