

RARE BOOKS LIB.

**The influence of safety measures on workers' safety
perception and behavior**

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Abstract

Human behavior is important in the causation of accidents. It is believed that human unsafe behavior is one of the major causes for accidents and injuries, and results in heavy financial costs. There are factors which might affect both safety behavior and safety perception (e.g. workplace characteristics, personal physical and psychological characteristics). It is of interest to consider how these factors affect safety perception, and how this perception affects or controls safety behavior. In an attempt to increase understanding of the effects of these factors and also to discover the nature of the relationship between these factors and safety behavior, several studies were conducted and are described in this thesis.

Examination of the effect of workplace characteristics in terms of presence of a Safety Officer, management commitment to safety, and safety training, on workers' safety perception and safety behavior showed that differences in safety perception and safety behavior of workers were not associated with those workplace characteristics. Instead, they were associated with condition of working such as compulsory safe working.

This study also revealed that age, gender, duration in job and experience of having an accident had no significant effect on safety perception and behavior.

Although examination of the effect of two types of intervention (knowledge only or both knowledge and feedback) in workers' safety perception and safety behavior showed a significant improvement in safety behavior for both groups, the group which received both knowledge and feedback showed more improved and more persistent safety behavior. The knowledge only group showed a significant improvement in safety perception.

This work also showed that the effects of the intervention (regardless of the type) were not similar for groups with different safety perception and behavior. The group with poor safety perception and behavior achieved better improvement in safety perception and behavior, while the group with poor perception/good behavior made a significant improvement in safety perception but did not improve in safety behavior.

Overall there was a negative significant relationship between safety perception and safety behavior. However personal characteristics did not have an influence on the relationship between safety perception and safe behavior.

Acknowledgements.....i
Abstract.....ii
Figures..... xi
Tables.....xi

Chapter 1. Introduction

1.1. Accidents and injuries are major problem..... 1
1.2. Accident causation models.....5
1.3. The role of human behavior in accident causation.....24
1.4. Factors likely to affect safety behavior.....25
1.5. Behavior modification through intervention.....31
1.6. Aims.....39

Chapter 2. Justification of the method

2.1. Introduction.....41
2.2. Measuring safety perception and safety attitude.....46
2.3. Design of the present study.....49
2.4. Behavioral measurement.....53

Chapter 3. Methodology

Overall design of the project	59
1. Linking safety attitude and perception with safety behavior	60
1.1. Sample selection.....	60
1.2. Description of the participating companies.....	61
1.3. Subject sampling.....	63
1.4. Instrument.....	64
1.4.1. Safety Perception/Attitude Questionnaire.....	64
1.4.2. The Observational Checklist.....	66
1.5. Procedure.....	69
Stage 1. Measuring safety perception and safety behavior.....	69
Stage 2. Intervention.....	73
2.1. Sampling and study population.....	73
2.2. Instruments.....	74
2.3. Procedure.....	76
2.4. Post intervention observation.....	79

Chapter 4. Results of stage 1 of the study

Question 1: The differences between companies in workers safety perception and safety behavior	
1.1. Introduction.....	81

1.2. Method.....	83
1.2.1. Data collection and data analysis.....	84
1.3. Results.....	84
1.3.1. Results of safety perception.....	89
1.3.2. Results of safety behavior.....	93
1.4. Discussion on the differences between companies on safety perception and safety behavior.....	97
Question 2: The relationship between safety perception and safety behavior	
2.1. Introduction.....	103
2.2. Method.....	105
2.3. Results.....	106
2.3.1. The relationship between safety perception and safety behavior for all workers.....	106
2.3.2. The relationship between safety perception and safety behavior for good behavior workers and for poor behavior workers.....	106
2.3.3. The relationship between individual items in the Safety Perception/Attitude Questionnaire and safety behavior.....	107
2.4. Discussion of the relationship between safety perception and behavior.....	110
Question 3: The differences between workers where the target safety behavior was mandatory (Company 5) and workplaces	

workplaces where the target safety behavior was not compulsory (the four combined companies).....	113
3.1. Introduction.....	113
3.2. Method.....	115
3.2.1. Data collection and data analysis.....	116
3.3. Results and discussion	
3.3.1. Safety attitude/perception.....	117
3.3.2. Safety behavior.....	123
3.4. Discussion.....	124
Question 4: The influence of personal characteristics such as age, gender, job experience and experience of having accidents on workers' safety perception and safe behavior.....	126
4.1. Introduction.....	126
4.2. Method.....	128
4.2.1. Procedure and data analysis.....	128
4.3. Results and discussion.....	130
4.3.1. Gender.....	130
4.3.1.1. Safety perception.....	130
4.3.1.2. Safety behavior.....	134
4.3.1.3. The relationship between safety perception and safety behavior for male and female workers.....	135

4.3.2. Age.....	135
4.3.2.1. Safety perception.....	135
4.3.2.2. Safety behavior.....	140
4.3.2.3. The relationship between safety perception and safe behavior for workers in different age group.....	142
4.3.3. Job experience.....	142
4.3.3.1. Safety perception.....	142
4.4.3.2. Safety behavior.....	146
4.4.3.3. The relationship between safety perception and safe behavior for workers with different job duration.....	146
4.3.4. Experience of having accident while working.....	147
4.3.4.1. Safety perception.....	147
4.3.4.2. Safety behavior.....	150
4.3.4.3. The relationship between safety perception and safety behavior for workers with and without experience of having an accident.....	151
4.4. Overall discussion.....	153

Chapter 5. The results of the second stage of the study

5.1. Introduction and background.....	157
5.2. Method.....	161

5.2.1. Subjects.....	161
5.2.2. Instruments.....	162
5.2.3. Procedure.....	163
5.2.4. Data collection and data analysis.....	168
5.3. Results.....	168
5.3.1. The effect of the intervention on safety behavior and safety perception for the entire group.....	168
5.3.1.1. The effects of the intervention on safety behavior.....	169
5.3.1.2. The effects of the intervention on safety perception of the entire group.....	169
5.3.2. The effects of the type of the intervention on subject's safety perception and safety behavior.....	170
5.3.2.1. The effects of different types of intervention on safety behavior.....	170
5.3.2.2. The effects of different types of intervention on safety perception.....	172
5.4. Discussion.....	173
5.5. The effect of the intervention for groups of workers with good and poor safety perception and behavior.....	175
5.5.1. The effects of the intervention on the safety behavior of the perception/behavior groups.....	175

5.5.2. The effects of the intervention on the safety perception of the perception/behavior groups.....	177
5.6. Discussion.....	179

Chapter 6. Summary and conclusion

6.1. The differences between companies where safe behavior was not compulsory in workers' safety perception and safety behavior.....	183
6.2. The influence of compulsory safety practice on workers' safety perception and behavior.....	186
6.3. The influence of personal characteristics on safety perception and safety behavior.....	188
6.4. The relationship of safety perception and safety behavior.....	189
6.5. The effects of the different types of intervention on safety perception and safety behavior.....	191
6.5.1. The effect of the intervention on the entire group of workers.....	191
6.5.2. The effect of the intervention on the safety perception and safety behavior of the groups of workers with congruent safety perception/behavior and the groups of workers with incongruent safety perception/behavior.....	192
References.....	195
Appendices.....	205

Figures

Figure 1.1. Heinrich's five factors accident sequence.....	5
Figure 1.2. An Attributional model of the safety management process (Dejoy, 1994).....	9
Figure 1.3. Fault Tree Analysis model (source: Ferry, 1991).....	13
Figure 1.4. Accident causation model (source: Wuorinen, 1984).....	14
Figure 1.5. A model of organisational accident causation (source: Reason, 1995)....	19
Figure 2.1. Sample observational form (source: sulzer-Azaroff et al. 1990).....	56
Figure 4.1. Means of workers' responses to the Safety Perception/Attitude Questionnaire.....	108

Tables

Table 1.1. Summary of accident causation models.....	20
Table 1.2. Accident causation models in terms of their emphasis on either the environment, the person or interaction of the person with the environment.....	21
Table 3.1. Distribution of the subjects by gender for each company.....	64
Table 3.2. Average percentage agreement in stage 1 for each workplace between observers 1 and 2 and between observers 1 and 3, showing number of worker observed in each workplace.....	68
Table 3.3. The number of Safety Perception/Attitude Questionnaire and the number of respondents.....	72

Table 3.4. Distribution of workers in each company participating in the second stage of the study. Gender distribution is also shown.....74

Table 3.5. Percentage average agreement in stage 2 for each workplace between observers 1 and 2 and between observers 1 and 3, showing number of workers observed in each workplace.....75

Table 4.1. The number of employees, description of production and required PPE for each company..... 86

Table 4.2. Company differences in the availability of Safety Officer, safety training and management safety commitment..... 87

Table 4.3. Mean scores and standard deviations for each item on the Safety Perception/Attitude Questionnaire for each of the companies studied. The results of the one way ANPVAs are also shown..... 90-91

Table 4.4. For each company the mean proportion of PPE worn and the average percentage wearing all required PPE are shown. The results of the one way ANOVAs are also shown.....96

Table 4.5. The results of Regression Coefficient analysis showing the significant variables in the Equation..... 109

Table 4.6. The frequency of safety training, management safety commitment and availability of Safety Officer, number of employees, description of production and required PPE in Company 5..... 116

Table 4.7. Mean scores and standard deviations for each item on the Safety

Peception/Attitude Questionnaire for workers in Company 5 and workers in the four combined companies. The results of t-tests are also shown.....	118-119
Table 4.8. The mean proportion of PPE worn and the average percentage wearing all required PPE for workers in Company 5 and workers in the four combined companies. The result of t-test is also shown.....	123
Table 4.9. Mean scores and standard deviations for each item in the Safety Perception/Attitude Questionnaire for females and males. The results of t-test are also shown. High scores infdicate positive responses.....	131-132
Table 4.10. The mean proportion of PPE worn and the average percentage wearing all required PPE for female and male workers.....	134
Table 4.11. Mean scores and standard deviations for each item on the Safety Perception/Attitude Questionnaire for workers in different age groups.....	136--137
Table 4.12. The mean proportion PPE worn and the distribution of PPE worn across observations are shown for all age groups of workers.....	141
Table 4.13. The relationship between safety perception and safety behavior of workers in four age groups	142
Table 4.14. Mean scores and standard deviations for each item in the Safety Perception/Attitude Questionnaire for workers with different duration in the job.....	143-144
Table 4.15. The mean proportion of PPE worn shown for workers with	

different job duration.....	146
Table 4.16. Mean scores and standard deviations for each item in the Safety Perception/Attitude Questionnaire for workers with and without accident experience.....	148-149
Table 4.17. The mean proportion of PPE worn and the average percentage wearing all required PPE for workers with and without experience of having an accident while working.....	151
Table 5.1. Distribution of workers participating in the second stage of the study....	162
Table 5.2. The average target safety behavior (mean proportion of wearing required PPE) and standard deviations for the entire Intervention group and the Control group at before and immediately after intervention.....	169
Table 5.3. the average safety perception and standard deviations for the entire Intervention group and the Control group at before and immediately after intervention.....	170
Table 5.4. The average target safety behavior (mean porportion of wearing required PPE) and standard deviations for each group at all three stages (pre-intervention, post-intervention 1 and at post-intervention 2).....	172
Table 5.5. Mean values for safety perception and standard deviations for all groups before and after intervention.....	173
Table 5.6. Mean safety behavior for the perception/behavior groups pre and post-intervention.....	176
Table 5.7. Mean safety behavior for the perception/behavior groups in the Control	

group are shown at pre-intervention and at post-intervention.....177

Table 5.8. Mean safety perception and standard deviation for each
perception/behavior group pre and post intervention..... 178

Table 5.9. Mean safety perception and standard deviation for each
perception/behavior group in the Control group pre and post-intervention.. 179

CHAPTER 1

INTRODUCTION

1.1. Accidents and injuries are major problems

Accidents and injuries are major causes of deaths, disabilities and financial costs. More than 50,000 Americans die annually from accidents, and one in four is injured seriously enough to require medical attention as a result of accidents and injuries caused by ignoring safety and by unsafe behavior (Waxweiler, Harel and O'Carroll, 1993). It is estimated that in the United States, medical care costs and lost productivity due to injuries exceed \$100 billion annually (Waxweiler et al., 1993).

Accidents and injuries occur in many settings including home, road and workplaces. For example, 30 of every 100,000 children aged 0-1 year and 19 of every 100,000 children aged 1-14 years die as a result of accidents and injuries including poisoning and violence each year (Australian Bureau of Statistics, 1996). In the year 1996, eight of every 100,000 deaths in children 1-14 years was a result of motor vehicle accident (Australian Bureau of Statistics, 1996).

In 1996 traffic accidents claimed 25.6 % deaths in Australia (McLennan, 1998). In this year 7554 deaths as a result of other accidents including poisoning were reported, of which 1102 deaths were the result of accidental falls, and 247 deaths were the result of accidental drowning and submersion (Australian Bureau of Statistics, 1996).

The national total for work-related compensated fatalities in 1993-4 was estimated at 454 (at the rate of 70 per million wage and salary earners), and the number of injuries and illnesses of five days or more duration was 172,428 (at the rate of 27 per 1,000 wage and salary earners) (National Institute of Worksafe Australia, 1993-94).

Fortunately there is evidence that accidents and injuries are declining in many settings. For example, the number of child deaths caused by unintentional injury fell by almost half (46%) to 359 deaths in the period 1979-1991 (Australian Bureau of Statistics, 1993).

Over the last few years, there has also been some reduction in road and traffic accidents. For example, the number of fatal accidents in 1996 was 1,842, compared with 2,489 in 1990 (Australian Bureau of Statistics, 1996). The number of fatal accidents including poisoning was 7,945 in 1990, compared to 7,554 in 1996, and fatal accidental drowning and submersions were 300 in 1990 compared to 247 in 1996 (Australian Bureau of Statistics, 1996). All these figures show some reduction in the number of most kinds of fatal accident.

Unfortunately this progress has not occurred in workplaces, and despite the attention occupational safety in Australia has received over the years, occupational hazards and injuries still exist and are even increasing in some areas, showing that workplace accidents and injuries are still major problems. For example, comparing 1993-1994 data with 1992-93 data there was some deterioration in occupational health and safety

performance over that time in Australia. National (excluding Victoria) workplace fatalities increased from 260 in 1992-93 to 324 in 1993-94 and the total number of injuries and illnesses increased from 124,996 in 1992-93 to 135,729 in 1993-94 (National Institute of Worksafe Australia, 1993-94).

Accidents and injuries in the workplace are serious problems for a number of reasons. They cause death and disability and waste working time, creating inputs of direct and indirect economic costs to society. They are also costly for victims. Larsson and Betts (1996), in their study of the variation of occupational injury costs in Australia, found that the distribution between the injured individual, the production system and the compensation system in terms of meeting these costs (paying the costs) varied considerably between the different Australian jurisdictions and workers compensation systems. Larsson and Betts noted that the time spent by injury victims and their families as a result of the injury was not counted, and reported that a large proportion of the cost due to occupational injury in Australia was paid by the injured worker.

Statistics demonstrated that accidents and injuries in workplaces cause hundreds of deaths, hundreds of thousands of injuries and illnesses and these cost billions of dollars each year. The cost of work-related injuries and diseases is estimated to be in the range of \$15 billion to \$37 billion per year (National Institute of Worksafe Australia, 1993-94). These costs do not however, include the social costs of the accidents and injuries in terms of physical pain, loss of prospects for further development, and general decline in

quality of life which may impact on employees who suffer work related accidents or illnesses.

In addition, accidents and injuries invade the safety climate of the workplace. Safety climate is defined as the attitudes and perceptions toward OHS shared by a work group (Coyle, Sleeman and Adams, 1995). Invasion of safety climate may have negative effects on workers' safety. Accidents have an overall negative effect on workers as they can imagine that the same accident might happen to them at some time. Kasal, Chisholm and Eskenazi (1981), in their study of the impact of the accident at Three Mile Island on the behavior and well-being of workers, found that workers felt insecure after the accident which befell their colleagues, as they were not certain that they would enjoy safe working practice any longer and an accident might have happen to them.

It may be assumed that the problem is even more serious than it appears, and that some accidents and injuries are not reported and not included in the foregoing statistics.

Evidence for this claim is found in the Larsson and Betts (1996) study mentioned above.

Larsson and Betts indicated substantial underreporting of occupational injury, especially from small businesses. This underreporting suggests that the real cost of occupational injuries in Australia might not be correctly estimated and reported, and that the

workplace accident and injury problem may be even larger than what the statistics

suggest. According to Holcom, Lehman and Dwayne (1993), accidents in the workplace continue to pose a significant problem, which needs to be addressed and prevented.

While there are likely to be different solutions for this problem, studying the causes of accidents and injuries in the workplace seems to be an efficient approach. A wide range of factors may increase the likelihood that accidents will happen. A number of authors have developed different models of accident causation which incorporate the factors most likely to be involved in accident causation. Some of these models relate to accident and injury in general and others relate to accident and injury in workplaces. The characteristics of the most important models are described in the next section.

1.2. Accident causation models

There have been many attempts to conceptualise the factors involved in accident causation. Earlier models included few components, focusing mainly on human behavior as a cause of accidents. An example is Heinrich's model which was developed in the 1930s and titled the Domino Theory. According to this theory, 88% of all accidents are caused by unsafe acts of humans. Heinrich proposed a five factor accident sequence in which each factor could be a cause for the next factor in the sequence. These factors are social environment, fault of person, hazard condition, unsafe act and accident (Heinrich, 1930), as shown in Figure 1.1

Figure 1.1: Heinrich's five factors accident sequence

Social environment → fault of person → hazard condition → unsafe act → accident

This theory places an emphasis on the behavior of workers as the initial cause of injury

that results through a domino sequence of events in a chain reaction. Each “domino” has only one cause and that cause has only one effect. Heinrich argued that both individual personality traits and environmental factors may cause undesirable traits of character, such as nervousness and recklessness. These traits may lead to unsafe behavior (failure to use protective equipment) and might create unsafe conditions (e.g. obstructed pathways) in the workplace. Unsafe behavior and unsafe conditions cause accidents and injuries. According to Heinrich, unsafe acts and unsafe conditions are the prime factors which cause accidents and injuries at work.

Although most modern management models are based on Heinrich’s Domino Theory, an understanding of this theory is still critical. Firstly, according to Heinrich the majority of accidents are caused by acts of humans and only a small portion of accidents are the result of other factors. This seems somewhat exaggerated in claiming that most accidents are caused by unsafe acts *as opposed* to unsafe conditions (Strahlendorf, 1995). Heinrich’s model is criticised for encouraging a “blame the victim” approach (Strahlendorf, 1995). The second criticism of Heinrich’s model is that it does not acknowledge management defects and faults and does not allow assessment of organisational weaknesses such as poor communication and lack of detailed responsibility (Strahlendorf, 1995). This aspect is important because the role of the management in the safety level of the workplace has been strongly argued (Johnson, 1975; Reason, 1995). In general, Heinrich’s model reflects the idea that attitude and perception affect a person’s behavior which in turn, could affect his/her propensity to

be involved in causing accidents (Heinrich, 1931).

The need to understand the importance of worker behavior and how and why the worker performs unsafe action has been the focus of attention for many authors and researchers. One example is Basic Attribution Theory, which assumes that people try to make sense of their environment, form a perception of it and naturally engage in attribution activities based on this perception (Kelley, 1967, 1973). This could mean that the individual's safe or unsafe performance is likely to be based on his/her perception and predictions of safety. The main focus of this theory is the individual, who tries to understand and make predictions of events in the environment by continuous examination of probabilities and covariations. Using this assumption, Kelley argues that the primary attributional task involves classification of causes of accidents by putting them into three categories: individual, task content (entity or task) and context (set of conditions or environment/circumstances related to the accident). In this theory the analysis of the causes of an accident is based on determining whether the accident was caused by the worker alone, by the nature of the task or by a set of circumstances. According to Kelley, distinctiveness, consistency and consensus are three elements that individuals use to gather information for causal attribution. For example in the case of a welder who develops a corneal ulcer as a consequence of welding, the immediate investigation of this accident is likely depend at least partially on (a) whether this worker has performed safely on other tasks (distinctiveness), (b) whether this worker has performed safely on this task in the past (consistency) and (c) how other workers performed on this task

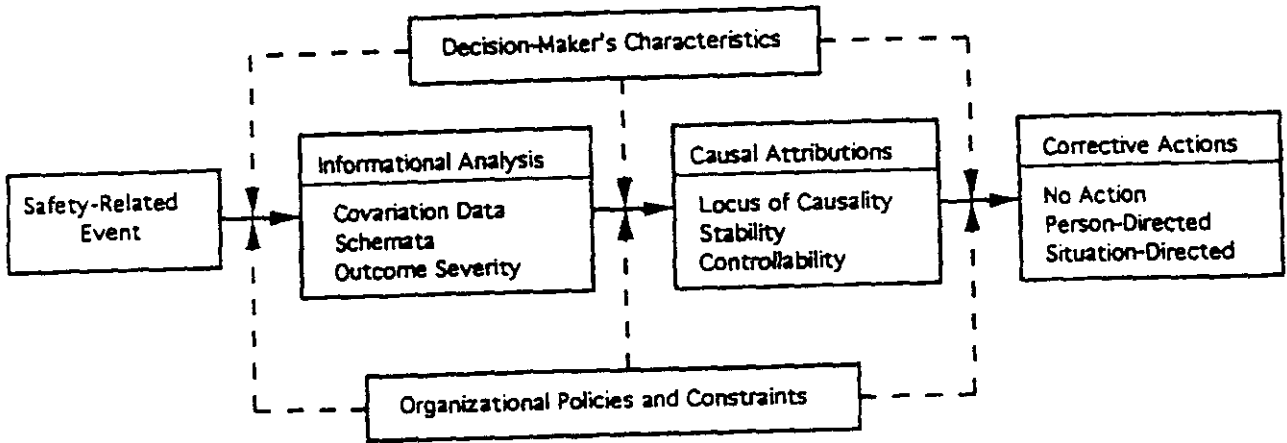
(consensus). Kelley concludes that the presence of distinctiveness and consistency and absence of consensus should lead to the conclusion that the worker is a safe worker and that the accident was caused by something related to either the nature of the task or the circumstances or both. In contrast, a positive answer to consensus and a negative answer to distinctiveness and consistency would suggest causality by the worker.

Although the structure suggested in Kelley's model may provide relevant information for accident causation, the data can be expected to yield less reliable attributions when there is conflicting or incomplete information (DeJoy, 1994). For example, if managers are required to attribute distinctiveness and consistency, they might have a bias toward certain workers and judge them on this basis. In other words, if a supervisor dislikes a worker for any reason (race, sex, cultural background, ethnic group, personality clash), it might affect his/her judgement of that worker's safety performance.

Based on attributional theory (Kelley, 1967, 1973) and causal analysis in workplace safety (Heinrich, 1930), an attributional model of the safety management process was proposed by DeJoy (1994). Two categories of factors are included in this model. One category focuses on the individual as a decision maker whose experience, beliefs and motives have the potential to influence the initial perception of events and the actions taken to correct the situation. The second category refers to organisational rules and

policies that might have an influence on the way that individuals process causal information. Figure 1.2 shows this proposed model.

Figure 1.2 : An Attributional model of the Safety-Management process (DeJoy, 1994).



As Figure 1.2 shows, the occurrence of some safety related event provides the stimulus for causal thinking on the part of those involved. Next the individual gathers and processes information about the event in terms of locus of, causality and stability and controllability. Locus of Causality identifies the cause of event as either internal (something about the person) or external (something about situation) to the person(s) involved in that event (DeJoy, 1994). For example the source of the cause of the event was either unsafe behavior or unsafe condition. Stability refers to the permanent and temporary variables in accident attribution (DeJoy, 1994), for example, stress could be classified as unstable (because it can vary from time to time) and skill could be classified as stable factor. According to DeJoy (1994), attribution about stability of causes are important in prediction about future events. For example, accidents attributed to stable

causes are expected to be reoccurring while accidents attributed to unstable causes produce more uncertainty and less definitive predictions about reoccurring of the event. Controllability refers to the cause as being either controllable or uncontrollable. The way the causes are categorised plays an important role in the types of corrective actions to be taken (DeJoy, 1994). The characteristics of the Decision-makers are also important, for example self-other attribution (people tend to explain the behavior of others in terms of internal cause instead use environmental factors as a cause to explain their own behavior). Finally Organisational Policies and Constraints (safety climate, organisational safety performance and economic factors) could play an important role in the attributions of workplace participants. It seems that in this model there is a holistic approach to the causes of accidents which in turn could provide sufficient information about the real causes for accidents compared to those of Heinrich who blames act of humans as a major cause for accidents.

Another important model of accident causation is the Energy model (Haddon, 1968). In this model the energy level and the control over that level are considered as factors in accidents. The assumption in this model is that all accidents are caused by releasing some form of high level energy, that is, an accident may occur because of either a destructive energy source or because of critical energy needs. The type of energy could be thermal, mechanical, electrical or chemical. The energy involved is controlled by human or technical systems. In this model the later phases of the accident process, such

as the loss of control of energy and the resulting harm, are the focuses for accident prevention (Saari, 1998). This model is criticised for the fact that as a result of modern technology and the use of computers, most accidents and mishaps caused by high levels of energy have been overcome (Strahlendorf, 1995). The other criticisms are that this model neglects human behavior and its role in causing accidents.

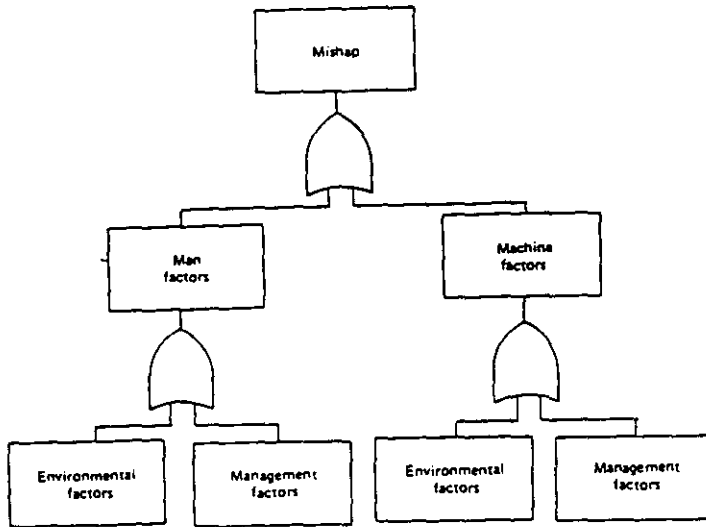
Some authors have tried to extend this approach to accident causation by emphasising the role of the organisation in particular management decisions and organisational processes rather than the role of the individual in accident causation. For example, in the MORT (Management Oversight and Risk Tree) model which was developed by Johnson (1975) together with the System Safety Development Centre of the US Department of Energy, an accident or mishap is defined as an unwanted loss which occurs because of inadequate energy barriers and/or control. According to MORT, all accidents arise from two sources, (a) specific task oversight and omissions and (b) the management system which controls the task. In this model, the environment consists of the physical conditions of the workplace and the management system that controls the work. The environment might have a direct or an indirect effect in causing accidents. Working conditions (e.g. heat, light, maintenance and the equipment needed in the working process) can have direct effects on accident causation, for example using inappropriate equipment in the working process. The indirect effects of the environment in accident causation are those management systems that control the task, for example, the role management plays in organisational relations. In this model, organisational factors

together with environmental factors are considered as combined or single factors in accident causation, while in most accident research, environmental factors or organisational factors are not the only factors considered in accident causation. The major criticism of this model is that it ignores the role of the individual worker in causing accidents.

Although all these models have made contributions to the understanding of the causes of accidents in the workplace, some of them (Heinrich's model and Kelley's model) place more emphasis on the role of human behavior in causing accidents, while others neglected many aspects of the human factor. For example, the Fault Tree Analysis (FTA) model which was developed by Bell Telephone Laboratories (Ferry, 1981), emphasises a range of factors in the cause and effect of accidents. In the FTA model all possible factors that are thought to contribute to the accident are diagrammed in the form of a tree. As Figure 1.3 shows, the accident (mishap) is centred at the top, connected by branches to the man-factor and machine-factor, then each of these factors is also connected by branches to environment factors and machine factors. The accident and its relation to the combination of the factors can then be examined to establish which factors play a role in causing the accident. This helps to see where the problems lie in a logical sequence. Ferry (1981) argued, however, that this model limits the information needed to analyse the accident. For example on the left branch of the tree (Figure 1.3), the man-factor branches out to environmental and management factors only, and does not include the influence of personal factors such as the individual's attitude, perceptions, level of

training and other characteristics such as age, sex, experience of an accident and years of experience of the work.

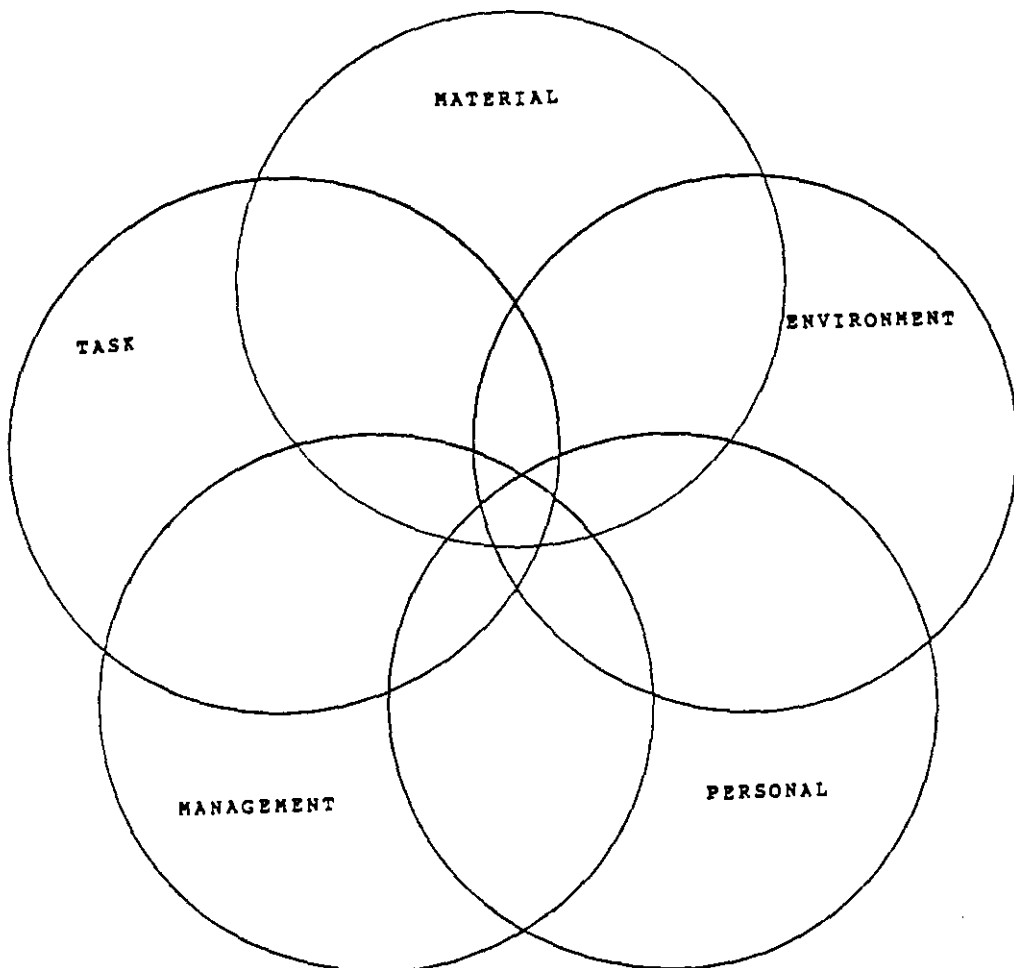
Figure 1.3: Fault Tree Analysis model (source: Ferry, 1981)



Wuorinen (1984) has taken a deeper approach to accident causation. In Wuorinen's model (Figure 1. 4), the causes of any accident can be grouped into five categories which are material, task, environment, personal and management. Environment factors include physical conditions such as weather temperature, noise pollution, house keeping and the time of the accident. Management factors include aspects such as effective safety roles, adequate supervision and previous identification of hazards. Material factors include the condition of the machinery and involvement of hazardous substances. Task factors include the nature of the task and the level of the risk involved performing the task, and personal factors include state of physical and mental health, experience of the task and

safety training. According to this model, for any accident, one or a combination of these categories could be a possible cause. Consideration of task category in determining the cause of an accident allows for the such questions as: Was safe procedure used to perform the task? Was there any variation(s) in working conditions which made the normal procedure unsafe? Were the appropriate tools, materials and equipment available to use? Did the individual or group involved in the accident have any training to perform the task safely?

Figure 1.4: Accident Causation Model (source: Wuorinen, 1984)



As Figure 1.4. shows, there are overlaps between categories occurred. This is to reflect the situation as it likely happens in real life. The advantage of this overlapping is that it prevents looking at causes in isolation and provides better opportunity to understand the effect of the interrelated factors in causing accidents.

Although Wuorinen's model attempts to cover almost all possible causes for an accident, the worker's perception of safety is not considered. For example, consider the possibility that there were no faults and errors in the task itself, neither material nor environment was faulty, and the person directly involved in the accident was experienced, trained and in a good physical and mental health. Why might the accident still have happened? In other words, this model assumes that given good mental and physical conditions all workers will under these conditions always act safely and be accident free. However, evidence is lacking for the assumption that all workers given good mental and good physical conditions will perform safely. Clearly there is no guarantee that this is so.

If an individual's perception and attitude play a role in his/her performance, it could be assumed that there might be some individuals who are more subject to accident.

Shimmin, Leather and Wood (1981), developed the concept of the Potential Accident Subject (PAS). According to Shimmin et al.(1981), PAS is any individual who by his/her presence in the workplace is a potential accident contributor, not necessarily a victim.

Later on Leather (1987), extended and revised this model to emphasises the dynamic interdependence of cognitive elements such as attitude, motivation, and structural or

organisational features such as the status of safety in organisational policy and management practice as contributors for accidents. In his modification and revision of PAS model, Leather took a systemic approach to accident causation, considering that the system is composed of a number of elements including individual, working group, organisational management and working equipment. The inputs for this system are the individuals' orientation to safety, working group relations, organisational management, safety planning, and availability of the equipment needed for doing the job. The outputs of this system are these safe and/or unsafe behavior performed by the individual worker and based on his/her attitude, perceptions and experiences of safety and safe performance. These outputs can act as a feedback and become inputs in their turn. The position of the PAS in this model is that he/she is the input and his/her behavior is the output. In the event of an accident, demands for change are returned to the system as feedback. This feedback may enforce modification of initial input.

Although the PAS model takes into consideration the dynamic interdependence of elements such as attitude and perception, motivation and organisational features, it does not include the process between perception and behavior of the PAS. For example, considering the PAS as a subject for input where attitude for safety might be the reason for unsafe behavior, what is the relationship between elements such as attitude and perception, motivation and organisational features, and the individual's unsafe behavior? Does negative attitude/perception of safety always cause unsafe behavior? Does lack of

motivation cause unsafe behavior? The relationships between safety perception and safe behavior and motivation and safe behavior are not clear nor explained in this model.

The role of human behavior in accident causation has attracted considerable attention. For example, in Hale and Glendon's (1987) model, human behavior is considered to play a problem solving role in controlling danger in the workplace. According to Hale and Glendon, danger always exists in the workplace with the potential for accidents, and elements such as workers' behavior e.g. skilled operators, task procedure e.g. preventive maintenance and organisational features e.g. allocation of responsibility for critical safety tasks play a role in the prevention of accidents. For example, the risk of severing a finger or hand always exists in work with a press machine. If a careless or skill less worker uses this machine, there is more chance of an accident occurring than if a careful worker works with the same machine.

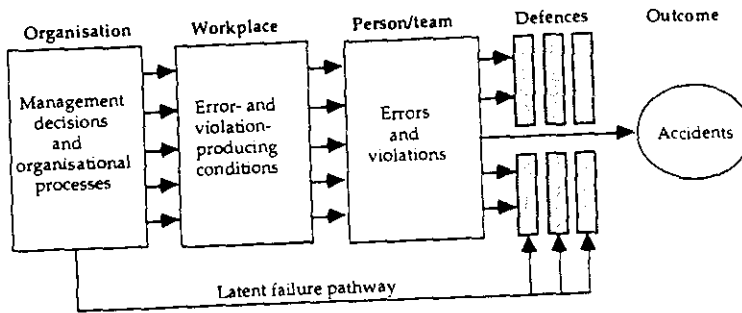
In Hale and Glendon's model the importance of the role of each above mentioned element is not clear. The model does not predict which element is more likely to cause an accident in a similar situation, for example, deviations in worker's behavior, task procedure or organisational features.

Another factor which seems important in the causation of accidents is the role of the organisation controlling the workplace. Perhaps Reason's (1995) work has made the great contribution on the role of the organisation in causing accidents. In his approach

to organisational error, Reason perceives that unsafe acts are consequences of organisational errors and argues that the organisational error could be the basic foundation of accident causation. Based on this perception, Reason introduced a model in which the aetiology of some major organisational accidents was outlined from two levels (a) errors in decision making and violation of conditions at management level, and (b) latent failure of organisational processes to deal with deficiencies existing in the workplace. Errors in decision making and promotion of violation of conditions at management level is the deliberate deviation of actions from safe operating procedures, which results in the performance of unsafe acts by individuals or teams of workers. According to Reason, this is an “active failure” by the organisation. Latent failure of the organisational process to deal with deficiencies existing in the workplace is the persistence of inefficient rules and routines, heavy workloads, broken and inappropriate tools. Figure 1.5 shows Reason’s model of organisational accident causation

Although Reason’s model introduced a unique and fairly new approach to accident causation by suggesting that the root causes of accidents might be traced to latent failures and organisational errors arising in the upper levels of the system, it is a unidimensional approach to the problem. For this reason there is doubt that this model could be generally applied and supported by any empirical evidence.

Figure 1.5: A model of organisational accident causation (source: Reason, 1995)



In conclusion, although accident theorists have tried to explain the causes for accidents and to provide linkages among the causes to understand why an accident occurred described so far, their success rate is not yet known. Table 1.1 summarises the accident theories and models:

Table 1.1: Summary of accident causation models

Accident causation model	Date	Main features
Heinrich's Domino Theory	1931	Chain reaction cause and effect: each link of chain has only one cause (faulty individual→unsafe act→hazard condition→ accidents and injuries).
Kelley's Basic Attributional Theory (BAT)	1967-73	Individual, task content and context. Distinctiveness, consistency and consensus based on psychological factors such as the individual's basic attribution of information. This is similar to Heinrich's Domino Theory.
Haddon's Energy model	1968	High level of energy controlled by human or technical system.
Man Oversight and Risk Theory (MORT)	1977	Accidents occur because of inadequate energy barriers and/or control. Energetic models (Gibson 1961) and Haddon (1968) and sequential models (Benner 1975) are based on this conceptualisation.
Fault Tree Analysis (FTA) model	1981	Man factor and machine factor, each in terms of environment factors and management factors.
Wuorinen's accident causation model	1984	One or a combination of five categories: material, task, environment, personal, management could be the causes of accidents.
Leather's model	1987	An accident prone individual who by his behavior might contribute to an accident and is in the system in which working group, management's and working equipment are elements of the system which affect the individual's behavior so as to cause accident.
Hale and Glendon's model	1987	Human behavior as a decision maker is important factor in controlling danger in workplace; task procedure and the organisation also play a role.
DeJoy's Attributional Model	1994	The workers are viewed as processors of information or decision makers. Attribution represents an important link between safety problems and the actions that are taken to control them.
Reason's accident causation model	1995	Active failure in management leads to unsafe acts committed by immediate worker. Latent failure starts from organisational processes and leads to deficiencies in the working system.

Analysis of these accident models and theories shows that in most of them environmental factors and human factors are included as the causes for accidents. Some of the models

take into account the individual's role as information processor, such as Leather's model, DeJoy's model and Hale & Glendon model. Organisational factors are included in a few models such as the MORT model and Reason's model, while others such as Kelley's model include a range of related factors as causes for accidents. Table 1.2 classifies postulated factors in these models.

Table 1.2: Accident causation models in terms of their emphasis on either the environment, the person or interaction of the person with the environment.

	Person	Environment	Interaction of person with the environment	Organisation
Heinrich's Domino Theory	√	√	√	
Basic Attributional Theory	√	√	√	
Haddon's Energy model	√	√	√	
Management Oversight and Risk tree		√		
Fault Tree Analysis model	√	√	√	
Wuorinen's model	√	√	√	
Leather's model	√	√	√	
Hale and Glendon model	√		√	√
DeJoy's Attributional Model	√	√	√	
Reason's model		√	√	√

Some of the models have similar approaches to accident causation. For example, Kelley's model and DeJoy's model are similar in their basic assumption that individuals' perception of the environment provides background for engaging in attributional activities. This means that the individual gathers the information from the environment, makes sense of it, forms a perception of it and processes the information about the

accident. Based on this information, the individual then engages in attributional activities.

While the factors included in these models might not be sufficient, each have some strength. For example, the strength of DeJoy's model is that it shows where attribution of causes fits into the safety management process. This could help managers to modify their safety programs, improve communication between workers and supervisors and increase the objectivity of accident reporting.

Hale and Gelendon's model is similar to Leather's model in that both place emphasis on the potential of the individual's behavior to cause or prevent accidents within a given workplace. Although these could be useful approaches, it is not clear what factors other than the factors existing within a given workplace, might have an influence on the individual's decision to adapt for safe or unsafe performance.

The MORT model, Haddon's Energy model and Reason's model all place more emphasis on the role of environmental and organisational factors. It seems that in these models human behavior is considered as a secondary factor, which assists in transferring of energy. Instead these models focus on the role of environmental and organisational factors. It is doubtful, however, that this focus is appropriate in most situations. The

reason for this claim is that individuals are capable of altering the direction of existing energy based on their decisions which either cause or prevent accidents (Hale and Glendon, 1987).

The Wuorinen and FTA models both place more consideration on the role of the environment and human behavior and interaction between these two factors as causes for accidents. However, they do not specify which are more significant in causing accidents, and although the significance of causal factors depends on the nature of accident, there are always some common factors which are more likely to contribute to accidents than others.

Different to this approach is the PAS model which acknowledges that some individuals are more liable to be involved in accidents than others. The model does not specify which characteristics and factors differentiate these individuals from other workers. Saari (1998) doubts that the theory behind this model is generally accepted and argues that if there is any evidence to support it, it probably accounts for a very low proportion of accidents with no statistical significance.

In conclusion, there are many similarities among the models. Most of the models

acknowledge human behavior as an important aspect of accident causation. Only a few of them include the rationale for behavior as part of the model (Heinrich model, Kelly's model, DeJoy's model and Hale & Glendon model). Since human behavior is acknowledged to be such an important aspect of accident causation, it is essential to look at this aspect of accident causation in more depth.

1.3. The role of human behavior in accident causation

A study by Williamson and Feyer (1990) showed that human behavior in terms of either human error or poor work practices was involved in 91.2% of work related fatalities in Australia. Heinrich (1931) is one of the earliest to identify human behavior as an important factor in causing accidents. Subsequently many studies have shown that the human factor is a major cause of accidents in the workplace. For example, Lawrence (1974), in his study of human error as a cause of accidents in gold mining, showed that 794 human errors caused 405 accidents and deaths, with the most dominant causes of accidents being failure to perceive warnings of danger. Lawrence concluded that failure to perceive warnings and underestimation of hazards are the causes of errors and particular attention should be paid to these two factors.

In another study, Salminen and Tallberg (1996) studied human errors in fatal and serious occupational accidents in Finland and found that 84-94% of accidents were due mainly to human error. These studies demonstrated the importance of human behavior in causing accidents. It seems that where the human factor was found, it occurred as faulty

human behavior and was linked to occurrence of the error. There are likely to be many reasons for unsafe behavior. Identification and better understanding of the causes of unsafe behavior may help to prevent it and to minimise the number of accidents and injuries. Understanding of the role of human factors in accident causation is likely to enhance the ability to prevent accidents and injuries.

1.4. Factors likely to affect safety behavior

There are many factors that are likely to affect safety behavior such as attitude and perception of safety. For example, Stern and Oskamp (1987) proposed that environmentally relevant action is the outcome of a series of factors including general and specific attitudes and beliefs. Hofmann, Jacobs and Landy (1995), in their literature review of safety performance in high reliability process industries, found that employee attitude was among the factors with important implications for safety performance.

There is evidence that safety perception and attitude might play a more important role in safety behavior than other factors. For example, Crowe (1995) investigated the relative effectiveness of safety values (safety judgement, choice, attitude, evaluation, argument, rationalisation and attribution of causality) and the combination of gender, class standing and demographic region to determine the most important factors for predicting safety behavior. The results showed safety values to be a better predictor than the other three factors in predicting an individual's safe behavior. According to Crowe, low safety values scores were associated with low safe practice scores and high safety values scores

were associated with high safe practice scores. This suggests that safety values have an important role in determining an individual's safety related behavior.

Perception of risk may also play an important role in the individual's decision to participate in appropriate behavior. Howarth (1987) argued that people will adapt to an increase in perceived risk by taking more care. Goldberg, Dar-EL and Rubin (1991), in a study of threat perception and the readiness to participate in safety programs, found that workers were sensitive to perception of personal jeopardy from existing safety hazards, and the perception of a high degree of threat had an effect on workers' readiness to participate in rectifying existing conditions. For example, perception of threat to workers' well being was found to be a factor that encouraged participation in safety programs. They also found that factors such as co-worker support and safety instruction had independent effects on readiness for participation in a safety program.

McDaniels, Kamlet and Fischer (1992), in their research on risk perception and the value of safety, examined the relationship between perceived risk and willingness-to-pay (WTP) for increased safety from technological hazards in both conceptual and empirical terms. McDaniels et al.(1992), defined WTP as pre-payments that are not contingent on the health outcome that is realised. Based on this definition, they developed a model to compare the WTP for well defined hazards (the hazards in which risks are relatively common and death rates are known) and less well defined hazards. The WTP for well defined hazards was more influenced by perceived personal exposure while in less well

defined hazards WTP was most influenced by the level of dread and the severity of the risks involved. This study also showed that perceived characteristics of hazards are important for risk evaluation; that is, a person's knowledge, information and estimation of hazards could determine the degree of the risk perceived in the hazards. This in turn helps the person to set priorities for behavior and to choose appropriate methods of risk management.

The concept of Risk Homeostasis (Wilde, 1989) holds the definition provided a controversial interpretation of the role of risk perception and how it might affect on individual's behavior. This theory holds that interventions that reduce the level of accident risk people are willing to accept can result in major and lasting reduction in the accident rate per hour of exposure to accident risk (Wilde, 1989). The main assumption of Risk Homeostasis Theory (RTH) is that people have a preferred or target level of acceptable risk. According to Wilde, there are a number of hypotheses relating to RHT:

- People compare the accident risk they perceive with their target level of accident risk.
- People try to minimise any discrepancy between experienced and target risk to less than they can notice in any given situation.
- The level of caution applied in behavior determines the accident rate.
- The past accident rate and the personal experiences associated with it affect the perceived level of risk and the subsequent level of behavioral caution.
- The introduction of new safety measures that do not influence the target level of risk will be followed by people making an estimate of the effect of these measures upon the

accident risk that would occur if they did not alter their behavior.

- Safety measures that reduce risk levels lead to a reduction in accident rate.

The Risk Homeostasis Theory is supported by some empirical studies (Wilde, 1989).

According to the RHT and according to the results of studies described in this review (Hofmann et al., 1995; Crowe, 1995; Howarth, 1987; Goldberg et al., 1991; McDaniels et al., 1992), perception of risk plays a role in determining safe behavior, in other words there are relations between safety perception and safe behavior. For these reasons the hypothesis of the present study is that individuals' safety perception and attitudes have a direct influence on their safety behavior.

Management and organisational factors may also affect individuals' safety behavior.

The management system which controls the work process may have direct and indirect effect on workers' behavior by creating pre-existing failures in the workplace

(Reason, 1995). It is possible that factors like management's attitude toward safety, as well as the perception of safety and the priority that management gives to safety at work, might also have an indirect effect on workers' safety attitude and as a consequence may affect their behavior. Hofman et al. (1995), in their literature review of individual, micro and macro organisational influences on safety performance, proposed that management's attitude to safety can influence individual workers' attitudes to safety.

Besides management and organisational influences on workers' safety behavior, there are factors like personal characteristics (age, gender, etc.) and psychological factors such

as stress and anxiety which might influence individuals' behavior. For example, Huey and Boehm-Davis (1992), investigated the effects of gender, age, education and experience of workers on system performance. This study revealed significant individual differences in performance, demonstrating that age, sex, education and experience influenced individual performance. For example, performance worsening associated with increasing age and better performance associated with more education. The influence of personal characteristics on safety performance is also supported by study of Reinfurt, Williams, Wells and Rodgman (1996), on the characteristics of drivers who did not use seat belts. In this study, they found that nonuse of seat belts was associated with males, younger age and poor driving records. Therefore, personal characteristics of the individuals may have an influence on their safety behavior.

Another aspect of personal characteristics which might influence individuals' behavior are those psychological characteristics such as stress and anxiety, personality type, personal beliefs, values, attitudes and perceptions. Guastello (1991) studied occupational safety and health risks in the manufacturing setting. Some results of this study showed that injuries occurred in a climate of elevated stress and anxiety. This suggests that individuals' psychological state has an influence on their safe performance.

Dunbar (1993), in his study of the relationship of emergency response experience and psychological stress with personal protective equipment (PPE) usage found that effective performance scores were negatively related to the outward expression of anger. In

summary, these studies show that psychological factors such as personality type, stress level, anxiety and even anger may have an influence on safe behavior.

Hale (1990), in his literature review on the subject of safety rules, considered individual behavior in terms of cognitive psychological theory, and used this framework to postulate that behavior is under the influence of individual production rules such as self-made rules based on attitude and perception. In the event that the person's own rules are not sufficient to prevent accidents, imposed safety rules are needed. Thus individuals' safety perception and attitudes are important in their safe or unsafe behavior. Kashima, Y., Siegal, Tanaka and Kashima, E.S. (1992), in their study on the consistency of attitude and behavior compared Australian and Japanese students and found that the Australian students held stronger attitude behavior consistency beliefs and made more attitude attributions than the Japanese. Although individuals' attitudes have an influence on their perception (Hale, 1990), the consistency of this relationship is not well understood.

In summary, the role of attitude and perception in determining individuals' behavior is postulated by some authors (Hale and Glendon, 1987; Hale, 1990; Kashima, 1992). This suggests that attitudes and perception are important in providing this individual's values for safety and safe behavior which could be an important determinant of safe behavior.

Although it seems that attitude and perception play an important role in behavior, yet it is

not clear that how this happens and whether perception and attitude always support behavior? In other words, is there a direct relationships between perception and behavior? Is a worker with good safety perception also a worker with good safe behavior?

The way in which attitude and perception play a role in modifying safety behavior is not well understood and needs to be investigated. The following section of the study outlines different techniques of intervention for behavior modification in relation to safety behavior.

1.5. Behavior modification through intervention

A number of studies have tried different approaches to accident prevention, evaluating different methods of intervention (Komaki, Heinzmann and Lawson, 1980; Zohar, Cohen and Azar, 1980; Komaki, Collins and Penn, 1982). Menckel and Carter (1985), in an attempt to develop accident prevention routines, tested the investigation and prompt reporting of accidents and near accidents to improve local safety activities in a company producing milled products. They found that investigation and prompt reporting of accidents was associated with improved accident reporting, prevention activities and reduction in accident severity. Reporting of near accidents led to improved knowledge of risks, but no reductions in accident frequency and severity were shown.

The development of an efficient accident prevention routine is important in company safety and is the centre of attention of many authors and researchers. Griffiths (1985), believed that the commitment of senior management is the key ingredient to reducing accident rates and improving safety behavior. Avory and Coggon (1994), in their study of safety behavior among the farmers found factors such as the individual's approach to safety in different sets of situations to be the main determinant of safety behavior. This means that the individual's experience of safety and safe behavior and customary manner of handling safety is the main determinant of safe behavior. Avory and Coggon also found that formal training in safe behavior increases the level of safe behavior commitment, for example in this study formal training in the use of pesticides was associated with more frequent use of PPE.

Providing knowledge and awareness sessions as an intervention method is supported by a number of studies. Girgis, Fisher and Watson (1994), in a study of a workplace intervention for increasing outdoor workers' use of solar protection, found significant increase in the safe behavior of the intervention group. The intervention consisted of individual skin screening and participation in an education session. Girgis et al.(1994), argued that although the intervention group showed a significantly greater improvement in their knowledge, no changes in attitude were detected.

Cope and Grossmickle (1986), evaluated three corporate strategies for safety belt use promotion, comparing different types of safety awareness intervention such as the type of presentation format (lecture versus discussion), the presence and absence of safety belt, pledger cards and the presence and absence of an incentive component. Although the workers' behavior showed an increase in safety belt use, sessions with a discussion format produced a greater increase in safety belt use than did lecture-based sessions. Pledge cards and incentives did not increase the impact of these awareness sessions.

The effectiveness of an occupational safety training program was also measured by Cohen and Jensen (1984) in an industrial setting. This study showed that a well designed and administered occupational safety training program emphasizing safe work practice based on accurate assessment of behavioral need can be effective in improving targeted behavior. Koenig and Wu (1994), studied the impact of a media campaign on drivers' risk taking behavior. They found that the media campaign produced significant long-term changes in altering some drivers' behavior in terms of enhancing pedestrian safety. Although the study was concerned with the impact of media campaigns on behaviors, the authors were not certain that the behavioral changes could be attributed only to the impact of the campaign. Some uncontrolled factors such as personal traits, habits and changes in traffic enforcement patterns may have contributed to changes in behavior.

Seppala, Saarela, Nasanen, Aaltonen and Saari (1987), examined the effectiveness of information and motivational measures in improving safety performance in shipyards and in the plywood industry. This study revealed that both measures were effective in improving preventive safety activities and lowering the accident rates.

Sulzer-Azaroff, Loafman, Merante and Hlavacek (1990), developed an injury prevention model to improve occupational safety in an industrial setting. Their study was conducted to measure the effect of targeting safety behaviors on accidents and lost time injuries.

The intervention consisted of goal setting and reinforcement through feedback.

Employees receiving weekly graphed feedback and praise, low cost rewards following achievement of the first goal and special rewards thereafter. The results showed 100% goal achievement, improvement in safety performance consistent with goals, and a significant decrease in accidents and lost time injuries. This shows that a combination of feedback together with reinforcement and goal setting was effective in improving safety behavior.

The effectiveness of interventions such as goal setting and feedback was also shown by Reber, Wallin and Chhokar (1990), in a study of improving safety performance at a farm machinery manufacturing plant. This study revealed that feedback in relation to goals could be a successful behavioral approach to safety. These findings are consistent with those of Sulzer-Azaroff et al. (1990). Similarly, feedback and incentives used by

McAfee and Winn (1989) to enhance workplace safety in the industrial setting were successful in improving safety conditions and reducing accidents in the workplace. The effectiveness of different types of feedback is shown in a number of studies. For example, Fellner and Sulzer-Azaroff (1984), evaluated the effectiveness of posted feedback in increasing safety practice in a paper mill. This method of intervention resulted in an increase in safety practice and a decrease in injury rate. Zohar, Cohen and Azar (1980), used information feedback to increase the use of ear protectors in metal fabrication, and found this method effective in increasing use of ear protectors to a level of 85%-90%.

Saarela (1989), used a poster campaign to enhance awareness of hazards and improve safety among workers in scaffolds in a shipyard. After the campaign, the number of occupational accidents was reduced and the workers were more conscious of the hazards associated with the use of scaffolds. Saarela (1989) suggests that there are numerous factors which may improve workplace safety, and poster campaign is one such method.

There are other studies investigated the effectiveness of incentives and enforcement. Mortimer, Goldsteen, Armstrong and Macrina (1990), evaluated incentives alone, enforcement alone and incentives combined with enforcement in increasing the use of seat belts by drivers. Both enforcement alone and incentives alone produced a significant

increase in the use of seat belts, but the greatest increase occurred with the combined use of incentives and enforcement.

A number of studies have tried to find the most effective intervention method of behavior modification. For example, Krause and Hidley (1992), in an attempt to discover the factors that have the strongest influence on behavior, introduced Antecedent-Behavior-Consequence (ABC) analysis. According to Krause and Hidley, an antecedent is a factor which precedes and evokes a given behavior and consequence is the outcome of a given behavior. For example, telephone rings (antecedent), someone answers the phone (behavior) to see who is at the other side of the line (consequence). The antecedent has an indirect control and the consequence has a direct control over behavior. For example, what would happen if the telephone rang and when picked up there was silence or a rude response? Obviously after a couple of times we would stop answering the phone (behavior), because we would no longer trust the phone (antecedent) to predict a consequence of interest to us.

Krause and Hidley argued that some consequences are more powerful than others and the strongest possible consequence is one that is immediate, certain and positive. Timing is important for a consequence to be effective. Similarly, a consequence that occurs immediately is more effective in controlling behavior. A more consistent consequence can have greater control over behavior and finally a positive consequence also controls behavior more powerfully than a negative consequence (Krause and Hidley, 1992).

Krause and Hidley (1992), consider that a negative consequence is less effective than positive ones. Saari (1998), also argues that punitive action is associated with negative side effects such as creating a dysfunctional organisational climate in the workplace, uncooperativeness and antagonism, and these might discourage the occurrence of safe behavior or even stimulate the occurrence of some unwanted behavior.

In conclusion, according to the studies reviewed above, there are many varieties of intervention for promoting safe behavior. Intervention consisting of knowledge and awareness was supported by Girgis et al (1994) and Cope et al (1985) and formal training was supported by Avory and Coggon (1994), and Cohen and Jensen (1984). Feedback is also believed to be effective in promoting safe behavior (Sulzer-Azaroff and Fellner, 1984; McAfee and Winn 1989; Zohar et al., 1980; Saari, 1990, Reber et al., 1990), while Locke and Latham (1984) reported that specific goal setting together with knowledge of the results (related to the specific goal) could be more efficient to increase safe performance. Mortimer et al. (1990), suggested that a combination of incentive and enforcement yields better results in safety behavior. On the other hand some researchers have found that combined techniques of knowledge and motivational measures such as feedback were more effective in safety behavior improvement (Chhokar, 1987 ; Seppala et al., 1987).

The type of feedback in the above studies was all positive feedback, while few studies address the effect of negative feedback such as punishment on safety behavior. Peters (1991) reviewed the effect of five strategies such as incentives, disciplinary actions, fear message, behavior modelling and employee surveys to encourage self-protective behavior and/or avoid unsafe behavior. Peters found little evidence exists on the extent to which organisations actually use disciplinary actions to improve safety or whether this approach was effective. Peters concluded that there are theoretically sound arguments on the disadvantages of using disciplinary actions, however this along with the lack of empirical basis for effectiveness of this approach makes it difficult to come up with a definite conclusion. In summary, the review of literature provides no sufficient evidence on the effectiveness of punishment to encourage safe behavior (Saari, 1998) and it is suggested that this method has negative side effects. It seems that more research is needed to be done to help better understanding of the effects of this type of behavior reinforcement.

In contrast to punishment, there is evidence that incentive programmes have a positive effect of enhancing safe behavior (Saari, 1998). Therefore in preparing any intervention it is important to consider the effects and side effects of the method chosen for behavior modification.

As was noted in the studies described above, some methods and approaches for

intervention were more effective than others. For example, providing workers with feedback on safe behavior had a better effect on their safety behavior than providing them with knowledge of safe behavior. There might be different reasons for this. One possible reason could be that certain interventions are effective for certain people only. This could mean that individual differences play an important role in the effectiveness of an intervention. For example, individuals with different safety perceptions and attitudes might have different responses to the feedback given for their behavior. None of the studies described in this review focused on the effect of different methods of intervention on individual worker's perception of safety. It seems that there is a need to study the effect of a single method of intervention (providing knowledge of safe behavior) and the effect of a combined method of intervention (providing knowledge together with feedback on safe behavior) on workers' safety perception and safety behavior.

1.6. Aims and questions of the study

The literature review shows that human behavior is important in safety, and factors such as the individual's safety attitude and perception, personal characteristics and workplace characteristics might play role in determining safety behavior. The literature review, however, does not provide sufficient information on the relationship between safety perception and safety behavior, mainly because of the very limited number of studies on the relationship between safety perception and safe behavior. The present project seeks to fill the information gap revealed by the literature review. It is hoped that the contribution of this study towards understanding the relationships between safety

perception and safe behavior will assist in the design and implementation of a comprehensive national strategy for the modification of safety behavior and the prevention of occupational accidents and injuries. The ultimate aims of the study are:

1. To understand the relationships between workers' safety perceptions/attitudes and their levels of safe behavior expressed as their use of safety measures.
2. To understand the influence of variables such as personal characteristics on workers' safety behavior.
3. To compare the effectiveness of intervention techniques, a single method of knowledge intervention and a combined method of knowledge and feedback intervention, on workers' safety attitude/perception and safety behavior.
4. To investigate how individual differences in safety attitudes and perception influence the effectiveness of these intervention.

To achieve these aims, number of questions were designed to be assessed and answered through the study.

Chapter 2

Justification of the method

2.1. Introduction

Safety perception and attitude are often assumed to be important determinants of safe behavior, although the nature of this influence and relationship is not yet fully understood. This thesis will take up the issue of the relationships between safety attitude/perception and behavior. In this context, it is important to consider the issues of the best measurement for safe behavior and safety attitude and perception. Therefore the accurate measurement of safety attitudes, beliefs and perceptions is an important issue.

Safety perception and attitude can be measured by questionnaire. For example, Assum (1997), studied the importance of attitude to road safety using 56 attitudinal questions concerning important aspects of road safety and to assess drivers' attitude toward road safety. Assum found that when no other factor is taken into account, accident risk was affected by drivers' attitude in that drivers with a positive attitude towards traffic safety had fewer accidents than drivers with negative attitudes. On the other hand when drivers' age and annual mileage were taken into account, the relation between attitude and accident risk disappeared. Assum concluded that the relationship between attitude and road accidents was not clearly understood and more investigation was needed.

Although the assumption that safety performance is affected by an organisation's socially transmitted beliefs and attitudes towards safety is not new and is supported by a number of researchers, there is no clear understanding on how this safety "climate" effects safety behavior. It is argued that the shared beliefs of a work group are related to their general level of safety in their work situation. This assertion is based on findings of Smith, Cohen, H.H., Cohen, A and Cleveland (1978), who found that workplaces with good safety records also have good management commitment to safety. In other words, organisational concern and support for safety activities is the main factor in a successful safety experience in the workplace.

The concept of safety climate was developed by Zohar (1980a). According to Zohar, safety climate refers to the workers' shared perceptions and attitudes of safety in their workplace. There are several definitions of safety climate. For example, Glennon (1982) defined safety climate as " employees' perception of the many characteristics of their organisation that have a direct impact upon their behavior to reduce or eliminate danger".

Niskanen's (1994) definition of safety climate is based on three assumptions (modified from James and Jones, 1974) as follows:

1. Safety climate is a perceptual variable, dependent on self measures from workers and supervisors.
2. The perceptions of climate are descriptive rather than evaluative.

3. Safety climate is considered to be a psychological climate.

Niskanen then referred to safety climate as a perception of the workers' and supervisors' behavior in terms of the context of their individual actions in the workplace. This perception also includes a set of attributes about particular work settings including maintenance, construction and other facilities.

Although the concept of safety climate is not a new concept, it seems that there are discrepancies about what it means and how it is measured. In other words, one of the major issues for refining the safety climate concept is the development of effective measures for the concept.

Literature review shows that there is currently relatively little knowledge of the components of the models of safety climate and how it should be measured.

Zohar (1980a) in his study of the organisational safety climate constructed and validated a 40 item measure of organisational safety climate and used it in 20 industrial settings which produced eight factors. These were, level of risk at work, management's attitudes toward safety, the importance of safety programs, effects of safe conduct on promotion, effects of required work pace on safety, status of safety officer, status of safety committee and effects of safety conduct on social status. Zohar argued that management's positive attitude and commitment to safety were prerequisites for achieving a successful level of safety in an organisation.

Brown and Holmes (1986) questioned Zohar's results for their generality. They found that Zohar's measurement model did not adequately represent the predefined safety climate in the samples they used. Brown and Holmes used their data to refine the model, using an explanatory approach to factor analytic model building, and found three significant principal factors. These factors were employee perception of how concerned management was with their well-being, employee perception of how active management was in responding to this concern, and employee physical risk perception. These three factors then were tested across two groups of samples: accident-involved and not accident-involved. The accident-involved samples showed a significantly lower level of risk perception, lower level of perception of management concern and lower level of perception of management action than the samples with no accident involvement. Brown and Holmes concluded that evaluation of these differences could provide alternative ways to prevent accident and injury. For example, evaluation of these factors could provide information on workers' attitude and perception of safe behavior. This information could then be used to prevent accidents by applying relevant accident-prevention intervention.

Subsequently, Brown and Holmes' three factor safety climate model was tested with construction workers by Dedobbeleer and Beland (1991). In order to perform the test, Dedobbeleer and Beland conducted two procedures using (a) the maximum likelihood method chosen by Brown and Holmes and (b) the weighted least squares method. Although the results from the maximum likelihood method indicated

that Brown and Holmes' model was supported by Dedobbeleer and Beland's data, the model was not retained because the weighted least square procedure showed that a two factor safety climate model was more appropriate. These factors were management's commitment to safety and workers' involvement in safety. The first factor (management's commitment to safety) consisted of three elements:

- workers' perception of management's attitude toward safety practice and workers' safety
- workers' perceptions of foreman's behavior
- availability of safety rules and instructions and proper equipment to perform safely

The second factor (worker's involvement in safety) consisted of four elements:

- worker's perception of susceptibility to injuries.
- workers' perception of risk taking at work.
- workers' perception of control over one's own safety at work.
- presence of regular safety meetings.

Some of the results of Dedobbeleer and Beland's (1991) study suggest that specific questions about both workers' perception of management's commitment to safety and workers' involvement or responsibility in safety should be included in safety climate surveys.

The above models attempted to determine which factors are enhanced in safe work

practice. Consequently, methods developed for evaluating safety climate should include investigation of the factors that are known to be associated with safe behavior.

Although measuring safety climate provides information about safety perception and safety attitude, it is not adequate for providing a good understanding of the level of safety in workplaces. Safety level refers to the extent of workers' involvement in safe behavior. For example, providing that there is a good safety climate in the workplace, do workers also observe safe work practices? In order to gain a better understanding of the safety level in a workplace, the safety behavior of the workers should be measured, along with the measurement of their safety perception and attitudes.

Measuring safety perception and attitude of workers along with measuring their actual behavior at work could provide an extensive source of knowledge and information about the level of safety in a workplace and might clarify the factors underlying workers' safe and unsafe behavior. This information then could be used as a resource in behavior modification.

2.2. Measuring safety perception and safety attitude

Several studies have attempted to develop appropriate measures of safety climate (Zohar, 1980a; Brown and Holmes, 1986; Dedobbeleer and Beland, 1991; Cox and Cox, 1991; Seppala, 1992; Niskanen, 1994; Donald, Canter and Chalk, 1991;

Williamson et al., 1995).

Although Brown and Holmes' (1986) three factor safety climate measure was supported by the results of another study (Dedobbeleer and Beland, 1991), it excluded several aspects of safety climate measure such as workers' perception of personal safety responsibility and workers' perception of safety priority. Similar criticisms apply to Dedobbeleer and Beland's two factor safety climate measure.

A safety climate measure was produced by Niskanen (1994), who used a three part questionnaire to study the safety climate in road administration. Responses were obtained on a five point scale from agreement to disagreement. The first part was a ten items questionnaire for workers and supervisors, and the second and third parts were 12 additional items for workers and 11 items for supervisors. The common ten items were:

- Safe work habits improve production
- The prevention of accidents is the responsibility of everyone
- Safety is a part of job performance
- The causes of accidents is workers' indifference towards safety
- The causes of accidents is middle management's indifference towards safety
- Accidents occur by chance
- It is easy to discuss safety with supervisors
- Supervisors emphasise cost effectiveness even if it means taking risks

- Supervisors emphasise safe work habits even if they incur extra expenses
- Supervisors give positive feedback for good work

The additional 12 items for workers and 11 items for supervisors were used to measure variables such as giving and monitoring of instructions, clarity of instructions, safety inspections, diversity of work, independence of work, influence on planning and organisation, discussions with workmates, importance of work and personal relations (Niskanen, 1994).

Niskanen's findings indicated that there were four dimensions in safety climate for workers: changes in work demands, appreciation of the work, attitude towards safety in the organisation and safety as a part of productive work. For the supervisors, safety climate involved the elements of changes in job demands, attitude towards safety within the organisation, value of the work, and safety as a part of productive work.

Seppala (1992), in an attempt to evaluate safety measures, safety improvements, and relationships to occupational accidents, investigated workers' perception of the safety climate and the relationship between safety climate perception and the occurrence of accidents in the workplace. Seppala concluded that there were three dimensions in safety climate:

- workers' indifference toward safety
- workers' concern about safety hazards

- organisational responsibility for safety

In another study, Cox and Cox (1991) attempted to measure employees' attitudes towards safety in a European company, using a questionnaire consisting of four sections. The first two sections measured employees' (a) attitudes to good safety practice and (b) attitudes to the company's safety philosophy and culture. The third section measured employees' perception of management's attitude to safety, and the fourth section sought suggestions on how attitudes to safety might be improved. Five point scales (strongly agree, agree, no opinion, disagree and strongly disagree) were used to record responses. Factors emerging from this evaluated by questionnaire were personal scepticism, individual responsibility, safeness of work environment, effectiveness of arrangements for safety, and personal immunity. Cox and Cox argued that the data from this study were useful to provide knowledge of the employees' attitudes to safety, and therefore to design strategies for enhancing organisational safety culture through attitude change.

The model proposed by Cox and Cox (1991) has a broader view of attitudes towards safety by including statements such as "safety works until we are busy", "People who work to procedures will always be safe".

2.3. Design of the present study

The design of this study included two stages. In the first stage, the individual worker's

safety perception/attitude and safety behavior were measured using the Safety Perception/Attitude Questionnaire and using the Observational Checklist. An appropriate coding system was used to make linkage of the individual's safety perception and safety behavior.

In the second stage of the study, two intervention methods were used to modify individual worker's safety perception and safety behavior. These methods consisted of a single method (providing workers with knowledge of safety) and a combined method (providing workers with knowledge of safety and providing them with positive feedback on their safe behavior). The full description of the first and second stage of the study can be seen in chapter 3.

Because the intention of the present study was to measure the safety attitudes and perceptions which are most likely to be associated with safety behavior, the Safety Perception/Attitude Questionnaire developed by Williamson et al. (1995), was used for this purpose. The reason for use of the Safety Perception/Attitude Questionnaire is that it is consistent with an approach which assumes that safety climate is based on workers' attitudes and perceptions about safety in general and their perceptions of the characteristics of the workplace related to safety issues. This questionnaire contained questions about attitude to safety and items about perception of safety in the respondents' workplace. The use of both types of items was likely to provide insight about the respondents' orientation toward safety from attitudinal and perceptual points of view

(Williamson et al., 1995). The questionnaire also contained items concerning safety behavior. It was therefore assumed that this Safety Perception/Attitude Questionnaire was an appropriate instrument to measure safety perception and safety attitude of workers in the present study.

The factors generated in the final version (short scale) of this Safety Perception/Attitude Questionnaire reflect general attitude and perception of safety in the workplace. These factors are (a) personal motivation for safe behavior (b) risk justification (c) positive safety practice (d) fatalism and (e) optimism. The short scale questionnaire contained 17 questions and includes perceptual and attitudinal items, three questions on the existence of dangers in the workplace and likelihood of accidents in the workplace, two questions about the meaning of safety and nine demographic-type questions. Attitudinal (philosophically based) items reflect beliefs and ideas about safety, such as “everyone has an equal chance of having an accident”, “people who work to safety procedure will always be safe”, “accidents will happen no matter what I do”, “if I worried about safety, I would not get my job done” and “not all accidents are preventable, some people are just unlucky”. While the perceptual questions (reality based) also focus on the safety beliefs of individuals, they reflect the respondent’s perception of reality and the real situation in their workplace. For example, “in the normal course of my job, I do not encounter any dangerous situations”, “if I worried about safety all the time, I would not get my job done”, “it is not likely that I will have an accident because I am a careful person”, “safety works until we are busy, then other things take priority” and “people who do not take the

necessary precautions are responsible for what happens to them”. Safety practice is reflected by items such as “people who work to safety procedure will always be safe”, “everybody works safely in my workplace” and “all the safety rules and procedures in my workplace really work”. Risk taking is reflected in one item “I cannot avoid taking risks in my job”.

In addition one question was included regarding personal motivation for safe behavior “it would help me to work more safely if (a) my supervisor praised me on safe behavior and (b) safety procedures were more realistic”. Three questions were included regarding risk justification “when I have worked unsafely, it has been because: (a) I didn’t know what I was doing wrong at the time, (b) I needed to complete the task quickly, and (c) the right equipment was not provided or wasn’t working”.

Likert-format questions with five categories of response were used for the first 17 items in the questionnaire. For most items the categories ranged from “strongly agree” to “strongly disagree”. For eight items on the perception of safety activities in the workplace, the categories ranged from “always” to “never”. Three questions in the safety evaluation section were in yes/no format. One item from this section ranged from “very likely” to “don’t know”, and the rest were in open ended format. For the purpose of this study, the results on the first 17 items in the short scale Perception/Attitude Questionnaire were analysed and discussed. The results on the rest of the questions in the questionnaire to be reported elsewhere.

While the Safety Perception/Attitude Questionnaire provides understanding of the workers perception and attitude of safety at work, it is very important to understand how this safety perception and attitude relate to their safety behavior. For this reason it is necessary to assess and measure the level safety behavior of the workers at work.

2.4. Behavioral measurement

Measuring behavior in a workplace is important in understanding the level of safety. Krause et al. (1984), considered that unsafe behavior is important in causing accidents. Ignoring the role of unsafe behavior could result in ignoring useful information about factors which are most likely to occur prior to an accident and to cause accidents. In this area, analysis of the information regarding workers' behavior for example, has been used mainly to assess and pinpoint the cause(s) of unsafe behavior. Behavioral analysis is the assessment of the consequences of desired and undesired behavior (Krause et al., 1984). Where the first step in behavior analysis is to measure the behavior.

One of the prerequisites in analysing behavior is that it must always be operationally defined. It is hard to measure safe work practice unless it is operationally defined, because the concept "unsafe work practice" might have different meanings for different people, however, behaviors such as "using shield while grinding" and "wearing respirator while spraying paints" are easy to measure because they are operationally defined safe

behaviors. Another advantage of defining safe or unsafe behaviors is that it makes it possible to provide appropriate feedback as these behaviors occur. This feedback could be useful in behavior modification.

Review of the literature shows that in the majority of studies, the behavior is measured using an instrument designed and tailored to the particular workplace.

Ojanen, Seppala and Aaltonen (1988), assert that behavior sampling based on random observations of behavior is a useful measure for evaluating workers' behavior while performing their task. Also behavior sampling may be used to determine the amount of changes in behavior over time (Ojanen et al., 1988).

Komaki et al. (1979), in their study of a behavioral approach to occupational safety, designed an observational code to measure the safety level. They also tailored the observational code to reflect the differences in tasks in each department. For example, for the wrapping department there were 15 items while for the makeup department there were 20 items to observe with only three items being shared by both departments. The observational code divided behavior into safe behavior, unsafe behavior or not observed. Any time an item (a behavior) was performed unsafely, it was recorded as "unsafe" regardless of the number of times it had been performed unsafely. Observations were carried out at different times of the day and were conducted four days a week. The percentage of safe performance was then calculated.

Sulzer-Azaroff (1987), believed that accurate observational recording to be important and essential in the process of an effective behavior modification program. Sulzer-Azaroff, Loafman, Merante and Hlavacek (1990), used an observational recording system based on one used by Sulzer-Azaroff and Felliner (1984) to measure the effect of targeting safety behaviors on accidents and lost time. In this observational recording system, safe performance was defined clearly as operations to be scored according to the number of workers complying and not complying with the proper procedure. In the observational recording process, repetitive movements (the operation of staple guns) were observed and counted for several sequences in a row. For conditions, each sub-unit's work area was divided into a set of zones. Safe conditions were scored for the number of instances and their locations indicated on a schematic map of the work area. A zone was scored as safe when no instances of unsafe performance were found. A sample observational recording form as used by Sulzer-Azaroff et al.(1990) is shown in Figure 2.1.

Figure 2.1: Sample observational form (Source: Sulzer-Azaroff et al., 1990)

DEPARTMENT _____ DATE _____
 SUPERVISOR _____ TIME _____
 OBSERVER _____

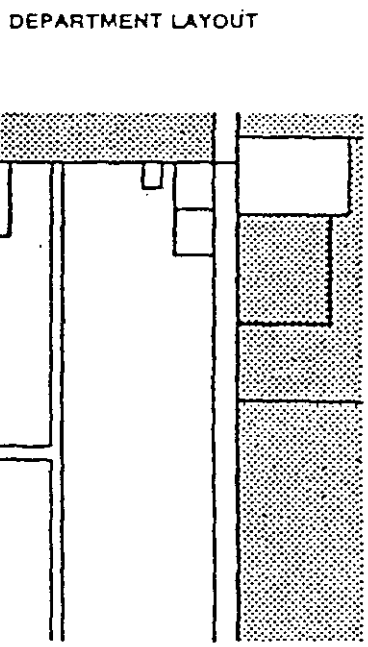
BEHAVIOR

Procedure	Number Using	Sub Total	Number Not Using	Sub Total	Total	%
Carry close to body: pivot, no twist	_____	_____	_____	_____	_____	_____
Slide Back Plane 1/3 out of cart LM and carry close to body	_____	_____	_____	_____	_____	_____
2 people lifting/carrying loaded tray	_____	_____	_____	_____	_____	_____
Equipment						
Safety Glasses at GD Machines	_____	_____	_____	_____	_____	_____
Shoes and Closed Toe & Heel No Canvas	_____	_____	_____	_____	_____	_____
	%		%			

CONDITIONS

Area	Subtotal Incidents
TOM Loaded trays hanging over cart into aisle area	_____
DO Doors to hydraulic unit closed	_____
AG Nozzles in place on air guns	_____
SL No oil/liquids in walking areas	_____
Handling	
LBP Loaded back plane trays 12 high maximum	_____
TS Trays MT or full on top of cart	_____
WF Wiring fixtures in racks	_____
NC NC tapes filed in cabinets	_____
TOTAL INCIDENTS _____	

_____ Of 2 Zones Safe
 _____ Of 2 Zones Not Safe
 _____ % of Zones Safe



NOTES: _____

For the purpose of the present study, workers' behaviors while working were observed and recorded on an observational checklist. The observational recording method used in the present study was similar to those of Komaki et al. (1979) and Sulzer-Azaroff et al. (1990). The observational checklist was used to measure safe and unsafe behavior of workers in terms of wearing or not wearing Personal Protective Equipment (PPE), by sampling workers' behavior. The reason for this selection was that wearing PPE increase worker's level of safety, failure to wear PPE will result in acute and/or chronic damage, access to PPE was easy and free of charge, management does not make PPE wearing a condition of continued employment and finally wearing or not wearing of PPE is easily observable.

The observational checklist used in this study was designed to allow the observer to record every safe and unsafe behavior performed by each worker at the time of observation. In the observational checklist there was a space provided for every single targeted behavior to be recorded. A plus (+) sign indicated that the safe behavior was performed, for example, ear plugs were placed correctly. A minus (-) sign indicated that the safe behavior was not performed, for example, ear plugs either were not worn or were not placed correctly. This design made it possible to compute the number of safe and unsafe behaviors for each worker for any observation period.

Accurate recording of safe and unsafe behavior could provide useful information for an

effective behavior modification programme. Sulzer-Azaroff et al.(1990) consider this information essential to effective behavior modification. For this reason, in the later part of the present study a behavior modification method was designed and was tailored as a technique to modify workers' safety behavior.

CHAPTER 3

METHODOLOGY

Overall design of the project

This study was conducted in two stages. The first stage involved investigation of the relationship between safety attitude/perception and safety behavior. For this, the workers were observed for safe behavior while working. Immediately after all observation were completed for these workers, their safety attitude and perception were measured and compared with control group. The second stage involved examination of the influence of variations in safety attitude and behavior on the effectiveness of safety interventions. For this, the workers participated in the first stage of the study were participated in a knowledge session. These workers then were divided in two groups. Group 1 who participated in the knowledge session only and group 2 who also participated in the knowledge session, but in addition received verbal and written feedback on their individual behavior. These groups were observed for safe behavior and immediately after observation were completed, their safety attitude and perception were measured and compared with control group. Finally all workers participated in the second stage were reobserved four weeks after and compared with control group to confirm the stability of their safe behavior. Details for the groups in each stage will be described in turn.

1- Linking safety attitude and perception with safety behavior

1.1. Sample selection

The sampling involved four steps:

Step 1 Initially all small and large factories located in the Sydney metropolitan area were identified from the Company Information List (compiled by the NSW Department of Industrial Relations). For this, 200 telephone contacts were made. Then the nature of their product was ascertained and the maximum number of items of PPE that should be worn by workers was determined, through telephone conversations with the Safety Officer for each work group in each company. During the telephone conversations initially information was gathered on the type of PPE workers were required to wear, the conditions for wearing and the availability of PPE. Then the nature, goals and advantages of the project were also explained and companies were invited to participate in the study. A total of 40 companies expressed interest in learning more about the project. The other companies did not participate for several reasons, 70% was because they chose not to participate, and 30% was because the nature of their product did not required PPE (e.g. import and export companies, major retailers, designers).

Step 2 An invitation package consisting of a copy of the safety perception questionnaire, a copy of the observational checklist and a letter explaining study procedures and the purpose, goals and nature of the study was forwarded to those companies who expressed interest in participating in the project.

Step 3 After two weeks these companies were contacted again by telephone to confirm participation in the study process and to make an appointment for a personal meeting with the management. Of those companies who initially expressed interest in the project and received the invitation package, 20 were interested to learn more about the project and agreed to a meeting with the investigator. After the meeting, 10 of these companies confirmed their participation in the project.

Step 4. In this step, five of these companies were not willing to initiate the study promptly. These companies were producers of:

- Metal products, steel and tubes
- Domestic and commercial furniture
- Display stands and metal shelving
- Aerosol products, domestic
- Woven fabrics.

There were a variety of reasons for these companies' refusing to participate in the study. Two companies were undergoing new management, one was planning relocation and the remaining two were facing the maximum production season and were too busy to participate. The remaining five companies were happy to initiate the project promptly.

1.2. Description of the participating companies

Company 1: This was a heavy engineering company with 300 employees. The product of this company was major construction equipment, e.g. pieces for bridges, tunnels, transmission line towers. The PPE requirements for safe working in this company were goggles, face shield, ear plugs, ear muffs, safety helmet, gloves and respirator (wearing respirators was required for some workers in some stage of production).

Company 2: This was a small company with 32 employees. The products of this company were paint brushes and paint rollers. The required PPE for workers in this company were goggles, face shield, ear plugs, gloves and face mask. There also were some other related safe practice requirements in this company. These requirements were to wear closed shoes and for long hair to be tied up properly.

Company 3: This company was a large manufacturing company with 200 employees. The products of this company were agricultural equipment, electrical appliances and domestic appliances (for example toasters, coffee makers, irons, mixers). The required PPE for the workers in this company were goggles, face shield (this PPE was a requirement only for workers in some workshops), ear plugs, gloves, face mask and respirator (this PPE also was a requirement only for workers in some workshops).

Company 4: This was a company with 154 employees. The products of this company were pumps for hair sprays, pumps for trigger sprays and items for the packaging

industry. The required PPE for workers in this company were goggles, face shield, ear plugs, gloves, face mask and closed shoes.

In companies 1, 2, 3 and 4, wearing appropriate PPE was not compulsory; although the workers were aware of the fact that appropriate PPE was considered necessary for their performance, there was no attempt to make PPE wearing compulsory, so that wearing PPE or not wearing PPE while working was a personal choice.

Company 5: This was a food production company with 120 employees. The required PPE for the workers in this company were ear plugs, ear muffs, gloves, cap and goggles. Unlike other companies, in this company wearing PPE was a condition of commencing work at the beginning of the shift. This means that wearing appropriate PPE was compulsory in this company, and workers without appropriate PPE were not allowed to enter the workshops.

1.3. Subject sampling

The subjects were all employees who worked day shift and the nature of whose job required wearing PPE while working. A total of 570 subjects were selected to participate in the study. Table 1 shows the distribution of subjects for each company:

Table 3.1. Distribution of the subjects by sex for each company.

	Male	Female	Total
Company 1	178	0	178
Company 2	11	18	29
Company 3	170	30	200
Company 4	50	13	63
Company 5	60	40	100

1.4. Instruments

Safety Perception Questionnaires and Observational Checklists were designed and used for data collection in this study.

1.4.1. Safety Perception/Attitude Questionnaire

The safety Perception/Attitude questionnaire used in this study was designed to measure safety climate (Williamson et al., 1995). The Safety Perception/Attitude Questionnaire can be seen in appendix 1. The item pool contained items about attitudes to safety as well as items about perception of safety in the respondents workplace. The attitudinal items concerned aspects of respondents' beliefs about safety which are likely to have been developed through experiences in and outside the workplace, and the perceptual items also revealed aspects of safety beliefs but were directed towards the respondents' perceptions of reality in their workplace (Williamson et al., 1995). The first 17 items

provided information regarding attitude and perception of safety. This part of the questionnaire contained two types of items, philosophical (which measures attitude) and reality based (which measure perception), items 1, 3, 8, 5 and 10 were philosophical items, while items 2, 4, 5, 6, 9, 11, 12, 13a, 13b, 14a, 14b and 14c were reality based items. Risk taking reflected in one item “ I cannot avoid taking risks in my job”. The remaining items (15 items) covered the existence of dangers in the workplace, the likelihood of accidents in the workplace, the respondent’s understanding of the meaning of safety and suggestions to improve safety in the workplace, and demographic items about age, gender, language background, education, experience in the current job, employment status, type of employment, and accident and injury experience.

Format for measuring

The first twelve items used Likert-type items with five response options of ‘strongly agree’, ‘agree’, ‘neither agree or disagree’, ‘disagree’ and ‘strongly disagree’. For items thirteen to seventeen the response categories ranged from ‘always’ to ‘never’. For items 15 and 16 (likelihood of accidents in the workplace) the response categories ranged from ‘very likely’ to ‘ very unlikely’ and ‘don’t know’. The remaining items had either ‘yes’ or ‘no’, single/multiple choice or open ended question format.

Because of the nature of some items, the direction of scoring was reversed for them.

These are items 1, 3, 6 and 12. In other words most items were scored

with 1 = 'strongly agree' to 5 = 'strongly disagree', such that disagreeing with the statement indicated a positive attitude to safety, however, for items 1, 3, 6 and 12, the scoring of the scale was reversed with 'strongly agree' scored as 5 and 'strongly disagree' scored as 1. This was done to make sure that high scores in each item always represented better safety perception/attitude. For example, for item 1 "Everybody has an equal chance of having an accident", a strongly agree response shows a positive attitude toward safety and would be scored as 5. This was the same for item 3 "People who do not take the necessary precautions are responsible for what happens to them", item 6 "People who work to safety procedure will always be safe" and item 12 "All the safety rules and procedures in my workplace really work".

1.4.2. The Observational Checklist

The Observational Checklist measured the safe and unsafe behavior of workers in terms of either wearing or not wearing PPE by sampling workers' behavior. The observation instrument consisted of a checklist in which an observer marked whether an individual was wearing or not wearing particular pieces of PPE. The checklist sheet allowed for up to 5 pieces of PPE to be recorded. The recording on the observation sheet (Behavior Checklist) was based on the number of the PPE expected to be worn in each workplace. It also included date, place, time and period of behavior being observed. Each individual was identified by a code number in the Observation sheet. This code number consisted of two to three letters and a three digit number. The letters were either the first

two or three letters of the name of the workplace or the first letter of the name of the workplace followed with another letter indicating the specific location of the worker (e.g. workshop), and the three digit number indicated the individual worker. The same code number was used for the Observational Checklist as for the Perception/Attitude Questionnaire. The Observations Checklist can be seen in appendix 2.

Reliability of observation method

The reliability of this observation method was assessed using the percentage agreement method (Komaki, Heinzman and Lawson , 1980). Reliability was calculated twice in each workplace, once during the main stage (first stage) of the study and then during the intervention stage (second stage). This was done to make sure that the time gap between the first stage and the second stage had no effect on the reliability of the checklist. In each stage the main coder (the investigator) and independent coders from the workplace observed the work force's behavior at work at the same time. This was done on two occasions with two different coders from each of the five workplaces. This means that the coding of the main coder was compared with that of two other independent coders across the course of this study.

Always more than one-third of the subjects in each work place were observed to determine the reliability of observation. For each workplace, the total number of items of PPE which should be worn was determined. In order to calculate the reliability of the observation method, observations by the main coder were compared with those of the

independent coders by checking the number of “agreements” between the coders on their coding. This means that the coding agreements were counted when equal numbers of PPE were recorded by two coders, and disagreements were counted when any differences were recorded in the number of PPE being worn by individuals in the workplace. For example, if one coder reported that four out of five items of PPE were worn, and the other reported that five out of five were worn, this would be regarded as one disagreement. At the end of observations, the average agreements between observer 1 and each of the two observers in each company were considered as the overall reliability of observation in each workplace. Table 3. 2 shows the reliability results in the first stage of study. As it is shown this table, a total of 287 subjects were observed for determining observational reliability in the first stage. The maximum agreement percentage was 100% between observer 1 and 2 and between observer 1 and 3 for company 2. The minimum percentage was 96.42

Table 3. 2. Average percentage agreement in stage 1 for each workplace between observers 1 and 2 and between observers 1 and 3, showing number of worker observed in each workplace.

	Observers 1 and 2 (% agreement)	Observers 1 and 3 (% agreement)
Company 1 (n = 108)	98.15	97.22
Company 2 (n = 28)	100.00	100.00
Company 3 (n = 88)	98.9	97.73
Company 4 (n = 28)	96.42	96.42
Company 5 (n = 35)	97.14	97.14
Mean % agreement (n = 287)	98.12	97.70

This means that the agreement was consistently high for first stage of the study.

The overall reliability for this stage was 97.91. This high average means that the observation method achieved a high reliability and that there appeared to be very little affect of observer bias.

1.5. Procedure

The procedure for data collection is described for each stage of the study as follows:

Stage 1: Measuring safety perception and safety behavior

Initially all subjects were observed individually for safe behavior (whether or not they were wearing all or some of their appropriate and required PPE or not wearing PPE at all) while working. The observations were carried out on a random basis. This means that the observations were done on different days and at different times of the days. The observation times were chosen carefully in order to avoid a fixed time schedule by observing subjects at different times of the day (before and after lunch and tea time, early in the morning, late at the end of the shift and within the shift). This was done to minimise the workers' guessing of observation time, hence to minimise any specially pre-arranged safe behavior by the workers (subjects). Although the subjects were aware of the observation at the time, they were not aware of the exact times and dates that observation would occur. The subjects were told that this observation was part of a safety research project, and that their co-operation was appreciated and their working privacy would be respected by the observer. Workers were asked to ignore the presence of the observer in the workplace. The subjects were observed for five

consecutive working days. The observation period for each individual lasted 1-5 minutes. Observations were conducted in full view of the employees but recorded as unobtrusively as possible. No names were recorded on the checklist. Every subject was given a code number and only the code number appeared on the checklist.

In each company the subjects were divided into small groups and an identification code number (described in the instrument section) was allocated to each subject. This code number was used as a way of linking each subject's questionnaire responses with observed behavior. This means that matching code numbers were recorded on the checklist for each subject and also on the Safety Perception/Attitude Questionnaire given to the same subject. This made possible the linkage of subjects' responses to the safety questionnaire and their safety behavior.

Prior to actual data collection each subject was observed several times by the investigator for familiarising purposes, to ensure that subjects could be easily identified by the observer. This means that the investigator spent as much time as possible familiarising herself with each subject by memorising either the subject's given name, appearance, working area and code number or by a combination of two or more of these factors. In fact for most subjects, all these factors were noted, memorised and sometimes recorded (in separate personal notes) by the investigator to make identification of the subjects certain. The familiarisation process stopped only when the investigator was confident of being able to identify the subjects.

For each observation period, each subject was observed as unobtrusively as possible.

The extent of safe behavior was scored for each individual worker in terms of the number of PPE items being worn at the time. This was then converted to a percentage score of the total number of items that should have been worn at that time. For example, a worker who was required to wear goggles, face shield and gloves but who at the time of observation while welding was wearing only a face shield, would be scored 0.33, as this subject complied with only one third of the appropriate PPE.

Immediately after all observations were completed, the safety questionnaires were administered by the investigator to the subjects in each workplace to obtain data on their safety attitude and perception. Locked return boxes which were opened by the investigator only were provided for each workplace. The investigator handed the questionnaire to each subject personally and explained the response method to the subjects. The subjects were encouraged to complete the Safety Perception/Attitude Questionnaire in their free time and drop it in the provided locked box(es) located in the areas. They were also encouraged to seek help regarding completion of the questionnaire and to discuss any problems with the investigator. All questionnaires were administered on the same day. Then the subjects were given one week to complete and return the questionnaire to the provided locked metal box(es). The investigator spent some time every day at the company and encouraged workers to complete the questionnaire and to discuss any problems regarding completion of the questionnaire.

One day prior to the last day for return of the questionnaire, the investigator walked through the company and reminded the workers to return the questionnaire on time.

The anonymity and confidentiality of the questionnaires were strictly considered in all stages of data collection. No names were recorded on the questionnaires and locked metal box(es) were provided in each workplace for returning the questionnaires.

Table 3.3 shows the number of participants and the number of returned Safety Perception Questionnaires for each company. Although 570 subjects were initially studied (observed 15 times and had safety perception questionnaires handed to them), only 301 questionnaire (52.8%) were returned. The lowest response range was for Company 1, where 21.35% of the questionnaires were returned and the highest response range was for Company 4, where 77.8 % of the questionnaires were returned. The reason(s) for not returning the questionnaire were not discussed with the workers because participating in the study was absolutely non-compulsory.

Table 3.3: The number of the Safety Perception/Attitude Questionnaire and the number of respondents.

	No. of questionnaire given	No. of questionnaire returned
Company 1	178	38
Company 2	29	20
Company 3	200	131
Company 4	63	49
Company 5	100	63
Total	570	301

Stage 2: Intervention

2.1. Sampling and study population:

Those workers who participated in the first stage of the study were the source population for the intervention stage. The criteria for selection were:

- The subject participated in the first stage and responded to the Safety Perception Questionnaire
- The subject agreed to participate in the second stage of the study
- Management agreed to the subjects' participation in the study

Four of the companies (companies 2, 3, 4, 5) participated in stage 2 of this study and one company (company 1) stopped participation after stage 1 of the study. There were several reasons for company 1 failing to participate in stage 2 of the study. At the time stage 2 was about to commence, there was a significant replacement of staff at the management level and a subsequent review of company policies. Around 80 workers were retrenched following the change in management. Some of these workers were subjects. All these factors made it difficult to proceed with stage 2 of the study in this company.

Although it was anticipated that all the source population from the remaining companies would participate in the second stage, a number of subjects either were not happy to take part in the intervention stage or were not encouraged by management to participate.

The major loss was for Company 5 in which only 47.6% of the subjects who participated in the first stage of the study also participated in the second stage of the study. The minor loss was for Company 4 (79.6%). Also 75.6% of the subjects in Company 3 and 70% of the subjects in Company 2 who participated in the first stage of the study also participated in the second stage. In total, 182 workers were happy to participate in the stage 2 of the study. Table 3. 4 shows the distribution of the subjects who participated in the second stage of the study.

Table 3. 4: Distribution of workers in each company participating in the second stage of the study. Gender distribution is also shown.

	Company 2	Company 3	Company 4	Company 5
Male	5	82	14	6
Female	9	5	13	18
Gender not addressed by respondent	0	12	12	6
Total	14	99	39	30

2.2. Instruments:

2.2.1. The Safety Perception Questionnaire: The same Safety Perception/Attitude Questionnaire which had been used for the first stage of the study was also used to collect data on subjects' safety attitudes and perceptions.

2.3.2. The Observational checklist:

This instrument had been used in the first stage was also used in the intervention stage to collect data on subjects' safe behavior. The same method of calculating reliability was conducted for the intervention stage (stage 2) of the study. Table 3.5 shows the results for this stage.

Table 3.5 : Percentage average agreement in stage 2 for each workplace between observers 1 and 2 and between observers 1 and 3, showing number of workers observed in each workplace.

	Observers 1 and 2 (% agreement)	Observers 1 and 3 (% agreement)
Co 2 (n =10)	100	100
Co 3 (n =60)	98	96
Co 4 (n =15)	95	95
Co 5 (n =20)	100	100
Mean % agreement	98.25	97.75

As Table 3.5 shows, 105 subjects were observed for determining observational reliability in the second stage. The maximum percentage agreement was 100 between observers 1 and 2 and also between observers 1 and 3. The minimum percentage was 95. To determine overall reliability for the second stage of the study, the average percentage agreement was calculated. The results revealed that average percentage reliability between observers for all companies was 98 for the second stage. This means that agreement was consistently high in stage 2 of the study. This high average means that

the observation method achieved a high reliability and that there appeared to be minimum effect of observer bias.

The high reliability results for the intervention stage were similar to those of the first stage. This shows that there was little change in the level of reliability of the main observer's judgements across the period of this study. In conclusion, the results of this study confirm the applicability and high reliability of this observation method to measuring safe behavior.

2.3. Procedure

When the intervention procedures were discussed with the subjects some of them were not happy to participate in all steps of the intervention stage because of time constraints, they stated that attending the knowledge session would interfere with their lunch or tea break, and that they always had only limited time to have a quick break and go back to work. However, these subjects agreed to be observed and to complete the Safety Perception/Attitude Questionnaire. For these reasons these subjects were placed in the Comparison group. The workers/subjects who agreed to participate in the intervention were placed in the Intervention group. It should be mentioned that there were no differences between the workers who did not consent and the workers who consented to participate in the intervention. However it is presumed that the workers in comparison group experienced more time pressure due to the location of their workshop. For example it would take much more time for them to get to the cafeteria from their

workshops and because they have only short break, they do not want to waste some of this break taking part in the intervention. Another presumption would be that they might have had tough foremen and that they did not want to take minimum chance to be late to work because of participating in the intervention. The selection was done one working day prior to the commencement of the intervention and the workers were notified of the commencement of the intervention stage. Three steps were followed in the intervention:

Step 1

An introductory talk was held by the investigator for those subjects who agreed to participate in the intervention group on the first day of intervention for each company. In this talk, which lasted five minutes, the importance of target safe behavior in terms of wearing PPE while working and the consequences of not wearing PPE were emphasised. The content of the talk was the same for each group of subjects and was always held in the workplace of each group in each company. Immediately after the talk, three video cassettes were shown. The first one “Eye Safety“ (Valley Videos, 1990) lasted 6.5 minutes and emphasised how and why eye safety is important while working and why eyes should be protected. The second video cassette “PPE” (Valley Videos, 1990) lasted 6 minutes and concentrated on the different types of PPE, how to wear each and why it is important to wear PPE all the time while working. The third video cassette “Hearing Conservation” (Film Australia, 1981) lasted 9 minutes and was about ear safety, specifying the importance of having healthy hearing, how hearing sensory deficiency

affects quality of life, and how to wear appropriate ear protectors to conserve hearing. The length of the entire session (video show plus introductory talk) was 21.5 minutes. The selection of these video cassettes was based on the fact that they provided information about the need for various forms of PPE and showed proper techniques for wearing PPE.

Immediately after the knowledge session, the subjects were divided in two groups. Group 1 received the introductory talk and was shown videos only (Knowledge group) while group 2 received the introductory talk and was shown videos but in addition received verbal and written feedback on their individual behavior over the observation period (Knowledge and Feed back group). The verbal feedback involved positive comments regarding each worker's behavior. The verbal comments were made to each worker directly by the investigator every time the worker was observed for his behavior while working (e.g. three times a day). The type of verbal comment can be seen in Appendix 3. In addition to verbal comments, each worker received two written comments. These comments can be seen in Appendix 4.

The workers in the Comparison group did not participate in the knowledge session and were not provided with feedback. They were told that they would be observed for five working days and would be asked to complete the Safety Perception/Attitude Questionnaire at the end of the observation.

The intervention was always done in the time scheduled by the manager of each factory for subjects' participation in the intervention stage. This time schedule was usually after lunch breaks. The introductory talk was always immediately followed by viewing information videos. The subjects were always encouraged to raise doubts, problems and questions regarding information in the videos.

Step 2

Observation of the target safe behavior for the subjects commenced immediately after intervention (15 observations for each subject over a period of 5 working days), except for those subjects who were supposed to receive feedback on their safe behavior. For this group of subjects the observation of the target safe behavior commenced after the first verbal feedback was given for their safe behavior.

Step 3

Immediately after observation of targeted safe behavior was completed, the Safety Perception/Attitude Questionnaire was administered to the subjects. The criteria for administration and collection of the questionnaire were the same as in the first stage of the study.

2.4. Post intervention observation

All subjects who participated in the intervention stage, including control groups, were reobserved four weeks after the intervention stage to confirm the stability of their safe

behavior. Again the same observational instrument (observations checklist) and same procedure (observation over five working days) were used to collect data. The Safety Perception/Attitude Questionnaire was not administered in post intervention observation because of practical difficulties and because the main aim of conducting the post intervention observation was to determine the maintenance effect of the intervention on the safe behavior of the subjects in the three groups, knowledge group, knowledge and feed back group and control group.

CHAPTER 4

Results of stage 1 of the study

Question 1: The differences between companies in workers safety perception and safety behavior.

1.1. Introduction and background

Workplace characteristics may affect perception of safety and safe behavior at work (Dejoy, 1996). This means that differences between workplaces may produce differences in workers' perception of safety and safe behavior at work.

The relationship between workplace characteristics and safety performance has been suggested by a number of studies. For example, Wrench (1972), showed that some characteristics of the work situation such as incentive payment schemes were associated with safe behavior. He demonstrated a negative relationship between incentive payment schemes and safe working. Similarly, Leather (1988), in his study of attitudes towards safe performance on construction work showed that work characteristics and workplace and safety attitude were related. He demonstrated that factors such as working conditions, payment schemes and the social organisation of the work place were related to the attitudes toward safety performance on construction work. Hofmann et al. (1995), reviewed the literature on safety performance in high reliability process industries (e.g. chemical and nuclear power plants). They argued that several variables appeared to have important implications for safety performance. Some of these variables were related to the individual, such as employee's attitude, knowledge and behavior, while others were related micro-

organisational variables, for example, self-regulation, organisational policies, design of work environment, the existence of safety representatives, management attitudes and accountability vigilance in maintaining records of safety related problems achievements, and other variables related to macro-organisational factors, for example, technological complexity, work force specialisation, vertical and horizontal communication and redundancy.

These studies provide some indication that workplace characteristics affect workers' perception of safety and safe behavior at work. In other words differences in safety perception and safety behavior of workers in two workplaces may be influenced by the differences in the characteristics of these two workplaces. This suggests that there are factors which differentiate safety levels in workplaces. Many of these factors include organisational practices and policies such as the existence of safety representatives, management attitudes towards safety, and types of communication channels.

While every organisation has characteristics which differentiate it from others, these characteristics also appear to have an effect on the safety perception and safety behavior of workers. For this reason, in the part of the study it was necessary to examine the differences between the companies recruited into this study in order to establish whether there were differences in safety perception and safety behavior of the workers in the different companies, and if so how they differed.

1.2. Method

The Safety Attitude/Perception Questionnaire and the Observational Checklist as detailed in the Method section were used to collect data on safety perception and safety behavior of workers in each of the four participating companies. For the Safety Perception/Attitude Questionnaire, the direction of scoring was reversed for items 1, 3, 6 and 12 because of the nature of these items. For these items, high scores showed that respondents tended to agree with the statement representing a positive attitude toward that aspect of safety. For the remaining items a high score showed that respondents tended to disagree with the statement, also representing a positive attitude toward that aspect of safety. This made it possible to have consistency in scoring items such that a high score in any item always indicated a positive safety attitude.

Information was collected in each workplace on work organisation and work practices for each of the companies. This included the number of workers in each company, the nature of production and the required PPE for each company, management safety commitment in terms of management involvement in the safety committees and management's supervision of workers safety performance at work, the frequency of safety training and the availability of a safety officer (in terms of whether the safety officer either was a permanent employee and was always available to the workers, or worked on a contract basis and only visited the company at certain times.

1.2.1. Data collection and data analysis

The mean scores for each item in the Safety Attitude/Perception Questionnaire were compared between the companies using one way ANOVAs with post hoc tests to enable pairwise comparison between group means while applying some control over Type 1 error. Using the Bonferroni correction for multiple comparisons, the multiple range test of LSD (Least Significant Differences) was conducted to compare differences between the companies. The Bonferroni adjustment was made to be more conservative by adjusting α for the number of comparisons made (17 comparisons) (Snedecor and Cochran, 1982). The effect of Bonferroni adjustment was that for an overall $\alpha=.05$ for the family of comparisons, the individual decision α was set at .003 based on an adjustment of α for the number of comparisons made. All analyses were conducted using the SPSS statistical procedure (Stevens, 1992).

To compare safety behavior, the mean scores for each individual's safety behavior (proportion of required PPE worn) averaged over 15 separate observations were used to determine the level of safety behavior in each company. A one way ANOVA with the post hoc tests described above was also performed to analyse these data.

1.3. Results

Table 4.1 shows the total number of workers working in each company at the time of the study, the type of production and the type of PPE required to be worn by the workers in each company. Although all four companies were involved in manufacturing, the range of production varied from major construction equipment to

domestic appliances (e.g. irons, heaters) and light domestic production (e.g. paint brushes, paint rollers, paint sprays, pumps for trigger sprays, packing items for domestic use and food production). The required PPE was almost the same for all companies (goggles, face shield, ear plugs, ear muffs, gloves) except that safety helmets and respirators were required for Company 1 and respirators were also required for some workshops in Company 3. The characteristics of the four companies participating in the study are shown in Table 4.1. The companies differences in the availability of Safety Officer, safety training and management safety commitment are also shown in Table 4.2.

Table 4.1: The number of employees observed, description of production and required PPE for each company. (v= required PPE).

	No of employee	production type	Required PPE							
			Goggles	Face shield	Ear plugs	Ear muffs	Gloves	Helmet	Respirator	Mask
Company 1	300	Major construction equipment	v	v	v	v	v	v	v	v
Company 2	32	Paint brushes and rollers	v	v	v	v	v			
Company 3	200	Domestic electrical appliances	v	v	v	v	v			v
Company 4	104	Paint sprays and pumps for trigger sprays, packing items for domestic use	v	v	v	v	v			

Table 4.2. Company differences in the availability of Safety Officer, safety training and management safety commitment.

	Company 1	Company 2	Company 3	Company 4
Safety Officer	2 permanent	1 contract based	1 permanent	1 contract based
Safety training	*None during ten weeks data collection	Three times during ten weeks data collection	Once during ten weeks data collection	*None during ten weeks data collection
Management safety commitment	● No supervision for safety performance; safety committee didn't exist.	◆ Weekly supervision for safety performance; active participation in safety committee.	♣ Some supervision for safety performance; no workers participation in safety committee.	● No supervision for safety performance; workers participated in safety committee only in one occasion.

* = Safety training was not held

● = Management neither observed nor complimented the workers for their safety behavior.

♣ = Foremen occasionally observed the workers for safety performance.

◆ = Manager observed and commented workers for safety behavior every week.

As Table 4.2 shows, although there were two permanent safety officers working in Company 1, there was no safety training provided for workers. This was because of the workload of the safety officers who were required to attend to tasks which were not related to safety, in addition to their safety duties. Also, management policy restricted workers' attendance at safety sessions. In Company 1, management did not allow workers to spend working hours in safety training. Because of lack of supervision of safety behavior by management, safety behavior was not actively encouraged. For these reasons it was considered that the workers in Company 1 received no support for safe behavior and were not encouraged by management to behave safely.

Company 2 had a Safety Officer (Safety Consultant) who worked on a contract basis and arranged for regular safety training sessions. The workers were encouraged by the management to participate in the Safety Committee. They also received occasional verbal comments from management for their safe behavior. The equipment used for production in this company was continuously checked for safety and efficiency.

Even though Company 3 had a permanent Safety Officer, there was only one short safety training session for the workers during the data collection period. There was some supervision of workers' safe behavior in this company. The workers in

Company 4 also did not have regular safety training. There was no permanent safety officer. The safety officer spent most of the time negotiating with the management regarding replacing the inappropriate old machinery. For this reason there was no

safety training for workers in Company 4. Also there was no supervision of workers' safety behavior in this company and safe behavior was seldom encouraged.

It seems that overall Company 2, which was the smallest company, could be classified as having the best safety environment because of regular safety training sessions, management's active participation in the safety committee and management's continuing supervision of safety behavior at work. Company 3 could be classified as having medium safety relative to the other companies because of having only one safety training session, management not participating in the safety committee and not directly supervising the workers' safety behavior. Company 1 and Company 4 on the other hand could be classified as having a relatively poor safety environment, not having safety training sessions, and management not supervising the workers' safety behavior.

1.3.1. Results of safety perception

Table 4.3 shows the distribution of safety perception and attitude of workers in Companies 1-4.

Table 4.3 : Mean scores and standard deviations for each item on the Safety Perception/Attitude Questionnaire for each of companies studied. The results of the one way ANOVAs are also shown.

Items	Company 1 n=38	SD	Company 2 n=21	SD	Company 3 n= 131	SD	Company 4 n= 49	SD	F value
1r Everyone has an equal chance of having accident.	4.03	0.94	3.62	1.78	3.76	1.31	3.51	1.22	1.32
2 In the normal course of my job I did not encounter any dangerous situation	3.16	1.22	2.76	0.94	3.39	1.21	3.26	1.13	1.85
3r People who do not take the necessary precautions are responsible for what happens to them.	2.32n	1.04	4.14 s	0.85	3.79 s	1.15	3.96s	0.97	22.91
4 Safety works until we are busy then other things take priority.	3.26	1.28	3.29	1.27	3.46	1.26	3.43	1.15	0.32
5 If I worried about safety all the time, I wouldn't not get my job done.	3.39	1.15	3.43	1.28	3.38	1.18	3.55	1.20	0.26
6r People who work to safety procedure will always be safe.	3.65	1.23	3.90	1.04	3.40	1.27	3.20	1.17	1.00
7 I cannot avoid taking risks in my job.	2.51n	1.34	2.62	1.24	3.33	1.09	3.37s	1.14	6.77
8 Accidents will happen no matter what I do.	2.76	1.07	3.00	1.41	3.20	1.04	3.02	1.05	1.71
9 It is not likely that I will have an accident because I am a careful person.	2.81	1.23	2.85	1.18	3.44	1.08	3.18	1.09	4.1
10 Not all accidents are preventable some people are just unlucky.	2.95	1.15	3.48	1.28	3.24	1.15	3.29	1.06	1.11
11 Everybody works safely in my workplace.	3.00	1.16	2.24n	0.76	3.14s	1.10	3.20s	1.23	4.33
12r All the safety rules and procedures in my workplace really work.	3.16	1.02	3.86s	0.96	3.42	1.16	2.94n	1.14	4.11
13a It would help me to work more safely if my supervisor praised me on safe behavior.	2.43n	1.31	2.57	1.39	3.11	1.22	3.39s	1.21	4.98

13b It would..... if safety procedure were more realistic.	2.31	1.10	2.44	1.04	2.86	1.18	3.04	1.20	3.33
14a When I have worked unsafely it has been because I didn't know what I was doing wrong at the time.	3.21	1.38	3.14	1.27	3.44	1.14	3.83	1.32	2.3
14b When I because I needed to complete the task quickly.	2.94	1.08	3.44	1.19	3.42	1.15	3.56	1.31	1.1
14c The right equipment was not provided or wasn't working.	3.18	0.99	3.78	1.06	3.3	1.17	3.63	1.04	1.89

s = Indicates statistically significant differences between that companies' mean score and the company mean score indicated by letter (n) for the same item
r = reverse scored due to the nature of the item.

As Table 4.3 shows, the majority of scores were in the mid-region, being neither agree nor disagree (scored as neither agree or disagree for most items and scored as sometimes for items 13a, b and 14a, b and c) for all companies. This was especially noted for Company 3 where 15 out of the 17 items scored in this way. Company 2 showed the widest distribution, with mean scores in the mid-region for 11 items. Company 1 had 12 and Company 4 had 11 items with mean scores in the mid-region of the scale.

The companies showed some variation in the range of scores for items. Company 3 displayed the smallest range (.93), while Company 2 displayed the largest range (1.90).

Comparing average scores for each item between companies showed that six items had roughly the same mean scores for all companies. In particular, the mean scores for item 1 were in the “agree” direction for all companies. This shows that workers in all companies tended to agree with the statement “Everyone has an equal chance of having an accident”.

For the remaining five items with similar mean scores across companies, the scores were all in the mid-region (neither agree or disagree). These items included:

Item 2: In the normal course of my job, I do not encounter any dangerous situations.

Item 4: Safety works until we are busy then other things take priority.

Item 8: Accidents will happen no matter what I do.

Item 9: It is not likely that I will have an accident because I am a careful person.

Item 10: Not all accidents are preventable, some people are just unlucky.

There was agreement between companies on the item with highest mean score. For Companies 2, 3 and 4, item 3 was scored in the “agree” to “strongly agree” region of the scale. There appeared to be considerable consistency therefore, between workers in these three companies in agreeing with the statement, “People who do not take the necessary precautions are responsible for what happens to them” (Item 3). In contrast, workers in Company 1 did not show this result. In fact the second lowest mean score for Company 1 was shown for item 3. Overall, the workers in Company 1 tended to disagree with this statement.

There was less agreement between companies on the item with the lowest mean score. Workers in Companies 1 and 3 shared the lowest mean score for the statement “It would help me to work more safely if the safety procedures were more realistic” (Item 13b). For Company 2, however the lowest mean score was for item 11, “Everybody works safely in my workplace” and for Company 4 the lowest mean score was for item 12, “All safety rules and procedures in my workplace really work”.

The results of ANOVA (with adjusted α level) and post hoc comparisons showed that mean scores for item 3 were significantly lower for Company 1 compared to the other three companies ($F_{(3, 230)} = 22.91$ and $p = .000$). This means that workers in Company 1 tended to have a poor perception and attitude towards safety responsibility.

Also a number of other items differed significantly between companies. In particular, workers in Company 4 showed higher scores on item 7 (I cannot avoid taking risks in my job) ($F_{(3, 227)}=6.77$ $p=.000$) and item 13a (It would help me to work more safely if my supervisor praised me on safe behavior), compared to Company 1 ($F_{(3, 221)}=4.98$ $p=0.002$). Item 11 (Everybody works safely in my workplace) was scored significantly higher for Company 4 ($F_{(3, 232)}=4.33$ $p=0.005$) and Company 3 compared to Company 2, and item 12 (All the safety rules and procedures in my workplace really work) was significantly higher for Company 2 compared to Company 4 ($F_{(3, 232)}=4.11$ $p=0.007$).

In conclusion the general results were similar between the companies. Most items were scored in the mid range, showing that workers neither agreed nor disagreed with those items. In addition, the companies had most agreements for items 1, 2, 4, 8, 9 and 10. This means that all companies shared the same tendency to neither agree nor disagree with these items. There were some differences between the companies for a few items, especially items 3, 7, 13a, 11 and 12. Company 1 had the lowest mean score for item 3 (People who do not take the necessary precautions are responsible for what happens to them) compared to other three companies. This means that workers in Company 1 were more likely to disagree with the concept of personal responsibility for behavior at work compared to employees of the other three companies.

The mean score for item 7 (I cannot avoid taking risks in my job) and item 13a (It would help me to work more, if my supervisor praised me on safe behavior) for Company 4 was significantly higher than the mean score for Company 1 on these

items. This means that Company 1 workers were more likely to say that they could not avoid taking risks than Company 4 workers and to use lack of supervisor praise as a reason for not always working safely.

The mean scores for item 11 for Company 4 and Company 3 were significantly higher than for Company 2. This means that workers in Company 4 and Company 3 were less likely to think that all workers in their workplace work safely, while workers in Company 2 tended to agree that workers in their company worked safely. The mean score for Company 2 was significantly higher than Company 4 for item 12, indicating that workers in Company 2 were also more likely than Company 4 workers to say that in their workplace, all the safety rules and procedures really work.

1.3.2. Results of safety behavior

The mean proportions of PPE worn for each company are shown in table 4.4. The word “always” was used for the workers who wore all required PPE all the times they were observed. The word “sometimes” was used for the workers who wore all required PPE more than once during the period they were observed. The word “never” was used for the workers who did not wear all required PPE even once during the periods they were observed. The scores may not sum to 100% as workers who were only observed to wear all PPE once during the observations were not included.

Table 4.4: For each company the mean proportion of PPE worn and the average percentage wearing all required PPE are shown. The results of the one way ANOVA are also shown.

Company	Proportion of PPE worn	% wearing all required PPE		
		Always	Sometimes	Never
Company 1	.79s*	0	92.10	5.26
Company 2	.78s	0	100.00	.00
Company 3	.56n	0	48.85	27.48
Company 4	.69s	0	44.89	22.44

*s= indicates statistically significant difference between that company mean score and the company mean scored indicated by letter “n”.

As Table 4.4 shows, Company 3 had the lowest average proportion PPE worn and Company 1 had the highest average proportion PPE worn. Results of one way ANOVA with post hoc testing (at $\alpha=.05$) showed that Company 3 was significantly different from the other three companies ($F_{(3,235)} = 70.95$ $p= .00$). The results showed that the level of safe behavior was significantly lower for Company 3 than for the other three companies.

Comparing the distribution of PPE wearing between the companies, as Table 4.4 shows, although none of the workers in any company wore all required PPE on every observation, most of the workers in Company 1 and all workers in Company 2 wore all required PPE sometimes while less than 50% of the workers in Company 3 and Company 4 wore all required PPE sometimes. In Company 1 it was very rare for any workers never to wear all required PPE. None of the workers in Company 2

never wore all required PPE. In Company 3 and 4 on the other hand, around one in four workers were never observed to wear all required PPE.

In conclusion, Companies 1 and 2 showed overall similar means for proportion of PPE worn but different distributions, while Companies 3 and 4 showed overall similar distributions but Company 3 showed a lower average proportion of PPE worn.

Finally, none of the workers in any company always wore all required PPE.

1.4. Discussion on the differences between companies on safety

perception and safety behavior

The findings suggest that there were many similarities and few differences between the companies regarding items in the Safety Perception/Attitude Questionnaire. The main similarities were that workers in all companies scored in the mid region for the majority of items. This means that for most items there was no strong tendency to either agree or disagree with the statement. In contrast, workers in all companies showed overall agreement for one item. For item 1, “Everyone has an equal chance of having an accident”, workers in all companies tended to agree with the statement. This suggest that they all have a shared belief of the probability of an accident.

There were a few differences between the companies. For example there was a statistically significant difference between Company 1 and the other companies for item 3 (People who do not take the necessary precautions are responsible for what happens to them), item 7 (I cannot avoid taking risks in my job) and item 13a (It would help me to work more safely if my supervisor praised me on safe behavior).

Company 1 workers showed disagreement with these statements. This suggests that workers in Company 1 showed a poor attitude since they tended to not believe in personal responsibility for safety, for their ability to control their risk, and to blame the level of supervisor support for their low level of safety.

There are several possible causes for this differentiation in safety attitude for workers in Company 1 compared to the other three companies. For example, due to the type of the production (heavy machines), workers in Company 1 were likely to be exposed to a greater inherent risk and danger in this workplace. Such conditions might have effects on workers' perception of safety at work and could be the reason for Company 1 workers' tendency to believe that they cannot avoid risk taking on the job. Similarly, Company 1 workers may have been more likely to believe that people are not responsible for their own safety because of the higher levels of existing risk in their workplace and also because of not being supervised for safe performance. The low score for item 13a suggests that workers in Company 1 believed that being praised by supervisors may help to improve safe behavior. Company 1 had the highest average of all companies for safe behavior. The workers in Company 1 also showed a better average percentage for wearing all required PPE compared to Companies 3 and 4. Thus although workers in Company 1 had a negative attitude to risk control and personal responsibility for safety, they showed better safety behavior. The reason for this could be the higher overt risk as found in Company 1 was a motivation for good safety behavior. For example being exposed to high level of risk could be associated with more awareness of risk which in turn could motivate them to wear PPE to protect themselves from immediate hazards. Their safety

attitude related to safety responsibility and risk control was inconsistent with their safety behavior.

Company 2 had the highest scores on item 3 (People who do not take the necessary precautions are responsible for what happens to them) and item 12 (All safety rules and procedures in the workplace really work), and the lowest score on item 11 (Everybody works safely in my workplace). This suggests a positive attitude of workers in Company 2 about personal responsibility for safe behavior (item 3), and approval of the general level of safety practice in their workplace (items 11 and 12). The possible causes for this attitude of workers in Company 2 may be traced to the condition and situation of their workplace. In this small factory the workers were encouraged by management to participate in the safety committee. They were also directly supervised, received occasional verbal motivation for their safe behavior by management, and attended regular safety training sessions. This suggests that providing workers with knowledge of safe behavior together with direct and continuous supervision could indicate the necessity and importance of safety and act as motivation for safety at work by providing grounds for expressing good safety perception and behavior by workers in Company 2. Workers in Company 2 showed the best average percentage of wearing all required PPE. They also had the second highest mean proportion for safe behavior.

More workers in Company 3 tended to believe in personal responsibility for safety at work (item 3) compared to workers in Company 1. Also workers in Company 3 were more likely to acknowledge that their co-workers did not always work safely in the

workplace (item 11). These workers were provided with some safety training sessions and had some indirect supervision for their safety behavior. These might be reasons for their better perception of safety responsibility at work (item 3), while lack of safety sessions and lack of supervision might result in poor perception of safety responsibility for workers in Company 1. None of the items scored lowest and the remaining items were in the mid-range for Company 3. Workers in this company had the lowest mean proportion for safe behavior. The average percentage for wearing all required PPE for this company was similar for that of Company 4.

In Company 4, more workers tended to believe in personal responsibility for safe behavior (item 3) and tended to believe that they could avoid risks in the job (item 7) and that they did not need supervisor encouragement for safe behavior (item 13a) compared with workers in Company 1. On the other hand more workers in Company 4 tended to acknowledge that their colleagues were not working safely (item 11) and that not all the safety rules and procedures were working (item 12) compared with workers in Company 2. Workers in this company had the second lowest mean proportion of PPE worn. Looking at these results suggests that workers in Company 4 believe that they either encounter no risks or that if they do, they can overcome them since they do not behave safely and they do believe they can avoid workplace risks. Interestingly though, they are aware that their colleagues don't work safely and the workplace is not safe. This suggests their self-protective "misconception" of the impact of risks in their workplace.

In conclusion, there were several reasons for similar *safety perceptions* in the

companies . All companies were in the manufacturing industry, two (Companies 1 and 3) were large companies, while Company 4 was of medium size and Company 2 was quite small. Every company had a safety officer. Unlike Company 2, the other three companies either had no or only one safety training session during the period of the study. Management safety commitment did not exist in Company 1, was low for Company 3 and medium for Company 4.

There were also similarities and differences in *safety behavior* between the companies. The similarities were that wearing of PPE was not compulsory in any company and none of the workers in any company always wore all required PPE. More than 40% of workers in all the companies sometimes wore all required PPE. Companies 1 and 2 showed the best results, since more than 90% of workers in these two companies wore all required PPE at least sometimes during the observation period.

The differences in safety behavior were that Company 3 showed the lowest score for safe behavior, although it had a similar of proportion wearing required PPE to Company 4. In three companies (1, 3 and 4) some workers never wore all required PPE in any of the observation periods. For two of the companies (3 and 4) about one-quarter of workers never wore all required PPE during any observation period. The results of Company 3 and Company 4 shows that when risk is not so high, the workers does not put much emphasis on risk and self protection, and as a result do not take precautions.

The findings of this part of the study show that Company 1, the largest company and most risk inherent, showed relatively good safety behavior, but different safety perception, Company 2, the smallest company with a relatively better safety environment, showed better perception of safety and high safety behavior. Company 3, a large company with a medium safety environment, showed similar safety perception to Company 4, and workers were more likely not to report that everybody worked safely in the workplace. Company 4 was different from Company 1, in the beliefs that safety is a personal responsibility, that risks could be avoided and in not needing motivation for safe behavior. It was also different from Company 2 in the belief that all safety rules and procedures really work. Both Companies 3 and 4 had poor safety behavior. It seems that responses to items reflected the actual conditions in the company (e.g. perception of safe working, rules, supervision) and suggest attitudes that are consistent with them (i.e. it is risky, I would better take precautions and : it is not very risky, so nothing much will hurt me and I don't need to take precautions.) The possible reason for Company 1 showing different safety behavior might be that it was generally a high risk work situation in which the risk was more apparent and workers were more exposed to it. Howarth (1987) argued that people will adapt to an increase in perceived risk by taking more care.

In conclusion, although the four companies involved some variations in the type of manufacturing, location, working facilities and size of the company, it seems that these variations along with differences in safety training, availability of safety officer and management commitment to safety, had no effects on the workers' safety perception and safety behavior.

Question 2: The relationship between safety perception and safety behavior

2.1. Introduction

Understanding the relationship between perception and behavior may provide information regarding the nature of this relationship. A review of literature shows that despite a significant number of studies that have investigated the relationships between worker attitude/perception about safety and behavior, still little is known about the nature of this relationship. Stern and Oskamp (1987) proposed that environmentally relevant action is an outcome of a series of causally linked external and internal factors. These included external factors like physical structures, social institutions and economic factors, and internal factors such as general and specific attitudes and beliefs, information and behavioral intention.

Dedobbeleer and Beland (1991) in an attempt to determine the influences of construction worker's acceptance of risk on their safety performance found that workers' acceptance of risk had an impact on their safety performance. When risk acceptance was high, workers' compliance with safety regulation was low. These studies suggest that there is a relationship between risk perception and careful behavior. In contrast, Elkind (1993), in a study of the correspondence between knowledge, attitude and behavior in farm health and safety practices, attempted to identify the roles of formal training, prior experience and reported knowledge of PPE use in the observed correct use of protective gear. The results of this study suggested that it is unlikely that educating farmers provided knowledge about farm hazards and

would improve farm safety; rather it was found that both stable traits of psychological reactivity and situational indices of PPE performance predicted use of PPE.

Although Elkind did not argue whether providing farmers with safety knowledge improved their safety perception, it is conceivable that farmers' attitudes concerning PPE could be a contributor to their use of PPE.

A common theme of the above studies is that they tried to discover the factors influencing workers' behavior, especially the role of the safety perception/ attitude on safety behavior. The studies did not consider the nature of the relationship between perception and behavior. For example, are those workers with poor safety perception expected to display poor safety behavior? More investigation is needed to provide better understanding of the nature of the relationship between attitude/perception and behavior.

In this part of the study, first the relationship between safety perception and safety behavior of the workers was examined. For this part of the project, the results from the workers in all four participating companies were combined, and the overall relationship between safety perception and safety behavior was determined. Because it was also anticipated that workers with different safety perception might show different safety behavior, it was decided to study the relationship between safety perception and safety behavior for those workers showing good and workers showing poor safety behavior. This was studied by dividing the entire sample into two groups of workers, those showing good safety behavior and those showing poor safety behavior and comparing the Safety Perception/Attitude questionnaire results for these

two groups. The aim of this part of the study was to learn more about the relationship between safety perception and safety behavior, and to examine the relationship between safety perception/attitude and safety behavior for groups of workers showing different safety behavior.

2.2. Method

The subjects and instruments were as detailed in the general method section.

2.2.1. Data collection, data analysis and procedure:

The relationship between safety perception and safety behavior was assessed using the Pearson Correlation coefficient (Snedecor and Cochran, 1982).

In order to investigate which item(s) in the Safety Attitude/Perception Questionnaire were more related to safety behavior, Multiple Listwise Regression statistical analysis (Tabachnick and Fidell, 1989) was used. The first 17 items on the Safety Perception/Attitude Questionnaire were used as predictor variables and mean safe behavior was used as the dependent variable for this analysis. The Multiple Regression analysis technique was chosen to best predict the effect of several independent variables on a dependent variable.

In order to examine the relationship between safety perception/attitude and safe behavior for groups of workers showing different safety behavior, the mean proportion of required PPE worn by all workers was used as a cut-off point for good and poor behavior workers (Klugh, 1974). For this, individual workers whose average proportion wearing required PPE was above .64 were categorised as showing

good safety behavior and those below .64 were categorised as showing poor safety behavior.

2.3. Results

2.3.1. The relationship between safety perception and safety behavior for all workers

The results of the *Pearson Correlation Coefficients* between the safety perception and safety behavior of workers was $r = -.1303$ $p = .044$. *This shows that there is a significant negative linear relationship between safety perception and safety behavior.*

In other words, changes in safety perception of the workers will not result the same changes in their safety behavior.

2.3.2 The relationship between safety perception and safety behavior for good behavior workers and for poor behavior workers

The relationship between safety perception and safety behavior of workers showing good behavior ($X_b = .74$ and $X_p = 3.28$) was $r = -.2068$ $p = .028$. This means that there was a significant negative linear relationship between safety perception and safety behavior for good safety behavior workers.

The relationship between safety perception and safe behavior for workers with poor safety behavior ($X_b = .54$ and $X_p = 3.30$) was $r = -.1985$ $p = .026$. This means that workers with poor safety behavior, also showed a significant negative linear relationship between their safety perception and safety behavior.

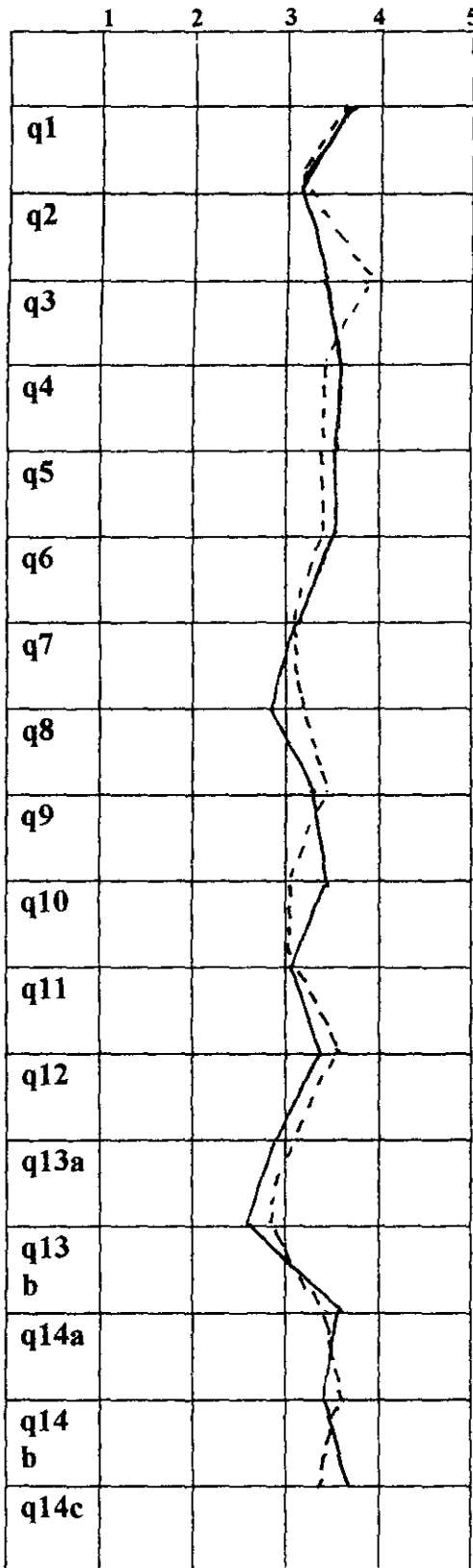
When the item scores from the Safety Perception/Attitude Questionnaire were examined for the good and poor safety behavior groups, it was evident that both poor and good behavior groups responded in a similar way for most of the items. The largest difference was for item 3. This means that good safety behavior workers showed relatively low scores (disagreed with) for the statement “People who do not take the necessary precautions are responsible for what happens to them”. This suggests that good safety behavior workers tended to have a more liberal attitude about personal responsibility for safety at work. Figure 4.1 shows the average score for safety perception for the groups of good and poor safety behavior workers which were created by dividing workers at the overall mean score.

2.3.3. The relationship between individual items in the Safety Perception/Attitude Questionnaire and safety behavior:

For the rest of this part of the study, all 17 items in the Safety Perception/Attitude Questionnaire were entered into the Multiple Listwise Regression model using the equation $Y = a + bX$ where ‘a’ is the value of behavior Y when perception $X=0$ (zero value of perception) and ‘b’ is the unit increase in behavior for each unit increase in perception. In this equation, safety perception was entered as an independent variable and the average proportion of wearing required PPE (safe behavior) for individual workers was entered as the dependent variable. Taken together all items accounted for almost 17% of the variation in safety behavior ($r^2 = .168$ $SD = .13$). Table 4.5 shows the results of Regression Coefficient for these variables. As the results of the Regression analysis in Table 4.5 show, only three independent variables (items 3, 8 and 9) are significant.

Fig 4.1: Means of workers' responses to the Safety Perception Questionnaire

— Good safety behavior workers (N= 113)
 - - - Poor safety behavior workers (N=126)



This means that any variation in these independent variables will have a significant effect on the dependent variable.

Table 4.5: The results of Regression Coefficient analysis showing the significant variables in the Equation.

Variable	Beta	T	Sig T
9	- 0.291513	-3.443	0.0007 s
3	- 0.240592	-3.081	0.0024 s
8	- 0.188024	-2.281	0.0237 s
1	0.100969	1.265	0.2076
2	-0.010742	-0.123	0.9024
4	0.151396	1.844	0.0669
5	0.028756	0.314	0.7542
6	0.018168	0.224	0.8228
7	-0.043340	-0.495	0.6209
10	0.088595	-1.090	0.2771
11	0.015179	0.178	0.8590
q 12	- 0.118203	- 1.442	0.1511
q 13a	0.067282	0.816	0.4154
q 13b	-0.080767	-0.982	0.3276
q 14a	0.060754	0.729	0.4671
q 14b	-0.085136	-0.855	0.3936
q 14c	0.108239	1.139	0.2564
Constant		10.875	0.0000

s = indicates significant effect

As Table 4.5 shows, all weights for Beta value for item 3, 8 and 9 are negative. This shows that the relationship between these three variables and safety behavior is a negative relationship. For example, workers with better safety showed a more liberal attitude about safety responsibility (item 3; people who do not take the necessary precautions are responsible for what happens to them). On the other hand, these workers showed more agreement with item 8 (accidents will happen no matter what I do) and less agreement with item 9 (it is not likely that I will have an accident because I am a careful person). This means that workers with better safety behavior also showed a lower perception of having control over risks and this might be the

reason for them wearing PPE. The attitude of not having control over risk does not express a negative attitude, instead it could be a motivator for better safety behavior.

2.4. Discussion of the relationship between safety perception and behavior

The results analysis revealed that overall there was a significant negative linear relationship between safety perception and safety behavior of workers in the four participating companies. This suggests that better safety perception of workers is associated paradoxically with lower level of safety performance at work. In other words, an improvement in safety perception for these workers might not improve their safety behavior. This was the same for workers showing poor safety behavior and workers showing good safety behavior. There could be several reasons for this incongruent relationship between perception and behavior, the possibility of It is possible that some items in the Safety Perception/Attitude Questionnaire may not be sufficient or effective in measuring safety perception, thus accounting for the incongruent overall relationship found between safety perception and safety behavior. It is also possible that only some items in the questionnaire are determinants of safe behavior.

The possibility that subjects' awareness of being observed might have resulted in subjects safe behavior (Using PPEs more during the observational period) is minimum because of the technique was employed for observation. In this technique, walk-through tours of all work shops and work stations were made along different routes and repeated at random times. These routes were walked in opposing

directions, so that the end point might randomly become the starting point for the next tour.

While these findings are inconsistent with those of Wicker (1969), they do not support the assumptions of Kerch, Crutchfield and Ballachey (1962) that behaviors are ordinarily consistent with attitudes.

Analysis of whether particular aspects of safety perception might be related to safe behavior, revealed that only workers who behaved safely, were characterised by beliefs that they have little control over when accidents will occur, a liberal attitude to personal responsibilities for safety possibly because they do tend to wear PPE, and that their behavior will reduce the likelihood of accident. This set of beliefs is apparently inconsistent with their relatively good safety behavior. This findings suggests that the relationship between safety attitude and behavior does not show simple, lawful rules, since we would expect that people with good safety attitudes are the persons of good safety behavior.

In this study the cost of compliance was the same for each company. For example, wearing PPEs were required but not compulsory. In each company all PPEs were supplied free of charge and were available at anytime of the day. The size, shape, weight and the material of which the PPEs were made up were comparable in between the companies and so was the awkwardness of acquiring, picking up, putting on and wearing them. It is possible to anticipate that these similarities generated the same general attitudes towards the use of PPEs in all companies. If so, it is possible

accept that compliance to safe behavior was not affected by the awkwardness of PPEs. This minimises the concept that poor safe behavior in this study might be encouraged by factors associated with PPEs. Having this in mind that “cost of compliance” were the same for each of the companies, it is possible, however, that good behavior is generated by other motivators, for example “reasonableness” of the PPE requirements for each of the companies, just as high overt risk and high perceived risk apparently promoted good safety behavior in Company 1, it may be that a belief that I have little control over accidents is a motivator for wearing PPE. If this is the case, it may be that these beliefs, will only affect self-protective behaviors such as wearing of hard hats, gloves and the like, which prevent injury, but do not prevent accidents,. On the other hand, these beliefs may not be associated with good safety behavior involving risk-taking since these workers believe that they have no control over when accidents will occur. Since this study only looked at self-protective behavior, this possibility would need to be investigated in a further study.

In summary, the findings of this part of the study suggest that, firstly the relationship between safety perception and safe behavior is a negative significant one and secondly that some aspects of safety perception such as having control over risk and personal responsibility for safety play an important role in the relationship between the safety perception and safety behavior than other aspects.

Question 3: The differences between workplaces where the target safety behavior was mandatory (Company 5) and workplaces where the target safety behavior was not compulsory (the four combined companies).

3.1. Introduction

Based on the belief that improving safety behavior will reduce the incidence of injury (Williams and Lud, 1992), several strategies have been employed to encourage safe performance of employees in different workplaces. Most of these strategies are based on behavioral approaches to safety such as disciplinary actions, frequent feedback and making safe behavior a compulsory condition of work.

Chhokar (1987) argued that the behavioral approach to safety at work consists of three basic elements: identification and pinpointing of specific behaviors which constitute the safe way of performing various tasks in a given work situation; training workers in these specific behaviors so that they are able to do their jobs in a safe manner; modifying and reinforcing workers to continue to behave safely by providing them with feedback based on periodic observation and monitoring of their actual behavior at work. It was suggested that this behavioral approach is effective in reducing accidents and enhancing safety at work.

For example, Komaki et al. (1978), in their analysis of a behavioral safety program, showed that frequent feedback was particularly effective in improving safety performance at work. The results of this study also suggested that positive

reinforcement together with behaviorally defining safe behavior (for example, performance of the actual safe behavior) is another approach in reducing unsafe behavior.

Some studies have examined the effects of the other behavioral approaches such as disciplinary actions, frequent feedback, and making safe behavior a compulsory condition of work. For example, Peters (1991), in his study of strategies for encouraging self-protective employee behavior, evaluated five strategies (incentives, disciplinary actions, fear messages, behavior modelling and employee surveys) to encourage workers to adopt self-protective behaviors and avoid unsafe behaviors, and found that all five strategies were effective to some degree. He argued that although all five strategies might be effective, there were some unanswered questions about the degree, duration and condition of effectiveness of the strategies. For example, choosing a strategy such as disciplinary action might be effective in stopping an undesirable behavior, but might result in the appearance of other behaviors that were just as detrimental. Therefore in most instances, it is probably not appropriate to view disciplinary action as the best way to initially respond to unsafe behavior.

Alternative methods may be more useful for encouraging safe behavior. Also a combination of two or more methods of intervention for safety behavior may be more effective. Some research has focused on the effect of combined strategies on safety behavior. For example, the effects of incentives and enforcement on the use of seat belts by drivers was studied by Mortimer et al. (1990), by measuring behavior before, during and after application of incentives alone, enforcement alone and both

incentives and enforcement. The findings showed that although all three strategies produced a significant increase in immediate use of seat belts and the combined use of incentives and enforcement had the greatest effect, the effect did not last long after measurement ended. However, the effect of enforcement alone had largely decayed in about 6 weeks while incentives retained their effect for at least 3 months.

These results suggests that enforcement has a better effect when incentives are also provided for the required safe behavior. The results do not indicate why this may be so since no measures were taken of how safety attitudes and perception were affected by enforcement and incentives. Clearly this information might help improve understanding of the role of enforcement and incentives in improving safety perception.

In this section of the study the effects of compulsory safety behavior on worker's safety perception and behavior are investigated. Also this part of the study investigated the relationship between safety perception and safety behavior for workers in a workplace where the target behavior was compulsory, in comparison with workers working in a workplace where the target behavior was not compulsory.

3.2. Method

The Safety Perception/Attitude Questionnaire and the Observational Checklist were used to collect data on safety perception and safety behavior of workers in a fifth company where the safe behavior was compulsory. The selection criterion was that the required PPE for workers in Company 5 was the same as that used in the other

four companies. The Questionnaire and the Checklist were used in the same manner as described in the general method section. This data were then used to compare Company 5 with the four combined companies on workers' perception of safety and safety behavior. Information was also collected for Company 5 on the availability of safety officer, safety training, management's safety commitment, the number of workers, the nature of the production, and required PPE. Table 4.6 show this information.

Table 4.6: The frequency of safety training, management safety commitment and availability of safety officer, number of employees, description of production and required PPE in Company 5.

	Company 5
Safety Officer	1 permanent
Safety training	non during 8 weeks of data collection
Management's safety commitment	ongoing supervision for safe performance
No of employees	100
Production	food
Required PPE	Goggles, Ear plugs, Gloves, Face mask, Ear muffs

3.2.1. Data collection and data analysis

Mean scores were calculated for the individual items in the Safety Perception/Attitude Questionnaire, and the independent sample t-test technique was used to compare the mean scores for each item for the four combined companies and Company 5. The Bonferroni adjustment was used to be more conservative by adjusting α for the number of comparisons made (Snedecor & Cochran, 1982). The effect of the Bonferroni adjustment was that for overall $\alpha = .05$ decision α was set at 0.003 based on an adjustment for α for the seventeen comparisons made. The

relationship between safety perception and safety behavior was assessed using the Pearson correlation coefficient technique.

The mean scores for each individual's safety behavior (proportion of required PPE worn) were used to determine the level of safety behavior for workers in the four combined companies and workers in Company 5. Independent samples t-test was also performed to analyse data.

3.3. Results and discussion

3.3.1. Safety attitude/perception

Table 4.7 shows the distribution of workers' perception/attitude in company 5 and the four combined companies:

Table 4.7: Means scores and standard deviations for each question in the Safety Perception/Attitude Questionnaire for workers in Company 5 and workers in the four combined companies. The results of t-tests are also shown.

Items	Company 5	SD	Four combined companies	SD	t	p
1r Everyone has an equal chance of having an accident.	4.12*	0.99	3.74	1.24	8.96	.003
2 In the normal course of my job I don't encounter any dangerous situation.	3.82*	1.02	3.27	1.18	10.5	.001
3r People who do not take the necessary precautions are responsible for what happens to them.	3.69	1.00	3.62	1.22	6.89	.010
4 Safety works until we are busy then other things take priority.	3.19	1.02	3.41	1.24	6.85	.009
5 If I worried about safety all the time, I wouldn't not get my job done.	3.35	1.04	3.42	1.19	2.55	.111
6r People who work to safety procedure will always be safe	3.28	1.20	3.44	1.24	1.80	.181
7 I cannot avoid taking risk in my job.	3.19	1.27	3.14	1.20	0.00	.995
8 Accidents will happen no matter what I do	3.22	1.05	3.08	1.10	.377	.539
9 It is not likely that I will have an accident because I am a careful person.	3.38	1.01	3.24	1.14	3.28	.071
10 Not all accidents are preventable some people are just unlucky.	2.96	1.09	3.22	1.15	2.08	.15
11 Everybody works safely in my workplace.	3.19	0.95	3.05	1.14	4.90	.028

12r All the safety rules and procedures in my workplace really work.	3.51	1.10	3.42	1.14	.57	.45
13a It would help me to work more safely if my supervisor praised me on safe behavior.	3.06	1.17	3.01	1.29	.956	.329
13b It would..... if safety procedure were more realistic.	2.86	1.06	2.78	1.19	2.68	.102
14a When I have worked unsafely it has been because I didn't know what I was doing wrong at the time.	3.78	1.02	3.45	1.25	7.77	.006
14b When I because I needed to complete the task quickly.	3.35	1.09	3.37	1.19	1.53	.217
14c The right equipment was not provided or wasn't working.	3.32	1.00	3.40	1.12	2.11	.147

*= indicates statistically significant difference between the Company 5 mean score and the four combined companies mean score for the same question.

r = indicates reverse scored due to the nature of the statement.

As Table 4.7 shows, the majority of scores were in the mid-region, being neither agree nor disagree for workers in Company 5 and workers in the four combined companies. The two groups showed slight differences in range of the scores for items.

Comparing average scores for each item between the two groups shows that 15 items had roughly the same mean scores. In particular, the mean scores for item 3 were in the agree direction for both groups of workers. This shows that the workers in Company 5 and workers in the four combined companies tended to agree with the statement that “People who do not take the necessary precautions are responsible for what happens to them”. For the remaining 14 items with similar mean scores, the scores were all in the mid-region (neither agree nor disagree). These were items 4, 5, 6, 7, 8, 9, 10, 11, 12, 13a, 13b, 13c, 14a, 14b and 14c.

There was agreement between the workers in Company 5 and workers in the four combined companies on the item with highest score and question with lowest score. As Table 4.7 shows, item 1 received the highest mean score and item 13b the lowest mean score for both groups of workers. This shows that workers in both groups tended to agree that everyone has an equal chance of having accident (item 1) and tended to believe that more realistic safety procedures sometimes would help workers to work more safely (item 13b).

The independent samples t-test analysis with Bonferoni adjustment was conducted to determine significant differences between the two groups. The results of t-test

analyses were different with adjusted α level. This indicated that taking Bonferoni adjustment into consideration, the groups showed significant difference in item 1 $t_{(df=297)}=8.96$ $p=.003$ and item 2 $t_{(df=295)}=10.5$, $p=.001$. This demonstrates that workers in Company 5 (where safe behavior was compulsory) were more in agreement with the statement that “everybody has an equal chance of having an accident“ (item 1) (please note that item 1 was reverse scored) than workers in the four combined companies. Also workers in Company 5 tended to disagree with the statement that “In the normal course of my job I do not encounter any dangerous situations” (item 2) while workers in the four combined companies tended to show more agreement with this statement.

It should be noted that when the Bonferoni adjustment was not used, in addition to items 1 and 2, other items could be judged as significantly different for the groups based on the traditional $\alpha = .05$ decision made.. These were item 3 (People who do not take the necessary precautions are responsible for what happens to them), $t_{(df=294)}=6.89$, $p=.010$, item 4 (Safety works until we are busy, then other things take priority) $t_{(df=294)}=6.85$, $p=.009$, item 11 (Everybody works safely in my workplace) $t_{(df=297)}=4.90$, $p=.028$ and item 14a (When I have worked unsafely, it has been because I didn't know what I was doing wrong at the time) $t_{(df=279)}=7.77$ $p=.006$. The results of t-test analysis revealed that workers in Company 5 were significantly different from workers in the four combined companies with these statements, by being in agreement with items 3 and 4, and being in disagreement with items 11 and 14a.. This suggests that making target safety behavior compulsory has an effect on some

aspects of safety attitude and perception, such as personal responsibility for safe behavior, safety priority, safety practice and justification of unsafe behavior.

In conclusion, the overall results were relatively similar between the workers in Company 5 and workers in the four combined companies in a number of responses. Both groups of workers responded in a similar way for most of the items. The workers in Company 5 and the four combined companies shared the items with highest and lowest scores. Although the two groups tended to agree that everyone has an equal chance of having an accident, workers in Company 5 were more in agreement with this statement. The two groups also shared agreement for item 3, showing that both groups of workers tended to be in agreement with taking responsibility for safety behavior.

There were some differences between the workers in Company 5 and workers in the four combined companies regarding certain items. Workers in Company 5 tended to disagree with the statement that “in the normal course of my job, I do not encounter any dangerous situations” (item 2), in that Company 5 showed a higher score for that item than the four combined companies. Workers in Company 5 also tended to agree more with safety priority (item 4) than workers in the four combined companies. These responses indicate a better perception of safety at work by workers in Company 5. Workers in this company also tended to justify their unsafe behavior by lack of knowledge (item 14a), while workers in the four combined companies neither agreed nor disagreed with this statement. This suggests that workers in Company 5 were more aware of the impact of the safety knowledge on their safety behavior

(because they paid more attention to safety) and tended to believe that having knowledge of safe procedure would result in better safety performance.

3.3.2. Safety behavior

The mean score for safety behavior was determined using the average proportion, in the same way as in the first part of this study. Table 4.8. shows the proportion of PPE worn expressed as the mean for workers in Company 5 and in the four combined companies. In this table the words always, sometimes and never are used to mean that the workers wore all required PPE either all the time, more than once or never wore them.

Table 4.8: The mean proportion of PPE worn and the average percentage wearing all required PPE for workers in Company 5 and workers in the four combined companies. The result of the t-test is also shown.

Company	Proportion of PPE worn	% wearing all required PPE		
	Safety behavior	Always	Sometimes	Never
Company 5	.86*	9.52	90.48	.00
Four combined companies	.70	.00	71.46	13.79

* = indicates a statistically significant difference between Company and four combined companies.

The results shown in Table 4.8 indicate that workers in Company 5 showed higher average scores for safety behavior than workers in the four combined companies. Results of the independent samples t-test showed that Company 5 was significantly different from the four combined companies, with higher levels of safe behavior for Company 5 compared with the four combined companies, $t_{(df = 300)} = 45.269$ $p = .000$

Comparing the distribution of PPE wearing between the groups shows that less than 10% of workers in Company 5 always wore all required PPE, but the remainder wore all required PPE sometimes. In contrast, in the four combined companies, no worker wore all required PPE in any observation and nearly 14% never wore all required PPE. Most of the workers (71.5%) in the four combined companies sometimes wore all required PPE, although this percentage was lower than that for the Company 5.

In conclusion, workers in Company 5 showed better safety behavior compared to the workers in the four combined companies. This is presumably because of the condition of compulsory safe behavior for workers in Company 5. Despite the significantly greater wearing of PPE in Company 5, the results showed that the condition of compulsory safe behavior was not sufficient to make the workers always comply with safe behavior while working.

3.3. Discussion

This section of the study illustrated the similarities and the differences in safety perception and safety behavior in Company 5 (compulsory safe behavior) and the four combined companies (non-compulsory safe behavior). The results of this investigation showed that making safety behavior compulsory had a positive effect on safety perception and safe behavior.

The differences between Company 5 and the four combined companies in safety perception/attitude were that workers in Company 5 were more likely to have the

perception that everyone has an equal chance of having an accident. This suggests that although they were working in conditions that were made safer by enforcing PPE use, workers still believed that they had a similar chance of having an accident. These workers also showed better perception of risks as they tended to be more likely to realise that they were vulnerable to having accidents and were more aware that there were hazards in their workplace than workers in the four combined companies. This suggests that although making safe behavior compulsory might help to reduce the exposure to some existing dangers, the workers were still more aware of other hazards around them. It is possible that focusing on the need to use PPE raises the awareness of hazards in the workplace.

Workers in Company 5 also tended to show better perception of safety responsibilities as shown by the higher support for the view that people have personal responsibility for safety (item 3) and they may be more aware of deficiencies in safety system in their company. Workers in Company 5 were more likely to report less than perfect safety behaviors by colleagues (item 11) and less than consistent priority for safety in the company practice (item 4).

The workers in Company 5 were less likely to use lack of safety knowledge to justify their unsafe behavior. This suggests that they did not try to excuse their unsafe behavior, and is consistent with the higher awareness of workplace risks suggested by their overall responses to the perception/attitude items.

Workers in Company 5 also showed higher scores for safety behavior than in the four combined companies, but the differences in safety behavior between the two groups were not as high as might be expected given that wearing PPE was a condition of employment. One possible reason could be that the compulsory safe behavior was not sufficiently enforced. If this was so, it suggests that more efficient enforcement might encourage better safety behavior. Other reasons could be that wearing PPE all the time while working was not comfortable in some way for example, poor functional design, interference with work task, nuisance value and conflict with other influences (Feeney, 1986), and this was the best they were willing to do.

In conclusion, workers in Company 5 differed in safety perception and attitude from workers in the four combined companies. They showed better safety perception in terms of taking responsibility for safety, in risk perception and in safety practice. Regarding the findings of this part of the study, it seems that making a target behavior compulsory does have an influence on safety perception and safety behavior.

Question 4: The influence of personal characteristics such as age, gender, job experience and experience of having accidents on workers' safety perception and safe behavior.

4.1. Introduction

The influence of the personal characteristics of workers on their perception of safety and safety behavior has been examined in a number of studies. For example,

Reinfurt, Williams, Wells and Rodgman (1996), in their study of characteristics of drivers who did not use seat belts in a high belt use state of the USA, examined the characteristics of these drivers with respect to gender, race and age. Part of the results of that study showed that nonuse of seat belts was associated with gender (male) and age (<35). In another study by Laflamme (1996), age related accident risks among male workers was investigated and some of the results showed that regardless of the type of accident, the rates were generally higher for younger workers than for older workers.

Gender is another personal characteristic which appears to have some influence on the individual's behavior. For example, Harre, Field and Kirkwood (1996), examined gender differences and areas of common concern in the driving behavior and attitudes of adolescents. Part of the findings of that study showed that males were significantly more likely than females to report involvement in unsafe driving behaviors.

Age and gender are not the only factors which appear to have an influence on safety behavior. Some studies have investigated the influence on safety behavior of other personal characteristics such as experience of having an accident. Napier and Pugh (1987), in their analysis of farm risks, examined the factors influencing accident rate and found no significant variables that accounted for accident rate. They argued that experience with hazards (accidents) does not cause a significant difference in accident rate.

Although the number of studies of the effect of personal characteristics on safety

behavior are limited, they all send message that some personal characteristics might be important factors affecting workers' behavior. For this reason, it seems that there is a need for these factors to be taken into account and examined in more depth. Therefore, this part of the study investigated the effect of personal characteristics such as age, gender, job experience and experience of having an accident on safety perception and safety behavior at work.

4.2. Method

The subjects and instruments were the same as described in the general method section. The data collected as part of the earlier study were also included. These data provided information about workers' personal characteristics such as age, gender, experience of having accidents while working and job experience. In this section of the study, these data were used to compare safety perception and safety behavior of workers with different personal characteristics.

4.2.1. Procedure and data analysis

The data were divided and compared in terms of four personal characteristics, gender, age, duration of experience in the job and experience of having an accident while working. Mean perception scores were used to compare the groups for their safety perception, and proportion of PPE worn was used to compare for safety behavior.

Data on gender were analysed by dividing samples into females and males. The mean

scores for the individual questions in the Safety Perception/Attitude Questionnaire were calculated and the ANOVA together with Post hoc independent sample t-test technique were used to compare the results for females and males. The Bonferroni adjustment was done to be more conservative by adjusting α for the number of comparisons made (Snedecor & Cochran, 1982). The effect of the Bonferroni adjustment was that for overall $\alpha = 0.05$ decision α was set at 0.003. The relationship between the safety perception and safety behavior was assessed using the Pearson correlation coefficient technique.

Gender differences were also investigated for safe behavior (proportion of required PPE worn), and independent sample t-test statistical technique was used to compare safety behavior for females and males.

The workers were also categorised into four age groups of < 30 (younger age), 30-39 (young age), 40-49 (middle age), 50 and above (mature age), and compared with each other for safety behavior and safety perception using the ANOVA and the Post hoc testing.

To study the safety perception and safety behavior of samples with different durations of work experience, the median score of duration of job experience was calculated for all samples and was used as a cut off point to classify samples into two groups. The first group contained workers with duration of job experience either equal to or below the median, and the second group contained those with duration of job experience above the median. This means that the groups with total duration of job experience

of 72 months and less were compared with the groups with total duration of job experience above 72 months. The mean scores for the individual question in the Safety Perception/Attitude Questionnaire were calculated and the independent sample t-test technique with the Bonferroni adjustment were used to compare the similarities and the differences in safety perception for the two groups of duration of job experience. Also the mean score for each individual's safety behavior and the t-test technique were used to compare safety behavior for these two groups of workers.

Finally, the samples were divided into two groups on the basis of their experience with an accident, one group which had experience of an accident while working and the other group which had no experience of an accident while working. The same procedures of using mean scores and the t-test with the Bonferroni adjustment as were used to compare the safety perception and safety behavior for the other variables, were also used to compare these categorised group of workers.

4.3. Results and discussion

4.3.1. Gender

4.3.1.1. Safety perception

Table 4.9. shows the distribution of scores on the Safety Perception/Attitude Questionnaire for females and males in the four combined companies.

Table 4.9: Mean scores and standard deviations for each item on the Safety Perception/Attitude Questionnaire for females and males. The results of the t-test are also shown. High scores indicate positive responses.

Items	Female	SD	Male	SD	t	Sig
1r Every one has an equal chance of having accident.	3.69	1.24	3.81	1.23	.051	.9594
2 In the normal course of my job I don't encounter any dangerous situation.	3.27	1.14	3.29	1.21	1.352	.1782
3r People who do not take the necessary precautions are responsible for what happens to them.	3.70	1.23	3.59	1.23	-.009	.9927
4 Safety works until we are busy, then other things take priority.	3.16	1.26	3.47	1.23	-2.332	.0209
5 If I worried about safety all the time I wouldn't get my job done.	3.49	1.18	3.39	1.22	-.011	.9916
6r People who work to safety procedure will always be safe.	3.57	1.13	3.40	1.28	.257	.7975
7 I cannot avoid taking risks in my job.	3.23	1.10	3.13	1.22	.746	.4570
8 Accidents will happen no matter what I do.	3.00	1.09	3.08	1.11	-1.014	.3122
9 It is not likely that I will have an accident because I am a careful person.	3.30	1.13	3.23	1.14	.493	.6230
10 Not all accidents are preventable some people are just unlucky.	3.47	1.06	3.19	1.17	.504	.6146
11 Everybody works safely in my workplace.	2.82	1.03	3.15	1.17	-.486	.6275
12r All the safety rules and procedures in my workplace really work.	3.69	1.16	3.22	1.14	1.037	.3013
13a It would help me to work more safely if my supervisor praised me on safe behavior.	2.88	1.29	3.04	1.29	-1.050	.2954
13b It would help me to....if safety procedure were more realistic.	2.89	1.03	2.73	1.23	.917	.3607

14a When I have worked unsafely it has been because I didn't know what I was doing wrong at the time.	3.47	1.39	3.44	1.21	-.814	.4166
14b When I.....because I needed to complete the task quickly.	3.60	1.24	3.34	1.13	.707	.4806
14c When I.....because the right equipment wasn't provided or wasn't working.	3.78	0.95	3.32	1.14	1.438	.1522

r = Reverse scored due to the nature of the question.

As Table 4.9 shows, the majority of scores were in the mid-region being neither agree nor disagree for both females and males. This was so for the male group for 15 out of 17 items and for 12 out of 17 items for females. The two groups showed little difference in the range of scores. This range was .96 for females and 1.03 for males. A few items had mean scores outside the mid-region. In particular, the mean scores for items 1 and 3 were in the agree direction for both females and males. This shows that the female and male workers tended to agree that everyone has an equal chance of having an accident (item 1) and tended to agree that people who do not take the necessary precautions are responsible for what happens to them (item 3). That is, most of the respondents in each group believed in the possibility of accidents and in personal responsibility for safety behavior.

The two groups differed on the items with highest and the lowest mean scores. As Table 4.9 shows, item 14c (When I have worked unsafely, it has been because the right equipment was not provided or was not working) had the highest mean score for females and item 1 (Everyone has an equal chance of having an accident) had the highest mean score for males.

The independent samples t-test analysis with Bonferroni adjustment was conducted to determine significant differences between the two groups. The results of the t-test analysis with adjusted α level at .003 show that there was no statistically significant difference between males and females on the items in the Safety Perception/Attitude Questionnaire. This means that male workers and female workers were not significantly different in the safety perception.

In summary, there were very similar results for females and males. Both groups of workers responded in a similar way for most of the items. For both genders, mean scores for most items were in the mid-range, except for item 1 and item 3 where both genders tended to agree with these items. This means that the majority of workers of both genders tended to agree that the chance of having an accident is equal for everyone. They also tended to believe that people who do not take the necessary precautions are responsible for what happens to them.

4.3.1.2. Safety behavior

Table 4.10 shows PPE wearing expressed as a proportion of the PPE required to be worn and the distribution of PPE wearing across observations. Means are shown for male and female workers.

Table 4.10 : The mean proportion of PPE worn and the average percentage wearing all required PPE for female and male workers.

	Proportion of PPE worn (safety behavior)	% wearing all required PPE		
		Always	Sometimes (more than one observation)	Never
Female workers n= 45	.66	0	53.3	20
Male workers n= 180	.63	0	58.3	22.77

The independent t-test analysis showed non significant differences between males and females for safety behavior ($t = -1.43_{(df=223)}$ sig = .155). This means that the level of safety behavior was not significantly different for female and male workers.

Comparing the distribution of PPE wearing for female and male workers shows that almost one fifth of workers of both groups never wore all required PPE and more than half of them wore all required PPE more than once (sometimes) during the observation period. None of the workers in either group wore all required PPE for all observations. The results of chi square analysis also revealed that male and female workers had similar distributions of wearing PPE ($\chi^2_{(df=115)} = 107.35$ $p = .68$).

4.3.1.3. The relationship between safety perception and safety behavior for female and male workers

The result of the Pearson correlation coefficient between safety perception and safety behavior for female workers were $r = -.2169$ $p = .152$ and for male workers were $r = -.1185$ $p = .113$. These results show that there was no significant linear relationship between safety perception and safety behavior for female and male workers. In other words, an improvement in safety perception would not result in a significant change in safety behavior for either group.

4.3.2. Age

4.3.2.1. Safety perception

Table 4.11. shows the distribution of scores on the Safety perception/Attitude Questionnaire for workers in each age group:

Table 4.11: Mean scores and standard deviations for each item on the Safety Perception/Attitude Questionnaire for workers in different age groups.

Items	age <30 n= 42	SD	age 30-39 n= 49	SD	age 40-49 n= 52	SD	age ≥50 n=81	SD	F ratio	F prob
1r Everyone has an equal chance of having accident.	3.29	1.25	3.94	1.23	3.78	1.25	3.84	1.24	2.47	.063
2 In normal course of job I don't encounter dangerous situation.	3.26	1.11	3.40	1.18	2.98	1.28	3.38	1.18	1.38	.25
3r People who don't take necessary precautions are responsible for what happens to them.	3.98	1.16	3.52	1.33	3.64	1.14	3.48	1.26	1.62	.185
4 Safety works until we busy then other things take priority.	3.90	1.10	3.44	1.15	3.10	1.19	3.28	1.35	3.55	.015
5 If worried about safety all the time I would not get my job done.	3.55	1.17	3.72	1.17	2.90	1.25	3.47	1.12	4.50	.004
6r People who work to safety procedure will always be safe.	3.64	1.03	3.54	1.33	3.53	1.23	3.26	1.30	1.10	.350
7 I cannot avoid taking risks in my job.	3.34	1.26	3.06	1.24	2.82	1.09	3.29	1.20	2.06	.106
8 Accidents will happen no matter what I do.	3.48	1.04	3.27	1.03	2.86	1.19	2.85	1.06	4.26	.006
9 It is not likely that I will have an accident because I am a careful	3.17	.95	3.25	1.25	3.33	1.26	3.18	1.13	.247	.863
10 Not all accidents preventable some people are unlucky.	3.13	1.06	3.47	1.17	3.44	1.26	2.99	1.10	2.57	.055

11	Everybody works safely in my workplace.	2.76	1.05	3.18	1.20	2.96	1.21	3.18	1.12	1.52	.210
12r	All safety rules and procedure in workplace really works.	3.33	.93	3.73	1.15	3.02	1.27	3.28	1.14	3.35	.020
13a	It would help to work more safely if my supervisor praised me on safe behavior.	3.45	1.20	3.04	1.12	2.85	1.47	2.83	1.31	2.297	.079
13b	It would...if safety procedures were more realistic.	2.56	1.23	2.71	1.17	2.81	1.16	2.91	1.20	.764	.515
14a	When I have worked unsafely it has been because I didn't know what I was doing wrong at the time.	3.39	1.22	3.36	1.33	3.60	1.17	3.54	1.27	.402	.752
14b	When I ...because I needed to complete the task quickly.	3.26	1.11	3.36	1.21	3.18	1.13	3.56	1.14	1.20	.310
14c	When I because the right equipment was not provided or wasn't working.	3.54	1.02	3.31	1.09	3.20	1.12	3.38	1.07	.973	.406

r = Reverse scored due to the nature of the question

As Table 4.11 shows, the majority of scores were in the mid-region being neither agree nor disagree for all age groups of workers. This was so for workers aged <30 (younger age) and workers aged 30-39 (young age) as 12 items were scored in the mid region. For the workers aged 40-49 (middle age), 13 items and for workers aged 50 and older (mature age), 14 items were scored in the mid-region. The groups showed different ranged of scores for items. The range was 1.42 for workers aged <30, 1.23 for workers aged 30-39, .97 for workers aged 40-49, and 1.01 for workers aged 50 and above.

Comparing groups on the average scores for each item shows that scores for the younger age group tended to be in the agree direction for a number of items. The younger respondents (<30), were in agreement with the statements that “people who do not take the necessary precautions are responsible for what happens to them” (item 3), “safety works until we are busy, then other things take priority” (item 4), “if I worried about safety all the time I would not get my job done” (item 5), “people who work to safety procedure will always be safe” (item 6) and “when I have worked unsafely it has been because the right equipment was not provided or wasn’t working” (item 14c). The young age (30-39) group workers, on the other hand, tended to agree with items 3, 5 and 6, and also tended to agree that “all safety rules and procedures in the workplace really work” (item 12) and that “everyone has an equal chance of having accidents” (item 1).

Item 1 was also scored in the agree direction for both the middle (40-49) and the mature age (≥ 50) groups. As shown in Table 4.11, the middle age group also tended

to agree with items 3, 6 and 14a (when I have worked unsafely it has been because I didn't know what was wrong at the time). The mature age group also tended to agree with this item and item 14b (when I have worked unsafely it has been because I needed to complete the task quickly).

There were not many differences between groups for the items with the highest and lowest scores. Item 3 had the highest mean score for the age group <30 and item 13b had the lowest mean score for this group. This means that the workers age <30 tended to agree with safety responsibility (item 3) but showed no tendency to either agree or disagree with that the statement that "It would help me to work more safely if safety procedures were more realistic". The highest mean score for the age group 30-39 was for item 1 and the lowest mean score was for item 13b, suggesting that these workers tended to agree that everyone has an equal chance of having accident and remained neutral about whether more realistic safety procedures would facilitate better safety performance. The age groups of 40-49 and 50 and above shared the item with the highest mean score, as they both showed the highest mean score for item 1. This suggests that the workers in both these age groups tended to agree with the statement that "everyone has an equal chance of having an accident". However, these groups differed for the item with lowest mean score. The lowest mean score for workers in the age group 40-49 was for item 13b (It would help me to work more safely if safety procedure were more realistic), while for workers in age group of 50 and above it was for item 13a (It would help me to work more safely if my supervisor praised me on safe behavior).

The results of the ANOVA with adjusted α level at .003 showed that there was no significant differences for the items in the Safety Perception/Attitude Questionnaire for the workers in the four age groups. These results suggest that the age factor has no significant influence on workers' safety perception.

In summary, as Table 4.11 shows, there were generally similar results for the four groups of workers in different age categories. All groups of workers responded in a similar way for all of the items and they showed no significant difference for any item in Safety Attitude/Perception Questionnaire. There were, however, some non-significant differences between the groups on items with higher and lower mean scores. Younger age workers showed the highest mean score for item 3 and the lowest mean score for item 13b. This means that younger workers tended to believe more in personal responsibility and tended to believe that more realistic safety procedures would facilitate safer behavior. The young age workers showed the highest mean for item 1, suggesting that the young age tended to believe more in equal chance of having accidents than the other age groups. According to these results, although there were some differences between the age groups in terms of safety perception, however, none of these differences were significant. It could be concluded that the age factor had no significant effect on the safety attitude and perception of the workers.

4.3.2.2. Safety behavior

Table 4.12 shows PPE wearing expressed as a proportion of the PPE required to be worn. Means are shown for workers in the different age groups.

Table 4.12 : The mean proportion PPE worn and the distribution of PPE worn across observations are shown for all age groups of workers .

age group	Proportion of PPE worn (safety behavior)	% wearing all required PPE		
		Always	Sometimes (more than one observation)	Never
19-29 n=35	.68	0	80	20
30-39 n=41	.61	0	73.17	24.39
40-49 n=39	.63	0	64.1	26.83
50 & above n=66	.65	0	77.27	22.73

As Table 4.12 shows, workers in different age groups showed little difference in the average score for safety behavior. Also the results of one way ANOVA showed no significant differences between the age groups for proportion of PPE worn at the time of observation $F_{(df=1, 220)} = 2.01$ $p = .113$.

Comparing the age groups for the distribution of PPE worn shows that between one out of four and one out of five workers of all ages never wore all required PPE. Workers aged 40-49 showed the highest percentage of not wearing all required PPE. The groups showed slight differences in wearing all required PPE more than once during observation. The highest percentage of PPE wearing was for the younger age workers, with four out of five wearing all required PPE more than once during the observation period, while the middle age group showed the lowest percentage wearing all required PPE “sometimes”. None of the workers in any age group always wore all required PPE. It seems that there were few differences between the age groups in their safety behavior and as ANOVA showed, these differences were not

significant $F_{(df=1, 220)} = 2.01$ $p = .113$. This suggests that age factors were not associated with significant differences in workers' safety behavior.

4.3.2.3. The relationship between safety perception and safe behavior for workers in different age group:

Table 4.13 shows the results of Pearson correlation coefficient between safety perception and safety behavior for age groups.

Table 4.13: The relationship between safety perception and safety behavior of workers in four age groups.

	age<30	age = 30-39	age =40-49	age =50 & above
Correlation	r =-.096	r = .014	r = -.244	r = -.142
	p= .544	p= .923	p= .081	p= .205

As Table 4.13 shows, there was no significant linear relationship between safety perception and safety behavior for workers in the four age groups. This means that any changes in safety perception will not be productive of significant changes in workers' safety behavior. These findings suggest that the age factor has no significant effect on the relationship between workers' safety perception and their safety behavior.

4.3.3. Job experience

4.3.3.1. Safety perception

Table 4.14 shows the distribution of scores on the Safety Perception/Attitude Questionnaire for workers with different duration in the job.

Table 4.14: Mean scores and standard deviations for each item on the Safety Perception/Attitude Questionnaire for workers with different duration in the job.

Items	duration in the job 72 months and less	SD	duration in the job above 72 months	SD	t	sig
1r Everyone has an equal chance of having accident.	3.71	1.15	3.73	1.34	-.11	.910
2 In the normal course of my job I did not encounter any dangerous situation.	3.44	1.16	3.24	1.17	1.21	.228
3 r People who do not take the necessary precautions are responsible for what happens to them.	3.77	1.20	3.42	1.20	2.00	.047
4 Safety works until we are busy then other things take priority.	3.47	1.22	3.37	1.30	.59	.556
5 If I worried about safety all the time, I would not get my job done.	3.43	1.27	3.46	1.12	-.18	.861
6r People who work to safety procedure will always be safe.	3.44	1.16	3.19	1.30	1.43	.155
7 I cannot avoid taking risks in my job.	3.28	1.24	3.09	1.16	1.10	.176
8 Accidents will happen no matter what I do.	3.17	1.07	2.93	1.16	1.46	.146
9 It is not likely that I will have an accident because I am a careful person.	3.28	1.03	3.26	1.15	.17	.863
10 Not all accidents are preventable some people are just unlucky.	3.14	1.10	3.24	1.17	-.60	.550
11 Everybody works safely in my workplace.	2.06	1.15	3.01	1.14	.29	.771
12r All the safety rules and procedures in my workplace really work.	3.29	1.03	3.26	1.13	.15	.881
13a It would help me to work more safely if my supervisor praised me on safe behavior.	2.03	1.28	2.87	1.34	.82	.414

13b It would..... if safety procedure were more realistic.	2.52	1.17	2.92	1.18	-2.32	.022
14a When I have worked unsafely it has been because I didn't know what I was doing wrong at the time.	3.40	1.27	3.59	1.21	-1.04	.300
14b When I because I needed to complete the task quickly.	3.35	1.20	3.49	1.11	-.79	.428
14c The right equipment was not provided or wasn't working.	3.47	1.08	3.35	1.12	.77	.441

r = Reverse scored due to the nature of the question

As Table 4.14 shows, the majority of scores were in the mid-region, being neither agree nor disagree. This was so for both groups of workers, as 15 out of 17 items for each group were scored in this way. Both groups were in agreement for item 1, that everyone has an equal chance of having an accident. The two groups differed on the items with highest and with lowest mean scores. As Table 4.14. shows, item 3 had the highest mean score for workers with a job duration of 72 months and less, and item 1 had the highest mean score for workers with a job duration above 72 months. This means that the workers with a shorter job duration tended to be more in agreement with the statement that “people who do not take the necessary precautions are responsible for what happens to them” while workers with a longer job duration tended not to agree or disagree with this statement. The lowest mean score for both groups was for item 13a. This suggests that regardless of job duration, workers tended to disagree with that statement that being praised by a supervisor for safe behavior would help them to work more safely. These workers also tended to report that unrealistic safety procedures hampered their working safely (item 13b). The groups also differed in the range of scores for items. This range was 1.25 for workers with a shorter job duration and .86 for workers with a longer job duration. This means that workers with a longer job duration showed a smaller range of scores.

The independent samples t-test analysis with the Bonferoni adjustment was conducted to determine significant differences between the two groups. The results of t-tests with adjusted α level at .003 showed that there were no significant differences between the groups for items in the Safety Perception/Attitude Questionnaire.

4.4.3.2. Safety behavior

Table 4.15 shows PPE wearing as a proportion of the PPE required to be worn.

Means are also shown for workers with different duration of job.

Table 4.15 : The mean proportion of PPE worn shown for workers with different job duration.

	Proportion of PPE worn (safe behavior)	% wearing all required PPE		
		Always	Sometimes (more than one occasion observed)	Never
workers with duration of job 72 months and less n= 101	.65	0	55.44	24.75
workers with duration of job above 72 months n= 90	.64	0	61.1	16.66

Comparing distribution of PPE worn between workers with shorter job duration and workers with longer job duration shows that almost one fourth of the workers with shorter job duration and one sixth of the workers with longer job duration never wore all required PPE. Also more than half of the workers in each group wore all required PPE more than once during observation period. None of the workers in both groups always wore all required PPE. The results of the independent t-test analysis showed that the two groups of workers were not significantly different from each other in safety behavior $t_{(df=189)} = .54$ sig = .590.

4.4.3.3. The relationship between safety perception and safe behavior for workers with different job duration

The result of the Pearson correlation coefficients between safety perception and safety behavior for workers with job experience of 72 months and less was $r = -.096$

$p = .337$ and for workers with job experience above 72 months was $r = -.050$ $p = .633$.

These results show that there was no significant relationship between safety perception and safety behavior for both groups of workers. This suggests that further investigation is necessary to learn more about the relationship between perception and behavior.

In summary, comparing results for safety perception and safety behavior of workers with longer and shorter job duration showed that there were more similarities than the differences between the two groups on their safety perception.

The results of the independent t-test analysis showed that the small difference in the two groups' safety behavior was not significant. There were also no significant linear relationships between safety perception and safety behavior for these groups of workers. All these findings suggest that duration of job has no significant influence on safety perception and safety behavior of workers

4.3.4. Experience of having accident while working

4.3.4.1. Safety perception

Table 4.16 shows the distribution of safety perception responses on the Safety Perception/Attitude Questionnaire safety perception for workers with experience of accident and workers with no experience of accidents.

12r All the safety rules and procedures in my workplace really work.	3.18	1.14	3.40	1.15	-1.40	.163
13a It would help me to work more safely if my supervisor praised me on safe behavior.	3.08	1.19	2.95	1.27	.72	.472
13b It would..... if safety procedure were more realistic.	2.83	1.30	2.71	1.20	.72	.470
14a When I have worked unsafely it has been because I didn't know what I was doing wrong at the time.	3.64	1.13	3.42	1.22	1.32	.188
14b When I because I needed to complete the task quickly.	3.46	1.15	3.26	1.17	1.20	.233
14c The right equipment was not provided or wasn't working.	3.33	1.09	3.49	1.20	-1.00	.319

r = reverse scored due to the nature of the question.

As Table 4.16 shows, the averages of scores for most items were in the mid-region being neither agree nor disagree for both groups of workers, those with and without experience of having an accident while working. The two groups were also similar in tending to agree with item 1 (every one has an equal chance of having an accident). Item 1 had the highest mean score for workers with experience of having an accident. The lowest mean score for this group was for item 11, showing that the workers with experience of an accident tended to agree with the statement that everybody works safely in the workplace. For workers without experience of an accident, item 3 showed the highest and item 13b the lowest mean score, suggesting that these workers tended to agree that people who do not take the necessary precautions are responsible for what happens to them and tended to disagree with the statement that “it would help me to work more safely if safety procedures were more realistic”.

The two groups also showed little difference in the range of scores for items. This range was .88 for workers with experience of an accident and was 1.11 for workers without experience of an accident while working.

As Table 4.16 shows, the results of the independent samples t-test analysis with the Bonferroni adjustment showed no statistically significant differences between the two groups on the items in Safety Perception/Attitude Questionnaire.

4.3.4.2. Safety behavior

Table 4.17 shows the distribution of the PPE worn by workers with and without experience of having an accident while working. Mean proportion of PPE

worn also is shown for these workers.

Table 4.17: The mean proportion of PPE worn and the average percentage wearing all required PPE for workers with and without experience of having an accident while working.

	Proportion of PPE worn (safe behavior)	% wearing all required PPE		
		Always	Sometimes (more than one occasion observed)	Never
workers with experience of having accident n=96	.63	0	64.58	19.79
workers without experience of having accident n= 124	.65	0	63.70	23.38

As Table 4.17 shows, almost one out of five workers with experience of having an accident while working never wore all required PPE and only slightly more workers who had not an accident never wore all required PPE. Also more than half of the workers in each group wore all required PPE more than once during observation period. None of the workers in both groups always wore all required PPE. The results of the independent t-test analysis revealed that workers in both groups were not significantly different from each other in safety behavior $t_{(df=218)} = -1.07$ sig = .288. This means that the levels of safety behavior for the workers with and without experience of having an accident were not significantly different.

4.3.4.3. The relationship between safety perception and safety behavior for workers with and without experience of having an accident.

The results of the Pearson correlation coefficient between safety perception and safety behavior for the workers with experience of having an accident was $r = -.144$ $p = .162$ and for the workers without experience of having an accident while working was $r = -.036$ $p = .692$. These results show that there was no significant relationship between safety perception and safety behavior for the workers with and without experience of having an accident. This means that a change in safety perception would not result in a significant change in safety behavior for these group of workers.

In summary, there were similar results for the two groups of workers, those with and those without experience of having accidents. Both groups of workers responded in a similar way for most of the items in the Safety Perception/Attitude Questionnaire. They also shared a tendency to agree with item 1. This suggests that both groups tended to agree that everyone has an equal chance of having an accident. This item was the highest scored item for the group with accident experience, and the lowest scored item for that group was item 11, suggesting that this group tended to agree that everybody works safely in the workplace. Item 3 scored highest for the workers without experience of an accident and item 13b scored lowest for them. This mean that the workers without experience of an accident agreed with personal responsibility for safety and did not tend to agree that more realistic safety procedure would help to work more safely. However, as data analysis revealed, these differences were not significant.

The small differences in the groups' safety behavior were not statistically significant. On the other hand there were no significant linear relationships between safety

perception and safety behavior for the groups with and without experience of an accident. These results suggest that experience of accidents while working has no significant influence on workers' safety perception and safety behavior.

4.4. Overall discussion

The findings of this part of the study suggest that demographic factors such as gender, age, duration of job and experience of having an accident while working have only minor if any effects on workers' safety perception and safety behavior, and have no effect on the relationship between workers' safety perception and safety behavior. Comparing males and females, workers perception of safety shows that both sexes responded in a similar way for most of the questions in the Safety Attitude/Perception Questionnaire as mean scores for most of the items were in the mid region showing a tendency to neither agree or disagree with the statements. The results of the t-test analysis revealed no significant differences in safety perception between male and female workers.

Regarding safe behavior, the results of the t-test and Chi Square revealed no significant differences between male workers and female workers. As the results of the Pearson Correlation Coefficients showed, there also were no significant relationship between safety perception and safe behavior of workers either with experience of accident or without experience of having accident. The results showed that gender had no significant influence on workers' safety perception or safety behavior, nor on the relationships between safety perception and safety behavior.

These findings do not support the findings of Harre et al. (1996), that males were involved in more unsafe behavior than females.

Comparing workers safety perception and safe behavior in different age groups show more similarities and few differences. All groups of workers responded in a similar way for most of the questions, although they were different on questions with higher and the question lower mean score. Younger workers tended to believe more in personal responsibility for safety and didn't believe that more realistic safety procedures would help in safe working compared to the workers in other age groups. Although this shows that younger workers have better safety attitude, it was not statistically significant. Mature age workers tended to believe more in having equal chance of accident for everybody. They also showed more tendency to see deficiencies in safety in their workplace in motivation for safe behavior. Both young age and middle age groups shared the tendency to believe more in equal chance of having accidents and more realistic safety procedures.

Although there were minor differences in distribution of the workers of different ages wearing PPE and in the average proportion wearing all required PPE, they were not significantly different from each other. No matter what their age, no worker was observed always wearing PPE and around one- quarter to one fifth of them were never observed to wear all required PPE. The relationships between safety perception and safe behavior for all age groups also were not significant. The results of this study also suggested that although age was related to some minor differences in safety perception, these differences were not significant. In other words age appeared to

have no significant influence on workers' safety perception and safety behavior or on the relationships between safety perception and safety behavior.

Duration of job also had no significant influence on workers' safety perception and safe behavior. Both groups of workers with longer duration of job and the workers with shorter duration of job responded in a similar way for most of the questions by being in the mid region where they neither agreed or disagreed. They also shared the agreement on equal chance of having accidents for everyone. The workers with shorter duration of job showed tendency to be more in agreement with the personal responsibility for safety. This group also tended to report more strongly that more realistic safety procedure would help them to work more safely. The results of the data analysis showed that these differences were not significant. There were no significant linear relationships between the safety perception and safe behavior for both groups of workers. The findings of this study suggested that duration of job made no significant difference to workers' safety perception or safety behavior.

Comparing the group of workers who had experience of accidents while working with the group of workers had not had experience of accidents while working shows that the two groups had more similarities than differences in safety perception as they both tended to be neither agree or disagree for most of the items in the Safety Perception/Attitude questionnaire. They also shared the agreement that everyone has equal chance of having accident. The groups however showed no significant differences in the Safety perception scores.

The two groups showed similar distribution of PPE worn and the difference on the average proportion of PPE worn was not statistically significant. There was no significant linear relationship between safety perception and safe behavior for either group of workers. In summary the findings of this part of the study suggested that the experience of having an accident while working had no significant effect on workers' safety perception or safety behavior nor on the relationships between safety perception and safety behavior. These findings support the findings of Napier and Pugh (1987), that workers' experience of hazards had no significant effect on the rate of farm accidents.

CHAPTER 5

The results of the second stage (Intervention) of the study

5.1. Introduction and background

Unsafe behavior at work is a safety problem which could be resolved with an appropriate intervention. Many different methods of intervention have been used to improve and maintain safe behavior. Some studies have demonstrated that providing knowledge through educational sessions about targeted behavior was successful for improving that behavior (Girgis et al., 1994; Grummon and Stilwels, 1984).

On the other hand, studies have also shown that increasing knowledge of safe behavior alone is not adequate to maintain safe behavior. For example, Komaki, Heinzmann and Lawson (1980), in their study of the effect of training and feedback on vehicle maintenance division workers, used a multiple baseline design with a reversal component with a total of five phases. Firstly baseline data were collected, then a training only phase commenced. In this phase, the desired behaviors were illustrated, discussed and posted. A training and feedback phase followed, in which supervisor observed workers' behavior on daily basis and provided graphed feedback about the level of the safety in the workplace. After the 26th and 36th weeks respectively, a second training only phase and a second training and feedback phase were introduced. The workers showed slight improvement during the first training only phase, and increasing substantially during the first training and group feedback phase. While the workers' performance declined during

the second training-only phase and improved once again during the second training and group feedback phase, only when feedback was provided at least three times a week.

Komaki et al concluded that the provision of training alone is not adequate to improve and maintain safe performance.

Zohar (1980b), also examined the effect of individual feedback on wearing PPE. In his study, Zohar used two behavior modification techniques. First technique was providing individual feedback to workers on their audiometric testing results at the beginning and at the end of their work-shift. This enabled the workers to see the temporary hearing loss due to not wearing earplugs. The second technique was a token economy system. Each worker who was using earplugs while working received a token to acquire a variety of less expensive goods. In this study, Zohar (1980b), found a marked increase in average level of wearing PPE.

Fellner and Sulzer-Azarof (1984), also studied the effect of posted feedback in increasing industrial safety practices and found that after posting feedback on safe and unsafe behavior for six months, safety practice improved in more than half of the industrial settings studied and there was also a 50% decrease in injury rate as a result of this intervention.

In another study, Seppala et al. (1987), attempted to improve safety performance in the workplace, focusing on increasing the effectiveness of safety activities and strengthening

the safe behavior of the workers by applying both informative (providing subjects with some knowledge on the hazards and proper actions to prevent accidents) and motivational (providing subjects with feedback) measures. They found that motivational measures in terms of performance feedback were especially efficient in establishing safe work practice.

Ray et al. (1991), in their study of the long term effect of a safety program, tried to determine the persistence of the improved level of performance achieved by implementing a behavioral feedback program which included identifying safe work practice, informing the workers of the safe practice, observing their performance and reinforcing safe performance in the form of feedback. This intervention resulted in a significant improvement in the safety behavior of the workers. In order to determine the persistence of this improvement, a sampling study was conducted after two years. This study indicated that the safety performance of the group had fallen back almost to the pre-feedback level. The authors concluded that the beneficial effects of a safety program may not persist for a long period of time.

Although a few studies have shown the effectiveness of feedback in changing safety behavior over a few months (e.g. Komaki et al.), Ray et al. (1991) found no persistence of safe behavior over two years. Because there are few studies of the persistence of new safety behaviors produced by intervention, there is a need for further research to clarify this issue.

In summary, the research on the effectiveness of knowledge based intervention on workers' safety behavior suggests that it is not highly effective, while the research on the effectiveness of feedback based intervention shows a stronger effect.

A number of studies have shown the combined technique of knowledge and feedback to be more effective than either single technique (Komaki et al., 1979; Chhokar, 1987; Saari, 1990). Even so, the combined technique might not be effective for all workers, and it is not clear how long the behavior changes produced by this type of intervention will last. These points suggest a need for further investigation.

Not all intervention studies have produced changes in workers' safety behavior. While some studies show significant improvement in workers' safety behavior, others show only some improvement and others fail to evidence any improvement. It might be that the same intervention is effective for some workers but not for all. It is possible that individual differences play a role in determining whether or not individuals will respond to an intervention. For example, individuals with different safety perception and safety behavior may respond differently to particular types of intervention. In other words, individual differences in terms of safety attitude and safety perception may prove to be determinants in achieving successful intervention.

For these reasons, this part of the study focused on the effect of safety intervention on the

safety perception and safety behavior of the workers in the participating companies. The effects of this intervention on workers with different safety perception and behavior were also compared. Two intervention methods were tested in this part of the study, a single method (Knowledge) and a combined method (knowledge and feedback). The aim was to improve workers' perception/attitude about safety and safety behavior at work by providing them with appropriate knowledge of targeted safe behavior (a) alone and (b) in combination with positive feedback regarding safe and unsafe behavior. It was possible to compare the effects of these different types of intervention with each other and with a comparison group.

5.2. Method

Design

Stage 2 of this study involved examination of the influence of variations in safety attitude and behavior on the effectiveness of safety interventions.

5.2.1. Subjects

The subjects were selected from the workers who participated in the first stage of the study. Three criteria used to select the subjects for this stage of the study were:

- The management gave consent for the subject to participate in the intervention stage of the study (For this reason workers in Company 1 did not participate in this stage of the study).
- The subject participated in the first stage of the study and responded to the Safety Perception/Attitude Questionnaire.

- The subject agreed to participate in the second stage of the study.

A total of 230 workers met the criteria and participated in the second stage of the study.

Thirty eight subjects did not return the Safety Perception/Attitude Questionnaire. Table 5.1 shows the distribution of subjects.

Table 5.1: Distribution of workers participating in the second stage of the study.

	Male	Female	Gender not listed by respondent	Total
Company 2	3	10	0	13
Company 3	91	6	4	101
Company 4	22	10	6	38
Company 5	18	20	2	40
Total	134	46	12	192

5.2.2. Instruments

The Safety Perception/Attitude Questionnaire used in the intervention stage was the same questionnaire which was used for the first stage of the study. This questionnaire was used again to collect data regarding subjects' safety perception /attitude at the intervention stage.

To measure safety behavior, the observational checklist used in the first stage was also used in the intervention stage to collect data on subjects' safety behavior.

5.2.3. Procedure

At the time that the first stage of the study was completed, subjects were told that there would be two types of intervention available for them. Some would have a knowledge session only and some would have a knowledge session followed by individual feedback on their safety behavior, while some would have no intervention at all, but all groups would be observed for their safety behavior and would be asked to complete the Safety Perception/Attitude Questionnaire. The subjects were also told that participation in the second stage of the study was not compulsory but would be highly appreciated. They were asked to advise the investigator verbally if they preferred not to participate in the second stage of the study. Those who advised the investigator of not being willing to participate in the second stage were excluded, and the rest were initially divided into two groups, Intervention group and Comparison group. The investigator used random selection to divide the subjects into groups and made sure that there was an adequate number of subjects participating in each group. Allocation was done one working day prior to the commencement of the intervention stage, and the subjects were informed of the time, date and procedure of the intervention. A total of 192 subjects participated in the second stage of the study.

- The Intervention group

An introductory talk for the Intervention group was given by the investigator in the morning of the first day that the second stage was commenced. This talk lasted 5 minutes and emphasised the importance of target safety behavior in terms of wearing

PPE while working and the consequences of not wearing PPE. The talk was always held in the workplace in each company and the content was the same for each group of subjects. Immediately after the talk, three video cassettes were shown. The first one "Eye Safety" (Valley Video, 1990) took 6.5 minutes and emphasised how and why eye safety at work is important and why eyes should be protected. The second video cassette "PPE" (Valley Video, 1990) took 6 minutes and focused on the different types of PPE, how to wear them and why it is important to wear PPE all the time while working. The third video cassette "Hearing Conservation" (Film Australia, 1981) took 9 minutes and was about ear safety, specifying the importance of having healthy hearing, how hearing sensory deficiency affects the quality of life and how to wear appropriate ear protectors to conserve hearing. The length of the entire session was 20.5 minutes.

The selection of these videos was based on the fact that they provided information about the need for various forms of PPE and showed the proper techniques for wearing PPE. Immediately after the knowledge session, the intervention subjects were randomly divided into two sub-groups. The Knowledge only group and the Knowledge and Feedback group. The Knowledge only group did not receive more intervention and were observed by the investigator for their safe and unsafe behavior for five working days, three times a day on different days and at different times of the day (before and after tea and lunch break, early in the beginning and late at the end of the shift and in between). This observation commenced immediately after the knowledge session. At the end of the observation, they were asked to complete the Safety Perception/Attitude Questionnaire.

The subjects in the Knowledge and Feedback group were also observed for targeted safety behavior, but in addition they individually received verbal and written feedback on their behavior. The verbal feedback was positive comments regarding each worker's safe and unsafe behavior. The verbal comments were given to each worker by the investigator each time the subject was observed, for safe or unsafe behavior while working. The type of comments can be seen in Appendix 3. In addition to verbal comments, each worker received two written comments. The verbal comments were given by the investigator immediately following the observation of safe (the worker was wearing all required PPE) or unsafe performance (the worker was not wearing all required PPE). The written comments were handed to the workers by the investigator as part of the ongoing feedback procedure and were given to back up the verbal comments. These written comments can be seen in Appendix 4.

-The Comparison group

The Comparison group did not participate in the introductory talk and were not shown the video cassettes and no feedback in any form was given to this group. Instead they were told that they would be observed and would be asked to complete the Safety Perception/Attitude Questionnaire.

The method and criteria employed for observation were the same as for all behavioral observations in the first stage of the study. The subjects were observed by the

investigator for their safe and unsafe behavior for five consecutive working days, three times a day and at different times of the day.

Immediately after all observations were completed, the Safety Perception/Attitude Questionnaire was administered by the investigator to the subjects in each workplace to obtain data on their safety perception and attitude. The method and the criteria for administering the questionnaire were the same as in the first stage of the study.

State of the art behavioral technology requires that observational monitoring and feedback be sustained permanently, primarily because natural contingencies (discomfort, extra time and effort) interfere being safe. Having this in mind, one month after observation was completed, all three groups (the Knowledge only group, the Knowledge and Feedback group and the Comparison group) were reobserved for their target safety behavior. This was to confirm the extent to which the intervention had a lasting effect on safety behavior. The same method and criteria for this observation were used as for the observations in the first stage of the study. A total number of 15 observations (three times a day for five working days at different times of the day) were carried out for subjects in each group. The groups were not required to complete the Safety Perception/Attitude Questionnaire at this time because the aim of this final observation was to measure the persistence of the effect of the intervention on the subjects' safety behavior.

In order to study the effect of the intervention on the congruent (safety perception was matching safety behavior, for example good safety perception and good safety behavior), and incongruent (safety perception was not matching safety behavior, for example good safety perception and poor safety behavior), perception/behavior groups, the subjects were classified into groups as showing poor or good safety perception and behavior. The criteria used for this classification were developed in the first stage of the study.

Workers who wore more than the mean number of required PPE across the 15 observations in the first stage of the study were classified as showing good safety behavior. This corresponded to wearing at least two-thirds of all required PPE on most occasions. Workers who wore less than the mean number of required PPE were classified as showing poor safety behavior. For each of these behavior groups, the workers were classified again into those who showed good safety perception and those who did not. The criterion for this categorisation was the average score on the Safety Perception/Attitude Questionnaire. Workers who showed higher than the average score were classified as showing good safety perception and those with lower than the average score were classified as showing poor safety perception.

Four groups of workers were identified as the result of this classification. These were:

- Good perception-Good behavior (congruent good group)
- Poor perception-Poor behavior (congruent poor group)
- Good perception-Poor behavior (incongruent poor behavior group)
- Poor perception-Good behavior (incongruent good behavior group)

5.2.4. Data collection and data analysis

A simple effects ANOVA with repeated measures on one factor (pre-post intervention) and one between subjects factor (intervention group) was used to compare the intervention groups. The Bonferroni adjustment was performed to be more conservative by adjusting α for the number of comparisons made (Snedecor & Cochran, 1982). The effect of the Bonferroni adjustment was for overall $\alpha = 0.05$ for the family of comparisons, individual decision α was set at .003 based on an adjustment of α for the number of comparisons made.

Firstly the results of the Safety Perception/Attitude Questionnaire and safe behavior observations were compared pre and post intervention for the entire intervention group. This was done using a t-test for two independent samples of safety perception and safe behavior of the participating subjects. This was repeated for all three groups (the Knowledge only group, the Knowledge and Feedback group and the Comparison group). The Safety Perception/Attitude Questionnaire results were compared within each group and between groups pre and post intervention. The safety behavior of all three groups was also compared immediately pre and post intervention and after four weeks within the groups and between each group.

5.3. Results

5.3.1. The effect of the intervention on safety behavior and safety perception for the

entire group

5.3.1.1. The effect of the intervention on safety behavior

The effects of the intervention on safety behavior was assessed by comparing results before and after the intervention. The results of the simple effects ANOVA was a statistically significant improvement on safety behavior for the entire intervention group ($F_{(df=1,150)} = 78.61$ $p = .00$). Table 5.2 shows the comparison between pre and post-intervention behavior for the entire intervention group.

Table 5.2. The average target safety behavior (mean proportion of wearing required PPE) and standard deviations for the entire Intervention group and the Comparison group at before and immediately after intervention.

	Intervention group	Comparison group
Pre-intervention	0.62 SD = 0.13	0.61 SD = 0.11
Post-intervention	0.89 SD = 0.11 $p = 0.00$	0.68 SD = 0.15 $p = 0.11$

From the mean values for the Intervention group before and after intervention, it clear that the Intervention group had a significant improvement compared to the Comparison group. The change for the Comparison group was not significant ($F_{(df=1,149)} = 6.55$ $p = 0.11$).

5.3.1.2. The effect of the intervention on safety perception of the entire group

A simple effects ANOVA was used to compare the effect of the intervention on safety perception of the entire group immediately after intervention. The results of the analysis

revealed that there was no statistically significant improvement on safety perception for the Intervention group ($F_{(df=1,149)} = 2.51$ $p = 0.11$). The Comparison group also showed no significant changes ($F_{(df=1,149)} = 0.42$ $p = 0.042$). Table 5.3 shows the comparison between pre and post-intervention for the entire Intervention group and the Comparison group.

Table 5.3. The average safety perception and standard deviations for the entire Intervention group and the Comparison group at before and immediately after intervention.

	Entire intervention group	Comparison group
Pre-intervention	3.38 SD = 0.48	3.23 SD = 0.39
Post-intervention	3.79 SD = 0.38 $p = 0.11$	3.26 SD = 0.34 $p = 0.042$

Although comparing the mean values shown in table 5.3 shows some improvements at after intervention for the Intervention and the Comparison group, however these improvements were not significant.

5.3.2. The effect of the type of the intervention on subjects' safety perception and safe behavior

5.3.2.1. The effects of different types of intervention on safety behavior

Table 5.4 shows means and standard deviations for the Knowledge only group, the Knowledge and Feedback group and the Comparison group before intervention,

immediately after intervention (post-intervention 1) and four weeks after intervention (post-intervention 2). The results shows that there was a statistically significant improvement in target safety behavior on pre-intervention and post-intervention for the Knowledge only group ($F_{(df=1,149)} = 108.9$ $p = .00$) and for the Knowledge and Feedback group ($F_{(df=1,149)} = 6.55$ $p = .11$).

Comparing these results shows that although both intervention groups showed significant improvement, the Knowledge and Feedback group achieved greater improvement on their safe behavior immediately after intervention (post-intervention 1) than the Knowledge group did.

Also comparing the groups' safety behavior post-intervention 1 and post-intervention 2 shows that the Knowledge only group was significantly different at post-intervention 2 ($F_{(df=1,148)} = 33.3$ $p = 0.00$). As table 5.4 shows, the mean values of safety behavior for this group dropped from 0.81 post-intervention 1 to 0.66 a post-intervention 2. This means that following knowledge only intervention, safety behavior was significantly lower four weeks after the intervention. Also comparing safety behavior post-intervention 1 and post-intervention 2 shows that safety behavior for the Knowledge and Feedback group was not significantly different post-intervention 2 ($F_{(df=1,148)} = 0.19$ $p = .67$), indicating no significant change in safety behavior. This means that the safety behavior for the Knowledge and Feedback group did not decline significantly after four weeks of the intervention.

The Comparison group did not show any significant differences post-intervention ($F_{(df=1,149)} = 0.02$ $p = 0.88$). This is indicating that the Comparison group remained unchanged during the time interval.

Table 5.4. The average target safety behavior (mean proportion of wearing required PPE) and standard deviations for each group at all three stages (pre-intervention, post-intervention 1 and at post-intervention 2).

	Knowledge only	Knowledge and Feedback	Comparison
Pre-intervention	0.63 SD = 0.15	0.6 SD = 0.1	0.61 SD = 0.11
Post-intervention 1	0.81 SD = 0.10 p = 0.00	0.98 SD = 0.02 p = 0.00	0.68 SD = 0.15 p = 0.11
Post-intervention 2	0.66 SD = 0.09 p = 0.00	0.85 SD = 0.04 p = 0.67	0.68 SD = 0.14 p = 0.88

Post-intervention 1 = Immediately after intervention

Post-intervention 2 = four weeks after intervention

As shown in table 5.4 both intervention groups improved on target safe behavior immediately post-intervention compared to the Comparison group. However, the persistence of this safe behavior varied for groups. The Knowledge only group showed less persistent target safe behavior compared to the Knowledge and Feedback group.

5.3.2.2. The effect of different type of intervention on the groups' safety perception

Table 5.5 shows the comparison pre and post-intervention 1 for the Knowledge only, the Knowledge and Feedback and the Comparison groups. The results of the simple effect ANOVA shows significant differences in safety perception pre and post-intervention for the Knowledge only group ($F_{(df=1,149)} = 10.24$ $p = .002$), while the difference was not significant for the Knowledge and Feedback group ($F_{(df=1,149)} = 4.04$ $p = 0.046$) and for the Comparison group ($F_{(df=1,149)} = 0.01$ $p = 0.927$). This means that the intervention had a significant effect on the safety perception of the Knowledge only group but had no significant effect on the safety perception of the Knowledge and Feedback group.

Table 5.5. Mean values of safety perception and standard deviations for all groups before and after intervention.

	Knowledge only	Knowledge and Feedback	Comparison
Pre-intervention	3.36 SD = 0.44	3.40 SD = 0.53	3.23 SD = 0.39
Post-intervention 1	3.74 SD = 0.43 p = 0.002	3.89 SD = 0.28 p = 0.046	3.26 SD = 0.34 p = 0.927

5.4. Discussion

The intervention produced significant improvements in safety behavior for both intervention groups, and a significant improvement in safety perception for the Knowledge only group. Although the intervention produced a significant improvement on wearing of PPE for both groups, the group which received both knowledge and feedback showed the greatest improvement in safety behavior compared to the group

who received knowledge only and compared to the Comparison group. This means that providing workers with knowledge followed by feedback resulted in better safety behavior. These results are consistent with those of Komaki et al. (1980), Chhokar (1987) and Saari (1990). The findings of this study showed that although both the Knowledge only group and the Knowledge and Feedback group showed a reduction on the level of safety behavior over four weeks period following completion of intervention, this reduction was significant only for the Knowledge only group. This indicates that providing workers with only knowledge of safe behavior had a less persistent effect on safety behavior compared to providing them with both knowledge and feedback by giving feedback to each individual on safety behavior. The Comparison group did not improve significantly in safety perception over the intervention period.

Although the intervention improved both groups' safety perception, this improvement was significant only for the Knowledge only group. Considering the fact that both groups were provided with the same content of knowledge of safety behavior, possible reasons for this difference could be either an artifact of the N or the uncontrolled variables such as differences in personal characteristics (attitude and perception of safety and safe behavior). For this reason, the following section of the study examined the effect of the intervention for the individuals with different safety perception and different safe behavior.

In summary, intervention produced significant improvement in safety behavior for both

incongruent good behavior group ($F_{(df=1,116)} = 3.43$ $p = .067$) showed no significant changes in wearing PPE pre-post intervention, although there was a trend for improvement in safety behavior in this group.

Table 5.6. Mean safety behavior for the perception/behavior groups pre and post-intervention.

	Pre-intervention	Post-intervention	Proportion of change
Congruent poor behavior n = 29	.53 SD = .07	.92 SD = .09 p = .00	.73
Congruent good behavior n = 28	.74 SD = .08	.89 SD = .12 p = .00	.2
Incongruent poor behavior n = 43	.53 SD = .08	.89 SD = .11 p = .00	.68
Incongruent good behavior n = 16	.75 SD = .07	.82 SD = .11 p = .067	.09

As Table 5.6 shows, the highest proportion of change in safety behavior was for the congruent poor group. This shows that the congruent poor group were more receptive and showed better response to the intervention compared to the other groups. The lowest proportion of change was for the incongruent good behavior group. Although the incongruent good behavior group improved slightly, it was not a statistically significant improvement.

Table 5.7 shows the proportion of change in average safety behavior for each perception/behavior group in the Comparison group. The results of the simple effects ANOVA for each group show that except for the incongruent group $F_{(df=1,28)} = 1.58$

$p = .219$), there were significant differences for all of the perception/behavior groups in the Comparison group, that is the congruent good group ($F_{(df=1,28)} = 5.74$ $p = .024$), the congruent poor group ($F_{(df=1,28)} = 20.87$ $p = .001$) and the incongruent poor behavior group ($F_{(df=1,28)} = 5.75$ $p = .023$).

Table 5.7: Mean safety behavior for the perception/behavior groups in the Comparison group are shown at pre-intervention and post-intervention.

	pre-intervention	post-intervention	proportion of change
Congruent poor behavior n = 10	.54 SD = .07	.56 SD = .15 p = .001	.09
Congruent good behavior n = 9	.69 SD = .06	.76 SD = .11 p = .024	.14
Incongruent poor behavior n = 43	.53 SD = .07	.61 SD = .08 p = .023	.05
Incongruent good behavior n = 6	.71 SD = .09	.82 SD = .04 p = .219	.1

As table 5.7 shows, the highest proportion of change in safety behavior was for the congruent group and the lowest proportion of change was for the incongruent poor behavior group.

5.5.2. The effects of the intervention on the safety perception of the perception/behavior groups

Table 5.8 shows the proportion of change in average safety perception resulted from the intervention for each perception/behavior groups. The results of the simple effects ANOVA for each group show that there were significant differences for all perception/behavior groups. This means that there was a statistically significant

improvement in safety perception from pre to post-intervention for the congruent good group ($F_{(df=1,116)} = 11.26$ $p = .002$), the congruent poor group ($F_{(df=1,116)} = 118.62$ $p = 0.001$), the incongruent good behavior group ($F_{(df=1,116)} = 42.32$ $p = .001$) and for incongruent poor behavior group ($F_{(df=1,116)} = 29.45$ $p = .001$).

Table 5.8: Mean safety perception and standard deviation for each perception/behavior groups pre and post intervention.

	pre-intervention	post-intervention	proportion of change
Congruent poor behavior n = 29	2.84 SD = .28	3.57 SD = .24 p = .00	.25
Congruent good behavior n = 28	3.61 SD = .26	3.82 SD = .40 p = .00	.06
Incongruent poor behavior n = 43	3.70 SD = .33	4 SD = .27 p = .00	.08
Incongruent good behavior n = 6	2.94 SD = .24	3.56 SD = .048 p = .00	.2

As table 5.8 shows the highest proportion of change was for the congruent poor group and the lowest proportion of change was for the congruent good group. This shows that the congruent poor group showed a better response to the intervention than the other perception/behavior group.

Table 5.9 shows the proportion of change in average safety perception in the Comparison group. The results of the simple effects ANOVA for each group shows that there were no significant differences for the congruent good group ($F_{(df=1,28)} = .23$ $p = 0.638$), the

congruent poor group ($F_{(df=1, 28)} = .00$ $p = .982$) and the incongruent good behavior group ($F_{(df=1, 28)} = 4.22$ $p = .049$), while the incongruent poor behavior group ($F_{(df=1, 28)} = 7.53$ $p = .010$) showed a significant change.

Table 5.9: Mean safety perception and standard deviation for each perception/behavior group in the Comparison group pre and post-intervention.

	pre-intervention	post-intervention	proportion of change
Congruent poor n = 10	2.99 SD = .17	3.04 SD = .28 p = .982	.01
Congruent good n = 9	3.57 SD = .2	3.57 SD = .40 p = .638	.00
Incongruent poor behavior n = 43	3.47 SD = .15	3.23 SD = .27 p = .010	.07
Incongruent good behavior n = 6	2.85 SD = .46	3.21 SD = .48 p = .049	.12

As shown in Table 5.9 the highest proportion of change in average safety perception in the Comparison group was for the incongruent good behavior workers.

5.6. Discussion

The intervention was associated with significant improvement in safety behavior for all subjects, regardless of the type of intervention. However, the improvement in safety perception was not significant for the entire intervention group. Data analysis revealed that the group which received knowledge and feedback made more improvement in safety behavior than the group which received knowledge only. On the other hand, regarding persistence effect of the intervention, although the level of safety behavior for

both the Knowledge group and the Knowledge and feedback group had decreased four weeks after the intervention, the decrease was significant for the Knowledge only group. This finding suggest that providing knowledge of safety together with positive feedback (a combined method of intervention) about targeted safety behavior was a more effective way of improving safety behavior than providing knowledge only (a single method of intervention).

Data analysis revealed that although the intervention produced better safety perception for both groups, the Knowledge only group showed a more significant improvement in safety perception than the Knowledge and Feedback group.

Regarding the perception/behavior groups, the intervention improved on these groups' perception of safety. This improvement varied for different perception/behavior groups. For example, the congruent poor group achieved a better improvement than the congruent good group. The reason for this difference in improvement might be that there was more potential for change in the congruent poor group, and the intervention encouraged and motivated them to achieve this change. For example, the knowledge session provided them with knowledge of safety and safe performance which in turn might have encouraged them to compare this new knowledge of safety with what they already knew about safety. As a result of this comparison, the congruent poor group might have become ware of their poor safety perception and this might have been a strong motivation for improvement.

The intervention also improved the safety behavior of all except the incongruent good behavior group. This improvement varied for the perception/behavior groups. The congruent poor group again showed the most improvement. The reason for the incongruent good behavior group not being affected by the intervention could be that these workers probably were aware of the correct techniques of wearing PPE, hence they found their knowledge matched the techniques explained in the intervention, and they may have believed their safety behavior to be adequate. If this group did not believe there was a need to improve or change their behavior, then this could explain their small improvement in safety behavior. Another explanation for this group not being significantly affected by the intervention could be that the good performers had less opportunity to improve because they were already approaching a ceiling and it is much easier to show a significant effect when there is lots of room for change.

Like all other groups who participated in the study, the incongruent good behavior group also significantly improved in safety perception. This improvement however had no significant effect on the group's safety behavior. The possible reason for this could be that the nature of the relationships between perception and behavior, there being no simple positive relationship between safety perception and safe behavior. This contention is supported by the findings of the first section of this study and discussed in the previous chapter.

Some of the findings in this chapter are unique, and there is minimum literature available as a background for these findings. Therefore the findings of this part of the study provide a suitable background for much further research.

CHAPTER 6

Summary and conclusion

The main goal of this study was to understand the relationships between worker's safety perception/attitudes and safe behavior. The safe behavior expressed by workers, as their use of safety measures. In attempt to achieve the study's main goal, different methods were conducted in two stages of the study. In the first stage, the differences between the workplaces in workers' safety perception and safe behavior were initially examined. Then the influence of compulsory safe practice on workers safety perception and behavior was studied. Finally the influence of personal characteristics such as age, gender, job experience and experience of having an accident on workers' safety perception and safe behavior were investigated.

The second stage of this study compared the effectiveness of intervention techniques, a single method of knowledge intervention and a combined method of knowledge and feedback intervention on workers' safety perception/attitude and safety behavior. This study also attempted to investigate how individual differences in safety attitude and perception influence the effectiveness of these intervention methods

- 6.1. The differences between companies (where safe behavior was not compulsory) in workers' safety perception and safety behavior

The findings of this part of the study showed that the workers in all companies had more similarities and few significant differences in safety perception. Workers in all companies shared belief of the possibility of having accident for everyone. They also showed significant differences in some aspects of safety perception such as safety responsibility, risk control (hazard perception) and the effect of supervisor approach to their safety behavior.

Although the workers in some companies were significantly different in perception of safety responsibility, hazard awareness and perception of the effect of supervisor approach to their safety behavior, it seems that these differences were not related to differences in their workplace. The workers in Company 1, for example, were significantly lower in perception of safety responsibility and perception of risk control compared to the workers in Company 4 who scored highest in these items, while the two companies were similar in terms of safety training and supervision of safety behavior since the workers in both companies did not receive safety training and were not supervised for their safe behavior.

For distribution of safety behavior in terms of wearing PPE, there were more similarities than differences. None of the workers in the companies wore all required PPE and more than 40% of the workers in all companies sometimes wore all required PPE.

Workers in Company 1 showed better safety behavior than other companies, although these workers showed significantly poor perception of safety responsibility and perception of risk control. This suggests that those aspects of their safety attitude related to safety responsibility and risk control were inconsistent with their safety behavior. A possible reason for Company 1 workers showing better safety behavior might be that they were exposed to more hazard and were more aware of the risks in their workplace.

On the other hand, the perception of safety responsibility of workers in Company 3 who had the poorest safety behavior, was significantly higher than that of workers in Company 1. It is possible that an explanation for this incompatibility could be found in the relationship between safety perception and safety behavior.

In summary, the findings of this part of the study suggest that workplace variations in use of safety training, availability of safety officer and management commitment to safety (frequently supervising workers in the work, active participation in safety committee) and had relatively small effects on workers' safety perception and behavior. It could be argued that the organisational contribution of these factors to unsafe behavior is non significant. This finding is not keeping with the findings of the literature review by Hofman et al. (1995), who argued that the existence of a safety representative and a positive management attitude to safety have important implications for safety performance. However, because only limited factors related to organisational safety

commitment were investigated in this study, it is suggestible that there is a need for further research to more clarify this matter.

It seems that some other factors may contribute to workers' safe behavior. One such factor could be the differences between the workplaces in terms of safety behavior being compulsory.

6.2. The influence of compulsory safety practices on workers' safety perception and behavior:

The results from this section of the study illustrated that making safety behavior compulsory has a positive effect on workers' safety perception and safety behavior. Workers in Company 5 (where safe behavior was compulsory) showed better perception of risk, perception of safety responsibility and safety practice than the workers in the four combined companies (where safe behavior was not compulsory). Thus workers in the workplace where safe behavior was enforced, tended to be more likely to realise that they were vulnerable to accidents and were more aware of existing hazards in their workplaces than workers in the non-compulsory workplaces.

The workers in the company with compulsory safe behavior did not try to justify their unsafe behavior and were more likely to realise that unsafe behavior at work is avoidable. Overall these workers demonstrated a better safety attitude. It could be that making safe

behavior compulsory along with continued supervision of workers' behavior results in better safety attitude and perception of workers.

There could also be other reasons for workers' better safety perception and behavior. One possible reason could be environmental factors. For example, workers see each other wearing PPE and one can imagine what he/she would look like without wearing PPEs while all others wearing them. This could possibly act as a motivator for individual worker to try to catch up with the group and wear PPEs. The other reason could be that the outcome of not wearing PPEs. That is, the undesirable and unpleasant consequences of not wearing PPEs that workers wanted very minimum risk of that. If so, then there might be a doubt that the worker would express the same safe behavior working in non-compulsory workplace as he/she expressed in compulsory workplace.

However, although the workers in the workplace with compulsory safe behavior showed significantly better safety behavior than workers in the other workplaces, their commitment to safe behavior was not as high as might be expected. For example, only 9.52% always wore all required PPE while working. An explanation for this could be that wearing PPE all the time was not easy or comfortable for the workers because their poor design, nuisance value or conflict with other activities (Feeney, 1986).

It is evident from the findings of this part of the study, that making safe behavior compulsory does have an influence on the safety perception and behavior of workers.

6.3. The influence of personal characteristics on safety perception and safety behavior

The findings of this part of study revealed that age, gender, duration of job and experience of having an accident while working had no significant effects on workers' safety perception and behavior.

Male and female workers showed similar perception of safety. Although female workers showed slightly better safety behavior than male workers, the difference was not significant. These findings are dissimilar to those findings of Reinfurt et al. (1996), who found that non-use of seat belts was associated with gender (males), and of Harre et al. (1996), who found that males were significantly more likely to engage in unsafe driving behavior than females.

Workers in different age groups also showed similar safety perception and similar safety behavior. This finding also is not consistent with those findings of Reinfurt et al. (1996), who found that non-use of seat belts was associated with younger age. Again, when duration of job was examined, the findings suggest that duration of job, had no significant influence on workers' safety behavior and safety perception. This finding does not support those of Huey and Boehm-Davis (1992), that workers' experience of work influenced workers' safety performance.

According to the findings of this part of the study, experience of having an accident while working had no influence on workers' safety perception and safety behavior. This finding is consistent with that of Napier and Pugh (1987), who showed that having experience of an accident had no significant effect on accident rate. One explanation for this could be individual differences in terms of perception and its relationship to behavior. For example, the way individuals perceive the role of unsafe behavior in causing an accident, how this perception relates to his safety behavior, and finally how long this new perception lasts.

6.4. The relationship between safety perception and safety behavior

The study of the relationship of safety perception and safety behavior of the workers showed that there was overall a significant negative relationship between safety perception and safety behavior of workers in the participating companies. However, it seems that some aspects of safety perception/attitude such as a feeling of control over risk and personal responsibility for safety play a more important role in the relationship between safety perception and safety behavior than the other aspects. This finding is consistent with that of Dedobbeleer and Beland (1991) on the impact of workers' risk acceptance on their safety performance. In their study, they showed that worker's acceptance of risk has an impact on construction worker's safety performance. In other words, construction worker's compliance with safety regulations is low when worker's acceptance of risk is high.

The findings suggest that workers' personal characteristics such as gender, age, duration of job and experience of having an accident while working have no significant effect on the relationship between safety perception and safety behavior. No overall linear relationship was found between safety perception and safety behavior of workers in different groups based on gender, age, job duration and experience of having an accident while working.

Regarding groups of workers with different safety behavior, there was a significant negative relationship between safety perception and safety behavior of workers who showed good safety behavior, and between safety perception and safety behavior of workers who showed poor safety behavior, suggesting that, better safety behavior was associated with a lower level of safety perception and suggesting that an improvement in safety perception might not result the same improvement in safety behavior. There might be a few possible reasons for this negative relationship. One could be that there might be some other factors not investigated in this study have influence on the relationship between safety perception and safety behavior. For example how important is a safe behavior for an individual and how much he/she believes in safety behavior, might play a role in the relationship of safety perception and safety behavior. Another reason could be an artifact of the analytic methods.

At this point it could only be argued that according the findings of this study, the relationship between safety perception and safe behavior is not a simple positive relationship.

The findings of this part of study provide many grounds for further research, for example clarifying the nature of the relationship between safety perception and safety behavior.

Another point to be investigated is the influence of as yet unidentified factors on the relationship between safety perception and safety behavior.

6.5. The effect of the different types of intervention on safety perception and safety behavior

6.5.1. The effect of intervention on the entire group of workers:

Findings of this study revealed that regardless of the type of intervention, there was a significant immediate improvement on safety behavior of the entire group of workers. That is, intervention consisting of either knowledge only or both knowledge and feedback was useful in improving safety practice. This type of intervention is practical and applicable and can be used easily to enhance workers' safety behavior in any work setting. This finding is in agreement with the findings of Chhokar and Wallin (1984) that a behavioral approach to safety was successful in improving safety behavior.

On the other hand, the intervention did not make a significant improvement in workers' safety perception. There might be several reasons for this, one of which could be the

type of intervention used. Because of the limited number of studies of the effect of different types of intervention on safety perception, it is not possible to find corroboration for these findings. These findings also consistent with the finding of the previous work that there was no overall simple positive relationship between safety perception/attitude and safe behavior and that behavior can change without attitude changing.

The type of intervention was an important factor in the improvement of workers' safety behavior. For example, workers who received intervention consisting of both knowledge and feedback showed better and more persistent safety behavior than workers who received intervention consisting of knowledge only. These findings support those of Komaki et al. (1980), Chhokar (1987) and Saari (1990). The findings of this part of study are useful for the purpose of establishing long term or even permanent safety behavior. The special benefits of the types of intervention applied in this study are that they are simple, not very time consuming and not costly for the company.

6.5.2. The effect of intervention on the safety perception and safety behavior of the groups of workers with congruent safety perception/behavior and the groups of workers with incongruent safety perception/behavior

Because the intervention did not make a significant improvement in workers safety perception, it was important to examine how individual differences in safety

attitude/ perception and in safety behavior(good perception/good behavior, good perception/poor behavior, poor perception/poor behavior and poor perception/good behavior) might have influenced the effectiveness of these intervention methods.

Interestingly, the findings of this part of study revealed that the intervention resulted in a significant improvement in safety perception for all perception/behavior groups, however, the greatest change occurred in the congruent poor group.

The intervention also resulted in a significant improvement in safety behavior for all perception/behavior groups except the incongruent good behavior group. The possible explanation for this could be that these workers were aware of their good behavior and did not believe there was a need to improve more on their behavior.

The congruent poor group again showed the greatest improvement in safety behavior.

The reason for this improvement could be that these workers were aware of the fact that they had potential for change in their safety perception and behavior. The findings of this part of the study suggest that personal differences in terms of pre-existing attitude, perception and behavior are to be considered as important factors in the process of achieving the better level of this characteristics and should always be considered in the implementation of any intervention.

Also the findings suggests that the intervention was most effective for those most in need of improvement in safety perception and safety behavior. The findings also suggest that

it is important and feasible for every work setting to arrange appropriate interventions to improve safety perception and behavior of workers.

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Appendices

SECTION A

We're interested in what you think about safety.
Below are a list of sentences about safety in the workplace.
Please look at each sentence and put a cross in one of the boxes provided
according to how much you agree with the sentence.

For example, look at the following sentence:

I will never have an accident

If you completely agree with this sentence, you would rate it like this:

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1. Everyone has an equal chance of having an accident.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. In the normal course of my job, I do not encounter any dangerous situations.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. People who do not take the necessary precautions are responsible for what happens to them.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Safety works until we are busy, then other things take priority.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. If I worried about safety all the time, I would not get my job done.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. People who work to safety procedure will always be safe.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. I cannot avoid taking risks in my job.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Accidents will happen no matter what I do.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
----------------	-------	----------------------------	----------	-------------------

9. It is not likely that I will have an accident because I am a careful person.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

10. Not all accidents are preventable, some people are just unlucky.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

11. Everybody works safely in my workplace.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

12. All the safety rules and procedures in my workplace really work.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

We're interested in knowing what you actually do about safety in your workplace and what would help you to work more safely.

These sentences are about particular safety activities.

Please indicate, by placing a cross in one of the boxes, how often you do each activity in your workplace.

Always	Often	Sometimes	Rarely	Never
--------	-------	-----------	--------	-------

13. It would help me to work more safely if:

a. my supervisor praised me on safe behaviour.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

b. safety procedures were more realistic.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

14. When I have worked unsafely, it has been because:

a. I didn't know what I was doing wrong at the time.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

b. I needed to complete the task quickly.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

c. the right equipment was not provided or wasn't working.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

SECTION B

Please answer the following questions by placing a cross (X) in the brackets or box beside the correct response.

Some questions will need a longer answer. For these questions, please write your answer on the dotted lines provided. You can use the inside front cover of the booklet if you run out of room.

15. Do you think there are any dangers in your workplace? () Yes () No

If your answer is YES, what are these dangers?

.....
.....
.....
.....

16. Do you think it is likely there will be accidents in your workplace within the next twelve months?

Very likely

Fairly likely

Fairly unlikely

Very unlikely

Don't know

If you think it is **LIKELY** that there will be accidents in your workplace, do you think that you will have an accident within the next twelve months?

Very likely

Fairly likely

Fairly unlikely

Very unlikely

Don't know

17. What do you think is meant by safety in your workplace?

.....
.....
.....
.....

18. Do you have any suggestions for improving safety in your workplace?

.....
.....
.....
.....

SECTION C

This section is for research purposes only.

No feedback will be given to your employer that may be used to identify you.

Now we would like to know a few things about you.
Remember, all questionnaires are anonymous (we don't need your name).
Please answer each question by placing a cross () in the brackets beside
your answer, or by writing your answer on the dotted lines provided.

19. Please tell us whether you are:

- () Male, or
- () Female

20. What age are you?

- () less than 20 years
- () 20-29 years
- () 30-39 years
- () 40-49 years
- () 50-59 years
- () over 60 years

21. What is the main language you speak at home?

.....

22. What is the highest level of education you have attained?

.....

23. How long have you been in your current job?

.....

24. Are you employed:

- () as a permanently full-time staff member
- () as a permanently part-time staff member
- () on a contract
- () as a temporary staff member

you do .

- () Office work
- () Outdoor work
- () Laboratory work
- () Vehicle driving
- () Workshop work
- () Food/Catering work
- () Cleaning work
- () Health services
- () Retail services
- () Other (specify)

26. Have you ever had an accident while working?

- () YES
- () NO

If your answer is YES, how long ago did you have this accident?

.....

.....

.....

28. What was the injury you received?

.....

.....

.....

29. Did you have to take time off work for injury?

- () YES
- () NO

If your answer is YES, how long did you take off work?

.....

Thank-you very much for your help in completing this questionnaire.

Written feedback

Date:

No...

Dear sir/madam:

This is to inform you that your safe behavior in terms of wearing appropriate Personal Protective Equipment while working, is highly appreciated. Expressing this behavior at work is considered professional and I like to congratulate you for this. Please keep on safe working.

Your sincerely

Zahra H. Habibzadeh

Verbal feedbacks

1. Comments while worker was wearing appropriate PPE

- It is nice to see you wearing those Personal Protective Equipment , you must feel much safe now.
- You see, now you have protected yourself from potential injuries, and may be feeling more confident to do the job. Is that so?
- I see you are taking no risk for accident by wearing those Personal Protective Equipment, this is really great.
- Wearing all your Personal Protective Equipment, you are presenting a good example of wise, safe and smart worker, you should be proud of yourself.

2. Comments while worker was not wearing appropriate PPE or was not wearing them at all

- Do you think you need your goggles to protect your eyes from getting damage?
- I see you don't have your ear plugs in, Did you know you are damaging your hearing?
Can I get a pair for you now?
- I think you better off with your gloves on doing this job, Do you have them with you?
- I see you are not wearing your helmet, don't you like it? why?

X

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