THE IMPLEMENTATION AND EVALUATION OF A BEHAVIOUR BASED SAFETY INTERVENTION AT SISHEN IRON ORE MINE

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FOR THE READER'S ATTENTION

The reader is reminded of the following:

- The references as well as the editorial style as prescribed by the *Publication Manual (4th edition)* of the American Psychological Association (APA) were followed in this dissertation. This practice is in line with the policy of the Programme in Industrial Psychology of the Potchefstroomse Universiteit vir Christelike Hoër Onderwys to use APA style in all scientific documents as from January 1999.

- The thesis is submitted in the form of research articles. The editorial style specified by the *South African Journal of Industrial Psychology* (which agrees largely with the APA style) is used, but the APA guidelines were followed in constructing tables.

- The name of the promoter appears on the research articles.

PREFACE

I would like to express my gratitude to the following for their contributions to this research:

- My Creator, for giving me the courage, insight and ability to complete this thesis.
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ABSTRACT

Subject: The implementation and evaluation of a behaviour based safety intervention at Sishen Iron Ore Mine.

Key terms: Behaviour based safety, critical success factors, activators and consequences.

World-wide it is estimated that workers suffer 250 million accidents every year, with 330 000 fatalities. In South Africa, the fatality rate is 426 per annum. Sishen mine also experienced safety problems, namely a high injury rate, an average of one fatality per annum, and 85% of injuries being caused by risk behaviour. Furthermore, the safety culture at the mine was moderate.

A proper safety management system requires continual attention to three domains, namely the environment (equipment, tools and housekeeping), the person (knowledge, skills, abilities, intelligence and personality), and behaviour. Sishen mine previously concentrated on the domains of environment and person, and virtually ignored safety behaviour. To correct this, Sishen mine adapted a behaviour based safety intervention programme.

The aims of this research were to determine drivers that motivate safety and risk behaviour, to identify critical factors for the successful implementation of such a programme, and to determine if the safety culture and performance were affected by the implementation of a behaviour based safety intervention programme.

A single-group non-experimental design was used. Questionnaires were used to conduct non-experimental surveys. The questionnaires addressed certain safety culture dimensions. A longitudinal survey was carried out before and after implementation of the behaviour based safety intervention programme.

The results showed that the safety culture at the mine improved since implementation of the intervention programme. Management support for safety improved by 6%, peer support for safety by 13%, personal responsibility for safety by 7%, management systems by 6%, and employees

actively caring for safety, by 3%. The improvement in safety culture also positively impacted on the injury rate at Sishen mine.

Results indicated the following factors as being critical for a successful behaviour based safety implementation (in order of importance): participation, structured implementation, training, readiness for such a programme, communication, observation and feedback, target critical behaviours, flexibility, effective intervention actions, and data management. The study identified issues and challenges which must be dealt with, especially those applicable in developing countries like South Africa, with unique circumstances such as social and political diversity.

The conclusion was that safety behaviour is mainly directed by activators, and motivated by consequences. The ABC model was identified as an important tool to analyse the drivers for safety behaviour in an effort to develop effective intervention actions.

It is recommended that companies shift their focus from traditional safety approaches to the human dimension of safety. Thus, it is recommended that the behaviour based safety model must be applied by companies in order to focus on behaviour. Secondly, it is recommended that factors that are critical for a successful implementation must be identified and ranked in order of importance. The attention which is paid to each critical factor should then be related to its relative importance. It is also recommended that activators and consequences must be regarded as important drivers for safety behaviour when intervention actions are to be developed, and that the ABC technique should be applied in practice to analyse the appropriateness of the intervention actions.

By way of conclusion, recommendations for future research are made.

OPSOMMING

Onderwerp: Die implementering en evaluering van 'n gedragsgebaseerde veiligheidintervensie by Sishen Ysterertsmyn.

Sleutelterme: Gedragsgebaseerde veiligheid, kritiese suksesfaktore, aktiveerders en konsekwensies.

Wêreldwyd is werkers jaarliks in ongeveer 250 miljoen ongelukke betrokke, wat 330000 ongevalle tot gevolg het. In Suid-Afrika word gemiddeld 426 werkers jaarliks noodlottig beseer.

'n Hoë beseringsfrekwensie, 'n gemiddeld van een noodlottige besering per jaar, en 85% beserings wat veroorsaak word deur risikogedrag deur werknemers, is by Sishenmyn ervaar. Sekere aspekte van die veiligheidskultuur by die myn het ernstig kommer gewek.

Die ontwikkeling van 'n doeltreffende veiligheidbestuurstelsel vereis aandag aan die omgewing (toerusting, gereedskap en huishouding), die persoon (kennis, vaardighede, intelligensie en persoonlikheid), en gedrag.

By Sishenmyn is daar in die verlede sterk fokus geplaas op die dimensies van die omgewing en die persoon. Slegs beperkte fokus is gerig op veiligheidsgedrag. Om die tekortkoming reg te stel, het Sishenmyn 'n gedragsgebaseerde veiligheidsintervensie geïmplementeer.

Die oogmerk met navorsing was om te bepaal of die veiligheidskultuur en veiligheidprestasie beïnvloed is deur die implementering van die gedragsgebaseerde veiligheidintervensie. Verder was die oogmerk om faktore te identifiseer wat krities is vir 'n suksesvolle implementering. Die laaste oogmerk was om 'n literatuurstudie te doen om die belangrikste drywers te identifiseer wat veiligheidsgedrag rig.

Nie-eksperimentele houdingstudies is uitgevoer waarin vraelyste gebruik is om persepsies te toets voor en na implementering van die veiligheidsintervensie. Die resultate toon dat die implementering van 'n gedragsgebaseerde veiligheidsintervensie 'n impak gemaak het op die

veiligheidskultuur by Sishenmyn. Bestuursondersteuning vir veiligheid het na implementering verbeter met 6%, kollegiale ondersteuning vir veiligheid met 13%, persoonlike verantwoordelikheid teenoor veiligheid met 7%, veiligheidstelsels met 6%, en werknemers wat aktief omgee vir medekollegas se veiligheid met 3%. Die verbetering in veiligheidskultuur het verder bygedra tot 'n verbetering van die ongeluksfrekwensie.

In die studie is bepaal dat die volgende faktore krities is vir die suksesvolle implementering van 'n gedragsgebaseerde veiligheisintervensie (in volgorde van belangrikheid): deelname, gestruktureerde implementering, opleiding, gereedheidsvlak vir so 'n program, kommunikasie, observasies en interpersoonlike terugvoering, identifisering en fokus op kritiese gedrag, buigsaamheid, effektiewe intervensies, en inligtingbestuur.

Die studie het knelpunte en uitdagings geïdentifiseer wat aangespreek moet word, spesifiek dié wat van toepassing is op ontwikkelende lande soos Suid-Afrika, met unieke omstandighede soos sosiale en politieke diversiteit.

In die studie was afgelei dat veiligheidsgedrag hoofsaaklik gerig word deur aktiveerders en gemotiveer word deur konsekwensies. Die ABC-model is geïdentifiseer as 'n instrument om drywers vir veiligheidsgedrag te analiseer in 'n poging om effektiewe intervensies te ontwikkel.

Dit word aanbeveel dat sterker fokus geplaas word op die gedragsdimensie in veiligheid, en dat 'n gedragsgebaseerde veiligheidsprogram gebruik word as hulpmiddel. Dit word ook aanbeveel dat kennis geneem word van die faktore wat krities is vir die suksesvolle implementering van so 'n program. Die rangorde van belangrikheid is belangrik omdat dit riglyne verskaf vir die faktore wat die meeste aandag verdien. Laastens word aanbeveel hoe die drywers vir veiligheidsgedrag in die praktyk toegepas kan word, en hoe die ABC-model gebruik kan word om veiligheidsgedrag te ontleed ten einde geskikte intervensies te ontwikkel.

Aanbevelings vir toekomstige navorsing word ter afsluiting in die dokument gemaak.

CHAPTER 1

INTRODUCTION

This thesis deals with the implementation and evaluation of a behaviour based safety intervention at Sishen Iron Ore Mine.

In Chapter 1 the motivation for the research is discussed in terms of the problem statement. The research method, research procedure and the outlay of chapters are also discussed in this chapter.

1.1 PROBLEM STATEMENT

International concern and awareness of the importance and magnitude of occupational safety and health remains surprisingly modest. Alarming as the fatality, accident and disease figures are, investment, operational, and management decisions often continue to be made in disregard of safety and health considerations.

World-wide it is estimated that workers suffer 250 million accidents every year, with 330 000 fatalities, 160 million cases of occupational diseases and an even higher number of threats to workers' physical and mental well-being, which cause further suffering. The economic losses are equivalent to 4 percent of the world's gross national product. The damage in terms of shattered families and communities is incalculable (Takala, 1999).

In South Africa the situation is no better at all. During the period 1999 – 2001, workers experienced and average annual number of 426 fatalities per annum (Department of Labour, 2002). The fatality rate in South Africa is 0,69 per 1000 employees, which is quite a shocking figure (Department of Minerals and Energy, 2002). However, statistics alone do not tell the whole story. The result of accidents is traumatic for those that are involved in accidents. Families lose breadwinners, children lose fathers, and safety and health issues rock communities to the core.

The question is whether anything has been done to turn this situation around. Obviously, a number of interventions were launched to deal with this problem. The government in Great

Britain, by means of statutory regulations, initiated the first intervention (University of Southern Queensland, 2001). Society is increasingly demanding a sophisticated response from its managers who are being called on to manage for motives other than a narrow and simple approach to private profit maximisation. This resulted in statutory laws (laws made by acts of Parliament) and common law (legal rules created by judges) (University of Southern Queensland, 2001) being introduced.

In the past a number of other safety interventions were developed to improve safety performance (Krieger & Montgomery, 1997). Of these, the most important was safety engineering, or safety design. This entails the design or redesign of buildings, equipment and work processes in anticipation of and to eliminate hazards in the workplace, e.g. equipment guards, emergency kill switches (Krieger & Montgomery, 1997). Another intervention of high importance was ergonomics. This intervention focuses on human beings and their interaction with products, equipment, procedures and environments. The aim is to change things people use and the environments in which they use these things, to better match the capabilities, limitations and needs of people (Sanders & McCormick, 1993). Other interventions that are worth mentioning include management audits, poster campaigns, near-miss reporting, root cause analysis, personnel selection, problem solving techniques and safety systems design (Guastello, 1993).

The development of a proper safety management system requires continual attention to three domains, namely the environment (equipment, tools, and housekeeping), the person, (knowledge, skills, abilities, intelligence, and personality) and behaviour (Geller, 1998a). During the previous century much emphasis was placed on improving "the environment" and "the person" (Geller, 1996). In South Africa in particular, most leading industrial and mining companies were affiliated with the SA National Occupational Safety Association (NOSA) in the past. The safety programme that was introduced by NOSA mainly involves a checklist for a safe environment, as well as considerable emphasis on the training and development of personnel. Very little emphasis has thus far been placed on behaviour interventions to improve the safety culture and safety performance of occupational safety in South Africa.

Thus, historically many organisations have focused on improving safety by addressing the work environment. Providing hazard-free facilities and providing better tools and equipment have worked well to improve safety. But many organisations have reached a plateau, continuing to rely

solely on these approaches that will bring only marginal gains (Gillmore, Perdue, Wu & Klap & partners, 2001). Reaching the performance plateau in safety performance calls for introducing a next stage, namely the continuous improvement stage (Krause, 1995).

The question is why it is necessary to focus on behaviour. Approximately 80 - 95% of all accidents are triggered by unsafe behaviour (Cooper, 1999a), which tend to interact with other negative features (termed pathogens) inherent in workflow processes or present in the working environment. These pathogens lie dormant and are relatively harmless, until such time as two or more combine and are triggered by unsafe behaviour to produce an accident.

Heinrich's research concluded that 88% of all industrial accidents were primarily caused by unsafe acts (University of Southern Queensland, 2001). Du Pont found that 96% of injuries and illnesses are caused by unsafe acts (University of Southern Queensland, 2001). Behaviour Science Technology has stated that between 80% and 95% of all accidents are caused by unsafe behaviour (Macdonald, 2002). Managers have come to realise that, firstly, people are not perfect and will make mistakes in spite of their best intentions and in spite of working in the best of surroundings. Secondly, managers realise that the work culture often allows or encourages risk behaviour.

In the last decades of the previous century, the behavioural approach to safety performance improvement was developed to focus on reducing hazards by understanding employee behaviours in the context of their work culture. Behaviour based safety can be defined as the application of principles and methods derived from the field of applied behaviour analysis to industrial safety. These principles include rewarding feedback and positive reinforcement to increase appropriate behaviours and corrective feedback to decrease improper behaviours (Blair, 2002). Applied to safety, this means safe behaviour is increased and risk behaviour is decreased.

Psychologists define *learning* as a change in behaviour, or potential to behave in a certain way, resulting from direct and indirect experience (Geller, 1996). In other words, we learn from observing and experiencing events and behaviour in our environment. The significance of corrective feedback in safety is that it will pave the way to safe habits – it will take the performer of a specific task through the phases of unconscious unsafe behaviour to conscious unsafe behaviour, to conscious safe behaviour, to unconscious safe behaviour (Shamrao, 2002).

Skinner (1965) distinguished between respondent behaviour (the specific reaction to a particular stimulus) and operant behaviour (behaviour emitted without specifically being attached to a particular stimulus) and which, if successful (i.e. if it elicits a reward) will be repeated. In Skinner's jargon, the operant is the response, the behaviour, and there are reinforcements that cause a particular operant to be learned. Rewards are positive reinforcements and punishments are negative reinforcements. *Teaching* is the presenting of positive reinforcements, while the withdrawing of negative ones is also very important, because both are continuously and intermittently needed to reinforce an action.

The behaviour based process was founded on this theory and involves the following broad process steps (Krause, 1995):

- Establishing a site's behavioural baseline in order to target specific behaviours.
- Performing peer-to-peer observation and positive feedback.
- Capturing data.
- Establishing problem solving and intervention systems.

The crucial question is whether behaviour based safety works. Typical results recorded in the past from companies that implement a behaviour based safety intervention, were as follows:

- 40-75% reductions in accident rates and accident costs year upon year, and 20-30% improvements in safe behaviour year upon year (Cooper, 1999a).
- 79% reduction in recordable injury rates by Safety Performance Solutions clients within seven years following behaviour based safety implementation (Gillmore et al., 2001).
- 69% reduction in recordable injury rates by 74 Behaviour Science Technology clients within five years following behaviour based safety implementation (Behaviour Science Technology, 1998).

Most of the published research on safety improvement interventions (Heinrich, 1959; Sanders & McCormic, 1993) systematically evaluate whether a particular programme has worked in a particular situation, but it does not compare one approach with another. Such research has limited usefulness when selecting between different approaches.

An exception was the research done by Guastello. His research compares the relative importance of different interventions with one another. Guastello's conclusion was that behaviour based

safety interventions accounts for 59,6% reduction in injuries at seven sites that were investigated by Guastello (Guastello, 1993).

There are many other companies that can provide evidence that implementation of behavioural based safety has yielded positive results. While the goal of such a programme, however, is to identify and increase critical safety related behaviour, the process can achieve much more than this. This process can be the key to improving on organisation's overall safety culture.

Safety culture is a state of organisational maturity that leads to commitment-based high performance. Safety culture was defined as "the product of the individual and group values, attitudes, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of an organisational health and safety programme" (Anonymous, 2002).

Today, organisations that truly have a safety culture outperform those that do not. Through the implementation of behaviour based safety one is moving towards achieving the desired safety culture, namely (Geller, 1996):

- Safety should not be a priority, but a value with no compromise.
- Everyone in the organisation actively care for the safety of themselves and others.
- People on ground level are empowered to make a difference in safety.
- Employees have overcome the struggle with human nature. In safety, human nature typically encourages risk behaviour. Safe behaviour often implicates discomfort (wearing a safety belt, putting on personal protective equipment), inconvenience and inefficiency. The consequences of risk behaviour in safety always tend to outweigh the consequences for safe behaviour. Supervisors often reward employees for taking shortcuts at work.

The advantages of creating a sound safety culture are quite obvious. The behaviour of people is driven by culture and not by supervisors, and the behaviour based safety process can contribute towards creating the desired culture.

Behaviour based safety interventions have been implemented in 800 organisations in developed countries, but only a limited number of implementations in developing countries. Polifin Ltd was the first company to implement behaviour based safety at their site in 1998, and have claimed to

have recorded good results (Hodson, Strydom & Franklin, 1998). As far as could be determined, Sishen mine was the second South African site to implement behaviour based safety intervention.

The point is that behaviour based safety is not a programme that can be bought off the shelf in a developed country and implement in a developing third world country without any adaptation. There are reasons why it is necessary to adapt the programme to fit the local circumstances:

- Quite a substantial percentage of employees in South Africa are still illiterate. As participation in the programme requires of employees to complete a checklist during the observation process it is necessary to address this issue when developing such a programme.
- Furthermore, a country like South Africa is very unionist. Because the behaviour based safety programme is supposed to be an employee-driven programme, this requires a special relationship with labour unions and it requires that union members form part of the organisational structure for behaviour based safety.
- Another issue in South Africa that requires adaptation of existing behaviour based safety programmes, is the fact that employees are exposed to eleven official languages. This requires training manuals to be translated and training to be presented to employees in at least three languages.
- One issue that needs to be addressed in South Africa is the cultural differences between black and white. Because of the previous political dispensation in South Africa, black employees are reluctant to walk up to their peers and start observing them. Their white counterparts are also reluctant to allow blacks to observe them. Managing this issue is very important for the successful implementation of the programme.
- Another issue is the perception of employees in South Africa towards safety. Because of the high crime rate in South Africa, employees (especially non-whites) do not perceive the workplace as being unsafe, in spite the very high injury and fatality rate. A total number of 22 000 civil citizens are murdered in South Africa per annum, and 88 000 armed robberies are executed every year (Gun Control Alliance, 2002). As a result employees perceive the 426 occupational fatalities as of little significance. They perceive the civil world as dangerous, rather than the workplace. This issue needs a special effort even before a behaviour based safety programme can be fully implemented.

All these issues require special care if a behaviour based safety programme is to be implemented in a developing country like South Africa.

Sishen Mine is the third largest iron ore mine in the world. The mine produces 26 million tons of beneficiated iron ore per annum, of which 20 million tons are being exported to 16 countries abroad and the balance is delivered to local steel works. The mine employs 3346 permanent employees, of whom 16,4% are illiterate. Sishen Mine implemented a behaviour based safety intervention in 2000 because of the following conditions (Sishen Mine, 2000):

- An unacceptable high injury rate of five injuries per 1 million hours worked. (The benchmark rate in similar leading companies is less than one injury per 1 million hours worked.) The injury rate reached a plateau in spite of the implementation of all other possible interventions (except behaviour based safety interventions) that are freely available.
- An average number of one fatality per annum, which was unacceptable (target = zero).
- 85% of all injuries at Sishen Mine are caused by risk behaviour and not by unsafe conditions or lack of training.
- The safety culture on the shop floor could improve. Employees were not empowered to make a difference in safety, and only supervisors and managers were in a position to contribute to safety. Safety was not a value as such, but a priority. However, that priority could be shifted to suit production needs.

It was against this background that the mine decided to implement a behaviour based safety intervention.

The research problem could be summarised as follows: Most industrial companies experience high and unacceptable levels of accident rates. Although many studies contribute to an understanding of the problem, and many solutions are offered to combat the problem, it is uncertain as to how this problem could be solved, or which tool should be used to focus more on the behaviour dimension of safety, especially in third world developing countries like South Africa, with its unique diversity and social differences.

The problem statement gives rise to the following research questions, with special reference to Sishen mine:

- What are the drivers of safety behaviour in the workplace, and how could those drivers be analysed and applied in the workplace to develop effective intervention actions?
- What are the issues and challenges that need to be dealt with during the implementation of such an intervention programme, especially in South Africa with its unique circumstances?

- What are the factors that are critical for a successful implementation of a behaviour based safety intervention programme?
- What is the nature of the safety culture at the mine?
- To what extent will a behaviour based approach to safety influence the safety culture at the mine?
- Will the implementation of a behaviour based intervention tool and a change in safety culture benefit the accident frequency rate at the mine?

The hypothesis is that implementing a behaviour based safety programme will bring about a major shift in the safety culture at the mine, and simultaneously yield a number of other spin-offs, like fewer injuries and less damage to equipment. This hypothesis needs to be tested, especially in an environment that differs vastly from that in the first world countries where behaviour based safety has been applied.

This research will contribute to the subject of Industrial Psychology in the following ways:

- It will provide guidelines to management as to which strategic interventions to implement in order to improve on safety culture and performance.
- It will demonstrate to management and employees how the primary characteristics of behaviour can be applied to enhance safety performance.
- It will set a practical model in industry for the implementation of a behaviour based safety intervention (structure, process, data collection, etc.).
- It will indicate the potential results for and the usefulness of a behaviour based safety intervention, especially in the environment of a developing country, like South Africa. The way in which the behaviour based safety intervention was adapted to suit the circumstances in a typical developing country will be put to the test in the research.
- It will provide a useful manual to management who are engaging in the implementation of such an intervention, consisting of lessons learnt and challenges for implementation in a developing country, as well as important issues to deal with and critical success factors to be addressed.

1.2 THE AIM OF THE RESEARCH

1.2.1 General objective

The general objective of this research is to determine the effects of the implementation of a behaviour based safety intervention on the safety culture at Sishen Mine.

1.2.2 Specific goals

The specific goals of this research may be formulated as follows:

- To determine which factors are critical for the successful implementation of a behaviour based safety intervention, especially in a developing third world country and to provide a "training manual" on how these critical success factors should be approached in practice.
- To discuss the drivers for safety behaviour in the workplace and to provide a tool for analysing the importance and motivational driving forces for behaviour in the workplace.
- To build a practical model of such a behaviour based intervention, describing the context, structure, methodology and process that were applied at Sishen Mine.
- To determine performance indicators, which will be useful to measure the effectiveness of the intervention programme.
- To determine the safety culture at the mine before the implementation of an intervention tool.
- To determine whether workers' participation in the intervention programme had any influence on the cultural aspects (e.g. actively caring for one another, peer support for safety, and supervisor support for safety).
- To determine whether the implementation of a behaviour based safety intervention tool and an improved safety culture in fact impacted on the accident frequency rate.
- To determine whether the application of a so-called behaviour based intervention tool is effective for the purpose of focusing on the behaviour dimension in safety.

1.3 RESEARCH METHOD

The research method consists of a literature review and an empirical study.

1.3.1 Research design

The aim of the research is to determine a correlation between the independent variable and the dependent variables (Huysamen, 1996). In this case the independent variable is the implementation of a behaviour based safety intervention. The dependent variables are firstly the safety culture at Sishen mine, and secondly the safety performance (outcome) at Sishen mine. The aim, then, is to research to what extent the implementation of the behaviour based safety intervention will influence the safety culture and safety performance at Sishen Mine.

The nature of the data determines the research methodology to be followed (Leedy, 2001). In this case the research is descriptive. The descriptive survey method deals with a situation that demands the technique of observation as the principal means of collecting the data. Data in a descriptive survey research are particularly susceptible to distortion through the introduction of bias into the research design. Particular attention will be given to safeguard the data against the influence of bias.

The aim of the study was not to compare different safety interventions or carry out experimental t-tests amongst sub-groups within the organisation, but rather to take a holistic view on how attitudes and behaviours in the organisation as a whole were influenced by the behaviour based safety intervention (before and after implementation).

Because of the lack of useful case studies in the industry, the study aimed at providing useful guidelines to the industry on how organisations should go about to secure a successful behaviour based safety implementation in an effort to improve on safety performance.

A survey will be designed by means of which a sample is drawn from the employees at the mine, in order to obtain the desired research objectives. A longitudinal study is recommended to test the influence of such an intervention (Huysamen, 1996). The first survey was carried out in January 2000 (just prior to the implementation of the safety behaviour intervention) and the follow-up survey 2 years later, to assess any significant changes. To determine the influence of the intervention on the safety performance at the mine, the safety statistics at the mine before and after implementation will be analysed.

1.3.2 Study population

Sishen mine employs 3346 permanent employees. During the survey the computer is employed to randomly select 600 employees, on the basis of selecting every fifth employee from the personnel list. Random selection is important if one wishes to draw accurate conclusions on behalf of the entire employee population (Spector, 2000). This sample will represent 18% of the permanent employee population. For the purpose of assessing the influence of the behaviour intervention on the safety statistics, the total mine is included in the analysis and not only one or some portions (sections).

1.3.3 Measuring battery

The survey battery from a leading Safety Consultancy group in the USA, trading as Safety Performance Solutions , is used to obtain the research information. The survey incorporates three separate scales, namely (Safety Performance Solutions, 2002):

- **Safety Perception Scale**

  The safety perception scale assesses employees' perceptions and opinions regarding how strongly they believe they and others within the organisation support safety. In addition it addresses perceived management support for safety, peer support for safety and personal responsibility for safety.

- **Safety Management System Scale**

  This scale measures employee perceptions of many formal safety management systems, including discipline, incident reporting and investigation, safety rules and procedures, safety training, safety communications, safety suggestions, rewards and reinforcement and hazard identification and correction. In addition, it also asks for employees' opinions about the company's overall safety performance, the effects of stress, drugs and alcohol on safety, and the level of employee involvement in safety efforts.

- **Actively Caring Scale**

Actively caring behaviour are those instances of behaviour which directly or indirectly impact on the safety of others. For each actively caring behaviour addressed on the survey (e.g. cautioning another employee when observing him or her performing risk behaviour), three separate questions are asked. Respondents will be asked:

- If they felt employees should perform the specific behaviour.
- If they are willing to perform the behaviour (willing to caution his/her co-worker).
- If they perform the behaviour (caution co-worker).

The results of the safety culture survey will be useful in several ways. Firstly, the results can serve as a diagnostic tool to help identify issues which may negatively impact on the organisation's safety culture and/or which may serve as an obstacle to improvement efforts.

Next the results can be used as a performance measure to assess the success of safety improvement efforts. Specifically, when implementing a behaviour focused safety improvement process, care and attention must be paid to employees' perceptions about safety and their opinions of the intervention processes.

Otherwise, if behaviour change without subsequent attitude change, the change is likely to be of short term and limited in scope. Therefore, repeated application of the survey battery can help determine if the behaviour-changing interventions are occurring in a way that leads to the attitude change needed for long-term continuous improvement (Safety Performance Solutions, 2002).

The research battery is specifically designed for Sishen, which has distinct demographic classifications within the organisation. Comparisons across different departments, different roles (gradings) and different race groups are possible because of the unique design.

In the survey respondents will be asked to respond to the survey items according to a five-point Likert scale (Safety Performance Solutions, 2002) with the following options:

- Highly disagree.
- Disagree.
- Neither agree nor disagree.
- Agree.

- Highly agree.

A higher response value generally represents a favourable opinion, although there are several reverse-scored items in which agreement with the statement would be undesirable. Scores on these items were reversed accordingly prior to analysis.

1.3.4 Data Analysis

The research will illustrate the responses, overall and by demographic categorisation, to each survey scale. Overall responses for each scale will be computed by taking the mean of all the questions making up that scale. The graphs that compares results will depict the percentage of respondents who agree, disagree and neither agree nor disagree.

Questionnaires are scanned into the computer and the SPS software analyses the responses accordingly. Since this research is longitudinal, the results of the first survey are compared with those of the second survey. The percentage of respondents who agree, disagree and neither disagree nor agree for each survey scale will be portrayed in a pie chart graph to compare the results for the respective periods. Microsoft Excel software is used to compare and portray the data.

1.3.5 Research procedure

The following steps are taken in the course of the research:

a) Finalise the research battery in terms of the demographic classifications.

b) Translate the research battery from English to Afrikaans for the sake of those employees who are not used to English. The translation procedure recommended by Brislin is followed (Brislin, 1970). In terms of this procedure two independent translators will translate the instrument from English to Afrikaans, and then two other independent translators will translate the product from Afrikaans to English. The end product will then be evaluated against the original questionnaire.

c) Develop a software query to determine the names of those employees who have been randomly nominated to complete the questionnaire.

d) Nominate a facilitator who could facilitate a number of group sessions for those employees who are illiterate. Only one facilitator is utilised for this task in order to avoid misinterpretation.

e) Communicate the purpose of the research, the names of the nominees and the scheduling of the facilitation sessions to all employees.

f) Manage the completion of questionnaires by employees and follow-up of questionnaires which are not returned to the research team. As recommended by Huysamen (1996), no names are stipulated on the questionnaire, in order to encourage employees to honestly answer the questions, although the facilitator keeps a record of employees who return their questionnaires (Huysamen, 1996).

g) The questionnaires are then sent to the SPS offices in West Virginia, USA, where it will be scanned into the computer and where the software will be used to analyse and print the results.

h) For the second follow-up survey, steps (c) to (g) will be repeated.

i) Compare the research results for the two periods, and make conclusions and recommendations which will be taken up in the dissertation report. In the final analysis the hypothesis will be tested in terms of validity.

1.4 CHAPTER DIVISION

The chapters are presented as follows in this research:

- Chapter 1 : Introduction.
- Chapter 2 : The implementation and evaluation of a behaviour based safety intervention at Sishen Iron Ore Mine.

- Chapter 3: Behaviour based safety: critical success factors and issues with which to deal.
- Chapter 4 : Drivers for safety behaviour: activators and consequences.
- Chapter 5 : Conclusions and recommendations.

1.5 CHAPTER SUMMARY

This chapter set out the problem statement, the aims of the research, the research method employed and the chapter division. The first research article is covered in Chapter 2.

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THE IMPLEMENTATION AND EVALUATION OF A BEHAVIOUR BASED SAFETY INTERVENTION AT SISHEN IRON ORE MINE

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ABSTRACT

World-wide it is estimated that workers suffer 250 million accidents each year, with 330 000 fatalities. This is in spite of traditional safety interventions like safety engineering and other safety interventions being implemented. Very little emphasis was placed thus far on behaviour interventions to improve the safety culture and performance in the workplace. Sishen Iron Ore Mine recently implemented a behaviour based safety intervention. The aim of this study was to determine to what extent the safety culture and safety performance were affected by the implementation of the intervention. A non-experimental attitude survey was conducted, using questionnaires to determine the outcome. The results showed that the implementation of the safety intervention brought about a substantial improvement in the safety culture at the mine, and positively impacted on the number of lost time injuries.

OPSOMMING

Dit word beraam dat werkers wêreldwyd 250 miljoen ongelukke jaarliks in industrieë opdoen, wat lei tot 330 000 ongevalle. Dit is ten spyte die toepassing van tradisionele beroepsveiligheid intervensies soos veiligheidingenieurswese en ander intervensies. Relatief min klem is tot dusver geplaas op gedragsintervensies om veiligheidskultuur en veiligheidsprestasie in die werkplek te verbeter. Sishen Ysterertsmyn het onlangs 'n gedragsgebaseerde veiligheidsintervensie geïmplementeer. Die doel van die navorsing was om te bepaal tot welke mate die veiligheidskultuur en veiligheidsprestasie beïnvloed is deur die implementering van die intervensie. 'n Nie-eksperimentele houdingopname is gedoen waarby vraelyste en statistiese ontledings gebruik is om die uitkoms te bepaal. Die resultate toon dat die implementering van die gedragsgebaseerde veiligheid-intervensie 'n wesentlike positiewe invloed uitgeoefen het op die veiligheidskultuur, sowel as op die veiligheidsprestasie van die myn.

World-wide it is estimated that workers suffer 250 million accidents every year, with 330 000 fatalities, 160 million cases of occupational diseases, and an even higher number of threats to worker's physical and mental well-being cause further sufferings. The economic losses are equivalent to four percent of the world's gross national product (Takala, 1999). In terms of shattered families and communities, the damage is certainly incalculable.

In South Africa the situation is in no way better. During the period 1999-2001, workers experienced an average annual number of 426 fatalities per annum (Department of Labour, 2002). This shocking fatality figures occurred in spite safety interventions, which were developed and applied over years to improve safety performance to prevent workers from injuries. Those interventions were safety engineering or safety design, ergonomics, management audits, poster campaigns, near miss reporting and root cause analysis.

Sishen mine is the third largest iron ore mine in the world. The mine produces 26 million tons of beneficiated iron ore per annum, of which ● 20 million tons are exported to 16 countries abroad and the balance are delivered to local steel works. The mine employs 3346 permanent employees, of which 16,4% is illiterate.

As is the case in most South African and overseas companies, Sishen mine also experienced a number of safety problems at the mine, namely (Sishen Mine , 2003):

- An unacceptable high injury rate of 5,53 lost time injuries per 1 million hours worked. The benchmark rate in similar leading companies is less than 2 injuries per million hours worked (Toellner, 2002). The injury rate reached a plateau in spite the implementation of all other possible interventions (except behaviour based safety) that are "on the market".
- An average number of one fatality per annum, which is unacceptable (target = zero).
- 85% of all injuries at Sishen mine being caused by at-risk behaviour and not by other reasons, like unsafe conditions or lack of training.
- The safety culture on the shop floor could improve. Employees were not empowered to make a difference in safety, and only supervisors and managers were in a position to contribute to safety. Safety was not really a value, although a priority. The priority, however, could be shifted to suit production needs.

This situation was problematic, and needs to be addressed in one way or another.

The development of a proper safety management system requires continual attention to three domains, namely the environment (equipment, tools and housekeeping), the person (knowledge, skills, abilities, intelligence and personality) and behaviour (Geller, 1996; Krause, 1995).

The *environment* refers to equipment, tools, machines, housekeeping, and heat/cold. A number of safety interventions were applied to continuously improve safety conditions in the environment, like engineering changes and ergonomics (Geller, 1996). Engineering changes involve interventions to make machines, equipment and tools safer, like installing safetyguards to prevent workers from working on certain parts of a machine while in operation. Safety engineering also included the introduction of robots or the comprehensive redesign of facilities to eliminate certain hazards in the workplace, e.g. extraction fans that reduce exposure to chemicals.

Ergonomics seek to change the things people use and the environments in which they use these things, to better match the capabilities, limitations and needs of workers. Ergonomics discover and apply information about human abilities, limitations and other characteristics to the design and redesign of tools, machines, systems, tasks, jobs and environment for productive, safe, comfortable and effective human use (Sanders & McCormick, 1993). Common applications for ergonomics include design of controls for data entry devices, manual handling materials, workspace design, environment designs for illumination, climate, noise and motion and designs for hand tools and devices.

The environment domain therefore requires a considerable amount of attention, because the deficiencies in the environment are usually obvious and easy to correct.

The second domain refers to person based factors, like knowledge, skills, abilities, intelligence, motives, personality and attitudes (Geller, 1998a). The first step in safety is to provide the workers with the necessary competencies to perform a task safely. This is normally done by providing the necessary guidelines (standard operating procedures and safety standards) as well as training. Recruitment specifications and batteries are normally

used to select the right person for the right job. These batteries are used to select for personal traits and intelligence. Traits are relatively permanent characteristics of people; they don't vary much over time or across situations.

Individual characteristics, such as personality traits, have been found to correlate with accidents (Hansen, 1989). The individual's current state of "mental health" may affect their predisposition towards accidents and links have been made between mental health and work performance (Defares, Brandjis, Naas & Ploeg, 1984). The difficult part is to work on people's motives, personality and attitudes, which ultimately influence safety performance. Person states are characteristics that can change from moment to moment, depending on situations and personal interactions (Geller, 1996). In the workplace one often experiences frustration or a lack of control over a specific situation. These states can influence behaviours. Frustration provokes aggressive behaviour, while a perception of helplessness inhibits constructive behaviour or facilitates inactivity. Personal states are sometimes very difficult to influence in the workplace, because of previous life experiences of the worker, like belongingness, self-confidence, personal control and the worker's perception regarding locus of control. Nevertheless, from a safety point of view it is important to pay thorough attention to this domain.

The third domain that requires continuous attention is behaviour. Behaviour refers to specific observable actions by an individual. There are three types of behaviour that concern safety, namely conscious behaviour, habitual behaviour and unintentional behaviour (Primedia, 2003). Conscious behaviour in safety refers to actions where workers consciously comply with or violate safety procedures, like when they are taking short-cuts to achieve certain goals. Habitual behaviour refers to actions that are being performed automatically, like fastening a safety belt (or not) before driving an automobile. Unintentional behaviour in safety refers to actions performed by workers who are unconsciously incompetent, or a state in which the worker did not know that there was a better way to perform a specific task. In order to continuously improve safety performance, it is quite obvious that much emphasis must be placed on these three types of behaviour.

Historically many organisations have focused on improving safety by addressing "the work environment" and "the person". In South Africa, in particular, very little emphasis has thus

far been placed on behaviour interventions to improve the safety culture and safety performance in the workplace.

Providing hazard-free facilities and providing better tools and equipment have worked well to improve safety performance but many organisations have reached a plateau, continuing to rely solely on those approaches that will bring only marginal gains (Findley, 2003; Gillmore, Perdue, Wu & Klap & Partners, 2001).

These traditional approaches to managing safety are based on efforts to improve engineering and work environment and/or authoritarian management models that rely on hierarchical structures, the formalising of rules and procedures and policing workers to enforce the rules (Findley, 2003). These methods have been responsible for some significant improvements in safety over the years. However, as some of the most common and severe accidents were eliminated, the results from traditional methods began to plateau and companies looked for new ways to address the remaining deficiencies. By also focusing on safety related behaviours before accidents happen, companies can make step-change improvements in their safety performance (Findley, 2003).

Statistics on the role of behaviour in accident rates provide valuable information in this regard. Many studies have indicated that between 80-95 % of all accidents are triggered by unsafe behaviour (Cooper, 1999b; MacDonald, 2002). Managers have come to realise that firstly, people are not perfect and will make mistakes despite their best intentions and despite working in the best of surroundings. Secondly, managers realise that the work culture and human nature often allow or encourage risk behaviours.

These statistics led Geller, Krueger, French and Williams (2000) to conclude that because human behaviour is a contributing cause to most incidents and injuries, safety excellence can only be achieved by addressing the human dimensions. In the last decades of the previous century, the behavioural approach to safety performance improvement was developed to focus on reducing hazards by understanding employee behaviour in the context of the work culture (Gillmore et al., 2001).

Behaviour based safety: an intervention tool

To conclude that more emphasis must be placed on the behaviour domain of safety, is only one part of the solution. The question remains as to how this should be done? Previous research suggests that a behaviour based safety intervention tool needs to be applied to address the behaviour aspect of safety (Geller, 1996; Krause, 1995).

A behaviour based safety intervention can be defined as the application of principles and methods derived from the field of applied behaviour analysis to industrial safety. These principles include rewarding feedback and positive reinforcement to increase appropriate behaviour and corrective feedback to decrease improper behaviour (Blair, 2002).

The behaviour based approach to safety is focused strictly on those observable, measurable actions that are critical to safety at a particular site facility (Krause, 1995). This is a very task oriented view of behaviour, and it treats safety related behaviour as critical work related skills to be identified and inventoried.

The behaviour based process firstly involves defining the problem (at risk behaviours), and then design and implement an intervention process to decrease behaviour causing the problem and/or to increase behaviour that can alleviate the problem (Geller, 1996). Geller provides four steps for the behaviour based process, namely (Geller, 1998a):

- Define the target behaviour to be increased or decreased.
- Observe the target behaviour through formal observations and record the results in a data management system.
- Intervene to change the target behaviour in desired directions.
- Test the impact of the intervention procedure by continuing to observe and record the target behaviour.

Cooper (1999a) sets the following essentials for a successful behaviour based programme:
It involves significant workforce participation; it fully engages the workforce in safety management, perhaps for the first time in their career; behaviour based safety deliberately adopting a bottom-up approach and not a topdown approach; without widespread

involvement, the ownership of and commitment to the process will be lacking and the process will probably fail.

A behaviour based programme targets specific unsafe behaviour. The focus of the programme is on that small proportion of unsafe behaviour that is responsible for most of the company's accidents. The unsafe behaviour identified in the process is written onto a checklist in a system where employees observe each other. Behaviour based safety is based on observational data collection, on the basis of "what gets measured gets done". Safe and unsafe behaviour are fed into a database system, so that behaviour can be monitored on a regular basis. The higher the number of observations, the more reliable the data. According to the Heisenberg Uncertainty Principle, the very act of observing and measuring people's safety behaviour alters the behaviour of those being observed (Cooper, 1999a). Thus, it involves a data-driven decision making process. The observation scores are turned into some form of metric: usually the percentage of behaviours performed safely and unsafely. By examining these trends it becomes clear on what corrective actions should be focused.

The process also involves a systematic improvement intervention. Interventions are not developed in a haphazard way, but specifically target the elimination of unsafe behaviour (Krause, 1995). After implementation, the effect of such an intervention will again be tested through observations.

There are two very important factors of the impacts of interventions on behaviour, namely the role that consequences play in behaviour, and the fact that safety is a continuous struggle against human nature.

Human nature (or natural motivating consequences) typically encourages risk behaviour (Geller, 1996). The human nature always prefers comfort, convenience, and inefficiency. Take the example of wearing protective equipment: wearing earplugs in a noisy environment for almost the entire shift, or a welder wearing a leather apron in a workshop at 40 degrees Celsius, is against human nature. Supervisors should be aware of these aspects, and should consider this when they attempt to change behaviour.

In addition, behaviour is motivated by consequences (Geller, 1996). It is crucial to understand this principle before one can develop effective behaviour change techniques. If consequences are soon, certain, and sizeable, those will be highly motivational factors that drive behaviour (Geller, 1996). In the workplace strange risk behaviour is often the result of perceived consequences. There are instances where employees were fatally injured at work because they chased production targets and production bonuses (the consequence). It is impossible to develop effective interventions if the power of consequences and perceived consequences are not considered.

Behaviour based safety involves regular focused feedback regarding performance. Feedback is the key ingredient of any type of improvement initiative. Such feedback usually takes three forms: Verbal feedback to people at the time of the observation; graphical feedback on large graphs placed in strategic locations in the workplace, and monthly briefings during safety meetings where observation scores are analysed.

Employees use simple and effective observation techniques such as checklists to periodically observe each other and then give appropriate one-on-one coaching feedback regarding safety related behaviour. Observation and feedback is a form of barrier removal. Sites can begin removing barriers to safety performance as soon as formal observations are underway. The aim of the feedback is in the first instance to positively reinforce the safe behaviour. It is a fact that most people tend to respond more to praise and social approval than any other factor (Cooper, 1999b). It is crucial to explicitly link the desired safe behaviour to the praise received.

Skinner (1965) researched the effect of positive reinforcement of behaviour. He made a number of conclusions about why positive reinforcement in fact reinforces behaviour. The main reasons are that it is being experienced as pleasant or satisfying by the receiver. Rewards are positive reinforcements and punishments are negative reinforcements. Through the observation and feedback process a learning culture is being established. Psychologists define learning as a change in behaviour, or the potential to behave in a certain way, resulting from direct and indirect experiences (Geller, 1996).

The significance of corrective feedback in safety is that it will pave the road to safe habits. In other words, humans learn from observing and experiencing events and behaviour in their environment. It will take the performance of a specific task through the phases of unconscious unsafe behaviour, to conscious unsafe behaviour, to conscious safe behaviour, to unconscious safe behaviour (Geller, 1998a). This process is explained in Figure 1.

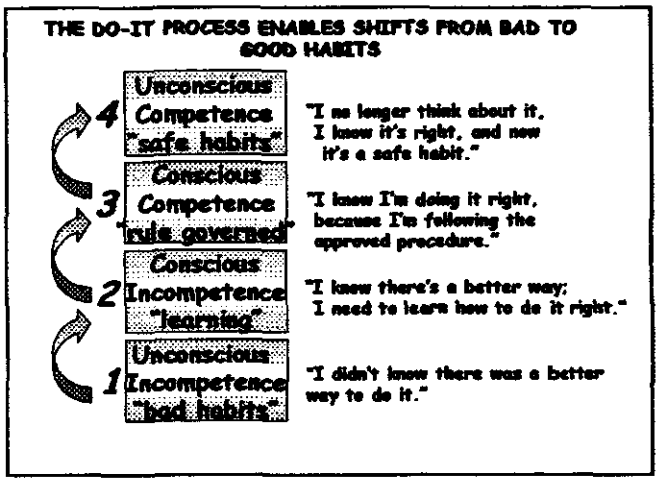

Figure 1: Stages in the learning process (Geller 1998a).

An illustration of the behaviour based process is depicted in Figure 2.

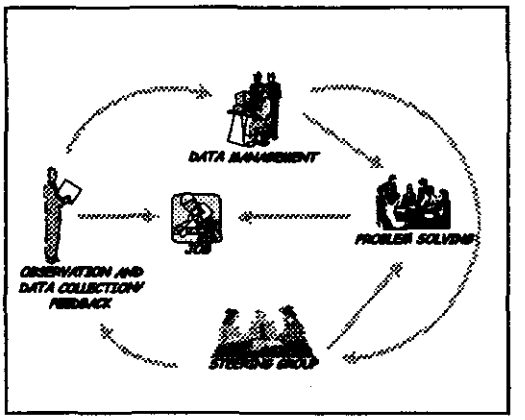

Figure 2: An illustration of the behaviour based process (Geller, 1996).

The crucial question is whether the application of a behaviour based safety intervention works for safety. Typical results from the implementation of behaviour interventions recorded in the past were:

- 40-75% reductions in accident rates and accident costs year after year, and 20-30% improvements in safe behaviour year after year (Cooper, 1999a).
- 79% reduction in recordable injury rates for SPS clients within seven years following behaviour based safety implementation (Gillmore et al., 2001).
- 69% reduction in recordable injury rates for 74 Behaviour Science Technology clients within five years following behaviour based safety implementation (Behaviour Science Technology, 1998).
- In a nationwide survey in America, 80% of respondents ($N = 129$) answered yes to the question: "Do you believe behaviour based safety is a viable approach for reducing at risk behaviours and activities". Only 3% responded negatively to this question (Geller, Boyce, Williams, Pettinger, DePasquale & Clarke, 1998).

Most of the published research on safety improvement interventions systematically evaluates whether a particular programme worked in a particular situation, but it does not compare one approach with another. Such research has limited usefulness when a choice must be made between different approaches. Examples are research performed by Bird & Germain (1996) on the value of a near miss reporting intervention, Heinrich (1959) on the contribution of dangerous physical or mechanical conditions and safety engineering interventions, and Simon (1976) on ergonomic interventions.

An exception was the research done by Guastello (1993). His research compares the relative importance of different interventions with one another. He concluded that behaviour based safety interventions accounts for 59,6% reduction in injuries at seven sites that were investigated, while other interventions together account for 40,4% of injury reductions (Guastello, 1993). In this research a behaviour based intervention was compared to other safety interventions, like ergonomics, engineering changes, government action, management audits, stress management, poster campaigns, personnel selections and near-miss reporting systems.

But while the goal of such a programme is to identify and increase critical safety related behaviours, the process can achieve much more than this. This process can be the key to improving on organisations overall safety culture.

Safety culture is a state of organisational maturity that leads to commitment based high performance (Anonymous, 2002). Safety culture was defined by the Institution of Electrical Engineers Health and Safety Commission as "the product of the individual and group values, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of an organisational health and safety program" (Anonymous, 2002, p. 2).

Today, organisations that truly have a sound safety culture out perform those that do not (Geller, 1996). Through the implementation of behaviour based safety one is moving towards achieving the desired safety culture, namely (Geller, 1996):

- Safety should not be a priority, but a value with no compromise.
- Everyone in the organisation actively cares for their safety and those of others.
- People at ground level are empowered to make a difference in safety.
- Employees have overcome the struggle with human nature. In safety, human nature typically encourages risk behaviour. Safe behaviour often implicates discomfort (e.g. wearing a safety belt and/or personal protective equipment), inconvenience and inefficiency.
- Employees do no get rewarded by supervisors for taking shortcuts at work.

The advantages of creating a sound safety culture are quite obvious. The behaviour of people is driven by culture and not by supervisors or standard operating procedures. And the behaviour based safety process can contribute towards creating the desired culture (Geller, 1996; Gillmore et al., 2001).

The aim of any behaviour based safety intervention is to create a safety culture that introduces a new dimension in safety performance: "Safety culture is the pervasiveness of collective safe behaviours and engineered work processes that recognise the dynamic and system relationships between workers and their environment, which seeks to reduce the risks of operational error and uncertainty through a shared mindset that drives an emphasis on inclusion participation, and forward thinking of all members in the organisation" (Anonymous, 2002, p. 1).

Behaviour based safety interventions have been implemented in 800 organisations in developed countries, but only a limited number of implementations have been implemented

in developing countries (Hodson, Strydom & Franklin, 1998). Polifin Ltd was the first company in South Africa to implement behaviour based safety at their site in 1998 (Hodson et al., 1998). Polifin claimed their behaviour based safety process has had a marked positive effect at the Midland site and that the site's injury incident rate has improved dramatically since launching the programme in 1997 (Hodson et al., 1998). As far as could be determined, Sishen mine was the second South African site to implement a behaviour based safety intervention.

Behaviour based safety is not a programme that can be brought off the shelf in a developed country and implement in that same form in a developing third world country. According to Blair (2002), every site is unique and customisation of behaviour based safety is crucial to success. There are reasons why it is necessary to adapt the programme to fit the local circumstances, and more research is necessary to prove these adaptions are successful. These reasons are:

- Quite a substantial percentage of employees in South Africa are still illiterate. As participation in the programme requires from employees to complete a checklist during the observation process, it is necessary to cater for this issue when developing such a programme.
- A country like South Africa is also very unionist. Because the behaviour based safety programme is supposed to be an employee-driven programme, this requires a special relationship with labour unions and even that union members form part of the organisational structure for a behaviour based safety intervention.
- Another issue in South Africa that requires a behaviour based safety programme to be adapted is the fact that employees are exposed to 11 official languages. This requires training manuals to be translated and training to be presented to employees in at least three different languages.
- One issue that needs to be addressed in South Africa is the cultural differences between black and white. Because of the political history in the past, black employees are not comfortable with walking up to their peers and observing them. Their white counterparts are also reluctant to allow blacks to observe them. Managing this issue is very important for the successful implementation of the programme.
- Another issue is the perception of employees in South Africa towards safety. Because of the high crime rate in South Africa, employees (especially non-whites) do not

perceive the workplace as being unsafe, in spite the very high injury and fatality rate. A total number of 22 000 citizens are murdered in South Africa each year, and 88 000 armed robberies are take place every year (Gun Control Alliance, 2002). So, employees perceive the 426 occupational fatalities in South Africa as of little significance. They perceive the civil world as being dangerous, not the workplace. This issue requires a special effort even before a behaviour based safety programme can be fully implemented.

All of these issues require special consideration if a behaviour based safety programme is to be implemented in a developing country like South Africa.

It was against this background that Sishen mine decided to implement a behaviour based safety intervention. The hypothesis is that implementing such a programme will bring a major shift in the safety culture at the mine, and that a number of other spin-offs will be gained at the same time, like less injuries and equipment damages. This hypothesis needs to be tested, especially within an environment that differs considerable from that in first world countries, where behaviour based safety has been applied. It remains a major question whether the adaptations made to the programme by Sishen Mine will be proved to be successful.

METHOD

Research design

The aim of the research is to determine whether there is a correlation between the independent variable and the dependent variables (Huysamen, 1996). In this case the independent variable is the implementation of a behaviour based intervention. The dependent variables are firstly the safety culture at Sishen mine, and secondly the safety performance (outcome) at Sishen mine.

The aim was to investigate the impact of the implementation of the behaviour based safety intervention on the safety culture and safety performance at Sishen mine. The nature of the data determines the research methodology to be followed (Leedy, 2001). In this case the research was descriptive. The descriptive survey method deals with a situation that demands

the technique of observation as the principle means of collecting the data. Data in a descriptive survey research is particularly susceptible to distortion through the introduction of bias into the research design. Particular attention is given to safeguard the data against the influence of bias.

The aim of the study was not to compare different safety interventions or carry out experimental t-tests amongst sub-groups in the organisation, but rather to take a holistic view on how attitudes and behaviour in the organisation as a whole was influenced by the behaviour based safety intervention (before and after implementation).

Because of the lack of useful case studies in the industry, the study aimed at providing a useful guideline to the industry on how organisations should go about to secure a successful behaviour based safety implementation in order to improve on safety performance.

A survey was designed whereby a sample was drawn from the employees at the mine, in order to achieve the desired research objectives. A longitudinal study was carried out to test the effect of such an intervention (Huysamen, 1996). The first survey was done in December 1999 (just prior to the implementation of the safety behaviour intervention) and the follow-up survey in 2002, to assess any significant changes. To determine the impact of the intervention on the safety performance at the mine, the safety statistics at the mine before and after implementation were analysed.

Study population

Sishen mine employs 3346 permanent employees. During the survey 600 employees were randomly selected by means of a computer, on the basis of selecting every fifth employee from the personnel list. Random selection is important if one wishes to draw accurate conclusions on behalf of the entire employee population (Spector, 2000). This sample represents 20% of the permanent employee population (based on the number of employees in 1999). For the purpose of assessing the impact of the behaviour intervention on the safety statistics, the total mine was included in the analysis, and not only one or some portions (sections). Five hundred and eighty five employees responded by completing the survey questionnaire. A total of 23 returned surveys were discarded because the respondents failed to

complete 14 or more survey items (10%). A breakdown of the survey respondents by Department, Position and Race, is depicted in Table 1 below:

Table 1

Breakdown of Survey Respondents by Department, Position and Race

Department

Department	Number	Percentage
Plant Maintenance	56	10,0%
Plant Production	97	17.3%
Mining Maintenance	52	9.3%
Mining Production	139	24.7%
Engineering Service	40	7.1%
Repair Shop	39	6.9%
Loading	32	5.7%
Materials Mgmt & Planning Dev	26	4.6%
BABI, Finance & CI	35	6.2%
Human Resources & Community Dev	46	8.2%
Total	562	100.0%

Position

Position	Number	Percentage
C/D Roles (Top management)	3	0..5%
E/F Roles (middle management)	27	4.8%
G Roles (First line management)	53	9.4%
Rest	479	85.2%
Total	562	100.0%

Race

Race	Number	Percentage
White	215	38.3%
Black	283	50.4%
Coloured	62	11.0%
Rest	2	0.4%
Total	562	100.0%

Measuring battery

The survey battery from a leading safety consultant group in the USA, trading as Safety Performance Solutions , was used to obtain the research information (see Appendix A).

The survey incorporates three separate scales (Safety Performance Solutions, 2002), namely:

- The *Safety Perception Scale* was used to assess employees' perceptions and opinions regarding how strongly they believe they and others within the organisation support safety. In addition it addresses perceived management support for safety, peer support for safety and personal responsibility for safety. The number of survey questions that relate to these survey items, are 14, 15 and 6 respectively.
- The *Safety Management System Scale* measures employee perceptions of many formal safety management systems, including discipline, incident reporting and investigation, safety rules and procedures, safety training, safety communication, safety suggestions, rewards and reinforcement and hazard identification and correction. In addition, it also asks for employees' opinions about the company's overall safety performance, the effects of stress, drugs and alcohol on safety, and the level of employee involvement in safety efforts. The number of survey questions that relate to these survey items, are as follows: drugs and alcohol (3), discipline (5), incident reporting and investigation (9), rules and regulations (4), safety training (5), safety communication (5), safety suggestions (3), rewards and recognition (4), hazard identification (3), employee involvement (3), and general (5).
- The *Actively Caring Scale* measures behaviour which directly or indirectly impact on the safety of others. For each actively caring behaviour addressed in the survey (e.g. cautioning another employee when observing him or her performing a risk behaviour), three separate questions are asked. Respondents are asked whether they felt employees should perform the specific behaviour, whether they are willing to perform the behaviour (willing to caution his/her co-worker) and whether they do perform the behaviour (caution co-worker). Fifteen survey questions in total relate to this survey item.

The results of the safety culture survey are useful in several ways. Firstly, the results can serve as a diagnostic tool to help identify issues which may negatively impact on the organisation's safety culture and/or which may serve as an obstacle to improvement efforts. Secondly, the results were used as a performance measure to assess the success of safety improvement efforts. Specifically, when implementing a behaviour focused safety improvement process, care and attention must be paid to employees' perceptions about safety and their opinions about the intervention processes. Otherwise, if behaviour changes without subsequent attitude change, the change is likely to be short term and limited in scope. Therefore, repeated application of the survey battery can help determine whether the

behaviour change interventions are occurring in a way that leads to the attitude change needed for long term continuous improvement (Safety Performance Solutions, 2002).

The measuring battery was specifically designed for Sishen with distinct demographic classifications within the organisation. Comparisons across different departments, different roles (gradings) and different race groups will be possible because of the unique design. In the survey respondents were asked to respond to the survey items according to a five point Likert scale of (Safety Performance Solutions, 2002):

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

A higher response value generally represents a favourable opinion, although there are several reverse score items in which agreement with the statement would be undesirable. Scores on these items were reversed accordingly prior to analysis.

Data analysis

Overall responses for each scale will be computed by taking the mean of all the questions making up that scale. The graphs depict the percentage of respondents who agree, disagree and neither agree or disagree. Questionnaires were scanned by computer and the SPS software (Safety Performance Solutions, 2002) was used to analyse responses.

Since this research was longitudinal, the results of the first survey were compared with those of the second survey. The percentage of respondents who agree, disagree and neither disagree or agree for each survey scale are portrayed in a pie chart, to compare the results for the respective periods. Microsoft Excel and Presentations software were used to compare and portray the data.

Research procedure

The following steps were taken in the course of the research:

- The research battery was finalised in terms of the demographic classifications.
- The research battery was translated from English to Afrikaans and Tswana for the sake of those employees that are not bilingual. The translation procedure recommended by Brislin was followed (Brislin, 1970). In terms of this procedure two independent translators translated the instrument from English to Afrikaans and Tswana, and then two other independent translators translated the product from Tswana and Afrikaans to English. The end product was then evaluated against the original questionnaire.
- A software query was developed to determine the names of those employees that have been randomly selected to complete the questionnaire.
- A facilitator was nominated to facilitate a number of group sessions for those employees that are illiterate. Only one facilitator was deployed for this task, in order to avoid misinterpretation.
- The purpose of the research, the names of those nominees and the scheduling of the facilitation sessions were communicated to all employees.
- Employees completed the questionnaires and the facilitator did follow up on questionnaires that were not handed back to him. Although no names were stipulated on the questionnaire, in order to encourage employees to be honest in answering questions, the facilitator kept a record of the employees who handed in their questionnaires (Huysamen, 1996).
- The questionnaires were then sent to the Safety Performance Solutions offices in West Virginia, USA, where they were scanned by computer and where the software was used to analyse and print the results.
- For the second follow-up survey, the steps were repeated (where applicable).
- The final step was to compare the research results for the two periods, and to make conclusions and recommendations, which were then taken up in the dissertation report. In the final analysis the hypothesis will be tested in terms of validity.

Design of a practical model for implementing behaviour based safety at Sishen mine

Sishen mine went through a number of implementation steps to implement the behaviour based intervention. These steps are shown in Figure 3.

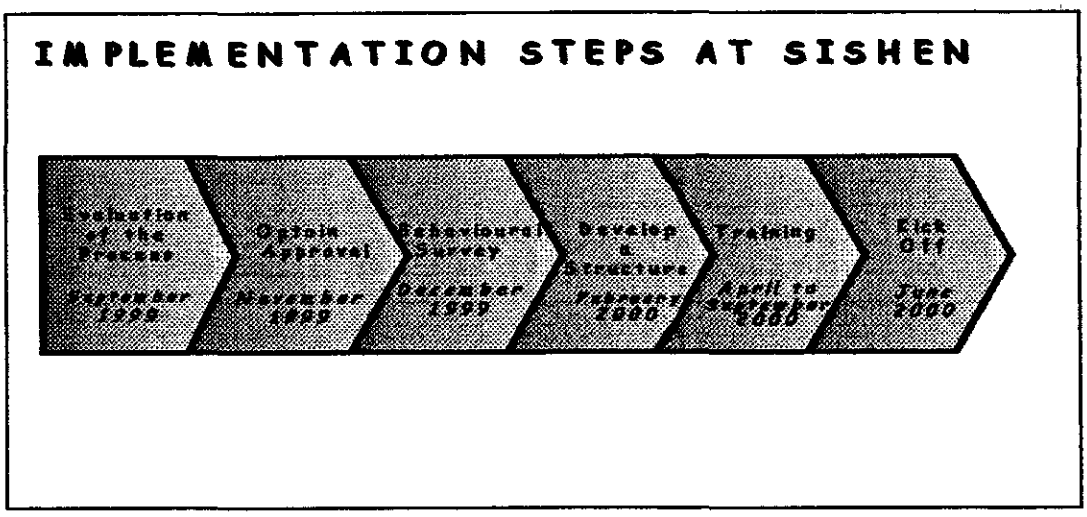

Figure 3: Implementation steps for the behaviour based programme at Sishen

The first step was to evaluate the concept of behaviour based safety. The mine compiled an investigation team which included members such as safety and health specialists at head office and two delegates from the mine, namely the General Manager and the Manager of Safety, Health and Environment. The mandate of this team was to thoroughly investigate the literature on the subject, and then to pay a visit to one or two mines abroad where the concept has been implemented. For this purpose the IMC Kalium Mine in Texas was visited. The investigation team also negotiated with the two leading consulting companies in the USA and got quotes from them regarding support costs. After this exercise the investigation team decided to make a recommendation to the Kumba and Sishen executive teams to implement such a behaviour based process at Sishen mine.

The second step was to achieve buy-in from the executive team, but also and most importantly, from the different labour unions. As this process is an employee driven programme, and as the mine is strongly unionist, it was important to get the commitment of the labour unions. This proved to be quite a challenge, for two reasons. Firstly, the mine should have involved them from the beginning as part of the investigation team. Secondly, the unions were very sceptical because they were cautious that this tool was only meant to

identify violation of safety rules amongst employees and to provide a stick to management to discipline the union's members. The principle of "no name, no blame" was adopted by the executives and unions.

What made negotiations easier was that management and the unions were equally concerned with safety. The advantages of behaviour based safety, like empowering employees at floor level to participate and make a difference in safety, were not only to the benefit of management but also to the employees. At last a strategic decision was made to implement a behaviour based process at Sishen mine, and Safety Performance Solutions (SPS), a consulting company in the USA, was appointed as the service provider.

The third step was to perform a culture survey. The aim of the survey was to assess the safety culture at the mine for the purpose of identifying those culture issues that needed extra attention to make the implementation successful. The survey incorporates three separate scales, namely Safety Perception Scale, Safety System Scale and Actively Caring Scale (Safety Performance Solutions, 2000). The research battery was specifically designed for Sishen Mine with distinct demographic classifications within the organisation. Comparisons across different departments, different roles (gradings) and different race groups were possible because of the unique design.

One of the biggest challenges for the mine was to translate the English version of the questionnaire into Afrikaans and Tswana. An even bigger challenge was to facilitate the completion of the questionnaires, because 16,4% of employees is still illiterate. Sishen consequently used a group technique to facilitate this process. This survey was then used as a baseline against which to measure future progress. The results of the survey are addressed in a later section of this script.

The fourth step in the implementation process was to develop a structure for the process. Because a behaviour based safety intervention is meant to be an employee-driven process, it was important that the members of the steering committee had to be chosen by employees and not by the employer. The structure was developed and negotiated with labour unions and finally accepted (Figure 4).

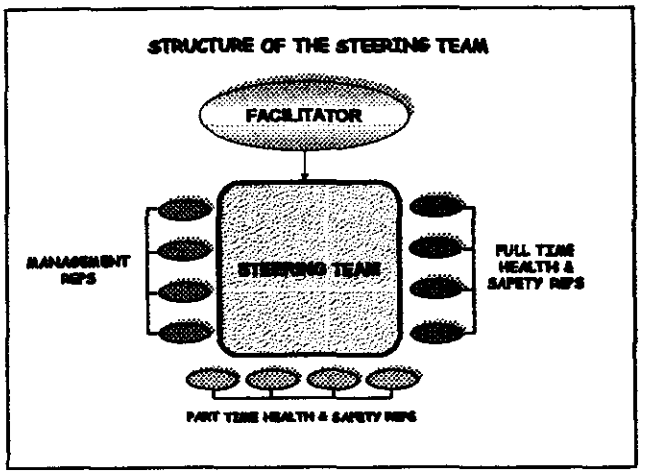

Figure 4: Steering team structure for behaviour based safety

The steering committee consisted of a full time facilitator who was appointed by the mine's executive committee. He was the only full time member and the only member who was appointed by management. The rest of the steering committee consisted of four full time health and safety officers (but only part time on this steering committee) nominated by labour unions, four employee representatives nominated by employees, and four management representatives, also nominated by employees. These 13 individuals formed part of the steering committee, and they also chose a management sponsor for the process. Therefore, except for the facilitator, all the members of the steering committee members were chosen by employees and labour unions.

The next step was to address training. Training was divided into three levels, namely training for management, for the implementation team, and for employees. Training for management emphasised the role of managers to support the programme. Training for the implementation team emphasised the roll-out planning that needed to be done, but also the execution thereof, including training and the way in which training should be given to the employees. Both the training for management and for the implementation team were presented by Safety Performance Solutions, the mine's consultant from the USA.

Training for the employees was developed and presented by the implementation team. The high illiteracy rate and the environment of at least three official languages being spoken on the mine posed a considerable challenge. Although participation in the programme was meant

to be voluntary, it was decided to put all the employees through the training programme of one full day. Part of the planning to complete the training was the huge task to schedule the 3345 employees into courses for the different languages. The translation of training material into the three languages was also a comprehensive task.

The next step was the execution of the training, which took the implementation team a few months to complete. This concerns only classroom training. Once most of the employees in a section were trained, a formal kick-off was arranged, and the section was ready to implement the programme. After implementation a number of on-the-job training sessions were held in the workplace to further coach people who still felt uncertain as to how they should go about to complete an observation.

The next step was to get employees to perform the DO-IT process, which involves the following basic steps:

- Define the behaviours that need to be targeted. This step requires analyses of previous incidents or accidents as well as a risk assessment at a specific plant. Once these behaviours have been identified, the next step is to develop formal checklists that employees can use to do observations (see examples as Appendix B and C).
- The fact that 16,4% of employees at Sishen mine were illiterate, posed a huge challenge to the steering committee. The end result was the development of a checklist for illiterate employees, on which employees could mark only the appropriate symbols (Appendix D).
- Data capturing. Checklists were occasionally collected from the different sections and data and comments are captured onto a database. At Sishen the data was captured by a clerk in the safety section and not by line management. The main reason for this strategy was to avoid putting a heavy administrative burden on line managers, which would ultimately give them a negative attitude towards the programme. Reports, which indicate the percentages of safe and risk behaviour towards each of the targeted behaviour, were readily available for line management. The total number of observations and the percentage participation were also measured.
- The intervention process required strong support for the programme by line managers, as well as the application of problem solving techniques to solve the risk behaviour problems in a specific section. After such interventions the success of the

interventions was tested by means of analysing the subsequent risk or safe behaviour that was observed.

The mine experienced numerous problems with software packages that were provided to them. The end result was the development of an in-house software system that was tailor-made for the specific needs of the supervisors. The basic challenge was to get more information from the database as to why a person performed risk behaviour, for example, why he/she did not wear protective equipment. It might be because of a lack of stock in the stores, or because the wearing of such equipment is very uncomfortable. It is the researcher's suggestion that one cannot develop interventions if this data is not available from the software system. Most software systems lack this information, and that is why Sishen developed its own unique software system.

After 20 months of implementation, the mine conducted another culture survey to compare results with the first survey. The aim was to assess whether the implementation of the behaviour based safety intervention had an effect on the safety culture at the mine. The exact same battery from Safety Performance Solutions was used, and the results were captured in the Safety Performance Solutions software system. These results are discussed below:

RESULTS

Before discussing the actual results, it is useful to discuss performance indicators in safety, as this could put the results into perspective. Safety metrics fall into two basic areas, namely leading indicators (which are measurements linked to actions taken to prevent accidents), and trailing or lagging indicators, which are measurements linked to the outcome of an accident.

Leading indicators are relevant to maximising safety performance by measuring, reporting, and managing positive safe behaviour (Toellner, 2002). To achieve the ultimate goal of reducing accidents, safety resources must be focused on accident prevention processes rather than accident management processes. Examples of proactive actions are focus on cultural issues, risk behaviour, participation, and human error. Leading indicators are portrayed below in Figure 5.

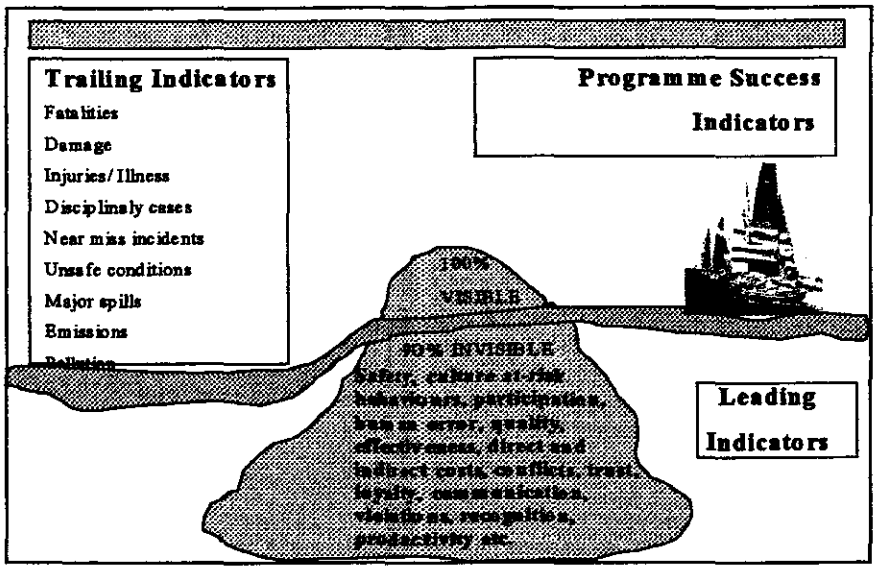

Figure 5: Leading and trailing indicators

The most common trailing indicators (e.g., total recordable index, lost time index and number of days restricted or lost time) used by the American industry are those driven by OSHA (Occupational Safety and Health Association) record keeping requirements. As mentioned above, these are reactive indicators and executives erroneously continue to use incident rate to measure performance. The reasons for this practice might be that it is a bottom line number, it seems straightforward and it is widely used in the industry.

The results for Sishen mine subsequent to the implementation of the behaviour based intervention are discussed according to the categories of leading and trailing indicators.

Results regarding leading indicators

Participation

Since implementation of the programme at Sishen the participation increased tremendously (Figure 6(a) and 6(b)).

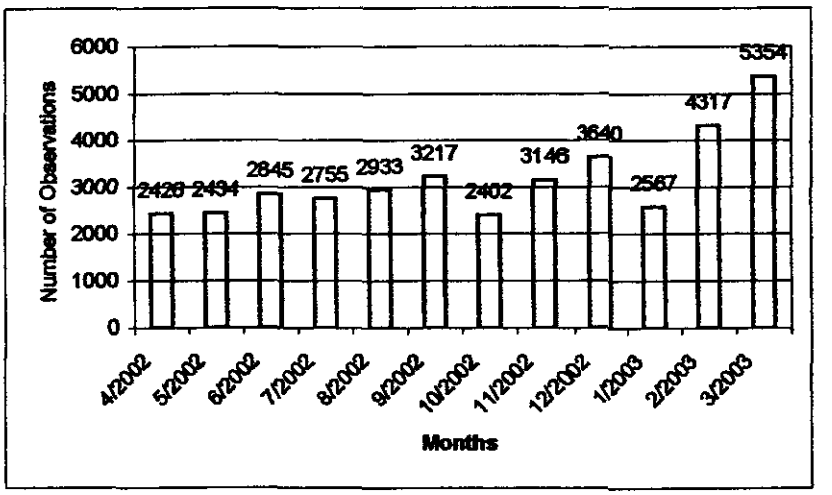

Figure 6(a): Total number of observations recorded at Sishen mine

The number of employee observations increased from 2426 to 5354 in March 2003 in 12 months. Similarly, the percentage of participation increased to 44% in March 2003 (Figure 6(b)).

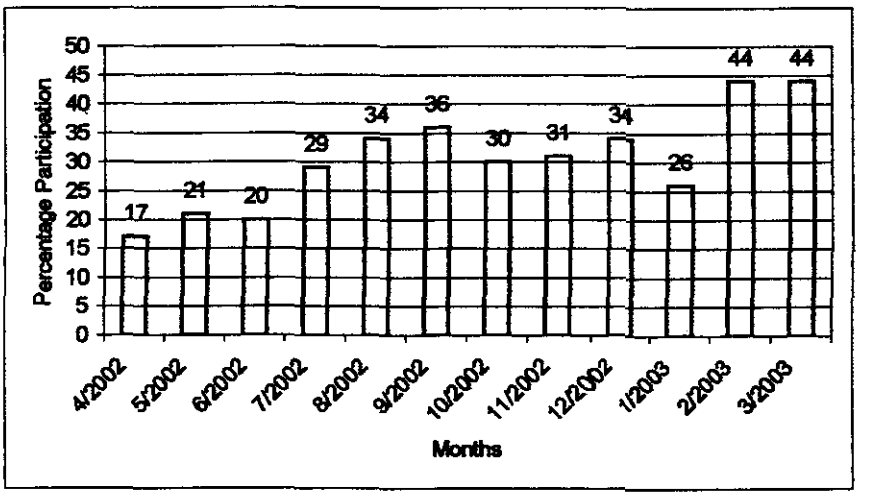

Figure 6(b): Percentage of employees who participate in the behaviour based safety programme.

The percentage of employees who participate in the programme increased from 17% to 44% during the 12 months ending March 2003.

Risk behaviours

From the total number of instances of behaviour that were observed, a percentage of "risk behaviour" and a percentage of "safe behaviour" are calculated by the software system. As an example, the percentage of instances of risk behaviour and of safe behaviour are illustrated in Figure 7(a) and 7(b) respectively.

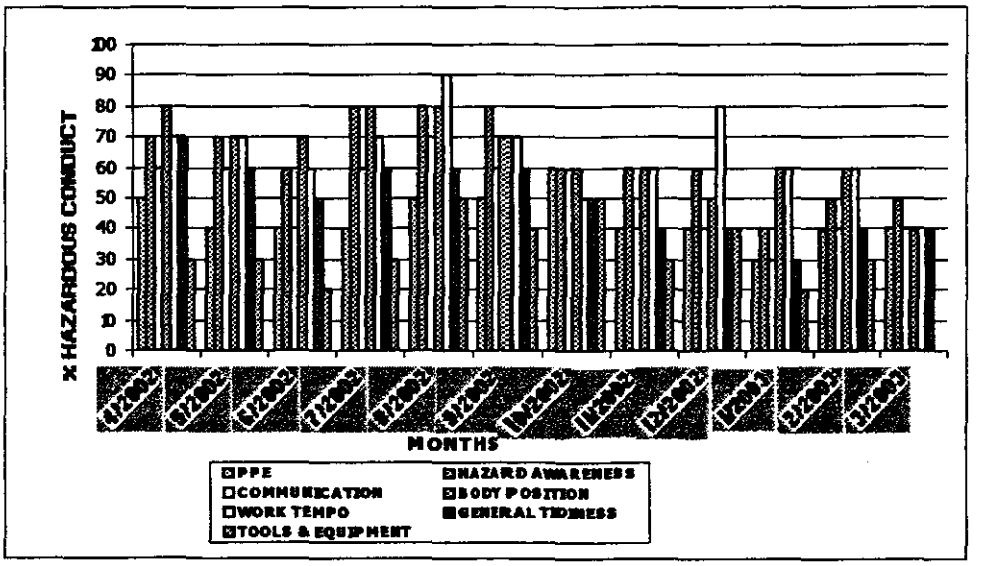

Figure 7(a): Percentage of instances of **unsafe** behaviour observed at Sishen mine for the 12 months ending March 2003.

Figure 7(a) indicates that a high percentage of instances of risk behaviour being recorded by observers (between 30% and 70%) at the beginning of the 12 months period. In all the categories (except tools and equipment) the percentage of instances of risk behaviour decreased from between 50 and 70% to between 30 and 50%.

Figure 7(b) shows that the percentage of instances of safe behaviour also increased during the 12 months period. The only exception was general tidiness, which already was on 97% at the beginning of the research period.

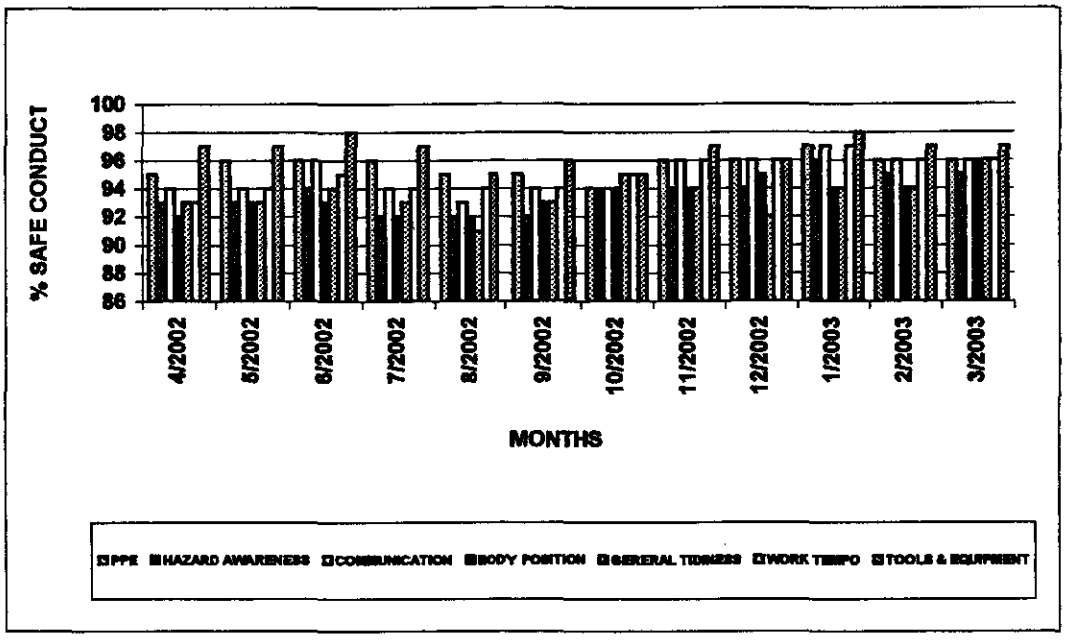

Figure 7(b): Percentage of instances of **safe** behaviours observed at Sishen mine for the past 12 months ending March 2003.

Culture

The safety culture incorporates three separate scales, each measuring a unique component. These are (Safety Performance Solutions , 2002):

- **Safety Perception Scale.** The safety perception scale assesses employees' perceptions and opinions regarding how strongly they believe they and others within the organisation support safety. In particular, it addresses perceived management support for safety, peer support for safety, and personal responsibility for safety. The management support for safety scale assesses whether employees feel the actions and attitudes of management are supportive to building and maintaining a total safety culture.

  The score for management support for safety responses was 56% favourable and 6% higher in the 2001 survey than the 1999 survey (50%). 40% scored neutral and 4% unfavourable in the 2001 survey, as opposed to 47% and 3% respectively in the 1999 survey (Figure 8, Table 2 item 1).

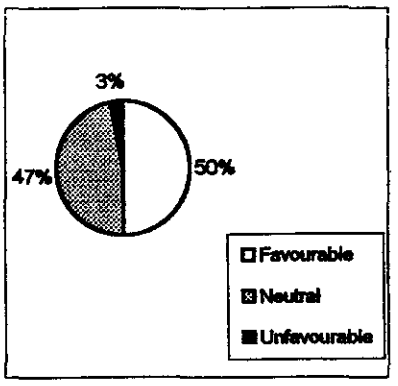

Figure 8(a): Overall perception for management support for safety at Sishen mine before implementing behaviour based safety (Dec 1999).

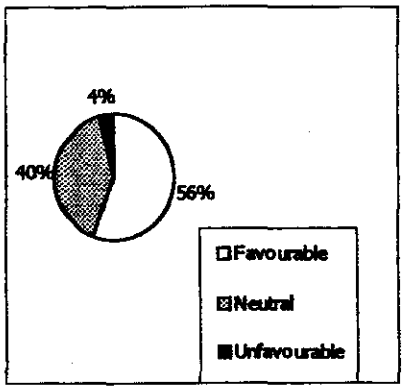

Figure 8(b): Overall perception for management support for safety at Sishen mine after implementing behaviour based safety (Oct 2001).

Table 2

Outcome of Culture Survey at Sishen mine with regards to Management Support for Safety

Item Nr.	Item Description	December 1999			October 2001		
		Favourable	Neutral	Unfavourable	Favourable	Neutral	Unfavourable
1.0	Overall Management support for safety	50%	47%	3%	56%	40%	4%
2.0	Management Support per Department						
2.1	Plant Maintenance	46%	46%	8%	68%	28%	4%
2.2	Plant Operations	32%	65%	3%	36%	53%	11%
2.3	Mining Maintenance	64%	35%	1%	58%	40%	2%
2.4	Mining Operations	51%	47%	2%	47%	49%	4%
2.5	Engineering Services	33%	60%	7%	68%	28%	4%
2.6	Reconditioning Section	54%	41%	5%	51%	46%	3%
2.7	Staff Functions	66%	34%	-	76%	22%	2%
3.0	Management Support per Position						
3.1	E+F Roles (Middle Management)	78%	22%	-	68%	32%	-
3.2	G Roles (First line supervisors)	70%	25%	5%	79%	17%	4%
3.3	Rest (Floor level employees)	46%	51%	3%	51%	44%	5%
4.0	Management support per race						
4.1	White employees	63%	33%	4%	68%	29%	3%
4.2	Black employees	38%	60%	2%	43%	51%	6%
4.3	Coloured employees	61%	39%	-	67%	27%	6%

The demographic analysis revealed evidence of a significant positive shift in the Plant Maintenance, Engineering Services, and Staff Functions (Table 2 items 2.1; 2.5 and 2.7). In the pay scale category, E and F roles (middle management and specialists) scored less favourable, while G roles (first line management) and the rest of the

employees scored more favourable in 2001 (Table 2 items 3.1 – 3.3). In the race category, all three races scored more favourable in 2001 (Table 2 items 4.1 – 4.3).

- **Peer support.** The peer support for safety scale assesses employees' perceptions and opinions regarding how strongly they believe their peers (e.g. co- workers) support safety. Examples of this would be if peers cautioning each about unsafe behaviour, peers appreciating feedback from their co-workers about safe behaviours, employees feeling pressure from co-workers not to take short-cuts in safe work practices, etc.

Responses from the 2001 survey scored higher than the 1999 survey (63% versus 50% favourable, 34% versus 49% neutral, and 3% versus 1% unfavourable) (Figure 9, Table 3 item 1). All departments (except for Reconditioning) scored higher in 2001, with several departments scoring significantly higher (Table 3 items 2.1 – 2.7). In the Pay Scale category, all groups scored much higher in 2001 (Table 3 items 3.1 - 3.3). In the Race category, all groups scored significantly higher in 2001 (Table 3 items 4.1 – 4.3).

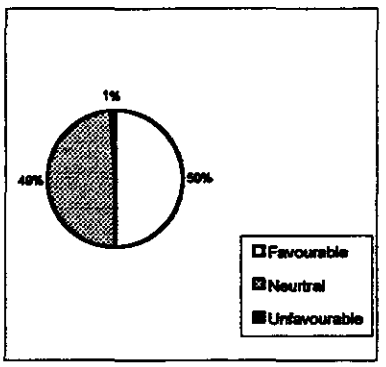

Figure 9(a): Overall perception of peer support for safety at Sishen mine before implementing behaviour based safety (December 1999).

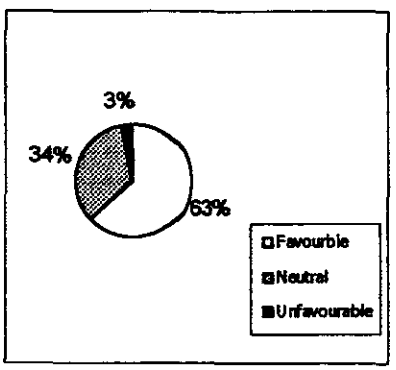

Figure 9(b): Overall perception of peer support for safety at Sishen mine after implementing behaviour based safety (Oct 2001).

Table 3

Outcome of Culture Survey at Sishen Mine with regards to Peer support for Safety

Item Nr.	Item Description	December 1999			October 2001		
		Favourable	Neutral	Unfavourable	Favourable	Neutral	Unfavourable
1.0	Overall Peer Support for safety	50%	49%	1%	63%	34%	3%
2.0	Peer Support for safety per Department						
2.1	Plant Maintenance	50%	48%	2%	66%	28%	6%
2.2	Plant Operations	51%	49%	-	55%	36%	9%
2.3	Mining Maintenance	42%	58%	-	58%	40%	2%
2.4	Mining Operations	56%	42%	2%	63%	34%	3%
2.5	Engineering Services	30%	68%	2%	70%	28%	2%
2.6	Reconditioning Section	49%	49%	2%	44%	54%	2%
2.7	Staff Functions	56%	43%	1%	74%	24%	2%
3.0	Peer Support per position						
3.1	E+F Roles (Middle Management)	41%	59%	-	60%	40%	-
3.2	G Roles (First line supervisors)	51%	43%	6%	73%	24%	3%
3.3	Rest (Floor level employees)	50%	49%	1%	61%	35%	4%
4.0	Peer Support per race						
4.1	White employees	46%	52%	2%	63%	34%	3%
4.2	Black employees	53%	47%	-	61%	34%	5%
4.3	Coloured employees	52%	48%	-	61%	33%	6%

- Personal responsibility for safety. The Personal Responsibility for safety scale assesses employees' perceptions and opinions regarding how strongly they believe they support safety. Examples of specific survey items are:
  - It is the responsibility of each employee to seek out opportunities to prevent injury to himself and others.
  - I have more respect for workers who work safely.
  - I follow safety rules as best as I can.
  - I sometimes overlook hazards to get the work done.
  - I am willing to put in extra effort to improve workplace safety.

Responses from the 2001 survey scored higher than the 1999 survey (86% favourable versus 79%) (Figure 10, Table 4 item 1.0).

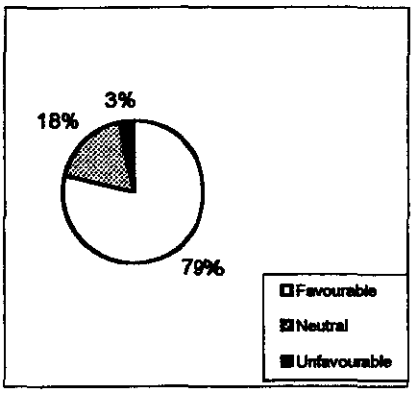

Figure 10(a): Overall perception of personal responsibility for safety at Sishen mine **before** implementing behaviour based safety (Dec 1999).

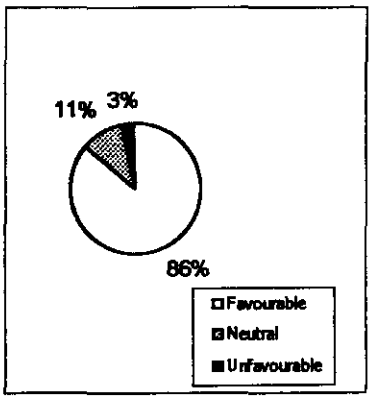

Figure 10(b): Overall perception of personal responsibility for safety at Sishen mine **after** implementing behaviour based safety (Oct 2001).

Table 4

Outcome of Culture Survey at Sishen Mine with regards to Perceptions of Personal Responsibility for Safety

Item Nr.	Item Description	December 1999			October 2001		
		Favourable	Neutral	Unfavourable	Favourable	Neutral	Unfavourable
1.0	Overall Personal Responsibility for safety	79%	18%	3%	86%	11%	3%
2.0	Personal Responsibility for safety per Department						
2.1	Plant Maintenance	77%	18%	5%	85%	11%	4%
2.2	Plant Operations	70%	26%	4%	84%	9%	7%
2.3	Mining Maintenance	77%	23%	-	88%	10%	2%
2.4	Mining Operations	84%	15%	1%	84%	12%	4%
2.5	Engineering Services	68%	25%	7%	95%	5%	-
2.6	Reconditioning Section	69%	31%	-	68%	32%	-
2.7	Staff Functions	94%	5%	1%	94%	4%	2%
3.0	Personal Responsibility for safety per position						
3.1	E+F Roles (Middle Management)	93%	7%	-	100%	-	-
3.2	G Roles (First line supervisors)	83%	9%	8%	94%	3%	3%
3.3	Rest (Floor level employees)	78%	20%	2%	83%	13%	4%
4.0	Personal Responsibility for safety per race						
4.1	White employees	84%	13%	3%	90%	9%	1%
4.2	Black employees	77%	21%	2%	82%	13%	5%
4.3	Coloured employees	76%	24%	-	85%	9%	6%

Four groups improved from the 1999 results, 2 groups scored the same and one group scored slightly lower (Table 4 items 2.1-2.7). In the Pay Scale category, all groups improved from 1999 (Table 4 items 3.1-3.3). In the Race category, all three races improved (Table 4 items 4.1- 4.3).

- **Safety management systems.** The safety management system scale measures employee perception of a variety of formal management systems, including discipline, incident reporting and investigation, safety rules and procedures, safety training, safety communication, safety suggestions, rewards and reinforcement, and hazard identification and correction. In addition, it also assesses employees' opinions about the company's safety performance, the effects of stress, drugs and alcohol on safety, and the level of employee involvement in safety.

Sishen's survey responses from 2001 scored higher in ten out of ten systems; thus overall perception towards safety systems improved since 1999 (Figure 11, Table 5 item 1.0).

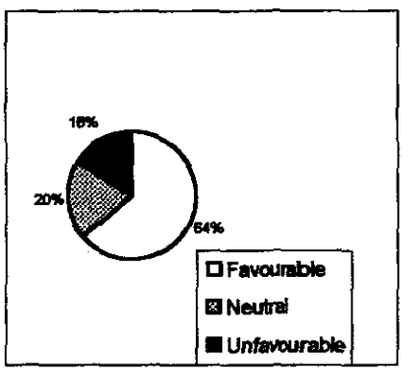

Figure 11(a): Overall perception of Sishen's management systems before implementing behaviour based safety (Dec 1999).

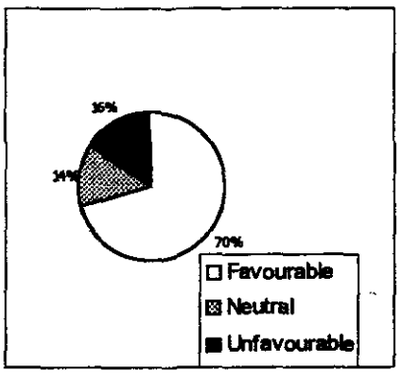

Figure 11(b): Overall perception of Sishen's management systems after implementing behaviour based safety (Oct 2001).

Table 5

Outcomes of Culture Survey at Sishen Mine regarding Perceptions of Management Systems

No	Item	December 1999			October 2001		
		Favourable	Neutral	Unfavourable	Favourable	Neutral	Unfavourable
1	Overall perception of management systems	64%	20%	16%	70%	14%	16%
2	Perception that drugs or alcohol is not a problem in the mine	58%	14%	28%	65%	13%	16%
3	Perception that employees will not be disciplined for having a work injury	55%	27%	18%	74%	26%	-
4	Perception that minor injuries are not being reported	46%	22%	32%	56%	16%	28%
5	Perception that injuries are thoroughly investigated	73%	13%	14%	75%	13%	12%
6	Employees understand the reasons behind Sishen's safety rules	73%	28%	19%	76%	13%	11%
7	Employees understand the potential of hazards in their jobs	73%	15%	12%	79%	11%	10%
8	Perception of good communication about safety	64%	18%	18%	66%	15%	19%
9	Employees received adequate training for their jobs	68%	15%	17%	77%	10%	13%
10	Employees received feedback by supervisors if they are observed working unsafely	58%	21%	21%	71%	14%	15%
11	Employee safety suggestions are taking seriously	64%	17%	19%	69%	16%	15%
12	Supervisors acknowledge employees for safe behaviours	52%	21%	27%	54%	21%	25%
13	Employees are motivated by the safety reward programme	67%	14%	19%	73%	11%	16%
14	Employees are encouraged to participate in defining safe work practices	73%	16%	11%	76%	11%	13%
15	Safety meetings help to make Sishen a safer place	74%	13%	13%	76%	10%	14%

The following comments may be made regarding these categories:

Stress, drugs and alcohol (Table 5 item 2). Although there was a 7% improvement from 1999 to 2001, 16% of responses still indicate alcohol or drug abuse is a problem in the workplace.

Discipline. Sishen improved in this regard from 55% in 1999 to 74% in 2001 (Table 5 item 3), but many employees still believe that it is common for employees to be disciplined for

having an injury. Almost one third of respondents felt that they had been disciplined for having an injury, and that discipline was not used often enough for serious safety violations.

Incident reporting and investigation. Responses concerning this aspect in 2001 (75% favourable) were only slightly better than in 1999 (73% favourable responses). Different groups showed different patterns, though, and mining maintenance for instance increased their favourable ratings by 22% while mining operations decreased their favourable ratings by 10%.

Rules and regulations. Research recorded a 76% favourable response in 2001 against the 73% in 1999. This represents a 3% positive shift. 11% responded unfavourable in 2001, as opposed to the 19% in 1999.

Training. On the question of receiving adequate safety training, 77% responded favourable in 2001, as opposed to 68% in 1999.

Communication. With regard to receiving feedback about observed unsafe work, the responses in 2001 were 71% favourable as opposed to 58% favourable in 1999. This represents a 13% improvement.

Safety suggestions. Sishen's 2001 scores improved slightly compared to 1999 (from 64% favourable in 1999 to 69% favourable in 2001). Most groups believed their safety suggestions were taken more seriously in 2001 than in 1999 (Table 5 item 11).

Rewards and reinforcement. Favourable responses in this category increased from 67% in 1999 to 73% in 2001, and unfavourable responses decreased from 19% in 1999 to 16% in 2001.

Hazard identification and correction. Favourable responses in this category increased from 73% in 1999 to 76% in 2001. Unfavourable responses increased from 11% in 1999 to 13% in 2001.

- **Actively caring for safety.** The actively caring scale measures individuals' intentions and attitudes toward demonstrating actively caring behaviour toward fellow employees. Respondents were asked if they were willing to perform actively caring behaviour, and if they currently performed the actively caring deeds.

Overall, Sishen 2001 showed slight improvements over Sishen 1999 (Figure 12, Table 6 item 1.0).

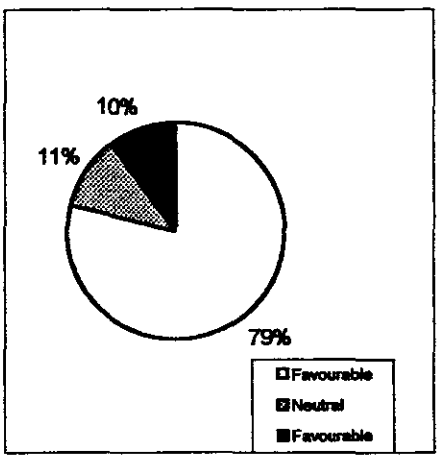

Figure 12(a): Overall perception of actively caring at Sishen **before** implementing behaviour based safety (Dec 1999).

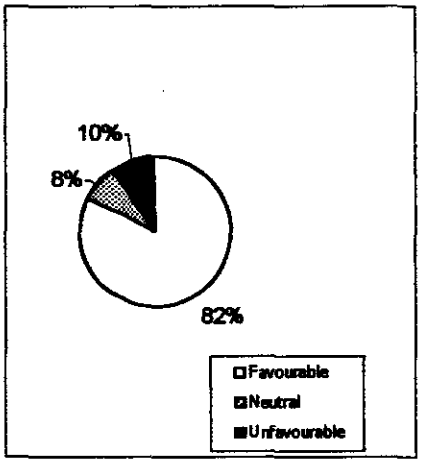

Figure 12(b): Overall perception of actively caring at Sishen **after** implementing behaviour based safety (Oct 2001).

Table 6

Outcome of Culture Survey at Sishen with regard to the Perception of Actively Caring

Item Nr.	Item Description	December 1999			October 2001		
		Favourable	Neutral	Unfavourable	Favourable	Neutral	Unfavourable
1.	Overall perception of actively caring for safety at Sishen	79%	11%	10%	82%	8%	10%
2.	Employees should actively care for one another	85%	7%	8%	85%	7%	8%
3.	Employees are willing to actively care for one another	83%	9%	8%	85%	6%	9%
4.	Employees do actively care for one another	79%	10%	11%	82%	8%	10%
5.	Employees should praise others for working safely	88%	6%	6%	88%	6%	6%
6.	Employees are willing to praise others for working safely	85%	7%	8%	88%	5%	7%
7.	Employees do praise others for working safely	80%	9%	11%	81%	7%	12%
8.	Employees should caution co-workers for working unsafely	88%	4%	8%	87%	5%	8%
9.	Employees are willing to caution co-workers for working unsafely	82%	8%	10%	83%	6%	11%
10	Employees do caution co-workers for working unsafely	88%	6%	6%	87%	6%	7%

All groups showed improvement from 1999, with Engineering Services showing the greatest increases. In particular, Sishen responses were very high for the " Praise" items. In terms of all the questions asked, an admirable increase of 5% for the "Should" items, 7% for the "Willing" items, and 16% for the "Do" items were recorded.

Trailing Indicators

In terms of trailing indicators, the most common indicator that is used in the industry is that of the lost time injury frequency rate. The performance of Sishen is portrayed in Figure 13. The lost time injury frequency rate is calculated by the number of lost time injuries per million hours worked.

For the year prior to the implementation of the behaviour based safety intervention (1999), Sishen recorded a lost time injury frequency rate of 5,53; that is 5,53 lost time injuries per million hours worked. For the year in which implementation commenced, the frequency rate dropped to 4,23 and to 4,33 and 4,32 respectively for the subsequent years (see Figure 13).

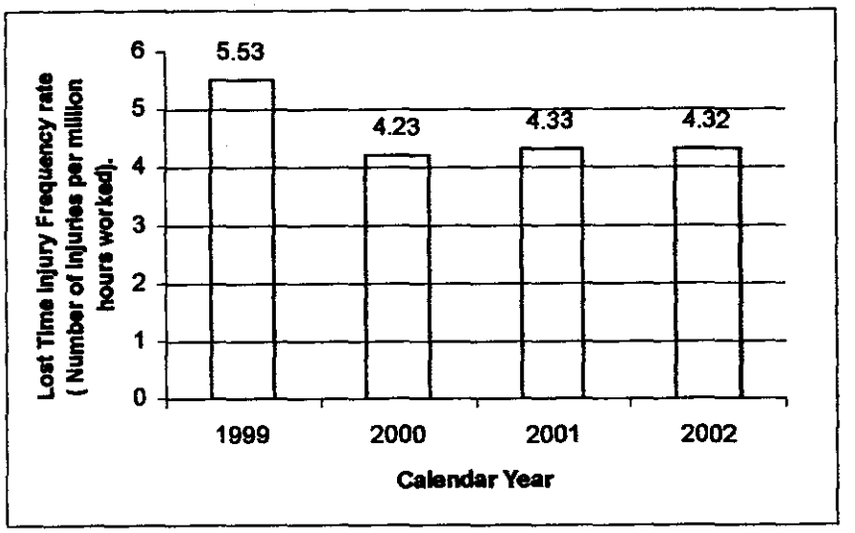

Figure 13: Trend for lost time injury frequency rate at Sishen mine prior (1999) and after implementation of behaviour based safety (2000 – 2002)

DISCUSSION

The increase in participation is encouraging because participation is voluntary and no pressure was enforced by management, and no management objectives have been set either. The conclusion is that employees' buy-in was achieved for the programme and that the employee's became aware of the advantages of the programme. During the programme, management emphasised recognition for participation.

The decrease in the percentage of instances of risk behaviour and the increase in the percentage of instances of safe behaviour were exactly what the programme was aiming at. Because risk behaviour is targeted and measured in the programme, employees are very much aware of the emphasis on this behaviour, which ultimately leads to the decrease in risk behaviour.

The detail of each question, indicate that employees perceive management as being less concerned with keeping injury statistics low and more concerned with keeping people safe, whereas employees perceive management as having become less concerned with production,

and more concerned with safety. Compared to 1999 data, managers were seen as more sincere about reducing injuries in 2001, and more willing to invest money and effort to improve safety. However it is disappointing that more employees felt that managers were likely to place production over safety. Supervisors were viewed less favourably than managers. More employees believed that supervisors were more likely to place production over safety, and to force employees to perform unsafe tasks. Furthermore, fewer employees perceived supervisors as encouraging employees to overlook hazards than in 1999.

There were significant gains from 1999 in two areas, namely giving and receiving feedback, and taking short cuts. In all the specific questions regarding these two issues, the 2001 perception was much more favourable than responses in 1999. In addition, employees responded much more favourably when asked if feedback for safe behaviour was appreciated. Unfortunately, employees were less appreciative about receiving feedback for unsafe behaviours. Employees reported they performed fewer shortcuts and felt less pressure from co-workers to perform these short cuts.

Regarding personal responsibility for safety, two aspects are worth discussing. Firstly, most groups reported that they had more respect for employees who try to work safely than for those who do not. Secondly, fewer employees reported overlooking safety hazards to complete the job than from 1999. When asked whether employees try to follow safety rules, the overall scores were similar to the 1999 scores. In a related item, employees were asked if they sometimes overlook hazards to complete the job. The overall response to this was more favourable in 2001.

The following conclusions may be made regarding safety management systems: The overall perception regarding management systems was 70% favourable in October 2001, compared to the 64% in December 2001. Although this is encouraging, there is a real concern regarding some of the sub items that were measured. These will be discussed in the subsequent paragraphs. Although there was a 7% improvement from 1999 to 2001, it is a concern that 16% of responses still indicate alcohol or drug abuse as a problem in the workplace. Management has installed a number of programmes to counter this problem, because the safety risk caused by drugs and alcohol is a serious concern.

The improvement from 55% (1999) to 74% (2001) in discipline is impressive, but it is discouraging that many employees still believe that it is common for employees to be disciplined for having an injury. The improvement is mainly because of a new approach towards conducting investigations, which involves not to concentrate on identifying a guilty party, but to concentrate on identifying the root cause of the problem. Furthermore, in spite of having been encouraged to report near misses, many groups showed a decrease in the belief that near misses are consistently reported and investigated. Although 75% of the 2001 respondents admitted they would report a minor injury if they sustained one, only 56% of 2001 respondents reported they felt minor injuries are not being reported (Table 5 item 4). The response for this item was 46% in 1999, and the decrease of 12% therefore is a real concern.

Sishen 2001 responses regarding rules and regulations were more favourable than the 1999 scores. Even though 76% of 2001 respondents feel that employees understand the reasons behind the company's safety rules (Table 5 item 6), 40% believe the site has too many safety rules.

The following conclusions have been reached regarding specific aspects of the programme:

- **Training**. Sishen 2001 scores on this aspect were more favourable than the 1999 scores. The biggest improvement concerned the perception that employees have received adequate safety training (Table 5 item 9). This is mainly because of the emphasis on safety training during the implementation of the behaviour based safety intervention.
- **Communication.** Sishen 2001 scores were higher than the 1999 scores. The biggest improvement (13%) was in the area of supervisor feedback, especially if workers were seen working unsafely (Table 5 item 10). There was an increase from 73% to 76% with regard to employees experiencing that they are being encouraged to participate in defining safe work procedures (Table 5 item 14). It may be concluded that these responses are the results of implementing a behaviour based safety programme by means of which people are encouraged to give feedback in a structured way.
- **Safety suggestions**. The 5% increase in favourable responses from 1999 to 2001 is mainly due to the structured way in which safety suggestions are recorded, investigated and feedback is given in the bahaviour based safety process.

- **Rewards and reinforcement**. Overall, Sishen 2001 scored higher than in 1999, although there were significant differences between different groups. A majority of employees felt the company's safety award programme motivated them to work more safely (Table 5 item 13). There was a tremendous amount of disagreement surrounding the issue of how injuries affect promotions and performance evaluations. Several groups believed that sustaining an injury would reduce an employee's chance of promotion and would result in a poorer performance assessment, while other groups did not.
- **Hazard identification and correction**. Overall, Sishen 2001 scored slightly higher than Sishen 1999. The sharpest differences were recorded on the issue of how often audits were conducted and whether the hazards found during the inspection were corrected quickly. The fact that employees understood the potential of hazards in their jobs better in 2001 (Table 5 item 7), was encouraging.
- **Other**. Two points are worth emphasising when reviewing the items in the other categories. Firstly, perceptions about the usefulness of the safety committee's efforts have improved considerably from Sishen 1999 (76% positive). Secondly, the 2001 scores are still much lower (39%) than would be expected in terms of whether the site spend too much effort on safety.

In a complete safety culture, employees not only feel a sense of responsibility for their own safety, but they also feel a sense of responsibility for the safety of one another. Furthermore, individuals are willing and able to act on that feeling of responsibility by going beyond the call of duty for the safety of a co-worker. That is, they routinely actively care for the safety of others by performing behaviour which will directly or indirectly influence the safety of others. Actively caring may be demonstrated through a variety of behaviours, such as offering to assist a co-worker to lift a heavy load, performing housekeeping duties other than those assigned directly to the individual, cautioning a co-worker about potentially risky behaviour, or recognising co-workers for their safe work practices.

The analysis of the results in Table 6, would seem to indicate that Sishen employees look for, and take advantage of opportunities to give each other positive feedback for safe behaviour. It also indicates that employees recognise and receive feedback, and look for hazards within their work environment. Employees at Sishen mine are thus caring for one another.

Although the decrease in the injury frequency represents a significant improvement of 20%, there is still room for improvement, and the belief is that an expectation of a frequency rate of 2 is not unrealistic.

CONCLUSION

The results in the above section, clearly show that the results in the report support the expected hypothesis. The implementation of the behaviour based safety intervention indeed established a new safety culture at the mine. The strongest impact is experienced in the areas of management support to safety, actively caring between co-workers, and a number of safety systems.

The intervention also favourably impacted on the lost time injury frequency. Although it was expected that such a shift in the culture would have a more significant impact on the safety statistics, it should be remembered that the outcome of an accident is coincidental (whether the injury is minor or major). Therefore it is difficult to draw conclusions from safety statistics. It is also encouraging that participation in the programme is still increasing. However, one would like to see participation increase from the current 44% per month to at least near 100% per month.

The value of the research is that it indicates that it is possible to make an impact with such an intervention, especially in developing countries, such as in Africa with its unique culture and restricting factors like illiteracy, racial issues, diversity etc. Similar results were achieved in first world countries like Australia and America, although the environment in those countries is quite different than in South Africa, especially in the mining industry. What must be realised is that to make a behavioural approach work in Africa, the approach needs to be more intense in order to deal with issues like labour union participation, illiteracy, politics and diversity.

The conclusion that behaviour based safety is an effective tool to address the behaviour dimension of safety, should not be interpreted as if it is suggested that behaviour safety will solve all the safety problems at a particular site. On the contrary, as was mentioned in the

introduction, it is essential to devote equal attention to all three dimensions of safety, namely the environment, the person, and behaviour.

In conclusion, the implementation of a behaviour based safety intervention adds a new and fresh approach to traditional approaches in search for safety excellence. The only way to make change sustainable is through cultural change, and behaviour based safety is an important technique to achieve this objective.

RECOMMENDATIONS

The research shows that achieving safety excellence requires going beyond the traditional safety focus of engineering, regulations and ergonomics.

Because human behaviour is a contributing cause to most incidents and injuries, safety excellence can only be achieved by addressing the human dimensions of safety. It is recommended that industrial companies shift their focus from traditional safety approaches to also include a strong focus on the human dimensions of safety. This recommendation does not imply ignoring the environment and person factors. Such an approach would be fatal because the three domains of safety are interrelated with one another. Instead, it implies a drive to include behaviour as an integral part of the safety system.

Secondly, the research proved that behaviour based safety could in fact be a very useful tool as an intervention to address the behaviour dimension and to influence safety culture. Thus, it is recommended that the behaviour based safety model should be applied by companies which have a need for it , and which wish to focus on the behaviour dimension of safety. It can be administered by individuals with, minimal professional training and can reach people in all settings where unsafe conditions occur. It is very unfortunate that behaviour based interventions have only been implemented in 800 organisations in developing countries (Hodson, et al., 1998), in spite the positive results achieved by so many industrial companies.

The discussion of the way in which Sishen actually implemented its behaviour based safety intervention clearly indicate that one cannot buy such a programme "off the shelf' in a

developed country and install the identical programme in a developing third world country. There are valid reasons why it is necessary to adapt the programme to fit the local circumstances.

It is thus recommended that companies, which consider the behaviour based safety tool should make the necessary adaptations to fit their particular circumstances. If these circumstances are ignored, it will have an adverse effect on the success of the implementation. Furthermore, companies will have only one change to successfully implement an intervention like behaviour based safety.

During the author's research a deficiency in research results were experienced regarding the relation between certain individual personal traits and the way people behave in terms of safety. For example, the relation between intelligence and at risk behaviour in the workplace is unclear and it is suggested that such information would be very useful to the industry and it is recommended that future research should be devoted to this subject.

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CHAPTER 3

RESEARCH ARTICLE 2

BEHAVIOUR BASED SAFETY: CRITICAL SUCCESS FACTORS AND ISSUES TO DEAL WITH

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ABSTRACT

World-wide it is estimated that workers suffer 250 million accidents each year, with 330 000 fatalities, in spite of traditional safety interventions like safety engineering and other interventions being implemented. Very little emphasis has thus far been placed on behaviour interventions to improve the safety culture and behaviour in the workplace. The aim of this study was to determine the factors which are important to ensure a successful behaviour safety implementation. A non-experimental survey was used. Representatives at an international conference were used as a study population. The results indicated the following factors as being critical for a successful behaviour based safety implementation: participation, structured implementation, training, readiness for implementation, communication, observation and interpersonal feedback, target critical behaviour, flexibility, effective intervention actions, and data management.

OPSOMMING

Dit word beraam dat werkers wêreldwyd jaarliks 250 miljoen ongelukke in die industrie opdoen, waarvan 330 000 noodlottige ongelukke is, ten spyte van tradisionele veiligheidsintervensies wat geloods is. Ongelukkig is tot dusver min klem daarop gelê om die veiligheidskultuur en gedrag van werknemers in die werkplek te verbeter. Die implementering van 'n gedragsgebaseerde veiligheidintervensie is 'n middel om die leemte te vul. Die doel van die studie was om die faktore te identifiseer en te prioritiseer wat krities is vir die suksesvolle implementering van so'n intervensie. 'n Nie-eksperimentele houdingstudie was gebruik. Verteenwoordigers op 'n internasionale konferensie is gebruik as studiepopulasie. Die resultate toon die volgende faktore aan as krities vir suksesvolle implementering: deelname, gestruktureerde implementering, opleiding, gereedheid vir implementering, kommunikasie, observasie en terugvoering, fokus op kritieke gedrag, buigsaamheid, effektiewe intervensie en inligtingsbestuur.

International concern and awareness of the importance and magnitude of occupational safety remains surprisingly modest, in spite the fact that workers suffer 250 million accidents every year, with 330 000 fatalities, and 160 million cases of occupational diseases. The economic losses are equivalent to 4% of the world's gross national product (Takala, 1999). In South Africa the situation is no better at all. During the period 1999 – 2001 workers experienced an average number of 426 fatalities per annum (Department of Labour, SA, 2002).

Alarming as the fatality, accident and disease figures may be, investment, operational, and management decisions often continue to be made in disregard of safety and health considerations. The question is whether anything has been done to reverse this situation. Obviously, a number of interventions were launched to deal with this problem. Government in Great Britain, by means of statutory regulations, initiated the first intervention. Society is increasingly demanding a sophisticated response from its managers who are called on to manage in ways other than with a narrow and simple approach to private profit maximisation. This resulted in statutory laws (laws made by acts of Parliament) and common law (legal rules created by judges) (University of Southern Queensland, 2001) being introduced.

In the past a number of other safety interventions were developed to improve safety performance. Among those, the most important for the purposes of this research was safety engineering, or safety design. This entails the design or redesign of buildings, equipment, and work processes in anticipation of and with the intent to eliminate hazards in the workplace, e.g. equipment guards and emergency kill switches (Krieger & Montgomery, 1997).

Another intervention of great importance is ergonomics. This intervention focuses on human beings and their interaction with products, equipment, procedures and environments. The aim is to change things people use and the environments in which they use these things to better match the capabilities, limitations and needs of people (Sanders & McCormick, 1993). Other interventions that are worth mentioning include management audits, poster campaigns, near-miss reporting, root cause analysis, personnel selection, problem solving techniques, and safety systems design. Unfortunately these interventions focus only on solving half the problem, namely the environment and certain personal aspects.

The development of a proper safety management system requires continuous attention to three domains, namely the environment (e.g. equipment, tools and housekeeping), the person (e.g. knowledge, skills, abilities, intelligence and personality) and behaviour (Geller, 1998a).

In the previous century much emphasis was placed on improving "the environment" and "the person". In South Africa in particular, most leading industrial and mining companies used to be affiliated with NOSA (National Occupational Safety Association). The safety programme that was introduced by NOSA mainly involves a checklist for a safe environment, as well as emphasis on training and development of personnel. Very little emphasis has thus far been placed in South Africa on behaviour interventions to improve the safety culture and safety behaviour of employees.

Thus, historically many organisations have focused on improving safety by addressing the working environment. Providing hazard-free facilities and providing better tools and equipment have worked well to improve safety, but many organisations have reached a plateau, continuing to rely solely on these approaches, which will bring only marginal gains (Gillmore et al., 2001).

It is necessary to focus on behaviour because approximately 80 – 95% of all accidents are triggered by unsafe behaviour (Cooper, 1999a), which tend to interact with other negative features (pathogens) inherent in workflow processes or present in the working environment. These pathogens lie dormant and are relatively harmless, until such time as two or more combine and are triggered by an unsafe behaviour to produce an accident. Heinrich's research concluded that 88% of all industrial accidents were primarily caused by unsafe acts, while Du Pont finds that 96% of injuries and illnesses are caused by unsafe acts. Behaviour Science Technology has indicated that between 80% and 95% of all accidents are caused by unsafe behaviour (Macdonald, 2002). These statistics led Geller, Krueger, French and Williams (2000) to conclude that because human behaviour is a contributing cause to most incidents and injuries, safety excellence can only be achieved by addressing the human dimensions.

Safety managers have come to realise that, firstly, people are not perfect and will make mistakes despite their best intentions and despite working in the best of surroundings. Secondly, they realise that the work culture often allows or encourages risk behaviour.

In the last decades of the previous century the behavioural approach to safety performance improvement was developed to focus on reducing hazards by understanding employee behaviour in the context of their work culture. Although it is a good idea to solve the safety problem by focusing on the behaviour dimension of safety, the question still remains as to how the focus should be shifted to include the behaviour domain, and which tool should be used to achieve this goal.

Behaviour based safety has been implemented at over 800 sites world-wide as a "tool" to address safety behaviour in the workplace (Hodson, Strydom & Franklin, 1998), and as far as could be determined, Sishen mine was the second company in South Africa to implement behaviour based safety in 1999.

The behaviour based process

Behaviour based approaches to safety focus on systematically studying the effects of various interventions on target behaviours, firstly by defining the target behaviour in a directly observable way, and secondly by observing and recording it in its natural setting. When a stable baseline measure of the frequency, rate or duration of a specific behaviour is obtained, an intervention is implemented to change the behaviour in beneficial directions (Geller, Boyce, Williams, Pettinger, DePasquale & Clarke, 1998).

Krause (1999) identifies the following activities in the behaviour based safety process:

- Identify safety related behaviours that are critical to performance.
- Gather data on workgroup safety excellence.
- Provide ongoing, two-way performance feedback.
- Remove system barriers to continuous improvement.

An illustration of the behaviour based process is depicted in Figure 1 (Geller 1998a).

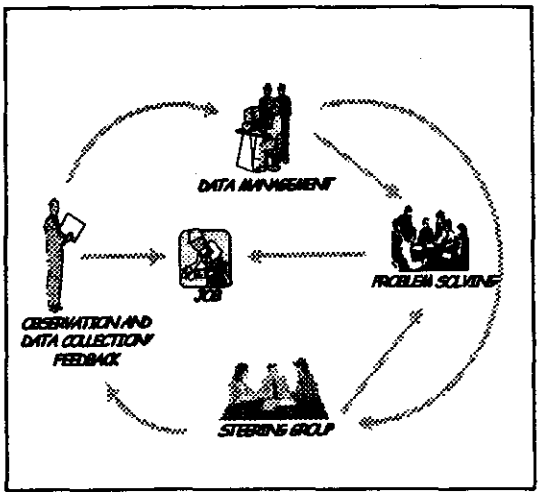

Figure 1. An illustration of the behaviour based process

To summarise, behaviour based safety refers to the application of principles and methods derived from the field of applied behaviour analysis to industrial safety. These principles include rewarding feedback and positive reinforcement to increase appropriate behaviour and decrease improper behaviour. Applied to safety, this means that safe behaviour is increased and risk behaviour is decreased. The basic objective is to improve human performance towards safety.

The crucial question is whether the application of a behaviour based safety intervention work for safety. Typical results recorded in the past were:

- 40 to 75% reductions in accident rates and accident costs year by year, and 20 – 30% improvements in safe behaviour year by year (Cooper, 1999a).
- 79% reduction in recordable injury rates for Safety Performance Solutions clients within seven years following behaviour based safety implementation (Gillmore et al., 2001).
- 69% reduction in recordable injury rates for 74 Behaviour Science Technology clients within five years following behaviour based safety implementation (Behaviour Science Technology, 1998).

Geller (2002a) did a nationwide survey in America to determine the success of behaviour based safety implementations. Among the respondent companies only 61% experienced behaviour based safety as a way of decreasing unsafe acts. In another study by Geller, et al. (1998), 80% (N = 129) of the respondents answered affirmative to the question: "Do you

believe behaviour based safety is a viable approach for reducing at-risk work behaviours?" Only 3% responded negatively to this question, while the rest indicated what they did not know.

Previous research has identified the following as strengths and weaknesses for a behaviour based safety intervention:

Strengths

- It enhances the safety culture and commitment (Smith, Cohen & Cohen, 1978).
- It puts the emphasis on the human dimensions of safety (Geller, et al., 2000).
- It targets specific risk behaviour, and does not intervene in a haphazard fashion (Geller, 1996).
- It is an effective tool for performance improvement (Krause, 2000).
- It is a cost-effective intervention (Pettinger, Boyce, Geller, in press).
- It empowers employees at shopfloor level to change things for the better (Jones, 2003).
- It applies scientific methods to improvement (Anonymous, 2003).
- The process creates the opportunities for coaching through the observation and feedback process (Geller, 1996).

Weaknesses

- Many psychologists argue that a behaviour based safety intervention must target attitude first (Geller, 2000).
- The intervention does not address the causes of accidents that are not behaviour related (United Steelworkers of America, 2002).
- It focuses only on specific risk behaviour and tends to ignore all other safety behaviour (United Steelworkers of America, 2002).
- It involves significant change efforts, and success is in no way guaranteed (Fograscher, 2003).
- Implementation requires significant resources (Krause, 1999).
- There are many barriers to successful implementation (Krause, 1999).

According to Fograscher (2003), behaviour based safety does not work in every company and in many Ohio companies, for example it was just another programme of the month. There was resistance to behavioural programmes that promised big benefits but only resulted in additional paperwork, and a mountain of wasted time for safety teams.

Success factors of behaviour based safety implementation

The research quoted above suggests that behaviour based interventions are most successful in the majority of companies where it was implemented. The immediate question is why behaviour based safety has failed in some of the companies where it has been implemented. The answers to this question are not obvious and certainly not simplistic. Two research studies were conducted in the past to determine factors that distinguish successful from unsuccessful behaviour based safety programmes.

The first study was conducted by Geller, et al. (1998). They researched the factors that contribute to failure when implementing a behaviour based safety intervention. They found the following items to be the biggest obstacles to a successful implementation (in order of decreasing importance):

- Lack of resources.
- Paperwork.
- Lack of trust.
- Poor attitudes.
- Lack of buy-in.
- Lack of communication.
- Lack of participation.

DePasquale and Geller (1999) also did some research to determine success factors. They identified the following items as the most critical to the success of a behaviour based safety implementation:

- Behaviour based safety training.
- Management support for the behaviour based safety programme.
- Interpersonal trust between employees and management.

There has also been debate in the literature as to whether rewards or incentives in order to enhance participation in a behaviour based intervention programme contributed to the success or failure of a behaviour based intervention programme. The debate is aiming at justifying three different approaches. The first approach is whether cash rewards or incentives alone should be applied. Secondly, there is the issue about the size of the reward or the incentive, and thirdly it is unclear whether cash rewards or incentives have any value at all.

There are arguments for and against the use of rewards and incentives in a behaviour based programme. Krause (1995) encourages the elimination of safety incentive programmes. According to Krause, safety incentive programs are more often than not harmful to real improvement efforts.

Geller (2003e) believes that whether or not a reward increases the behaviour upon which it follows, it is apt to improve one or more feeling states that make people more likely to actively care about the safety of others. According to Geller, this justifies using rewards, even when behaviour is not directly influenced. Daniels (2002) also believes that incentives can be useful reinforces, but warns about several factors that tend to reduce their effectiveness, like the fact that they are practically always delayed, the fact that not all incentives are desirable to all performers, etc.

On the question of whether recognition for safe behaviour should be linked to cash rewards, Daniels (2002) concluded that money is not the best incentive, because it is soon spent and the memory of it soon fades, whereas other tangible incentives are kept longer as a constant reminder of some safety accomplishment. Authors like Geller (2003c) prefer incentives above cash rewards, and believe that tangibles can add to the quality of interpersonal recognition if they are delivered as tokens of appreciation.

Champagne and McAfee (2002) offer an opposite viewpoint in their research at a large paper-mill company. In this research substantial cash awards were offered to employees for performing safely, which resulted in lost-time accidents declining dramatically from 31 to 14 during a two-year period. This led them to conclude that cash rewards can be an effective means at enhancing safety related behaviours.

The Occupational Safety and Health Association (OSHA) guidelines and recommendations for safety incentive programmes emphasise the value of psychological rewards over large monetary ones (Industrial Safety and Hygiene News, 2003). Most authors are not against the use of money or incentives as positive reinforces, but the general warning is against the size of the reward. Making money or an award more important than safety, is like making it an end in itself, and such a practice is intolerable. Komaki, Heinzmann and Lawson (1980) concluded that behaviour programmes, particularly those employing no monetary consequences such as feedback, have been found effective as motivational strategies.

Unfortunately, only limited research has been carried out to explain the process and organisational factors that can facilitate the successful implementation of a behaviour based safety approach. As a result organisations are left to muddle through the unending case studies provided by consultants. Although such literature may be enlightening and informative to some degree, it does not adequately inform readers of the underlying critical success factors that lead to successful behaviour based safety implementation

The problem is to determine the most significant critical success factors. If one had to draw up a list of all success factors, there would be quite an exhausting list of 100 or more items on which industry had to concentrate in an effort to make a successful implementation. Such a list would be of no assistance but would instead create confusion. It is important to identify and rank the most critical success factors, in order for it to serve as a guideline for industry during similar behaviour based implementations. There was no obvious answer to the question as to which factors are the most critical for a successful implementation. Research was therefore necessary to determine those critical factors.

One of the factors that make it very difficult to determine and rank critical success factors was the fact that circumstances vary from site to site. According to Blair (2002), every site is unique and customisation of behaviour based safety is crucial to success. Circumstances vary substantially between first world and third world countries. Factors that are critical for success at one site may not be critical at another site.

Thus, the research problem is that there are no guidelines available as a training manual for those sites that aim at implementing behaviour based safety as a new tool to focus on the

behaviour dimension of safety as well. The aim of the research is then to determine and rank those factors that are critical to the success or failure for a behaviour based safety implementation. The secondary aim of the study is to provide insights as to how those critical success factors may be approached and applied in practice, especially in a third world environment where different issues and challenges are applicable.

METHOD

Research design

A survey was designed by the author in order to achieve the desired research objectives. The first step in the survey was to do a comprehensive literature study in order to compile a complete list of success factors for a behaviour based safety implementation. A number of resources were retrieved in this regard (ASSE, 2002; Blair, 2002; Iverson & Erwin, 1997; Krause, 1999; Loafmann, 2002; Spigener & McLaughlin, 2001). From the comprehensive list the author combined some of the critical success factors mentioned in the literature, and identify the 20 most critical success factors.

Study population

The author attended a Users Conference for Behaviour Based Safety in Los Angeles, USA, in May 2002. Safety Performance Solutions , the consultant company from the USA which was appointed to support Sishen mine during the implementation of its behaviour based safety programme, presented the conference. The representatives at the conference were experienced users of behaviour based safety in the USA or elsewhere, and most of them were also customers of Safety Performance Solutions.

The 132 participants at the conference were used as the study population for this research because they are most experienced in implementing behaviour based safety at their plant or site. The participants were requested by the master of ceremonies at the conference to complete the questionnaire and return it to the conference reception desk. They were requested to rank the 20 success factors on the questionnaire in order of importance.

A total number of 84 companies responded to the request and completed the questionnaires. The 84 responses represent 63,6% of the total number of representatives at the conference. Since a 63,6% response was regarded as representative of the study population, the result could be accepted as a fair distribution of the views of users at the specific conference, and for that matter the views of behaviour based safety users all around the world.

The composition of the population group (representatives at the conference) in terms of sex, occupation and nationality was as follows:

- Men 108, women 24.
- Line managers 54, safety managers 78.
- USA citizens 111, from other countries 21.

Measuring instrument

The survey battery was compiled by the author (Appendix E) from the list of critical success factors debated in the literature, as mentioned above. The survey battery incorporates 20 critical success factors which in the view of the current and other authors were regarded as the 20 most important success factors in the implementation of a behaviour based safety intervention. The questionnaire not only incorporates a short description of each success factor, but also includes a related statement to further elaborate on the detail regarding a specific success factor. The respondents were requested to rank the success factors and related statements in order of importance (in their experience), with 1 being the most important, 2 being the second most important, and 20 being the least important.

Data analysis

The report illustrated the responses of the 84 companies which responded by completing the questionnaire. The outcome of questionnaires was fed into a Microsoft Excel software programme and the software analysed the responses accordingly. Ultimately the 20 success factors were ranked according to their importance as indicated by the respondents. The end result was represented in a table indicating the rankings awarded to each success factor, as was calculated by the data software.

Research procedure

The following steps were taken in the course of the research:

- Finalise the research battery in terms of the critical success factors on the questionnaire.
- Develop a software query on Microsoft Excel to analyse the data from the responses on the questionnaires.
- Attend the Safety Performance Solutions users conference and communicate the purpose of the research and the procedures for completing the questionnaire and the submission procedure to the representatives at the conference.
- Collect the questionnaires at the conference reception desk.
- Feed the data from the questionnaires into the software computer programme.
- Run the software programme and portray the final results in a table.

RESULTS

The result of the ranking, as explained above, is illustrated in Table 1.

Table 1

Summary of Rankings for Critical Success Factors by Conference Participants

Critical success factors	Total number of ranking points	Average number of ranking points	Standard deviation	Ranking out of 20
Readiness for Implementation	463	5.447058824	3.69	4
Address Issues	914	10.75294118	4.97	11
Competence Facilitator	1151	13.54117647	3.85	15
Role of Data Management	817	9.611764706	5.26	10
Effective Interventions actions	769	9.047058824	4.86	9
Provide Resources	1148	13.50588235	3.91	14
Flexibility	675	7.941176471	4.46	8
Observation & Feedback	551	6.482352941	4.22	6
Measure Programme Success	1102	12.96470588	4.26	13
Buy-in and Participation	423	4.976470588	3.52	1
Barrier Removal	1070	12.58823529	4.08	12
Training	450	5.294117647	3.59	3
Identify Critical Behaviours	561	6.6	4.06	7
Structured Implementation	446	5.247058824	3.49	2
Level of Integration	1382	16.25882353	2.96	18
Connections and Networking	1415	16.64705882	2.58	20
Communication	465	5.470588235	4.63	5
Competence External Consultant	1281	15.07058824	3.47	17
Individual Factors	1164	13.69411765	3.80	16
External Factors	1393	16.38823529	3.00	19

The results clearly indicated that the 10 critical success factors for a successful implementation of a behaviour based safety intervention, are as follows (ranked in order of importance): Buy-in and participation, structured implementation, training, readiness for a behaviour based safety implementation, communication, observation and interpersonal feedback, define critical behaviours to target, flexibility, effective intervention actions, and the role of data management. The 10 most critical factors are discussed in the subsequent paragraphs, with the emphasis on how it was implemented at Sishen mine. Special reference is made to barriers to implementation and issues which must be dealt with, especially in a third world country like South Africa.

Structured implementation

The first critical factor is structured implementation. It is very important to have a well-considered blueprint for the entire implementation sequence. This involves understanding the necessary steps for implementation. In successful change efforts, the implementation plan involves a very clear plan, a path forward with specific steps and a predefined sequence of events and timeline. Figure 2 illustrates Sishen mine's broad implementation plan.

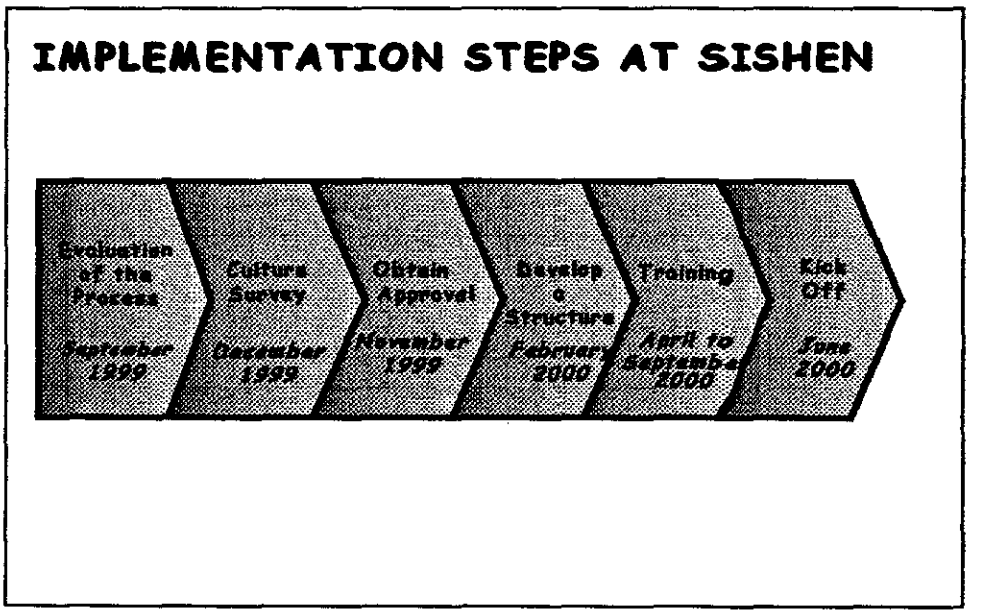

Figure 2. Implementation steps for the behaviour based safety process

After planning and strategy, structure normally follows. It is important to establish an organisational structure that will address all the needs of the process. An implementation team must be established to take responsibility for the total implementation. Since implementation is not the sole responsibility of the implementation team, the roles and responsibilities of each level in the hierarchy are to be spelled out in detail. It is also important that the skills of the implementation team matches the skills needed for the process.

The fourth step in the implementation process was to develop a structure for the process. Because a behaviour based safety intervention is meant to be an employee-driven process, it was important that the members of the steering committee were chosen by employees and not by the employer. The structure was developed and negotiated with labour unions and finally accepted (Figure 3). In this structure the full-time facilitator was nominated by management, but all the other members of the steering team (including the management representatives) were elected by the employees.

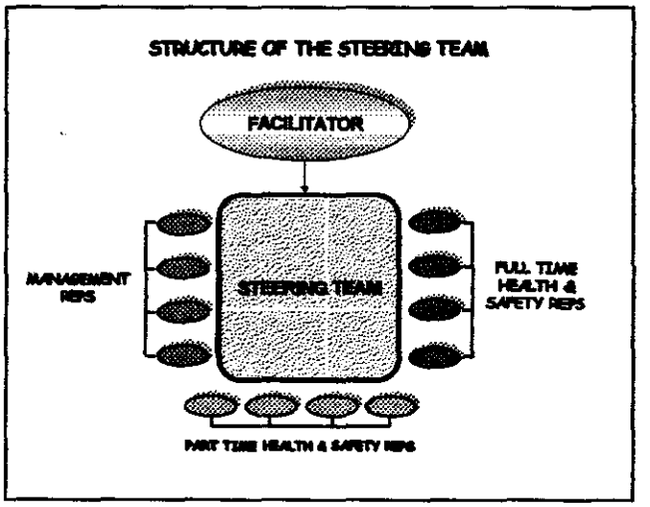

Figure 3. Steering team structure for behaviour based safety

Proper sequencing of implementation events is important. For example, it is not recommended to provide conceptual training long before anyone could start with the process. By the time that the process is ready, people would have lost interest and their expectations would have cooled down. Moreover by the time they are supposed to use the skills, they would have lost them.

After the implementation plan has been finalised, it must be implemented rigorously. The structure of the plan should therefore not be improvised at all. Rather than pursuing every possibility, the site must steadfastly pursue precisely those steps that lead to their objective (Krause, 1999).

The structured approaches cultivate a clear understanding of the stages through which the change effort will unfold and the types of barriers and resistance it will have to overcome. The plan will include phased or sequenced remedies for overcoming resistance. Without a strong structural approach, implementation will become a trial-and-error exercise, where everyone does what he thinks is right. Such an approach will be disastrous for the success of the programme.

The second critical factor is flexibility. Having promoted a strong structural approach in the previous section does not imply zero flexibility. Structure and rigor do not mean inflexibility or rigidity (Blair 2002; Krause, 1999). To the contrary, behaviour based safety is certainly not a programme that can be bought off the shelf in a well-developed first world country like the USA and implemented in Africa without modifications. Sishen has learned this lesson very early in the implementation process. In South Africa there are a number of issues that need to be dealt with to ensure a successful implementation.

The first issue is that of diversity. The workforce is divided into four different races, namely whites, blacks, coloureds, and indians. Within the black and coloured groups there are different ethnical groups, and there are different age and gender groups as well. Dealing properly with the issue of diversity is very important for behaviour based safety. A successful implementation is dependent on employees caring for one another- a value that is very much adversely affected by diversity. Employees must understand each other's culture and background if they are to care for one another.

The previous political dispensation in South Africa created different social classes. This climate is to the disadvantage to the implementation of behaviour based safety, because non-whites usually do not have the courage and assertiveness to address, observe and criticise

their white colleagues' behaviour. This adversely affects participation, which is of the utmost important for a successful implementation.

Sishen mine partially overcame this issue by having all its employees undergo a culture-bridging programme before implementation. The aim of this exercise was to teach everybody about the culture and traditions of his black/white colleagues. This was very helpful in creating a better understanding and a caring culture amongst employees. Caring was also institutionalised as one of the main foundational values at the mine, and it helped to create the right climate before implementing the programme. This was reinforced by industrial theatre plays, to further enhance the importance of this value.

Another issue in a developing country is the high level of illiteracy. As the programme requires from the observer to complete a checklist, this issue would also adversely affect the success of the programme if all functionally illiterate individuals were to be excluded from participation. In order to accommodate illiterate individuals, Sishen developed a symbolic checklist for illiterate employees. This checklist allows them to participate by only marking symbols on the checklist (see Appendix D). In Sishen's case, 16,4% of employees were illiterate and it was critical for the success of the programme to get participation from this group.

Another aspect in which the programme had to be adapted for South Africa was the perception of safety. During the year 2000, a total of 22030 civilians were murdered in South Africa, of whom 49,3% were shot (Gun Control Alliance, 2003). 1600 out of every 100 000 people will be victims of violent crime in the next year; that is 1 in 63. Of these 59 will be murders, 68 attempted murders, 168 robbery with extenuating circumstances, 252 rapes, 565 assaults with intent to do grievous bodily harm and 488 common assaults (Gun Control Alliance, 2003). As a result at this scenario employees regard the civilian territory as more dangerous than the workplace. As long as this perception exists, there will be no case for change, and the employees will not participate in a programme to enhance the safety performance at a particular site.

Sishen mine attempt to change this perception of the mine as a safe workplace by showing the employees gruesome photographs and videos of horrible accidents that were previously experienced at the mine and other similar industrial sites.

In developing countries, like South Africa, it is critical for the success of the programme to be flexible and to be adapted to fit the local circumstances. Without such considerations, the behaviour based programme will be doomed to failure.

A third critical success factor is participation. The programme requires significant workforce participation. Without participation there is no programme. It fully engages the workforce in safety management, perhaps for the first time in their career. Behaviour based safety deliberately adopts a bottom-up approach and not a top-down approach. Without widespread involvement, the ownership and commitment to the process will be lacking and the process will probably fail (Cooper, 1999a).

The question is really how to get people involved and how to sustain such involvement. At Sishen mine it was regarded as important to achieve labour union buy-in from the beginning. This was done through involvement of the union in the approval stage. However, this proved to be very late in the process and it would have been a better option to involve the unions from the investigation stage. There are valid reasons why a labour union would in principle be against the adoption of a behaviour based programme. Victim blaming is at the heart of behaviour based safety programmes, according to the UAW union (2002). Unions frequently believe that management is implementing such a programme to identify workers who are violating safety rules, and that the observation information will be used against the union's members in disciplinary hearings.

The solution to this issue, as experienced from Sishen's viewpoint, is to establish and emphasise common ground. Management and unions have much common ground concerning safety. Management does not want their employees to get injured, and neither do unions wish their members to get injured.

Sishen's behaviour based implementation team solved this issue by establishing a "no name, no blame" approach. When an observation is performed, only the name of the observer is

being recorded and not the name of the observee. In addition, supervisors are not allowed to do formal observations on individuals who report directly or indirectly to them. These arrangements paved the way for 100% buy-in by the unions and undisturbed participation by their members.

Another issue that needs to be resolved is the issue of whether the programme should be voluntary or compulsory for employees. As this programme was meant to be worker driven, Sishen aimed to develop a culture wherein participation was driven internally and not externally (to suit the mandates of management). Therefore, the steering committee for the behaviour based programme at Sishen mine decided that participation in the programme would be voluntary.

After this decision, the issue of training for the programme was raised by the steering committee. The Steering committee decided to make training compulsory for all employees, because it is only in the training sessions that employees would learn about the background and rationale of behaviour based safety. This proved to be a successful approach because a number of employees admitted that they were participating in the programme in spite their initial decision not to participate, and that the training persuaded them to change their minds.

The issue whether cash rewards or incentives should be paid to participating employees also had to be considered. Companies that reward employees for taking an active role in the safety effort believe that the true value of an incentive programme is the motivational and recognition aspect and they do not see incentives as a way to bribe their employees to work more safely (Champagne & McAfee, 2002; Daniels, 2002; Geller, 2002c; Geller, 2003e). Other companies, again , believe that incentives are only meant to buy participation (Komaki, et al., 1980; Krause, 1995).

It was the viewpoint if the behaviour based steering committee at Sishen mine that they were more interested in quality than quantity observations. If substantial rewards were being offered for participation in the behaviour based programme, there would always be a danger that employees would participate for the sake of receiving the reward and not because they were internally driven to work safely. Geller (2002c) concluded that if the focus of a recognition process in behaviour based safety is placed on a material reward, the words of appreciation may seem less significant. But, according to Geller, tangibles can add to the

quality of interpersonal recognition if they are delivered as tokens of appreciation. Therefore the steering committee at Sishen decided to issue small tokens of appreciation to those individuals who are top performers in the programme, like sets of glasses with the programme's logo printed on them. Sishen also issued T-shirts to those employees who completed the training session and kicked off with a first observation. No cash rewards are awarded for participation in the programme at Sishen mine.

Management style regarding goal setting with regard to participation is also as important factor. Normally the success of such a programme will be highly dependent on the setting of challenging goals for participation. For the purpose of this programme, Sishen mine chose not to set individual or section goals for participation. The reason was that the mine aimed to attract natural, shared responsibility for safety among all employees. Behaviour based safety depends on sharing responsibilities among the workforce (Geller, 1999). A behaviour based programme will attract more participation when it is perceived as founded on the right principles, customised and owned by the workforce, and fuelled by a proactive need to achieve safety rather than a reactive need to avoid failure.

Programme participation should be encouraged with positive consequences such as personal recognition, and group celebrations, and never forced with threats of punishment.

The way Sishen mine and the steering committee for the programme dealt with these issues appears to be very successful, if the constant growth in participation is considered (Figure 4 and 5). Although the current participation level is on 44% (Figure 4), the number of observations increased to 5300 in March 2003 (Figure 5).

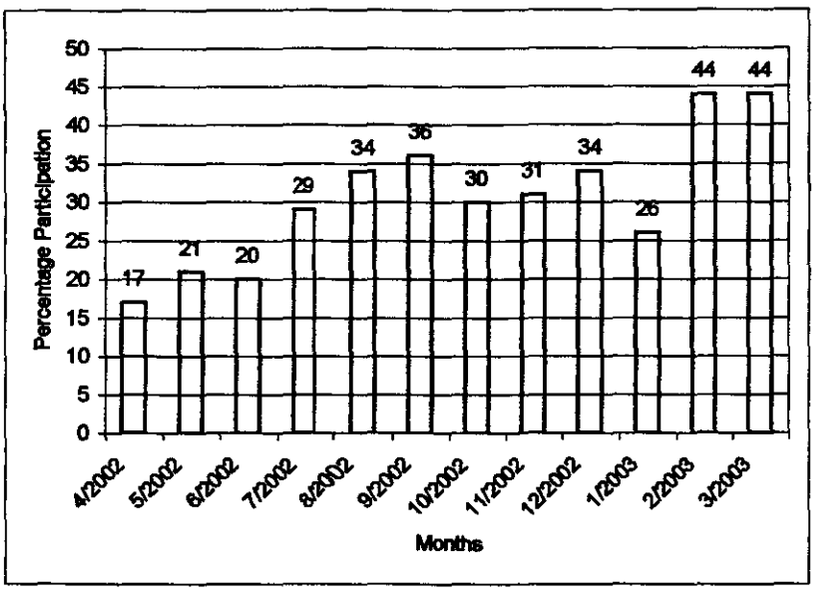

Figure 4. Percentage of employees that participate in the behaviour based safety programme

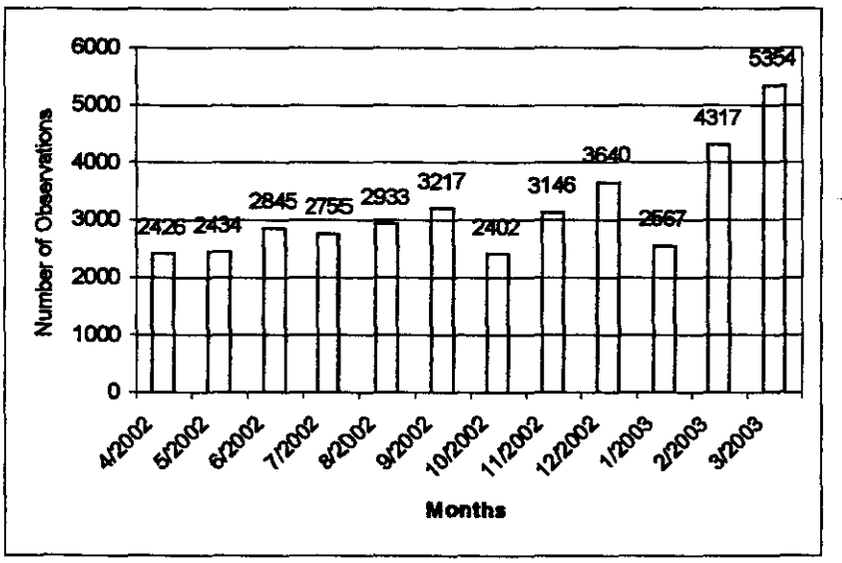

Figure 5: Total number of observations recorded at Sishen mine

Providing adequate behaviour based training is the fourth critical factor for the success of the programme. Conceptual and reflective learning experiences can be a potent source of stimulation. Training programmes are learning experiences designed to produce desired cognitive and/or behaviour change among participants. An employee's first exposure to a behaviour based safety process often occurs during a training session. As such, employees'

perceptions regarding the quality and relevance the behaviour based safety training they received, may have great potential for determining the frequency and quality of involvement in a behaviour based safety process.

Komaki, Kenneth, Barwick and Scott (1978) researched the effects of a motivational component in which employees were trained and received reinforcements for desired behaviours. The results indicate that when safety was behaviourally defined and positively reinforced, workers not only reacted favourably to the programme but also substantially improved their safety performance.

Before starting the training, it is important to develop a well-planned training strategy. This must comprise the training goals and challenges, the different organisational levels to be trained, training methods and training material to be used. The ultimate goal with training is to change the safety related behaviour of the trainees (Krause, 1999). To achieve this goal one should meet a few difficult challenges. One of the most important challenges is to overcome low adaptive readiness. Low adaptive readiness occurs when an employee either does not recognise a hazard or does not possess the necessary skills or knowledge to cope with the hazard. This barrier affects both the novice and the experienced employee.

Without effective training, employees rarely identify more subtle forms of behaviour (such as those related to body position) that are equally critical in exposing them to risk. Thus, increased awareness cannot prompt safer behaviour unless the workforce is aware of what that behaviour comprises. Geller (2002b) criticises training of step-by-step procedures, because people first should be educated first about the principles and rationale behind the behaviour based programme. Otherwise the programme will attract less than desired involvement and will not last very long.

Training at Sishen mine was presented separately to three hierarchical levels, namely the employees, supervisors and managers. Training for employees focused very much on the rationale and the programme steps, namely how to define risk behaviour, how to observe from checklists, how to intervene and how to test the results through system feedback. Training for supervisors also included rationale and process training, but the emphasis was on how to support the programme and how to support employees to participate.

Iverson and Erwin (1997) found that social support correlated negatively with injuries. The role of management and supervisors in any behaviour based programme cannot be overemphasised. Management support involves covering the expense of the programme, giving employees resources and time off the job to learn the principles and guidelines, customise procedures, do observations and implement intervention strategies. However, it is critical that managers and supervisors demonstrate interpersonal support by verbalising understanding and belief in the principles, and by recognising individuals and work teams for accomplishing programme objectives. These points should be part of the training to be presented to supervisors and management.

Furthermore, it was very important for Sishen to assure implementation team competence. This group is critical to successful implementation. They must have good people skills and task competence, and they should have the ability to be effective communicators. Most importantly, they should believe in the change effort.

Sishen mine presented various opportunities for learning to employees by deploying the services of various South African consultants to develop and facilitate interventions relating to team building, role clarification, communication, conflict handling and other similar courses. This effort was worthwhile, and could be recommended to any company that have plans to implement a behaviour safety strategy.

The training of employees was not restricted to classroom training, but also involved on-the-job training. After implementation commenced, the implementation team got feedback from the data system to identify those employees who failed to participate. The implementation team then made appointments with those individuals and supported them while the employee was performing an observation. This action helped to give employees confidence to do observations on their own.

At Sishen there was one significant barrier which had to be overcome with regard to training, namely the issue of language. All the training manuals were received in English from the United States of America, whereas in South Africa there are 11 official languages. To make the training effective, it was therefore necessary to translate the training manuals in two

South African languages, namely Afrikaans and Tswana. It was also necessary to present the training in the three different languages.

A fifth critical success factor was communication. The value of a good communication strategy in any change programme is often ignored. Communication is critical for the successful implementation of a change programme like behaviour based safety. Communication involves how well the change effort is marketed internally in the organisation. The purpose of communication is not only to explain but also to engage supportive activity at all levels of the organisation. The first step in the communication strategy is to sell a case for change to the workforce. Ultimately people will not do what does not make sense to them. The workforce must understand what behaviour based safety can do for their company as well as for the individual employee.

At Sishen mine the communication programme kicked off with a road show for all the employees. Sishen also utilised the union management to spell out the advantages of implementing behaviour based safety. Employees had the opportunity to ask questions about the programme and to raise their concerns. The mine also distributed a booklet to every individual employee. Dr Scott Geller is the author of this booklet with the title *What can behaviour based safety do for me?* (Geller, 1998b). Selling the case for change was also part of the training that was presented to employees and management. Selling the case for change and obtaining buy-in are a critical step, but subsequent to that, it is equally important to keep the programme alive with communication.

At Sishen a separate and unique newsletter was developed for the programme. This newsletter was utilised to achieve buy-in, but more so to portray the successes of the programme. Sishen learned early in the process to advertise what was referred to as "the pockets of excellence." Individuals and sections that demonstrated commitment were singled out during information sessions and photos of those individuals were published in the newsletter. Small tokens of appreciation were also handed to these individuals. The progress in terms of participation for each department was also reported in the newsletter, and these also motivated good and bad performers to improve on their performance.

A unique name was selected for the programme, and the implementation team designed a logo. This logo was printed on all the promotional material. Every individual would receive a T-shirt for his first completed observation, also with the logo printed onto the back of the T-shirt. A sticker was developed with the following script: "I support the BBS programme, please observe my safety behaviour". Employees attached the stickers to their hard hats.

Another critical factor is to define critical behaviour. This is also the first step in the behaviour based safety process. It is not an easy task to identify behaviour that causes accidents. Root-cause behaviour is difficult to identify, for three reasons. Firstly, it is frequently so subtle that people are unaware they are performing them. Secondly, it is convenient and people do not view it as unsafe because this behaviour facilitate task performance. Thirdly, the chance that it can cause accidents seems remote. However, if accidents are to be reduced, the challenge is to identify and change these subtle, convenient, seemingly safe instances of behaviour. Targeting the wrong behaviour is a guarantee for the failure of a behaviour based safety programme.

Work teams are under the impression that it makes sense to select behaviour that is easy to observe, has been discussed frequently at safety meetings, or those instances that are obviously reckless. The danger to such an approach is that if true causes of injuries is subtle behaviour, it is not likely to be identified as target behaviour. By selecting the wrong behaviour (that which does not correspond to the greatest potential for accidents), work teams may improve the frequency of certain behaviour, but accidents will continue to occur. When this happens, people often conclude incorrectly that the process is failing, while the real problem is that teams are targeting the wrong behaviour. If they continue to do so, a potentially good process will unnecessarily be replaced by another.

In the process of defining risk behaviour, it is useful to do an ABC analysis (see Figure 6), which is a behavioural science method for analysing and developing ways to influence safe and risk behaviour. "A" stands for Activators, "B" for Behaviour and "C" for Consequences (Geller, 1996). This analysis removes confusion about the relative effectiveness of activators and consequences for changing behaviour.

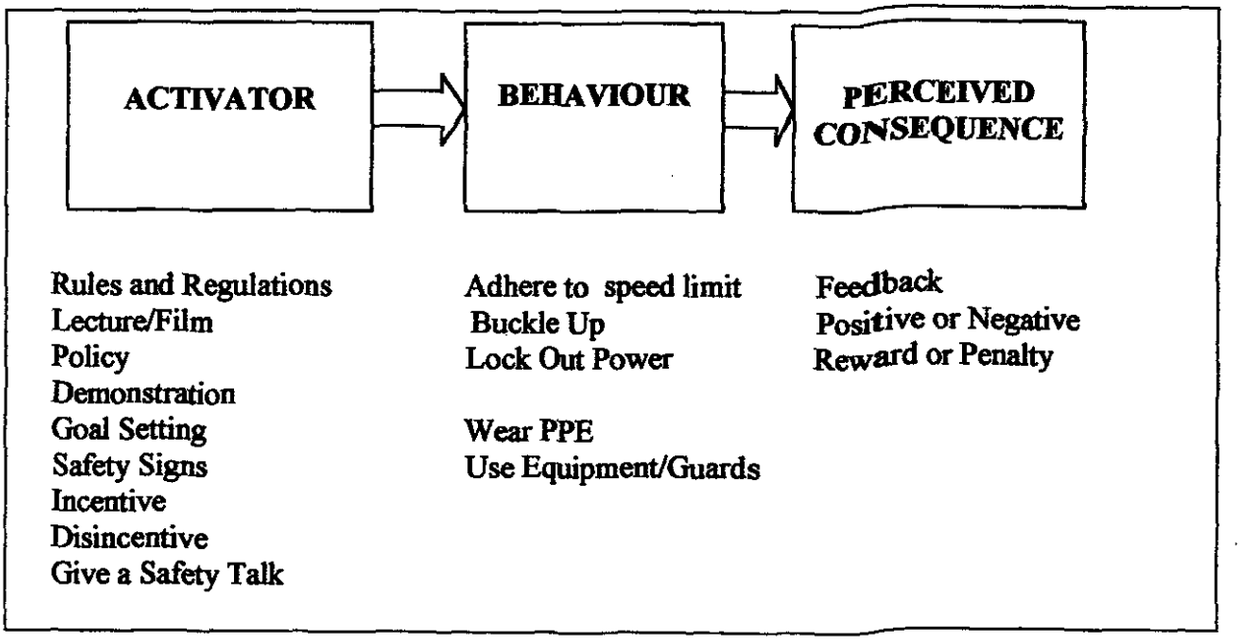

Figure 6. The ABC Model

Conventional wisdom places too much emphasis on activators and not enough on consequences. Behavioural science has shown that consequences shape behaviour, while activators primarily trigger behaviour. Furthermore, in the range of possible consequences, those that are soon, certain and sizeable have the most powerful effect on behaviour (Geller, 1996).

The issue then is to influence the consequences in such a way that behaviour will ultimately be changed. Many fatal accidents occurred because of consequences, e.g. taking short cuts by not stopping a conveyer belt to clean underneath, because of employees driving for a production bonus. Subsequent to such behaviour, the employee also usually gets a tap on the shoulder for his/her brave effort from his peers and even the supervisor, which is an additional consequence that boosts his/her ego.

At Sishen mine the implementation team and several work groups initially sat down to review their accident reports in an effort to determine target behaviours. After carefully analysing those incident reports, they identified a set of risk behaviours that served as the final common pathway in their most serious and/or numerous incidents. The critical behaviours were then arranged for inclusion on a data sheet or generic checklist (Appendix B). From the analysis, several specific checklists were developed. For example, because finger and hand injuries

caused the most injuries at the mine (Figure 7), a specific checklist was developed to improve performance in this category (Appendix F).

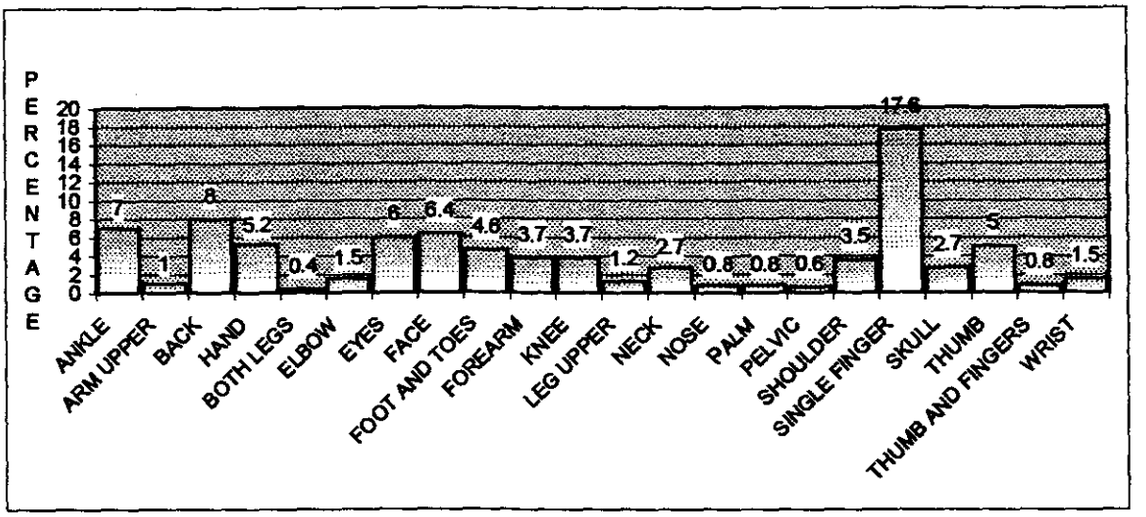

Figure 7. Percentage body location of injuries at Sishen Mine

One problem was that Sishen employed a substantial number of equipment drivers, who are not accessible to other employees who can observe their behaviour. The solution was the development of a checklist from which the operators could do self-observations (Appendix G). Eventually good responses were obtained from this category.

The seventh critical component is related to the observation and feedback process. In this process, employees routinely observe one another, using a brief checklist to guide their focus. After observation, the observer reviews his or her observation with the observee. Positive feedback is given for safe behaviour and corrective feedback is given for any behaviour thought to be risky. In addition to the one-on-one discussion between the observer and observee, the data from an entire group's observations is periodically compiled and analysed to determine areas that warrant further attention. If observation and feedback is not carried out effectively, this could do more harm to a behaviour safety programme than what is to be gained from it.

The following principles should be followed to make the feedback process effective:

- The observer always asks permission from the observee to do an observation. This is a very important rule, because participation to the programme at Sishen is voluntary. Observing somebody who is not willing to participate can do a lot of harm to the programme.
- Feedback must concentrate on the positive and the negative. Positive behaviour must always be reinforced. It is a fact that most people tend to respond better to praise and social approval than any other factor (Cooper, 1999b). It is crucial to explicitly link the desired safe behaviour to the praise received. Skinner (1965) researched the effect of positive reinforcement on behaviour. He concluded that positive reinforcement of behaviour is effective because the receiver experiences it as pleasant or satisfying.
- Feedback must be constructed in such a way as to enhance a learning culture. Learning is defined as a change in behaviour, or a potential to behave in a certain way, resulting from direct and indirect experiences (Geller, 1996). The significance of corrective feedback in safety is that it will pave the way to safe habits. It must take the performance of a specific task through the phases of unconscious unsafe behaviour, to conscious unsafe behaviour, to conscious safe behaviour to unconscious safe behaviour (Geller, 1998a). The stages in the learning process are shown in Figure 8.

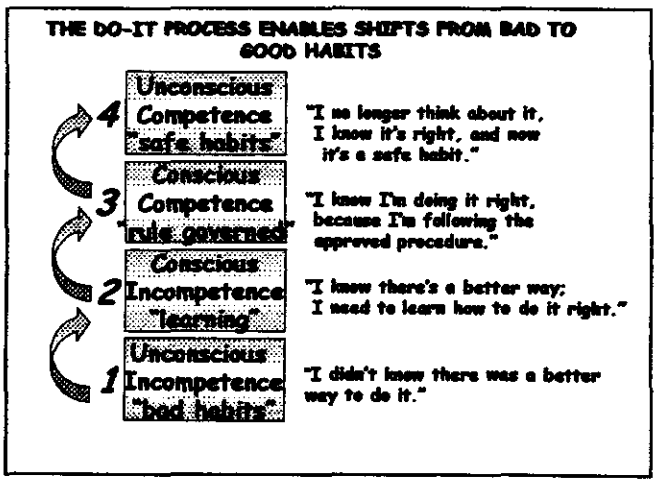

Figure 8. Stages in the learning process

Figure 8 shows that observation and feedback is crucial to identify the unconscious unsafe behaviour for the observee. The observee is then responsible for climbing the ladder to safe habits. The success of the process depends on the following important factors:

- It is recommended that feedback be given immediately after the target behaviour.
- If the observer identifies unsafe behaviour, he/she should do more than just give feedback. He/she should also give specific directions for improving the behaviour and to make the task safer. Furthermore, feedback should always be discussed with the observee, without being prescriptive.
- Feedback needs to be given with straightforward and objective words. Ambiguous subjective language can be counterproductive (Geller, 2003d).
- Giving good feedback requires up-to-date knowledge of the performer's abilities for a certain task. It also requires specific knowledge about the safe and risky ways of performing the task. This is a prime reason why the most effective safety coaching usually occurs between co-workers on the same work team.
- The attitude of the observer during an observation process is most important. Feedback will be ineffective if it is viewed as a way of exerting top-down control or if it is demonstrating superior knowledge by the observer. The climate should be relaxed and friendly and the observer should demonstrate empathy with the observee. Sishen mine went so far as to implement reverse feedback. After the observation and feedback to the observee is completed, the process is reversed and the observee gives feedback to the observer on his experience of the observation performance. The observee also uses a checklist to help him to structure his feedback (Figure 9). Sishen mine found this a very helpful tool to ensure observers are doing their observation and feedback in a proper way.

	REMEMBER THE FOLLOWING	GOOD	CAN IMPROVE	COMMENTS
1	Delivered one-on-one feedback			
2	Seems sincere			
3	Express concern for welfare of person			
4	Focus on behaviour, not person			
5	Respectful			
6	Encourages discussion			
7	Listens attentively			
8	Offers suggestions appropriately			

Figure 9. Feedback evaluation checklist

The above clearly demonstrates the importance of the quality of observation and feedback for the process. Dysfunctional observation and feedback can do more harm to the entire programme than what is generally accepted.

The eighth critical aspect relates to the role of data. Part of behaviour based safety is the ongoing systematic process that workgroups use to examine their behavioural data and select targets for improvements. At the heart of employee driven behaviour safety performance is the ongoing collection and analysis by the workforce of its own behavioural data. This aspect is critical to the success of the programme, because this phase is important to ensure sustainable continuous improvement.

It must be clear that there is quite a difference between injury data and behavioural data. At Sishen there was useful data regarding injuries when the programme kicked off, but behavioural data was non-existent. The challenge was to get the data to be proactive and not reactive; in other words it had to prevent future risk behaviour. The quality of the information determines the quality of the action plan (Krause, 1997).

An effective data system should be able to provide at least two kinds of summary data, namely reports and graphs. These summary reports should be able to cover any data range. It should be able to select locations, for example for the lowest organisational level at which observations are identified. The data system must have the capacity to draw reports for an individual work group, a department, or for the entire organisation.

The following types of reports are essential for all the different levels in the organisation:

- Percentage risk behaviour reports.
- Percentage safe behaviour reports.
- Number of observations received.
- Number of employees who participate.
- Percentage of employees who participate.
- Name of employees who participate (to identify pockets of excellence).

The first two pieces of data are necessary to measure the success rate after implementing a specific intervention. Data concerning participation is necessary to track the success of involvement. What Sishen mine experienced in practise was that there is not efficient behaviour tracking software on the market. Most leading consultants are quite concerned about the process but not about how companies can capture and portray the data.

The one single deficiency that was noted was that the number of incidents of risk behaviour is almost always available from the reports, but all systems on the market lack to report the reasons for a specific occurrence of risk behaviour. Take the example of employees in a specific workgroup not wearing personal protective equipment (PPE): it is insufficient to know the numbers, without knowing why they are not wearing PPE. It might be because the items are frequently out of stock, or because employees perceive the PPE as uncomfortable, or it can be a system problem e.g. that employees qualify for a predetermined number of PPE in a cycle, and that since most of them exceed those numbers, they do not qualify for further issuing of PPE.

The point is that without knowing the reasons for such risk behaviour, it is not possible to determine effective intervention actions. This general deficiency in software systems motivated Sishen mine to develop its own software system. During observations, the observer will ask the observee for the reasons why the observee is performing the risk behaviour, e.g. why he is not wearing PPE. The possible reasons were added on the checklist (see Annexure H). The observer only marks the applicable block on the checklist. Those marks are then fed into the data software system, and a report can be produced from the software system as to why many employees did not wear PPE, as indicated by each of the individual reasons mentioned on the checklist. This information will then be used to plan intervention actions.

The ninth critical component refers to interventions. Using the comments and observation data, workgroups must target areas for improvement, and they must solve the problems. There are a number of problem solving techniques available to solve problems. Krause (1995) discusses one technique in detail. It involves the following basic steps: identify the problem; identify root causes; generate potential actions, evaluating possible actions; develop an action plan; implement the action plan; and do follow-up (measure and evaluate).

Sishen mine has to a great extent utilised their Omega programme to solve these safety related problems. The Omega programme is developed from the so-called quality circle group technique that was extensively used by Japanese companies. Small groups in a section were established with a group leader and no more than eight group members. These Omega

groups went through a very structured process to solve problems, very similar to the technique describe by Krause (1995).

There are a few barriers that prevent employees from intervening. The first barrier is **low adaptive readiness**. This condition occurs when an employee or group either does not recognise a hazard or does not possess the required skills or knowledge to cope with the hazard. This barrier can only be removed by continuous training. The observation process is a handy tool to make employees aware that they are unconsciously incompetent. It also keeps the veteran worker alert via frequent reminders that habit is not always correct.

The second barrier is **disagreement on safe practices**. It occurs when a worker possesses the skills to recognise and handle hazards, but for whatever reason his or her perception of risk differs from the employer's. It involves a conscious choice to perform a task in a manner that the company deems unsafe. One effective technique to remove such a barrier is to perform job safety analyses for each task that incorporates employee input. Apart from this, employees should always be motivated to report unsafe practices and not to accept traditional ways of doing things unconditionally.

The third barrier is **personal choice**. Personal choice refers to the case where a worker knows that he is engaging in risk behaviour, but chooses to continue to do so because something can be gained as a result of that choice. In other words, the consequence drives his behaviour. It might be a production bonus or praise from his peers or even the supervisor. This barrier can be removed by changing the consequences. Employees must be taught that safety is the first priority in the plant, and not production. It is equally important to systematically provide each worker with opportunities to make safe choices and to provide positive feedback in response to those decisions.

The fourth barrier is **personal factors**. The most obvious factor is impairment, which can range from drug and alcohol abuse to stress, fatigue, illness or the use of prescription medications, or simply physical impairment. Individual characteristics, such as personality traits, have been found to correlate with accidents (Hansen, 1989). Similarly, individual's current state of health may affect their predisposition towards accidents, and links have been made between mental health and work performance (Defares, Brandjes, Naas & Ploeg, 1984).

Many researchers suggest that stress and anxiety play a contributory role in accidents (Baker & Marshall, 1987).

Personal factors can be addressed in several ways. For example, when employees are fatigued due to overtime, the company may opt to reduce overtime. Addressing non-work-related factors is more challenging. The first challenge is to identify those employees who are acting differently. Corrective action might then be to temporarily place the individual in a safer job environment.

Another barrier to implementing improvement interventions is **culture**. Culture refers to "how things are done around here". It is a system of shared assumptions and values. A culture develops over time and usually does not change quickly. The best example is where employees take short cuts, or where the culture is that "real men don't wear hard hats". Cultural barriers may be the most difficult to overcome. Leadership by example and personal contact play a key role to establish a system of shared values. Behaviour change through observation and feedback is a key to overcoming such culture.

The sixth barrier is **ineffective management systems**. An ineffective management system encourages risk behaviour because it allows an employee to find easier ways (outside the system) to execute a job. Such a system places obstacles in the worker's way, which are often overcome by taking risks. An example is where management decides to store ladders in a locked, centralised location, because they are disappearing. If that location is 10 minutes away from a job that requires a ladder for 10 seconds once per day, the average worker will use something else, such as an oil drum or a toolbox. There is no simple solution to this barrier. Removing this barrier requires a conscious effort by management to identify and correct faulty systems. Observers should deliberately focus on identifying such barriers during the observation process.

The last barrier is **inappropriate rewards**. The key question is what employees are truly rewarded for. A worker is rarely promoted because he/she performs safely. Typically, a worker is rewarded based on those items for which he is held accountable as a result; hence a worker is more likely to complete a job even if it requires some risk behaviour.

A second less formal type of inappropriate reward involves peer pressure, which is a strong motivator. One work team might for example be producing slightly less products than another, but while working safely. The fast group may pressurise the safe group to take some risk in order to produce more. Similarly, if supervisors provide positive feedback only in response to high production numbers, workers may believe it is more important to get the job done than to do so safely.

The first step to remove this barrier is to examine the accountability system and to determine what is truly important. Management should also provide as much positive feedback for safe performance as it does for meeting production standards.

The discussion of the barriers emphasised the importance of obstacles to the implementation of intervention actions. Without constructive intervention actions, there is no improvement and without improvement there is no use for having a programme with observations and data and everything else that goes with the programme. Therefore the construction and implementation of effective intervention actions are most critical to the behaviour based process. It goes without saying that it is equally important to subsequently test these actions to measure the effectiveness of interventions that were implemented.

The tenth factor that is critical to a successful implementation is readiness for a behaviour based safety programme. According to most of the companies that have implemented a behaviour based safety programme, it is a great solution to enhance poor safety performance and it promises to turn a company's safety culture into something to be proud of. Behaviour based safety does not work in every company. In many companies it was just another "flavour of the month". Certain conditions in those companies were barriers to successful implementation. Conditions like management support, management systems and company culture are key to determining whether a company is ready for behaviour based safety. Readiness is a critical success factor, and everybody who has experience in this field will warn that: if a company is not ready for behaviour based safety, it should rather not be implemented.

Fograscher (2003) defines five conditions that determine a company's readiness and dramatically influence the likelihood of success:

- Effective leadership. Leadership must be active, visible and lively in its commitment to injury prevention. It is very helpful if top executives can articulate a clear and inspiring objective that injury free performance is the only acceptable goal. Managers in safe companies treat safety as a live management responsibility rather than the job of the safety department. Ideally, the top executives include safety as a core organisation goal equal to productivity and quality. Leadership support is to a safety programme as water is to a young seedling: it cannot survive without it. The findings of Iverson and Erwin (1997) as discussed above, about the importance of social support by the supervisor are most applicable to determining readiness for a behaviour based safety implementation.
- Systems. In order for behaviour based safety to be effective, the basic safety systems and programmes need to be in place. Simard and Marchand (1994) found that organisational variables such as safety systems could be considered as determining factors of effectiveness in preventing accidents. Proper systems could mean adhering to international safety standards (OHSAS 18000), a proper accident investigation system, hazard audits, record keeping systems, etc. More advanced system enhancements, like observation, coaching, involvement teams, job safety analysis, and accountability, rely on the basics being in place.
- Involvement. Safety involvement teams are a tool through which successful behaviour based safety programmes gain involvement. A well-trained team, which is skilled in problem solving and decision making, gets results. Teams are the link between individual coaching and sustainable intervention actions. Employees' involvement enhances innovation, ownership and results. As mentioned above, Sishen utilised its quality circle teams (Omega) to also address safety problems at the mine.
- Measurement and accountability. What gets measured, gets done. Clearly defined responsibilities at every level in the organisation are key for top performance. The process or activities to create the right environment are far more important than injury rates in the quest to create a sound culture. Things get done when performance evaluations include safety meetings, hazard correction, and measured goals; otherwise nothing is achieved.
- Organisational style. A positive social climate of trust, openness, respect for individuals, caring for one another, positive reinforcement, etc. are features of an intangible or organisational lifestyle that dramatically affects safety performance. With a more negative organisational style, involvement is low, and coaching seems like scolding. Where culture and climate variables have been associated with outcome measures such as

safe behaviour (Tomas & Oliver, 1995) and safety activity (Cheyne, Cox, Oliver & Tomas, 1998), they have shown a positive correlation. If organisational style and climate or culture do not enhance safety, the implementation of behaviour based intervention would be futile.

As readiness is crucial to the success of implementing a behaviour based intervention, it is necessary to test the status of the above conditions before a final decision is made to implement such a programme. Sishen mine did indeed conduct a comprehensive culture survey before implementation, and only after the results were known and measured against a benchmark norm, did Sishen mine make the final go-ahead decision. This survey also served as a baseline to measure any cultural change subsequent to the implementation of the behaviour based programme.

DISCUSSION

The results obtained from the questionnaires indicate a strong tendency for buy-in and participation as being the most important success factors. Results also indicate the standard deviation for this as one of the lowest of all 20 items (3.52). This is not surprising, because without buy-in and participation from the employees, there will be no programme.

The second most important success factor according to the results was structured implementation. The very low standard deviation for this factor is indicative of the fact that responses consistently placed it high on the list of critical success factors.

Training was ranked third with a standard deviation of 3,59, which also indicates consistent responses. The behaviour based approach to safety offers unique training opportunities for a site. The emphasis on coaching for skills development and on peer-to-peer behavioural observation and feedback obviously goes beyond the typical specialised training in safety rules and procedures. Research studies indicate the potential of the behaviour of employees being reinforced to achieve desired critical behaviour (Komaki et al., 1978).

Although the role of data management was ranked tenth, the standard deviation for this factor was 5,26, which was the highest of all 20 items. This is an indication that responses were not

very consistent and that some respondents rated this item high while others scored a low rating.

Level of integration, external factors and connections and networking were ranked 18th, 19th and 20th respectively. This means respondents regarded these 3 items as the least critical on the list for a successful implementation. The standard deviation for these three items were respectively 2,96; 2,58 and 3,0, which are the lowest for all 20 items. This implies that respondents were very consistent in their view that these 3 items are the least important on the list for a successful implementation.

From the literature review and the author's own experience it was surprising that certain of the factors were not ranked among the top 10. Factors like providing adequate resources, barrier removal and measuring the programme success, are very important to successful implementation, and should not be discarded.

CONCLUSION

The results clearly indicate which ten factors are regarded as the most critical for a successful behaviour based safety implementation. However, this in no way implies that the other ten factors that were rated 11 – 20, are unimportant. On the contrary, the limitations of the research must be considered in the sense that the outcome was only a general response from a group of specialist's perceptions.

It might well be that the ranking of these success factors differs from site to site according to circumstances. For example, the competence level of the facilitator might not be as important in a group where the role players in the organisation already have good insight into the theory and practice of behaviour based safety, or where the role players are quite used to change management principles and their application. It must also be clear that the 20 factors covered in this study in no way present a complete list of critical success factors.

These critical success factors can be used to effectively evaluate a change effort such as behaviour based safety, to determine if it has the necessary elements needed to survive the

initial period of resistance inherent to all change processes. These are the right ways to approach the implementation of behaviour based technology in the industrial adult world.

Implementing a change effort like behaviour based safety in any organisation is a significant undertaking. One only has one chance to succeed. If the change effort is poorly planned or does not take into consideration those elements and factors crucial to success, the effort may never get started or it may fade once the initial enthusiasm wanes.

RECOMMENDATIONS

Companies that are implementing behaviour based safety, should take note of the critical success factors and rankings. Attention that is devoted by the implementation team and management to these critical factors, should be related to their relative importance.

Implementers of behaviour based safety should regard all the success factors as important, and not only those that were rated high on the ranking list. Ignoring any of these success factors could be fatal to successful implementation.

Implementation teams should utilise the information in this study as a guideline and a manual as to how the issues and barriers regarding the success factors should be approached in practice. Companies that operate in developing countries in particular, with unique circumstances like diversity and a high degree of social differences, should use this study information as a guideline to address certain issues and barriers to implementation.

With regard to further research, it is proposed and recommended that a similar study be conducted amongst a population group from third world developing countries. As this study mainly tested the perceptions of a population group in the USA, it is necessary to determine how the ranking of and perceptions about success factors differ in a third world environment.

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CHAPTER 4

RESEARCH ARTICLE 3

DRIVERS FOR BEHAVIOUR IN SAFETY: ACTIVATORS AND CONSEQUENCES

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ABSTRACT

Behaviour is at the centre of our universe. In the workplace people must perform all sorts of behaviour to deliver the required end products. In terms of safety, it is important to pinpoint those forms of behaviour, which directly affect the outcome of the business process, like safe or risk behaviour. The primary purpose of promoting safe behaviour is to prevent injury. The nature of safety behaviour in the workplace is very much driven by drivers like person factors or motivational factors. The aim of the study was to review the literature to determine the strongest drivers for safety behaviour. The results showed that safety behaviour is mainly directed by preceding events (activators), and motivated by consequences. The ABC model is a very important tool which helps the manager to analyse these drivers in an effort to develop effective intervention actions, and thereby to increase safe behaviour and decreasing risk behaviours.

OPSOMMING

Gedrag vorm die kern van die mens se hele bestaan. In die werkplek moet werknemers verskillende gedrag uitleef om die eindproduk te lewer. In terme van beroepsveiligheid is dit belangrik om die gedrag te identifiseer wat die uitkoms van die besigheidsproses beïnvloed, soos veilige- of risikogedrag. Die primêre doel daarvan om veilige gedrag te promoveer, is om beserings en skade te voorkom. Die doel van die studie was om 'n oorsig oor die literatuur te doen ten einde belangrike drywers vir veilige gedrag te identifiseer en om 'n gereedskapstuk te identifiseer wat gebruik kan word om die drywers te ontleed sodat die beginsels in die praktyk toegepas kan word. Die resultate het aktiveerders en konsekwensies as die belangrikste drywers vir veiligheidsgedrag uitgewys. Die ABC gereedskapstuk is as belangrikke hulpmiddel geïdentifiseer om die drywers in die praktyk te ontleed, ten einde die mees geskikte intervensies te ontwikkel om gedrag te manipuleer.

International concern for and awareness of the importance and magnitude of occupational safety remains surprisingly modest, in spite of the fact that workers suffer 250 million accidents every year, with 330 000 fatalities, and 160 million cases of occupational diseases. The economic losses are equivalent to 4 percent of the world's gross national product (Takala, 1999).

In South Africa the situation is no better at all. During the period 1999 – 2001, workers experienced an average annual number of 426 fatalities per annum (Department of Labour, SA, 2002). Alarming as the fatality, accident and disease figures may be, investment, operational, and management decisions often continue to be made in disregard of safety and health considerations.

The question is whether anything has been done to reverse this situation. Obviously, a number of interventions were launched to deal with this problem. The first intervention was initiated by government in Great Britain by means of statutory regulations. Society is increasingly demanding a sophisticated response from its managers who are being called on to manage with objectives other than a narrow and simple approach to private profit maximisation. This resulted in statutory laws (laws made by acts of Parliament) and common law (legal rules created by judges) (University of Southern Queensland, 2001) being introduced in this regard.

In the past a number of other safety interventions were developed to improve safety performance. Among those, the most important for the purpose of this research was safety engineering, or safety design. This entails the design or redesign of buildings, equipment and work processes in anticipation of and to eliminate hazards in the workplace, e.g. equipment guards and emergency kill switches (Krieger & Montgomery, 1997).

Other interventions that are worth mentioning include ergonomics, management audits, poster campaigns, near miss reporting, root cause analysis, personnel selection, problem solving techniques, and safety systems design. But unfortunately these interventions focused only on solving one part of the problem, namely the environment and certain personal aspects.

The development of a proper safety management system requires continual attention to three domains, namely the environment (equipment, tools, housekeeping, etc.), the person (knowledge, skills, abilities, intelligence and personality), and behaviour (Geller, 1998a).

During the previous century much emphasis was placed on improving "the environment" and "the person". In South Africa in particular, most leading industrial and mining companies were in the past affiliated with NOSA (National Occupational Safety Association). The safety programme that was introduced by NOSA mainly involves a checklist for a safe environment, as well as emphasis on training and development of personnel. Very little emphasis has thus far been placed on behaviour interventions to improve the safety culture and safety behaviour of employees in South Africa.

So, historically many organisations have focused on improving safety by addressing the working environment. Providing hazard-free facilities and providing better tools and equipment have worked well to improve safety, but many organisations have reached a plateau, continuing to rely solely on these approaches that will bring only marginal gains (Gillmore, Perdue, Wu & Klap & partners, 2001).

The question is why it is necessary to focus on behaviour. Approximately 80 – 95% of all accidents are triggered by unsafe behaviour (Cooper, 1999a) which tends to interact with other negative features (termed Pathogens) inherent in workflow processes or present in the working environment. These pathogens lie dormant and are relatively harmless, until such time as two or more combine and are triggered by an unsafe behaviour to produce an accident. Heinrich's research concluded that 88% of all industrial accidents were primarily caused by unsafe acts. Du Pont determined that 96% of injuries and illnesses are caused by unsafe acts. Behaviour Science Technology has found that between 80% and 95% of all accidents are caused by unsafe behaviour (Macdonald, 2002).

These statistics led Geller, Krueger, French & Williams (2000) to conclude that because human behaviour is a contributing cause to most incidents and injuries, safety excellence can only be achieved by addressing the human dimension. Safety managers have come to realise that firstly, people are not perfect and will make mistakes despite their best intentions and

despite working in the best of surroundings. Secondly, they realise that the work culture often allows or encourages risk behaviour.

In the last decades of the previous century the behavioural approach to safety performance improvement was developed to focus on reducing hazards by understanding employee behaviours in the context of their work culture and the factors that drives behaviour.

A number of theories were developed in the previous century to explain why people behave in the workplace like they do, and what drives behaviour. Those theories can be classified into two categories, namely those that emphasise the inner needs and drivers of individuals, and those theories that focus on the external needs, that is the cognitive outcomes. In the first category, four prominent theories were develop, namely the Maslow hierarchy of needs, theory X and Y by McGregor, ERG theory by Alderfer, and McClelland's theory of needs (Robbins, Millet, Cacioppe & Waters-Marsh, 1981).

In terms of theories for cognitive outcomes, the cognitive evaluation theory, the equity theory, the goal setting theory and expectancy theory are the most important (Robbins, et al., 1998).

In the context of this article's subject, it is worth to shortly mention the essentials of the expectancy theory. The expectancy theory argues that strength of a tendency to act in a certain way, depends on the strength of an expectation that the act will be followed by a driven outcome to the employee (Robbins, et al., 1998).

The principles in the expectancy theory corresponds with Skinner's research on operant conditioning which argues that behaviour is a function of consequences (Skinner, 1965). Skinner believed that by creating pleasing consequences to follow specific forms of behaviour, the frequency of that behaviour increases. People are most likely to engage in desired behaviours if they are positively reinforced for doing so. Behaviour based safety intervention tools today is mainly build upon the principles of Skinner's work and those of the expectancy theory.

Behaviour based safety has been implemented at over 800 sites worldwide as a means to address safety behaviour in the workplace (Hodson, Strydom & Franklin, 1998), and as far as could be determined Sishen mine was the second company in South Africa to implement behaviour based safety in 1999.

Behaviour based approaches to safety focus on systematically studying the effects of various interventions on target behaviours, firstly by defining the target behaviour in a directly observable way, and secondly by observing and recording it in its natural setting. When a stable baseline measure of the frequency, rate, or duration of a specific behaviour is obtained, an intervention is implemented to change the behaviour in beneficial directions (Geller, Boyce, Williams, Pettinger, DePasquale & Clarke, 1998).

One of the critical steps in the behaviour based safety process is the implementation of interventions to change the behaviour in beneficial directions (Geller, et al., 1998).

Those interventions might include:

- Elimination or substitution, e.g. substitute the hazardous material, reduce energy or pressure, force, or change the process.
- Engineering controls, e.g. ventilation systems, machine guarding, sound enclosures, platforms and guard railing.
- Warnings, e.g. computer warnings, signs, back- up alarms.
- Training, procedures and administrative controls.
- Personal protective equipment.

The problem is that no process can be made risk free. The key to risk is people and their variable behaviour. The success in the development and application of intervention actions depends heavily on management and supervisors understanding why people behave in the workplace like they do.

People have the capacity to behave unsafely and to override any engineering controls. Understanding why risky behaviour occurs can help design effective interventions. That is, tools and strategies based on principles of behaviour psychology can facilitate a more thorough analysis of the situation, and can help to determine the root causes for the risk

behaviour, and can therefore guide the implementation of interventions to encourage employees to perform the behaviour safely (Gillmore et al., 2001).

From the author's experience, most supervisors and managers do not understand why risk behaviour occurs. They do not understand the interrelationship between the three domains of safety, namely the environment, the person and behaviour. And if they understand the theoretical concepts, they sometimes do not know how to apply this in practice to develop effective intervention strategies.

There is no simplistic answer as to what drives safety behaviour. Injury is caused by factors in the environment, behaviour and the person. Factors within and between these three domains are interactive, dynamic and reciprocal (Findley, 2003).

A change in a factor within one domain influences factors in that domain and eventually has impact on factors within the other two domains. For example, changes in an environmental factor affects people's behaviour and attitudes, and behaviour change usually results in some sort of change in the environment or person factors.

Thus, this interrelationship requires a consideration of interactive variables within two human domains (person and behaviour) operating within a particular set of environment factors. Many research studies have been conducted in the past to assess person factors as drivers for safety behaviour. Individual characteristics, such as personality traits have been found to correlate with risk behaviour (Hansen, 1989). Similarly, individuals' current state of mental health may affect their predisposition to have an accident (Defares, Brandjes, Naas & Ploeg, 1984).

The link between stress and occupational accidents is not clear, although some researchers suggest that stress and anxiety play a contributory role in accidents (Baker & Marshall, 1987), and stress related processes might mediate the effects of organisational and physical hazards on the individual (Cox & Cox, 1993).

Similarly, individuals' levels of tension have been found to mediate partially the effects of organisational variables and work environment variables on safe behaviour (Tomas & Oliver,

1995). However, Rundmo (1994) proposes that, while perceived risk causes a strain on the individual, which may then influence their behaviour, it has no direct effect on their tendency to take chances at work.

There is also the relation between social environment and safety behaviour. In terms of occupational safety, Iverson and Erwin (1997) found that social support had a negative correlation with risk behaviour: the more the support, the less the risk behaviour. Two types of social support have been distinguished in the literature: supervisory support (Michaels & Spector, 1982) and co-worker support (Blau, 1960). The effects of social support researched by Iverson and Erwin (1997) can also play an important role to buffer job stress (House, 1981; Kirmeyer & Dougherty, 1988), and in this way can indirectly affect safety behaviour. Similarly, Dwyer and Raftery (1991) have proposed that risk behaviour is produced by the social relations at work.

Safety climate and safety culture are also important drivers for safety behaviour at work. High-level organisational factors, such as management commitment and involvement, have been included in various studies of occupational accidents and safety behaviour. Smith, Cohen and Cohen (1978) found low accident companies to have higher levels of management commitment and involvement. Management commitment has also been found to be an important aspect of safety climate (Cheyne, Cox, Oliver & Tomas, 1998; Zohar, 1980).

Many investigations of safety culture and/or related safety climate have also included variables that drive safety behaviour and tap into the social environment of the workplace, such as involvement (Cox & Cheyne, 1998), participation and ownership (Lee, 1995), and work group encouragement and support (Donald, 1995).

From this literature, it could be argued that a good safety climate and culture are important drivers for safety. Where culture and climate variables have been associated with outcome measures such as safe behaviour (Tomas & Oliver, 1995) and safety activity (Cheyne et al. 1998), they have displayed a positive relationship: the more positive the views of culture in a company, the safer individuals' behaviour is.

Indeed, Donald and Young (1996) assert that it is reasonably well accepted by practitioners and researchers alike that culture, climate and attitudes play an active role in safety behaviour and accidents.

Many other researchers have conduced that behaviour is activated by antecedents and motivated by consequences. According to Geller (2003b), substantial research has verified that behaviour is influenced markedly by activators (or stimuli like signs preceding behaviour) and consequences (pleasant or unpleasant events following behaviour). One of Skinner's (1965) important legacies is "selection by consequences", which means behaviour is motivated by events or conditions that follow it. Pleasant consequences increase behaviour and unpleasant consequences decrease behaviour.

This activator-consequence-behaviour sequence is a basic principle of human motivation, founded on years of rigorous behavioural science research. The principle is indisputable (Geller, 2003b). Two types of consequences are familiar: reinforcement increases behaviour, whereas punishment decreases behaviour (McSween, 1995). Many research studies have proved that in positive reinforcement (an element of operant conditioning theory), we have an effective intervention tool in safety behaviour modification (Amacom, 1978).

Komaki, Kenneth, Barwick and Scott (1978) conducted research on the effect of positively reinforcing safe practices. The results suggest that defining and positively reinforcing safe practices is a viable approach to occupational safety behaviour modification.

This key principle of activators and consequences explains the special challenges of promoting safety and health in the workplace (Geller, 2003b). Risk behaviour in the workplace is often followed naturally by immediate and pleasant consequences, like comfort, convenience, excitement and sensory stimulation. In contrast, safe and health behaviours are usually accompanied by inconvenience, discomfort and boredom.

The literature suggests an ABC analysis tool to analyse the situation in order to design the most appropriate intervention action to behaviour modification. Krause (1997) concluded that the basic tool of applied behaviour analysis is known as ABC analysis, and that it provides the powerful foundation of behaviour change technology. According to BAS production, the

ABC model helps the supervisor to manage behaviour through activators and consequences. According to Slottje (2002), a greater insight can be gained in why somebody is performing the way he does, by doing an ABC analysis.

The goal of ABC analysis is to discover which antecedents and consequences are influencing a particular behaviour. Once these factors are known, they can be changed, and when the antecedents and consequences change, behaviour will change. The point is that the powerful characteristics of activators and consequences need to be considered when designing and evaluating an intervention program (Geller, 1996). However, the problem is that very few supervisors and managers understand these theories. The almost unlimited theoretical literature regarding activators, consequences and the ABC analysis does not make safety and line managers competent to apply those theories in practice.

The aim of this study, then is to determine important drivers for safety behaviour and to provide guidelines about how they could be applied in practice to change safety related behaviours in the desired direction. The study will also demonstrate how an ABC analysis can be used to arrive at conclusions on the way that the drivers are being applied in the development of intervention strategies. The end product will be a useful manual for behaviour based safety users, to extend their knowledge and technical competence in this regard.

METHOD

Research design

The research embraces a comprehensive literature study regarding the motivational drivers for behaviour as well as the tools available to analyse the drivers in order to determine the most appropriate intervention actions.

Research procedure

The following steps were taken to complete the study:

- Identify the literature sources to complete the study.

- Obtain the literature sources.
- Complete the literature study.
- Digest and record the references in the final document.

RESULTS

From the literature study it was found that there are many factors that drive safety behaviour. These include:

- Environmental factors, like safety climate, safety culture, management support for safety, empowerment, and safety systems.
- Person based factors, like personality traits, mental status, stress, self-esteem, self-efficacy.
- Motivational factors, like activators and consequences.

There is general consensus in the literature that activators and consequences are the main drivers for safety behaviour (Geller, 1996; Krause, 1997; McSween, 1995). It was confirmed that the ABC technique is a useful tool to analyse the safety behaviour drivers in practice in order to develop the most appropriate intervention actions.

DISCUSSION

This section is aimed at discussing how activators and consequences impact on safety behaviour and how they can be utilised for behaviour modification.

An antecedent or activator is something that occurs before a certain behaviour. Gillmore et al. (2001) define an activator as something that precedes behaviour and serve to guide, prompt, direct, or catalyse behaviour. That is, activators tell us what we should be doing. Examples of activators are a stop sign, which triggers drivers to apply their brakes or a warning sign in the workplace that warns employees to wear specific protective equipment when performing a specific task. Thus, an activator is an important part of the ABC model to get behaviour started, as it prompts one to take action.

In the industrial world of safety, activators also include safety policies, safety goals and directives, announcements, safety training programmes, safety procedures, vision statements, and so forth. All these set the stage for safe work behaviour or performance to take place. Managers are also frequent users of activators, telling people what to do, figuring out what to tell them to do, or figuring out what to do because people did not do what they told them to do. They spend approximately 80% of their time using the A of the ABC, neglecting the B and the C (BAS Production, 2003).

The use of activators has advantages and disadvantages. One of the disadvantages is that they do not guarantee a change of behaviour or that a specific behaviour will occur or not occur. Another disadvantage is the way in which it is applied. In the industrial safety environment, procedures, signs and slogans for safety are often presented to employees in an overload fashion. This led Geller (2003a) to remark that as such, they could do more harm than good, and that the way activators get translated into procedures or operations needs to be eliminated or improved.

Geller (2003a) offered six guidelines for increasing the impact of activator techniques. He suggests that if one follows these guidelines when developing new activators, one will increase safe behaviour and decrease risk behaviour, and will help to develop the kind of attitudes needed to sustain behaviour change. These guidelines are:

- It is important that activators are being developed in accordance with specific behaviour that one would like to target in the workplace. According to Geller (2003a), behaviour research has proved that signs with general messages and no specification of a desired behaviour to perform or an undesirable behaviour to avoid, have very little impact on actual behaviour. Examples in the workplace of such activators are signs or slogans like "prevent accidents" or "preserve the environment".
- Specific messages must tell employees what specific behaviour is needed or appropriate, like the Decibels that are being measured in a specific area and that noise protection is required, or it should give direction on how to perform a task safely, like "use only the right tool for this task". Signs should be developed in such a way that they are simple to read. Complex signs with a many words will not have the required impact and will be overlooked.

It often happens that activators like signs lose their impact over time. This process is referred to as habituation. Through habituation a person learns to respond to an event that occurs repeatedly. If there is no obvious positive or negative consequence from responding to a stimulus, the organism stops reacting to it. The organism perceives it as a waste of time and energy to continue responding to an activator that seems to be insignificant.

The relevance of habituation for safety is that it is human nature to habituate to everyday activators in the workplace environment that are not supported by consequences, as is the case with so many safety activators in the industrial workplace. It then happens that a sign or slogan loses its impact over time, and that it might eventually be ignored. It is therefore essential to add some positive consequences, like positive feedback or recognition, to support compliance with safe behaviour activators.

Habituation also tells us that the safety activator messages need to be varied if they are to be effective. When an activator is changed it will become more noticeable. Some plants make use of video screens and user-friendly computer software to display many kinds of messages in break areas and lunchrooms. From the author's experience it is helpful to put this item on the weekly checklist to ensure that signs have been changed, and to make a specific person like the safety representative in a particular area responsible for changing posters and slogans. Otherwise it might get changed only once in a while and become less noticeable.

It is obvious that when people contribute to a safety effort, it will increase their ownership and commitment to both safety and the improvement process. Likewise, when individuals feel a greater sense of ownership and commitment, their involvement in safety achievement is more likely to continue. This involvement feeds ownership and commitment, and vice versa. Another advantage of involving the target audience is to ensure that only appropriate activators in a particular workplace are being displayed.

The involvement will ensure that activators are not being chosen for behaviour that are not being targeted in a particular workplace. The author have witnessed so many instances where a company's head of safety decides which generic theme will be targeted during a particular month, e.g. personal protective clothing. Yet it is unclear how it will change behaviour in an

area that does not make use of protective clothing, for example the employees in the finance department.

The optimum time for using an antecedent or activator is just before the worker has the opportunity to follow the direction. The shorter the delay between the direction and the execution of a task the greater the probability of compliance . That is why certain activators are not effective, like memos, standard operating procedures, and newsletters.

McSween (1995) criticizes written procedures as antecedents in so far as that they can only qualify as an antecedent if the employee is referred to the procedure immediately before starting the job. According to McSween, an individual's unsafe response to a situation may rather suggest a problem with training or instruction that the employee has received at some time prior to the behaviour of interest.

According to Geller (2003a), researchers found greater increases in vehicle safety belt use when "buckle-up" messages were located at parking-lot entrances/exits, than from television messages or other media. One of the most effective activators of speed reduction is the beeping sound of a speed alarm device. This activator is not only salient, and response specific, but also proximal to the response opportunity. A key point of McSween's arguments is that antecedents affect behaviour because of the consequences. In the example used above, the salient beep of the speed alarm device in the car effectively motivates reduction in vehicle speed because it enables drivers to avoid a negative consequence (speed fine). If an employee is wearing his protective clothing, it enables him to avoid a negative consequence of getting seriously injured.

It is therefore the task of management to apply the principles described above, and to determine those antecedents that are actually driving behaviour in the workplace, in order to gain maximum value from it.

Common sense tends to identify the antecedent as a most powerful stimulus for behaviour. The antecedent then is an important driver for behaviour. However, applied behaviour analysis demonstrates that consequences are more powerful determinants of behaviour than antecedents are (Krause, 1997). Consequences have been defined as "events that follow

behaviour". Consequences increase or decrease the probability that the behaviour will recur in the future. Activators direct behaviour, whereas consequences motivate behaviour (Geller, 1998a).

Consequences may come from the outside or inside. Employees receive directions, rewards, or punishments from others (external), but also give themselves internal directions, rewards, or punishments. A specific goal, may for example be an activator that can be a very powerful motivator if it specifies achievable consequences. The goal can be given to an individual from others, or the employee can identify his own goal. If the goal comes from others, it is an external activator. But if the individual believes in the goal and feels a sense of commitment, the goal becomes internalised.

Receiving a reward for reaching a goal is an external consequence. However, this might not be the only consequence in this situation. The reward might only be viewed as a token of appreciation for a job well done. Internal consequences like pride, feelings of accomplishment, a greater sense of belonging with one's work team, and an increase in self-confidence and self-esteem are actually more important if long-term involvement is desired.

Realising the importance of internal controls and consequences influences the way management should exert external control, especially in the field of safety. An employee who does something only for external consequences, does not develop an internal rationale for the activity. Thus, if external consequences for safe behaviour are sizeable (as in a big reward for not sustaining an injury), people feel no obligation to develop an internal justification for their actions. Their environment is adequately controlled by external consequences.

The external consequence, like interpersonal feedback may be only a token of appreciation and not large enough to fully justify the effort needed to follow all safe operating procedures all the time. If employees follow the safety requirements in this situation, they develop internal controls to justify their behaviour. In other words, when people perform without sufficient external motivators, they legitimise their actions with internal consequences.

To summarise, it is important for management to develop internal control for employees to perform safe behaviour over the long term in situations where external controls are not

available. They need to give themselves internal consequences of pride, dignity and self-respect when they go out of their way for safety. Thus, optimal safety management requires intervention that promotes the right balance between external and internal control.

Behaviour, however is not only influenced by internal or external consequences. Behaviour is also motivated by the type, namely whether it is positive or negative. Consequences can either increase or decrease the behaviour they follow. It is generally accepted that reinforcement increases behaviour, whereas punishment decreases behaviour (McSween, 1995).

Applying positive reinforcement will increase the likelihood that a desired safe behaviour in the workplace will be performed, or it will increase the intensity with which it is performed. Examples of positive reinforcement in the workplace are praise, a bonus, giving attention to an employee, caring for an employee, etc. It should nevertheless be taken into account that individuals have preferences. Some people prefer a pat on the back while others get reinforced by just an approving look or only a cynical remark.

Negative reinforcements also increase the likelihood that the behaviour will recur . In contrast to positive reinforcement, people frequently behave in a certain way because they have to, not because they want to. They act to avoid a negative consequence, for example being punished or getting reprimanded by the boss. In issues like safety rules, negative reinforcement can be effective. Nevertheless, negative consequences are less desirable than positive ones. Still, management frequently uses them. There is much debate about safety and punishment. When being punished, the person gets something he or she does not want. Punishment leads to fear and will stop the behaviour from continuing. Being reprimanded after launching a good safety suggestion, can then also inadvertently stop this behaviour of launching new safety ideas.

Extinction is also a form of punishment, for example when an employee is trying to introduce a new idea, but where nobody notices him or pays him any attention. After a few minutes he may try again, and may again be ignored. Eventually he will lose interest and stop paying attention. Ignoring involves withholding social reinforcement and results in the extinction of

behaviour. This situation occurs frequently in business and safety when, for example, productive behaviour is ignored, creating negative consequences for the employee.

What is equal important is how employees react to negative consequences. Geller (2003b) discusses four possible reactions, namely escape, aggression, apathy and counter-control. People attempt to avoid negative consequences, for example by trying to escape from those who administer the punishment. Other forms of escape might be cheating or lying. The ultimate form of escape from excessive negative consequences is suicide. Unpleasant attitudes, emotional feelings or strange behaviour are produced when people attempt to escape or avoid negative consequences. This might adversely affect an employee's safe behaviour in the workplace. Another reaction may be in the form of aggression. Instead of escaping, people might choose to attack. The author has seen this form of reaction in a number of accident investigations: employees who fear negative consequences like disciplinary actions, always tend to attack the system or other persons for their risk behaviour. Another reaction may be apathy, where the employee decreases his involvement because of expected negative consequences. When people feel controlled by negative consequences, they opt to simply resign themselves to doing only the minimum which is required, in which case they will not go beyond the call of duty to enhance the safety and health of a co-worker.

Counter-control by employees has serious implications for safety. This happens when employees follow only safety rules when they believe they can get caught. Examples are when a driver is only putting on his safety belt when he sees a traffic officer. People also often try to beat the system, for example where a pre-use inspection card is completed without carrying out the prescribed physical inspection, or where a vehicle driver installs a radar detection device to counter-control speed monitoring.

There is a common myth in safety that it is human nature to work safely. This is far from the truth. On the contrary, it is often more convenient, more comfortable, more expedient, and more common to take risks than to work safely (Geller, 1998a). Many consequences involved in safety are natural consequences that occur simply as a result of our human nature. Examples are discomfort associated with wearing protective equipment, like wearing a leather apron when doing welding in a workshop in mid- summer when temperatures rise to

40 degrees Celsius, or wearing ear protection for an entire shift. These are "built-in" consequences that make the use of safety equipment less likely.

Following safety procedures is often time consuming. Climbing a structure without a safety harness or making a quick weld without a hot-work permit will result in getting the job done more quickly. In so many instances at work employees receive rewards (consequences) for taking shortcuts. Especially when a production bonus is part of the reward system, employees often get a tap on the shoulder for taking shortcuts, from peers but also from the supervisor.

Unfortunately, most built-in consequences support unsafe acts rather than compliance with safety procedures. Too often, following safety procedures creates delay, discomfort, or inconvenience that punishes the individual who comply with established safety practices. On the other hand, following safety procedures reduces the risk of injury, which also is a built-in consequence. Unfortunately, the likelihood of actually avoiding injury by following a safety procedure usually is too low to provide adequate reinforcement to offset the built-in punishing consequences.

Successful safety management requires from management to create a culture where employees develop the emotional intelligence to do the right thing, even when the consequences are relatively low. Actively caring for safety often means fighting human nature and resisting the influence of the basic ABC principles.

Factors that influence the impact of consequences

After establishing that consequences are more powerful than activities, it is appropriate to look at different kinds of consequences. It is quite obvious that not all consequences will have the same impact on behaviour change. There are factors that influence the effectiveness or impact of consequences, and thus some consequences are more powerful than others. For sustained performance improvement, the most effective consequence is one that is simultaneously soon, certain and positive (Krause, 1995).

In terms of timing, a consequence that follows very soon after the behaviour would be more effective than a consequence that occurs later. If a vehicle driver exceeds the speed limit on a

highway road for example, there is a possibility that he would be fined by a traffic officer. That is a consequence, but if he gets caught he will only receive a summons to pay in three months' time. The consequence is thus not soon enough to influence the driver's behaviour. Yet everybody knows that if you get caught at 160 km/h there would be consequences coming into affect very soon after the behaviour, like being jailed or being brought to a hearing on the spot. This consequence would certainly discourage one from driving at such a speed.

The timing factor may also be the reason why the battle against Aids is so hard to fight. If people are infected with the HIV virus, the expected remaining life of such a person can vary between 10 and 20 years, depending on the medical aid and treatment which he/she receives. The consequences are not soon enough to change the behaviour of people, in this case to practice safe sex.

In the industrial world of safety this factor causes a lot of problems for management, especially in the field of occupational health. Employees are very careless with regard to occupational health hazards like extensive exposure to noise and certain chemical hazards. This is because the impact will only be experienced over the medium to long term. The consequences are not soon enough. This requires special communication programmes to make employees aware of the consequences.

The second factor that influences the power of a consequence is consistency. A consequence that is certain to follow a behaviour is more effective than an unpredictable or uncertain consequence.

This factor also explains a number of strange human behaviours in the workplace. The probability of getting hurt from failing to comply with a given safety procedure is generally too small to be effective in maintaining safe practices.

Given the accident incidence rates for most industries, the probability of being injured on a particular job is fairly low, even if an employee fails to comply with safety procedures time and again. If the incidence rate is 2 injuries per million man-hours worked, an employee will

have an injury based on chance about once every 20 years. Such probabilities are part of the problem in safety.

This factor of probability has got widespread implications in industrial safety and road safety. Take the example of a vehicle driver who is driving a car in a big city. He would not deliberately skip a red traffic light during peak traffic hours because his perception of the probability that there is a ± 95% change that he would collide with another vehicle.

In the workplace the probability of injuries is not as consistent as in the above example. The outcome or consequence of an incident is most of the time unpredictable. Employees may take shortcuts for years on a particular job, without experiencing negative consequences. This causes the employee to gradually adapt his perception of the consequences for that specific job, until one day, when the environment changes, and something triggers an accident. In such a case the employee may pay with his life for the risk behaviour.

Another factor that influences the power of consequences is the size of the consequences, or the significance rating. In the first instance, it is generally accepted that positive consequences are more effective than a negative consequence. This implies that somebody will work harder to achieve a positive consequence than he will to avoid a negative consequence (Geller, 2003c).

Secondly, the significance of a consequence plays a role in the motivational support. If the consequences are insignificant, it will hardly influence the behaviour of the employee, and vise versa. A pedestrian would not skip a red traffic light in the city at lunchtime because he knows the consequences, and that it would probably be fatal to do so. In the workplace, the same principle of perceptions applies. An employee who is cleaning underneath the conveyer belt that is in operation should know what the significance of the consequences will be if he gets caught between the belt and the drum.

Fortunately or unfortunately, most organisations are safe enough for employees to be complacent. The challenge for management is to provide added consequences that support safety compliance.

At Sishen mine, employees are trained to do mini-hazard analysis before starting with a significant task. This requires from the supervisor to evaluate the consequences for that specific task together with employees who is responsible to perform that particular task. They analyse the environment and determine how people can be injured, whether it will be a significant injury, and the probability that an employee gets injured. The team must complete a checklist before the task commences. This is a very handy tool to communicate and analyse the safety risk of a particular job before execution, and in practice it is noticed that it definitely impacted on the behaviour that is demonstrated by employees.

The last subject that needs to be addressed is the difference between perceptions and reality with regards to consequences. It is critically important to understand that perceptions of risk vary among individuals (Geller, 1998a). If one needs to improve safety, it is thus necessary to change the perception of risk and consequences in the workplace.

Selective sensation or perception is a human dimension that influences our thinking, attitudes, emotions, and behaviour. In the workplace, the perception of consequences by employees can be shaped by a number of reasons, and this can dramatically influence the way one interacts with other co-workers or with a specific task that needs to be performed.

There are at least three important factors that shape the perception of the employees regarding risks and consequences in safety. Those are personal background, past experiences and the environment.

In terms of personal background it is obvious that quite a number of factors play an important part in the shaping of risk and consequence perception. Heinrich (1931), Hansen (1989), and Defares et al. (1984), did extensive research in this regard and he defined two distinctive personal factors which play an important role in shaping risk and consequence perception. These are:

- Ancestry. These include recklessness, stubbornness, and other undesirable traits of character that may be passed along through inheritance.
- Personal traits such as violent temper, nervousness, excitability, inconsiderateness, ignorance, or internal/external locus of control.

These factors cause individual differences in terms of consequence perception. People respond to and handle the task as they perceive it. Personal change in behaviour may only be achieved once a change in personal constructs has been achieved. Although this might be a very hard task to accomplish, changing personal factors is very important to bring about an improvement in safety.

The second factor that shapes perception of consequences is past experience. Familiarity breeds complacency (Geller, 1998a): familiarity is a powerful determinant of perceptions and consequences. Any operator will remember his first experience with a piece of heavy earthmoving equipment, and how attentive he was when first learning to operate the machine. However it was not long before he would change his perception of the possible consequences, and change his behaviour accordingly, like driving with only one hand on the steering wheel, while tuning the radio or air conditioner with the other hand.

Many accidents happen in the industrial environment because of experienced employees who adapt their behaviour through the years according to their perceptions of "no negative consequences". The author has found in practice that activators like horror video recordings about accidents that were experienced in the industry in the past can be very helpful to review employee's perceptions about the real consequences of a specific task.

The last issue that shapes perception of consequences is the environment in which employees are engaged. In South Africa in particular, most big companies are affiliated with the National Occupational Safety Association (NOSA). Members of this organisation are audited annually , and a star grading (1-5) is awarded to those affiliated members. In the last audits, Sishen mine was awarded a 5 star rating by achieving more than 98% in the audits. The message which this sends to the employee is that he/she is operating under almost perfect conditions? In addition, many organisations have a vision or goal of zero accidents, which causes the employee to perceive the consequences of the different tasks as insignificant. Management must be careful not to create the impression that employees are operating in a safe and risk-free environment, because this might change the employees' perception towards consequences, which might ultimately lead to risk behaviours.

A practical ABC analysis of the workplace

As discussed above, two very important drivers of safety behaviour are antecedents and consequences. Knowing the theory alone is insufficient: it needs to be applied in the workplace. By doing an ABC analysis managers gain a greater insight in why somebody is performing the way he does, and it provides the manager with information that he can use to change the undesired behaviour by changing the consequence environment.

Figure 1 is an illustration of the ABC model (Geller, 1998a). In the ABC model, the A stands for Activators, B for Behaviour and C for Consequences.

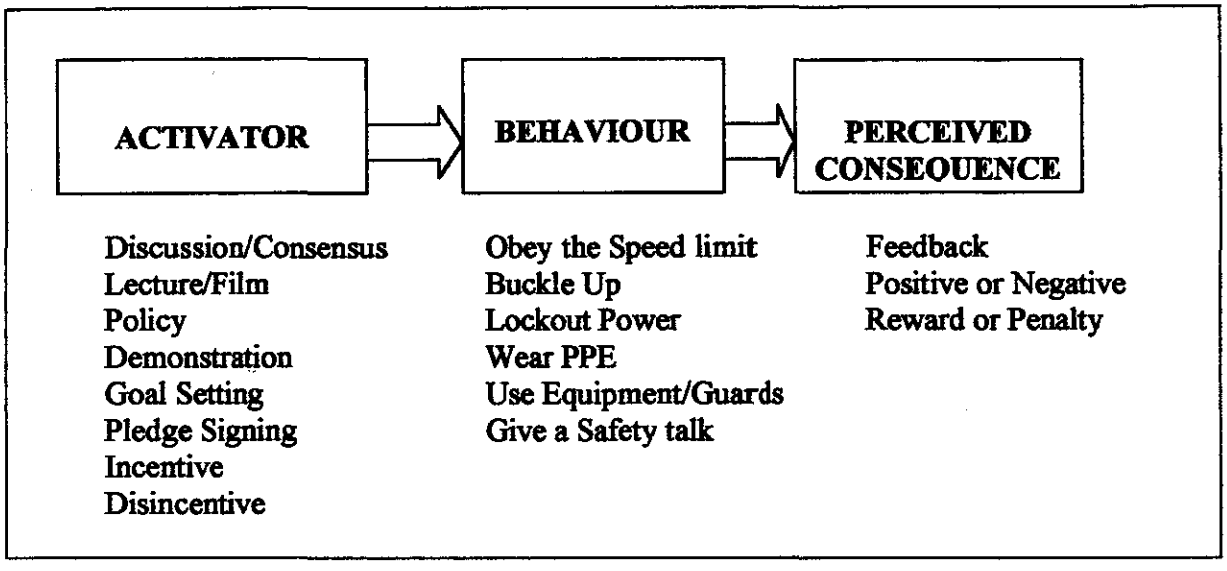

Figure 1. The ABC model

The following steps are recommended to perform an ABC analysis (Slottje, 2002):

Step 1: Identify the behaviour that one would like to analyse in this effort, as to make sure that critical behaviour is being identified, as it is not sensible to try to analyse all behaviour, because of the extent of such an exercise. Furthermore, ensure that the behaviour that one wants to change is observable and measurable and not ambiguous. As an example, assume that wearing protective clothing/equipment is a problem behaviour in the workplace.

Step 2: Write the problem behaviour on top of the ABC sheet (Figure 2).

Step 3: Identity the antecedents that activate and set the stage for the behaviour to occur. This step is necessary to gain a useful perspective why people behave in the way they do.

Step 4: Identify and write down the consequences influencing the behaviour in the workplace. These are the consequences that make sense to the employee and impact on their behaviour.

Step 5: Identify and write down to what extent the employee will experience the activator or consequence in terms of significant rating, timing, (immediate or future) or consistency (certain or uncertain).

Step 6: Develop intervention actions to fix the problem behaviour.

The problem behaviour (employees not wearing protective clothing/equipment) is analysed in terms of the ABC analysis model below (Figure 2).

Problem Behaviour: Employees not wearing protective clothing/equipment

Antecedents	Consequences	Significant/Insignificant	Immediate or Future	Certain or uncertain
1. Sign: "Noise protection required in this area"	Might experience hearing disability	Insignificant or significant	Future	Uncertain
	Very uncomfortable	Significant	Soon	Certain
2. Peer pressure (Peers do not regard the wearing of PPE as important or wasting time).	Nothing happens – no disciplinary action for not wearing PPE.	Insignificant	Never	Certain
	Losing bonus	Significant	Soon	Certain
3. Peer criticism if he wears PPE.	Avoids criticism and confrontation with peers	Insignificant	Soon	Certain
	Possible reprimanding from supervisor	Significant	Soon	Uncertain

Figure 2. ABC analysis

Activator signs may be used to make employees aware of the consequences of not wearing protective clothing, in this case hearing protection. At least two possible consequences will come up in the mind of the employee who has to perform the task. Firstly, he might sustain a hearing disability if he does not wear his PPE. This consequence might be significant or insignificant, depending on the noise level. The consequences of inability will be felt long after performing the risk behaviour, but the mere fact of getting deaf is unfortunately quite uncertain. Thus, there is no strong and reliable consequence in this case, namely that the risk behaviour leads to inability, and the consequence will be felt soon after the behaviour is performed.

Secondly, the employee will think about the implications for himself in terms of how the wearing of PPE will influence his human nature. He will probably experience the wearing of PPE as very uncomfortable. The consequences of this will be significant, and he will feel uncomfortable immediately after putting on his PPE. The consequence of discomfort will be certain and consistently. In this case the consequence is soon, sizeable and certain, and the consequence will definitely very much impact on the behaviour of the employee.

Another activator that drives behaviour and contribute to the problem behaviour in this case might be peer pressure. It might be a case that peers do not regard the wearing of PPE as important or that they might regard wearing PPE as wasting time and being the cause of not achieving their production targets. In this instance, if the consequence of not wearing PPE is that no disciplinary action is being taken, the employee will regard the consequence as insignificant, occurring soon after the risk behaviour (no actions being taken), and certain, because he is certain that no action will be taken against him. In this case therefore the power of the consequence is strong, and will influence the employee not to wear his PPE.

Secondly, if the consequence of wearing his PPE will prevent the employee from achieving the production target and will probably result in losing a production bonus, this will heavily impact on his safe behaviour. The consequence will significantly impact on his personal goals, he will feel the impact soon (end of the month) and the impact will be certain (no bonus for not reaching production targets). The power of this consequence will be very strong for demonstrating risk behaviour, because the consequences are soon, sizeable and certain.

As illustrated by the ABC sheet (Figure 2) there are a lot of significant, soon and certain ratings tied to the consequences. This means that the problem behaviour has a lot of positive reinforces which keep the risk behaviour going. Therefore: it does not make sense for the team members to change their behaviour. The question then is how to fix this problem behaviour.

Firstly, it can be attempted to add some negative, immediate and certain consequences. Secondly, existing significant, immediate and certain consequences may be removed. As in case of the above example, there is a lot that a manager can do to influence the power of consequences. The most powerful consequences are those that are significant, immediate and certain, in the case of the example, the manager should thus concentrate on the two issues of the discomfort of the PPE, and secondly on the issue of time being wasted by putting on PPE. In both cases the consequences are soon, certain and sizeable. This does not, however mean that the manager will address only these two issues.

Certain steps may be taken to eliminate or mitigate the problem behaviour. In the case of the PPE being uncomfortable, there are a number of solutions to make PPE more comfortable. Sishen mine changed from the traditional and uncomfortable earplug in noisy areas to a product brandnamed Variphone. The Variphone is a lightweight and custom-moulded earplug that maximises wearing comfort. The attenuation is individually tuned so that the wearer is well-protected against harmful noise while ensuring communication and ability to hear warning signals. The product lends itself to systematic checks regarding efficiency. The employees are very much pleased to wear this product.

This intervention by management changed the perceived consequences of discomfort from significant/immediate/certain, to insignificant/immediate /uncertain, which motivates employees to change their risk behaviour to safe behaviour (starting to wear PPE).

The second issue in the example is that of the application of PPE being time consuming, thereby causing the team to miss production goals and eventually being penalised by losing production bonuses. There were similar complaints by employees at Sishen mine, and in this instance the Variphone was also experienced as very suitable because the employee is able to

communicate while wearing the Variphone without the need to stop machinery or to remove the ear protection.

Management interventions in such instances can vary from applying more user-friendly PPE (like safety harnesses with quick locking mechanisms) to changing the bonus target to allow for time to properly apply these consequence management principles.

CONCLUSION

Behaviour is at the centre of our universe. People behave in a manner that they feel is comfortable or necessary. In the industrial world profit is the key goal. In order to reach this goal many actions must take place. People have to push buttons, write reports, have meetings, put final products in a box or place an order at a supplier. Whatever employees do or whatever has to be done, certain patterns of behaviour are involved.

Without behaviour, there will be no production. Because there are so many instances of behaviour in business, it is important to pinpoint those forms of behaviour that directly affect the outcome of the business process, like safety behaviour. Those forms of behaviour must support the goal and mission of the company. In business, managers mostly focus on results instead of behaviour. They tend to manage results, but there is a big difference between the two. Behaviour is part of the throughput of a process, while results are outputs. Therefore managing only results is not always as effective as it might seem.

The content of the above sections of this paper explains the special challenges of promoting safety and health in the workplace. Of course, the primary purpose of promoting safe and healthy behaviour is to prevent injury or improve a person's quality of life. Whether one succeeds in increasing safe behaviour or decreasing risky behaviour depends on many factors. As discussed above, it depends on whether one is targeting the right and critical behaviour. It depends on the personal characteristics of the individual who is performing the behaviour and perceiving the consequences, and also on the context of the environment and social aspects and personal dynamics that influence behaviour.

Above all, success in increasing safe behaviour depends heavily on management and supervisors understanding why people behave like they do. Only if they understand these principles and concepts, will they be able to develop effective intervention actions and be successful in ensuring continuous improvement in safety.

In conclusion, behaviour based safety is founded on a primary principle that behaviour is directed by preceding events (antecedent events or activators), and motivated by consequences. Rewards (or positive consequences) support behaviour and increase the likelihood that the behaviour will recur. Punishment (or negative consequence) on the other hand, decreases occurrences of the behaviour it follows. In other words, employees do things to receive positive consequences and to avoid (or escape) negative consequences, and people stop doing things that lead to negative consequences.

The ABC model is a very important and useful instrument that helps the manager or supervisor to manage consequences and behaviour. Unfortunately, it is not as simple as ABC. It requires careful analysis of the problem behaviour, and it needs to address the problem with a Pareto approach. As there are thousands of forms of behaviour and consequences in the workplace, it is impossible to analyse all of them. The focus and effort should rather be on those vital few behaviour that impacted heavily on the safety performance of the company.

RECOMMENDATIONS

Based on the results of this study the following is recommended:

- That special attention be devoted to the behaviour drivers of activators and consequences for the purpose of developing safety interventions. This does in no way imply ignoring other drivers for safety behaviour, such as person factors and environmental factors that impact on safety behaviour.
- That the ABC technique be applied in practice to analyse the appropriateness of the intervention actions that are to be taken to solve safety problems in the workplace.
- That the content of this document be widely used as a guideline and training manual for supervisors and managers to sensitise them about the important role that activators and consequences plays in safety behaviour. The suggestion is that line managers must be well-trained in the theoretical concepts and trained to become competent in how the ABC

model can be applied to determine which intervention actions should be installed to increase safe behaviours and decrease risk behaviours.

In terms of future research, it is recommended that the relative importance of activators and consequences should be compared against other person based factors, such as personal traits or mental health in terms of their contribution to safe behaviour.

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CHAPTER 5

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

In this chapter, conclusions are drawn regarding the specific objectives of this study. The limitations of research are also discussed, followed by recommendations for organisations and future research.

5.1 CONCLUSIONS

The first research objective was to determine those factors that are critical to the success of behaviour based safety implementation. Only limited research has been carried out previously to explain the process and organisational factors that determine success or failure. The aim was to provide a useful manual to companies who would like to adopt a behaviour based safety approach so that they do not need to learn only by experience.

The results indicate the following factors as the most critical to a successful implementation (ranked in order of importance): buy-in and participation, structured implementation, training, readiness for behaviour based safety implementation, communication, observation and interpersonal feedback, define critical behaviour which must be targeted, flexibility, effective intervention actions, and the role of data management.

The results do not correspond with previous research because this study included a comprehensive list of possible success factors, whereas previous research included only four or five possible success variables. Although the 10 most important factors were determined by the specific population group, it is in no way concluded that other factors should be ignored. The conclusion is that special effort should be put into these 10 factors and that inputs should be related to the importance of a factor.

It can also be concluded that there are special issues to deal with and special challenges on the road to a successful behaviour based safety implementation, especially in a third world country like South Africa, with its unique circumstances and social differences. It is essential that these

issues and challenges should be considered and that they should be dealt with in a proper way, in order to achieve a successful implementation.

The following conclusions were made with regard to issues and challenges:

- Rewards or incentives for participation in the programme: rewards and incentives are useful but should be limited to small tokens of appreciation to prevent the reward from becoming the reason why employees participate.
- With regard to the issue of whether participation in the programme should be voluntary or compulsory, it was concluded that participation should be voluntary in order to ensure that employees participate because of their internal sentiment towards safety and not to serve the mandates of management.
- Regarding the challenge of illiteracy amongst employees, it is recommended that a symbolic checklist be used to ensure that those employees are given the opportunity to participate in the programme.

It was clear that implementing behaviour based safety in any organisation is a significant undertaking. If the change effort is poorly planned or does not consider the critical success factors, issues or challenges, the effort may never get off the ground or it may fade away once the initial enthusiasm wanes.

The second research objective was to do a literature study to determine the strongest drivers for safety behaviour. The principles in the expectancy theory correspond with Skinner's research on operant conditioning, which argues that behaviour is a function of consequences. The study concludes that by creating pleasing consequences to follow specific forms of behaviour, the frequency of that behaviour increases. People are more likely to engage in desired behaviour if they are positively reinforced for doing so.

The study has identified activators and consequences as probably the strongest drivers for safety behaviour. This study developed this general belief in a number of research studies and the conclusion was made that activators and consequences are probably the strongest drivers for safe or risk behaviour. It was also concluded that the ABC model is a very useful tool to identify and analyse activators and consequences for specific targeted behaviour. Such an

analysis can be useful to determine the most appropriate intervention actions to modify safety behaviour. This conclusion corresponds with findings from other studies.

The study concluded that it is essential for supervisors and managers to be well-trained in the concepts of the factors that drive safety behaviour. Only if they understand these concepts and if they are competent to analyse the impact of the drivers on safety behaviour, will they be in a position to design effective intervention actions which will favourably impact on safety performance.

The third study objective was to develop a practical model of a behaviour based safety intervention programme to serve as a manual for those companies that intend to implement such a programme at their plant. The following conclusions were made from this model:

- Evaluation of the programme and its requirements is essential before approval is obtained to implement a behaviour based safety programme. Such an evaluation is necessary to determine whether the programme will suit the company's needs and whether the necessary resources are available.
- It is crucial to draw up a structured implementation plan.
- Since this is a programme that requires substantial buy-in from the workers, it is essential to obtain buy-in from the workers and the labour unions before the go-ahead decision is taken.
- Part of the initial implementation is to do a baseline culture survey for the purpose of determining the company's readiness for adopting such a programme, and for the purpose of identifying standards against which progress can be measured.
- Developing an effective structure is a logic step subsequent to a strategic decision to implement a behaviour based safety programme. The structure should involve the workers and not only management. A steering committee should drive and manage such a programme.
- Appropriate training for the different levels in the organisation and for the steering committee is essential in the practical model.
- The process to be followed in the execution of the programme should be cleared and should be part of the training process. The following steps are important in such a process: define the behaviour that needs to be targeted; develop and use formal checklists that can be completed by employees during observations; capture data effectively; and develop of

effective intervention actions in order to increase safe behaviours or decrease risk behaviour.

The study also confirmed that it is possible to make a successful behaviour based safety implementation in a third world country like South Africa, in spite of the challenges and issues that are applicable, like political and social differences and the level of diversity. The precondition is that the design of the intervention must be adapted to fit the local circumstances in the fashion it was done in the study.

The fourth study objective was to determine useful performance indicators to measure the effectiveness of the behaviour based safety intervention programme. The conclusion was that leading indicators should be used instead of trailing indicators. This approach shifts the focus from traditional indicators to proactive indicators, such as culture improvements, percentage safe or risk behaviour, and participation levels in the programme.

Although there are many limitations to the use of accident frequency rates, it was concluded that such a trailing indicator must be used to partially determine the success of the programme. The limitations of this indicator should always be considered when the results are analysed.

The next specific research objective was to determine the safety culture at Sishen mine before implementing any intervention programme. The results indicate a moderate safety climate and culture at the mine before implementing the programme. The percentage of favourable responses by respondents towards the different culture categories were as follows in 1999 (before implementing the intervention program): management support for safety was 50%; peer support for safety 50%; personal responsibility for safety 79%; perceptions regarding safety systems 64%; and actively caring amongst employees 79%. The indications were that there was room for improvement in the areas of management support for safety, peer support for safety, and overall perception of Sishen's management systems.

With regard to management systems, the percentage of favourable scores in 1999 were as follows regarding the problem areas: the perception that drugs and alcohol are a problem in the workplace was 58%; the perception that employees will not be disciplined for sustaining an

on-the-job injury 55%; the perception that minor injuries are not being reported 46%; and the acknowledgement of employees by supervisors for safe behaviours 52%.

In terms of departmental measurements, the culture status in 1999 indicates a number of problem areas. The departments of Plants Operations and Engineering Services recorded very low favourable scores for management support for safety (32% and 33% respectively). Mining maintenance and engineering services scored very low on peer support for safety (42% and 30% respectively).

In terms of measurement per position (or grade), there were substantial differences between position groups in 1999. Floor level employees scored only 46% favourable towards management support for safety, whereas first-line managers and middle management scored 70% and 78% respectively.

In terms of peer support for safety, the floor level employees scored 50% favourable against the 41% of middle management. Thus the perceptions at floor level are that there is substantial peer support for safety, which is not the case at middle management level.

In terms of race measurements, black employees recorded very low favourable scores (38%) towards management support for safety, whereas the other race groups scored above 60%. With regard to peer support for safety, white employees scored less favourable (46%) than blacks (53%) and coloured employees (52%).

In terms of personal responsibility for safety, white employees indicated significantly higher favourable scores (84%) than blacks (77%) and coloured employees 76%. This is probably because most senior level posts are occupied by white employees, and because they bear more responsibility because of their managerial responsibilities than those working at shop floor level.

The next research objective was to measure the extent to which employees participate in the behaviour based safety intervention programme and if such participation influenced the culture at Sishen mine in any way.

instrument to achieve this objective and to solve the safety problem of a high prevalence of accidents and fatalities in the workplace.

5.2 LIMITATIONS

In terms of article 1, one of the limitations was that the research was performed in a big mining group in South Africa, which does not allow for making of generalisations regarding other industrial companies. It is known that the mining industry tends to have a unique working climate and culture.

Similarly, the population group used in article 2 consisted of highly specialised line managers and safety personnel from first world countries, mainly the USA. As a result the same conclusions cannot be applied to third world developing countries. It is almost certain that the perception of critical success factors would differ substantially between these two environments.

Another limitation of the survey study in article 1 was the high level of illiteracy (16,4%) in the population group. This posed special challenges regarding the way the survey had to be conducted, and the possibility cannot be ruled out that the recorded responses could have been influenced by this factor.

Furthermore, since this survey study was longitudinal and the first survey was conducted in 1999 and the subsequent survey in 2001, it was not possible to use the exact same population group. This might have influenced the results to a certain extent. However, the results obtained were in the expected direction, and concurred with previous research.

5.3 RECOMMENDATIONS

5.3.1 Recommendations to address the problems

The universal safety problem of 250 million accidents and 330 000 fatalities each year can be alleviated if the recommendations of this study are applied. From the research it is clear that achieving safety excellence requires going beyond the traditional safety focus of engineering, ergonomics and regulation.

Because human behaviour is a contributing cause to most incidents and injuries, safety excellence can only be achieved by also addressing the human dimensions of safety. It is therefore recommended that industrial companies shift their focus from traditional safety approaches to include a strong focus on the human dimensions of safety as well. The recommendation does not imply ignoring environmental and person factors. Such an approach will be fatal, because the three domains of safety are interrelated. The recommendation implies that a focused drive must include safety behaviour as an integral part of the safety system.

It should be clear from this paper that the implementation of a behaviour based safety intervention is a major exercise and that it involves the application of important change principles. It is therefore recommended that such an effort must be well-planned and that the focus must be on those critical factors that determine successful implementation, as identified in this research.

It is recommended that any planning for such an implementation should be made according to the critical success factors and their ratings. In particular it is recommended that much effort must be devoted to achieving buy-in from the workers and to achieving participation. Without buy-in and participation, there will be no programme.

The issues and challenges as discussed in this paper are of utmost importance to the successful implementation of and to sustainable, continued improvement in safety. Ignoring these issues may seriously jeopardise the programme or even result in it never getting off the ground. It is thus recommended that sufficient effort must be devoted to these issues, challenges and critical success factors by management and the implementation team.

The study indicates activators and consequences as exceptional drivers for safety behaviour, and it is recommended that a substantial portion of management time must be devoted to activators and consequences if they wish to modify safety behaviour successfully. Again, this recommendation does not imply ignoring other factors that drives safety behaviour, like individual characteristics, social environment, safety climate and safety culture. The recommendation implies a strong focus on activators and consequences.

The study further recommends that the ABC model must be adopted by supervisors and managers to analyse the impact of activators and consequences on safety behaviour. Furthermore, this analysis must be applied to develop intervention strategies in an effort to modify safety behaviour.

Moreover , the research proved that behaviour based safety can in fact be a very handy tool as an intervention to address the behaviour dimension and to influence safety culture. Thus, it is recommended that the behaviour based safety model be applied by companies which need and wish to address the behaviour dimension of safety. Focus has to be diverted to the behaviour dimension of safety, but the problem is identifying the way it should be done and identifying the drivers for safe behaviour on which there have to be concentrated.

The final recommendation concerns the aspect of flexibility. Throughout this study, it was the intention to emphasise the need to adapt behaviour based safety implementations to fit a company's unique business and environmental circumstances. Particularly those companies that operate in third world conditions should take note of the special challenges mentioned in the study. The major consulting companies that support behaviour based safety implementations are based in the first world countries, and are not aware of the special challenges that apply in third world conditions. It is thus recommended that the findings in this paper be utilised as a guideline and manual to sensitise management and implementation teams to the importance of adapting their programmes to fit their own unique circumstances.

5.3.2 Recommendations for future research

The following recommendations are made for future research:

- This study and the author's experience have both identified a real necessity in the safety world for further research on the drivers for safety behaviour in the workplace. Aspects which must be determined include, for instance, the relation between individual personal traits like intelligence on the one hand and safe or risk behaviour on the other hand.
- There is a need to research the relative importance of behaviour drivers in safety. Currently, specialists in safety have different opinions of which drivers for safety behaviour are the most important, but it would be useful if the relative importance could be tested.

- In terms of critical success factors for a behaviour based safety implementation, it is recommended that the relative importance of success factors must be tested amongst typical third world companies that have implemented behaviour based safety programmes. It is suspected that the outcome be will quite different from what was found in research in first world companies. Such research would be very useful to local companies that wish to addresses safety behaviour in an effort to enhance safety performance.

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Safety Culture Survey

A. ⓪①②③④⑤⑥⑦⑧⑨ B. ①②③④ C. ①②③④

Highly Agree
Agree
No Opinion
Disagree
Highly Disagree

1. New employees receive enough safety training before working alone. ①②③④⑤
2. Reporting minor injuries is usually a waste of time because most can't be prevented anyway. ①②③④⑤
3. Employee safety suggestions are taken seriously. ①②③④⑤
4. Employees appreciate feedback from their coworkers about their safe behaviors. ①②③④⑤
5. Employees do not like it when their coworkers violate safety rules, even when no harm is done. ①②③④⑤
6. Employees in my work area caution each other about unsafe behaviors. ①②③④⑤
7. Employees receive quick response to their safety suggestions. ①②③④⑤
8. I am willing to put forth a little extra effort to improve workplace safety. ①②③④⑤
9. I feel pressure from my co-workers to "short cut" safe work practices. ①②③④⑤
10. Discipline of some sort should be used for serious safety violations. ①②③④⑤
11. Safety rules and procedures are regularly reviewed with employees. ①②③④⑤
12. Safety meetings help make this a safer place to work. ①②③④⑤
13. Safety hazards found during inspections are usually followed-up on quickly. ①②③④⑤
14. Besides performing their own jobs safely, employees should do other things to help improve workplace safety. ①②③④⑤
15. When an incident is investigated, the results are promptly shared with involved employees. ①②③④⑤
16. I sometimes overlook hazards to get the job done. ①②③④⑤
17. The safety committees' efforts help improve safety. ①②③④⑤
18. The site uses a consistent procedure for dealing with employees who violate safety rules. ①②③④⑤
19. Site management views safety violations very seriously even when no damage has resulted. ①②③④⑤
20. Supervisors regularly discuss safety improvement goals and efforts with employees. ①②③④⑤
21. I observe the work practices of my coworkers to give them safety feedback. ①②③④⑤
22. My supervisor is well informed about important safety issues. ①②③④⑤
23. I enjoy being with my coworkers. ①②③④⑤
24. Employees should caution their coworkers about working unsafely. ①②③④⑤
25. I am encouraged to stop a job if a safety hazard is identified. ①②③④⑤
26. Production demands do not override site management's concern for safety. ①②③④⑤
27. Information needed to work safely is available to all employees. ①②③④⑤
28. Stress from factors outside of work affects my ability to work safely. ①②③④⑤
29. Site management consistently sets a good example for safety through their own safe behaviors. ①②③④⑤
30. I have received adequate job safety training. ①②③④⑤
31. When an employee sees a safety hazard, they should correct it themselves if possible. ①②③④⑤
32. Employees here often "short cut" safe work practices. ①②③④⑤
33. I have been disciplined for having a work injury. ①②③④⑤
34. Employees understand the safety rules and procedures for their own jobs. ①②③④⑤
35. Incidents and injuries are thoroughly investigated. ①②③④⑤
36. Minor injuries often go unreported. ①②③④⑤
37. Discipline is not used often enough for serious safety violations. ①②③④⑤
38. Employees are encouraged to correct safety problems themselves when possible. ①②③④⑤
39. Employees fully understand the potential hazards of their jobs. ①②③④⑤
40. Employees are provided information regarding the type, frequency, cause, and cost of accidents. ①②③④⑤
41. Safety audits/inspections are effective in identifying and correcting safety hazards. ①②③④⑤
42. Employees should praise each other for working safely. ①②③④⑤
43. Employees understand the reasons behind the company's safety rules. ①②③④⑤
44. I trust my coworkers. ①②③④⑤
45. I have never been forced to perform a task which I said I thought was unsafe. ①②③④⑤
46. If I approach my coworkers about their unsafe behaviors, they will react negatively. ①②③④⑤
47. Besides working safely myself, I am willing to do other things to help improve workplace safety. ①②③④⑤
48. It is the responsibility of each employee to seek out opportunities to prevent injury to others. ①②③④⑤
49. Besides working safely myself, I do other things to help improve workplace safety. ①②③④⑤

Annexure A.2

	Highly Agree	Agree	No Opinion	Disagree	Highly Disagree
50. When told about safety hazards, my supervisor is appreciative and tries to correct them quickly.	1	2	3	4	5
51. I don't give safety feedback to my coworkers because I'm not sure I can do it well.	1	2	3	4	5
52. Supervisors routinely acknowledge employees for safe behaviors.	1	2	3	4	5
53. When employees in my group are cautioned about working unsafely, they begin working more safely.	1	2	3	4	5
54. I am willing to caution my coworkers about working unsafely.	1	2	3	4	5
55. I try to follow safety rules as best I can.	1	2	3	4	5
56. The site has too many safety rules and regulations.	1	2	3	4	5
57. The site spends too much effort on safety.	1	2	3	4	5
58. Supervisors sometimes encourage employees to overlook hazards to get the job done.	1	2	3	4	5
59. Employees should observe the work practices of their coworkers to give them safety feedback.	1	2	3	4	5
60. Site management is willing to invest money and effort to improve our safety performance.	1	2	3	4	5
61. Work stress affects my ability to do my job safely.	1	2	3	4	5
62. Site management is more concerned about keeping the injury statistics low than with truly keeping people safe.	1	2	3	4	5
63. Site management does not fully understand the real safety issues at my site.	1	2	3	4	5
64. Our safety award program(s) motivate me to work more safely.	1	2	3	4	5
65. It is the responsibility of each employee to seek out opportunities to prevent injury to him- or herself.	1	2	3	4	5
66. Site management seems genuinely interested in reducing injuries.	1	2	3	4	5
67. Site management places most of the blame for an accident on the injured employee.	1	2	3	4	5
68. I am willing to praise my coworkers for working safely.	1	2	3	4	5
69. When I see a safety hazard, I correct it myself if possible.	1	2	3	4	5
70. The risk level of my job concerns me quite a bit.	1	2	3	4	5
71. Alcohol or drug abuse is a problem at my site.	1	2	3	4	5
72. An employee who gets injured will likely receive a poorer performance evaluation.	1	2	3	4	5
73. When I see a coworker working unsafely, I caution him/her.	1	2	3	4	5
74. Production demands do not override supervisors concern for safety.	1	2	3	4	5
75. Compared to other workplaces, I think mine is rather risky.	1	2	3	4	5
76. Following all safety rules and regulations needlessly slows down my job.	1	2	3	4	5
77. Employees who work safely have a better chance for promotion than those who don't.	1	2	3	4	5
78. I am willing to observe the work practices of my coworkers to give them safety feedback.	1	2	3	4	5
79. Site management truly wants to know about all incidents and injuries, even if they are minor.	1	2	3	4	5
80. I would feel free to discuss the causes of my injury with the investigation team.	1	2	3	4	5
81. I am encouraged to report near misses.	1	2	3	4	5
82. Employees participate in inspections for potential hazards.	1	2	3	4	5
83. I have more respect for workers who work safely than for those who don't.	1	2	3	4	5
84. I would be willing to have a coworker observe me while I work to give me feedback about safe and unsafe behaviors observed.	1	2	3	4	5
85. Employees are given feedback by supervisors if they are observed working unsafely.	1	2	3	4	5
86. Employees in my work group participate in defining safe work practices.	1	2	3	4	5
87. If I received a minor injury on the job, I would report it.	1	2	3	4	5
88. It is common for employees to be disciplined for having a work injury.	1	2	3	4	5
89. Most employees would feel uncomfortable if their work practices were observed and recorded by a coworker.	1	2	3	4	5
90. Most of my coworkers actively support the site's safety programs.	1	2	3	4	5
91. When I see a safety hazard, I am willing to correct it myself if possible.	1	2	3	4	5
92. Employees in my work group recognize each other for working safely.	1	2	3	4	5
93. Work productivity and quality usually have a higher priority than work safety.	1	2	3	4	5
94. When asked to do a new job, I receive enough training to be able to do it safely.	1	2	3	4	5
95. My supervisor asks me what I need to do my job more safely.	1	2	3	4	5
96. Employees appreciate receiving feedback from their coworkers about their unsafe behaviors.	1	2	3	4	5
97. Near misses are consistently reported and investigated at my site.	1	2	3	4	5
98. Safety audits/inspections are conducted regularly in my department.	1	2	3	4	5
99. When I see a coworker working safely, I praise him/her.	1	2	3	4	5

GENERIC CHECKLIST SISHEN IRON ORE MINE

Obtain permission before any observation is done

Environment	
TIME OF OBSERVATION	
Clear	
Fog	
Rain	
Windy	
Inside	
Outside	
Daytime	
Night-time	

Observer Name
Observer Employee No
Observer Tel No
Section Observed
Date
Type of work done

S - SELF DISCIPLINE

I - INTRODUCES

S - SAFETY AND

H - HELPS TO

E - ENCOURAGE

N - NEW IDEAS

		Safe	At risk	Comments
PPE	1.1 Use of PPE			
	1.2 Condition of PPE			
	1.3 Right PPE for task			
	1.4 Correct Size			
Hazard awareness	2.1 Eyes on task/path			
	2.2 Removal of hazard			
	2.3 Control of hazard			
	2.4 Recognition of potential hazard			
	2.5 Using your senses			
Communication	3.1 Warn bystanders			
	3.2 Ask for help			
Body position	4.1 Ergonomics			
	4.2 Lifting/Bending			
	4.3 Pushing/Pulling			
	4.4 Twisting/Turning			
	4.5 Line of fire			
	4.6 Pinch points			
General tidiness	5.1 Neat/Untidy/Dirty			
	5.2 Environment/Hygiene/Health			
Work Tempo	6.1 Fast/Slow/Normal			
Tools & Equipment	7.1 Handling			
	7.2 Condition			
	7.3 Correct tool			

COMMENTS CONTINUE ON REVERSE SIDE

ANNEXURE C

Pedestrian Checklist Sishen Iron Ore Mine

Obtain permission before any observation is done

Time of observation:	
Visibility	
Rain	
Windy	
Inside	
Outside	
Daytime	
Night-time	

Observer Name
Observer Employee No
Observer Tel No
Section of Observer
Section Observed
Date

BBC BEHAVIOUR BASED CARE

S - SELF DISCIPLINE

I - INTRODUCES

S - SAFETY AND

H - HELPS TO

E - ENCOURAGE

N - NEW IDEAS

		Safe	At risk
Approaching the road	1.1 Watching oncoming traffic		
	1.2 Ignore oncoming traffic		
	1.3 Alert		
	1.4 Ignore stop sign		
Walking too slow	2.1 Attention distracted		
	2.2 Standing on the road		
	2.3 Purposefully		
Pedestrian crossing	3.1 Taking short cuts		
	3.2 Using the pedestrian crossing		
	3.3 Cross on other parts of road		
Waiting	4.1 Standing too near to the road		
	4.2 Playing on the road		
	4.3 Cross halfway and turn back		
	4.4 Patience		
Road construction	5.1 Construction work underway		
	5.2 Obstruction		
	5.3 Road cordened		

Area observed

COMMENTS ON REVERSE SIDE

Observeerder inligting
Leina la moelatloko / Naam
Nomore ya tiro ya moelathloko/ Kontr No.
`Nomore/ Nommer
Lefapha le le etsweng thloko / Afdeling
Letlha / Datum
Mofuta wa tiro e e dirilweng/ Tipe werk

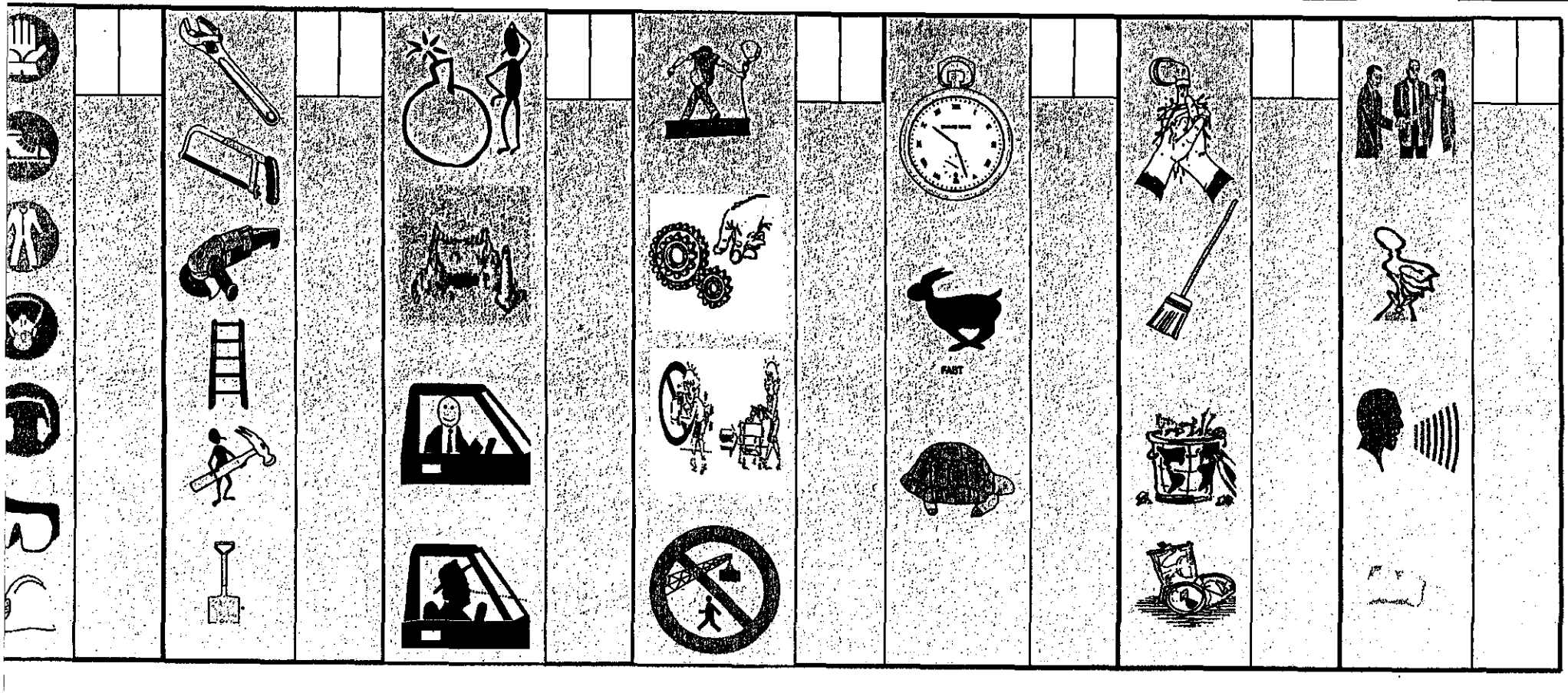
SISHEN

KARATA YA KELO-THLOKO KA KAKARETSO

ALGEMENE NASIENLYS

Neelwa tetlelelo pele ga o ela
Tlhoko / Verkry toestemming vooraf

PBT ☐ TOOLS ☐ GEVARE ☐ LIGGAAMS POSISIES ☐ WERK SPOED ☐ ALGEMENE NETHEID ☐ PRAAT/ VRA ☐



Annexure D

Kumba Resources: Sishen Mine
Behaviour Based Safety Survey

Dear Conference attendee,

It will be highly appreciated if you will take a few minutes to complete this survey and return it to the conference reception desk.

Critical success factors

The under mentioned list of critical success factors will influence the success of a behaviour based safety implementation in any organisation. Please rank the statements below in order of importance with 1 being the most *important*, 2 the second most important, ...and 20 the least important.

Critical Success Factor	Related Statement	Rank
Structured Implementation.	Blueprint with implementation steps and sequence is being drawn up and implemented vigorously.	
Flexibility.	Program being adapt to suit the needs of a specific site.	
Buy-in and Participation.	Engaging the workforce to participate in the program.	
Training.	Well-planned training strategy, necessary resources, effective training to execute the process.	
Communication.	Well planned communication strategy, communication engage supportive activity at all levels of the organisation, selling a case for change, obtaining buy-in at all levels.	
Define critical behaviours.	Selecting the right (and not wrong) behaviours to target.	
Observation and interpersonal feedback.	Following the correct principles during observation and feedback to ensure effective process execution.	
The Role of data.	Ongoing collection and analysis of behavioural data (not injury data), and utilise data for continuous improvement Data pro-active to prevent future at risk behaviour (not re-active)	
Sustaining the process through connections and networking.	Staying in touch with other external sites and sharing common experiences and new techniques with them.	

Provide appropriate technical resources.	Budget, people, training facilities and equipment, etc.	
The role and competency of the facilitator.	Knowledge about the theory of behaviour based safety and competence to understand his role and manage the implementation team and "market" the program (selling his ideas), be a change agent.	
The role and competency of an external consultant.	Knowledge about the theory of behaviour based safety and experience to guide a site and implementation competence.	
Level of integration between traditional safety and behaviour based safety.	The extend to which the behaviour based safety program is part of traditional safety systems.	
Dealing with Behaviour based safety issues.	Management properly deals with issues like voluntary/mandatory participation, incentives for participation, setting participation goals (or not), organisational alignment (align vision and values with day to day safety practices), dealing with the blaming mindset, etc.	
Removing barriers to implementation.	Management remove obstacles, e.g. system barriers, paperwork, resistance to change, readiness for implementation, personal factors, and do damage control to lessen the negative impact.	
Sufficient measures to program success.	The purpose and goal of the program is linked directly to a measurement system. Systematically tracking of process indices indicative of program success is being done.	
External factors	E.g. Legislation, macro-economic climate, external political issues.	
Individual factors inherent to the make-up of employees.	E.g. Assertiveness, belonging, self-esteem, self-efficacy, personal control.	
Effective intervention actions.	Using data to identify problems, using problem-solving techniques to solve problems, intervene and testing the effectiveness of intervention actions.	
Readiness for a behaviour based safety implementation.	Effective leadership in the organisation, basic safety systems already in place, safety involvement teams already active, responsibilities in organisation well defined, sound organisational style (positive social climate, trust, openness, respect, caring, positive reinforcement).	

Annexure F

FINGER INJURY CHECKLIST SISHEN IRON ORE MINE

Obtain permission before observation is conducted

TIME OF OBSERVATION	
VISIBILITY	
RAIN	
INSIDE	
OUTSIDE	
WIND	
DAY	
NIGHT	

NAME OF OBSERVER
OBSERVER EMPLOYEE No.
OBSERVER TEL. No.
OBSERVER SECTION
SECTION OBSERVED
DATE
TYPE OF WORK

S - SELF DISCIPLINE

I - INTRODUCES

S - SAFETY AND

H - HELPS TO

E - ENCOURAGE

N - NEW IDEAS

Behaviour	Safe	At-risk
1. Wearing of gloves		
2. Correct type for the job		
3. Condition of gloves		
4. Harzard awareness		
-Electricity		
-Pinch points		
-Warm objects		
-Movingparts		
-Line of fire		
-Acids/harzardous substances		
-Sharp objects		
5. Safe guards		
6. Ask help from co-workers		
7. Tools		
- Handling		
- Condition		
-Correct type for task		
8. Eyes on task		
9. Work tempo		
10. General tidiness		

COMMENTS ON REVERSE SIDE