An Analytical Accident Investigation Model for the South African Mining Industry

Chapter 1

BACKGROUND AND STATEMENT OF PROBLEM

1.1. INTRODUCTION

Industrial accidents and injuries have notably plagued man since the industrial revolution. Yet the carnage did not attract the attention of managers as a major economic issue until the early 1800s. It was during this time that the industrial revolution exposed a growing number of workers to new and dangerous machines in an ever more dangerous work environment.

In contrast to other sciences, very little concern has been exercised in recording the history of safety practice. According to Guarnieri (1992) accident research only started in the 1900s. The general belief during the 1800s was that alcohol consumption was the primary cause of accidents and this reinforced the deep-rooted Western idea that people were responsible for their own safety and that the injured had to be at least partially blamed for accidents. This 19th century belief appears to be still prevalent in the South African mining industry.

The democratisation of South Africa during 1994 with the election of Nelson Mandela as the President of South Africa was one of the factors resulting in attitudinal changes with industrial accidents and associated injuries becoming more unacceptable to the public, state agencies, public organisations, mining houses as well as the victims and their families.

Following a number of horrific mine accidents involving groups of people at a time, there were again public outcries in South Africa for stricter actions against errant mine managers and owners. Yet prosecution may not prove effective, as this approach may do nothing to eliminate the causes of many accidents. The majority of accidents could be prevented if the basic causes of similar accidents are identified by accident investigation techniques followed by appropriate preventative remedial actions.

In South Africa, as in most other countries, employers are legally responsible, apart from moral concerns, for reducing the risk of accidents and alleviating the suffering of those affected. Already the Mines and Works Act, Act No. 12 of 1911, stated, "the governor-general may make regulations ... in respect of ... the safety and health of persons employed in or about mines..."

The current Mine Health and Safety Act, 1996 (Act No. 29 of 1996) aims to protect the health and safety of persons working at mines and to promote a culture of health and safety in the mining industry.

The continuous upgrading of legislation no doubt had an effect in reducing the number of accidents in South African mines, but according to speakers at the 33rd annual meeting of the United States Risk & Insurance Society during 1995, the best way to alleviate the damage from an industrial accident and to prevent future accidents is to establish a comprehensive accident investigation process.

The South African mining industry is said to be among the most advanced in the world. This statement is valid in many respects, but is not generally true regarding safety and accident investigation.

In an International Labour Organisation (ILO) report (Safety and Health in Mines 1994, no. 51) 19 countries are compared regarding fatal accidents in mining operations, taken on an annual basis between 1989 and 1991. South Africa rated 14th out of the 19 countries, with countries like Turkey, Yugoslavia, Papua New Guinea and Pakistan rated worse.

It is postulated that the relatively inefficient manner in which accident investigations and their results are managed in the South African mining industry, may be one of the major contributing factors to the unacceptably high level of accidents.

1.1.1. THE CURRENT STATE

The accidents reported to the Principal Inspector of Mines in terms of Minerals Act Regulation 25.1.1 in force in terms of Schedule 4 of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996) are recorded in the South African Mines Reportable Accident Statistical System (SAMRASS). This regulation states that *"whenever an accident results in -*

(a) the death of any person;

(b) an injury to any person likely to be fatal

(c) unconsciousness from heatstroke, heat exhaustion, electric shock or the inhalation of fumes or poisonous gas, or any incapacitation normally requiring treatment in a decompression chamber, or

(d) incapacitation from heatstroke, heat exhaustion, electric shock or the inhalation of fumes or poisonous gas which will prevent the affected person from resuming his normal or similar occupation within 48 hours, or

(f) an injury which either incapacitates the injured person from performing his normal or similar occupation for a period totalling 14 days or more, or which causes the injured person to suffer the loss of a joint, or part of a joint, or sustain a permanent disability,

the manager of the mine or the works shall report such accident to the Principal Inspector of Mines."

For the purpose of this research only the accident statistics of coal and gold mines will be utilised to establish the seriousness of the matter under investigation. Reportable injuries in these two sectors represent 89,1% of all reportable injuries while fatalities represent 84,4% of the fatalities in the South African mining industry for 1984 to 1997. As the focus of this investigation is on accident recording, analysis and preventative application of the results, the inclusion of other mining sectors is not regarded as a value-adding exercise.

Bear in mind that in addition to the fatalities and reportable accidents a vast number of other lost time accidents in mines are not reported to the Inspector of Mines under the current regulations. According to studies by Bird and Germain (1996) on 1 753 498 accidents, there were 9,8 reported minor injuries for every major injury that resulted in death, disability, lost time or medical treatment. They did not report the ratio between serious injuries (reportable), as defined by the South African Minerals Act Regulation 25.1.1, and the other lost time or medical treatment accidents. Notwithstanding this, it can be expected that at similar ratio of about 1 to 10 will be found if these definitions are utilised to separate the various accidents by severity.

From the above accident statistics it is clear that the number of accidents in the mining industry is unacceptably high and that a new approach is required to improve the situation.

1.1.2. THE STATUTORY FRAMEWORK

The Leon Commission of Inquiry into safety and health in the mining industry under the chairmanship of Judge Ramon Leon in 1994 identified shortcomings in the Minerals Act, 1991 (Act No. 50 of 1991) which regulated the industry before the promulgation of the Mine Health and Safety Act during 1996.

The Commission concluded that the drastic revision of various Acts in the past that eventually led to the Minerals Act 1991 (Act No 50 of 1991), did not adequately provide for mine health and safety issues. These were confused with the regulation of optimal exploitation of minerals and land rehabilitation issues, although the connection was only tenuous.

As a result of the Leon Commission findings the shortcomings were addressed by embarking upon a new tripartite process to draft the Mine Health and Safety Act, 1996 (Act No. 29 of 1996).

It is notable that the Act distinguishes between investigations and inquiries. Investigations by Inspectors of Mines are provided for under section 60 and inquiries under section 65. In addition, Section 11.5 requires employers to investigate certain accidents at or on the mine and, on completion prepare a report that identifies the causes and underlying causes of the accident of the accident. In addition to this, the employer must also identify any unsafe conditions, acts, or procedures that contributed to the accident, followed by recommendations to prevent similar accidents.

The Mine Health and Safety Act, for the first time in the South African context, recognised that the procedure of investigating accidents could influence the effectiveness of the investigation, hence Section 63(1) that establishes a procedure whereby a certificate of no prosecution may be issued in order to enhance the effectiveness of investigations.

The legislator clearly tried to establish two different approaches, one to identify the causes of an accident and the other to establish responsibility. This research provides a model for investigation only, since establishing responsibility is a legal rather that a managerial pursuit.

1.1.3. COST ASPECTS OF ACCIDENTS

Safety measures always cost money and the employer must foot the bill. A perpetual conflict of interest exists between employer and employee as to the type and magnitude of safety measures that could be considered reasonably practical and reasonable necessary.

The principles of risk assessment as discussed by Marx *et al* (1997), require preventative measures to undergo a cost benefit analysis to establish the required extent to be implemented.

In order to do a reasonable cost benefit analysis it is required to have an idea of the costs per annum associated with accidents in the mining industry.

A study by Marx (1996) using an activity based costing approach to fall of ground accidents indicate that the average cash flow cost to the mine of fatalities caused by falls of ground was R 462 872 while the average cash flow cost of reportable fall of ground accidents was R233 398 in 1994 monetary terms.

Using the above as a basis it would appear that the cash flow cost of accidents to the mining industry in South Africa from 1984 to 1997 amounted to R338,57 billion which gives an average of R 23,04 billion per annum.

The equivalent cost of fatalities and reportable accidents for 1996, using these figures, is calculated to be R1,95 billion. Considering that the total value of minerals sold from South African mines during 1996 amounted to R63,10 billion, according to the 1997 annual publication by the South African Central Statistical Services, the calculated cost of accidents is equivalent to 3.09% of this value.

There is sufficient financial motivation for investigating ways of reducing accidents in the mining industry.

1.2. BACKGROUND

Mining is possibly the world's oldest industry and also one of the most hazardous. Mining differs from almost all other industries in that the work environment continually changes as the work proceeds. Notwithstanding this it is true that the management of mining safety has much in common with safety management in other industries.

One way companies could achieve a competitive advantage is to minimise the cost of industrial accidents by integrating an accident investigation management program into their overall business strategy, according to Powers and Arnstein (1995).

Most modern accident investigation systems aim to determine the causes of accidents in order to prevent them, offer methods of safer design and ensure that risks will be eliminated or minimised by eliminating these causes. The traditional accident investigation approach in the South African mining industry was focused on blame-fixing rather than on these principles. Hermanus and Leger support this view in their submission to the Leon Commission (1993). They found that 65% of the accident investigation reports they examined concluded that the injured or dead person was responsible for the accident.

Preventive measures are seldom identified during accident investigations. In the few cases where preventive measures had been identified during accident investigation, the measures were not implemented in the business strategy of the mine or the industry.

Should this become a matter of course a great number of accidents could be prevented (Hermanus and Leger 1993).

Unreliable accident information is an open invitation to disaster, while good information pertaining to accidents may be used to make a wide range of operational, management and strategic decisions. One of the few practical ways to ensure that accurate accident information is used as a basis for decisions is to undertake in-depth studies of the fundamental contributing factors of accidents.

Accidents mostly result from a combination of factors, which must be present simultaneously or sequentially. An unsafe act or situation does not give rise to an accident until someone is exposed to it and both physical as well as psychological factors, in combination with unsafe work systems, trigger the accident. Combining environmental hazards and human factor hazards multiplies accident potential. The larger the number of hazards, the sooner the accident potential will increase.

1.2.1. Comparison: Gold v. Coal Sector

If one knew what would happen in the future, the outcome of any decision would depend only on how logical and rational the decision was. To manage uncertainty, however, requires a study of the nature of events.

Events may either be dependant or independent. Independent events have no effect on the probability of other related events. A typical example of such independent events is accidents that occur in the gold mining industry versus accidents in the coal mining industry. When a comparison of these two sectors in the mining industry is done that compares the probability of an accident happening in the gold mining sector with the probability of an accident occurring in the coal mining sector the two events are not related and can be viewed in isolation from one another.

Extracts from the statistical summary of accidents (1997) of the Chief Inspector of Mines for these two sectors are reflected in table 2.2 and table 2.3 in Chapter 2 of this thesis.

Significant to this study is the relative performance of the two sectors. A superficial comparison of table 2.2 and table 2.3 indicate that the accident rate in coal mining is significantly lower that that in gold mining.

A number of gold mining managers interviewed during the pre-study believe that this difference can largely be ascribed to the difference in depth of mining in the two sectors. No scientific proof for this claim could be provided.

Depth of mining could influence the number of fall of ground accidents since rock stresses increase with depth. During 1997 however, the injury rate for fall of ground accidents in the gold mining sector was 6,02 compared to the rate of 19,54 for all accidents. This represents a 30,8 % contribution to the total rate.

Coal mining had a fall of ground accident rate of 0.92 during 1997 that represents 18,9 % of the 4.88 total rate. During 1989 this percentage was 27,3 % for coal and 29,2 % for gold mining sector, indicating no significant difference between the contribution of fall of ground accidents in the gold mining sector and the coal-mining sector.

This trend is common for the period from 1984 to 1997 and therefore indicates that depth of mining does not contribute significantly to the total accident rate.

Some other factor or factors must contribute to this difference in accident rates between the two sectors. This researcher is of the opinion that the approach to accident investigations in coal mining is one of the major contributing factors that places managers in that sector in a position to use the results from investigations for accident prevention.

1.3. EXTENT OF RESEARCH

When investigating effective accident investigation and how to manage the results in South African mining it is important to note that the key to successful investigation lies in ascertaining and eliminating the root causes of accidents, rather than in assigning blame to the parties involved. (Woolsey: 1995).

It is envisaged that this may be achieved by replacing traditional approaches of accident investigation in some mining sectors with new methods that focus on fundamental contributing factors rather than apportioning of blame.

This research will focus on investigators and present a model that will provide them with an aid to determine accident causes, and will also ensure that managers and supervisors could utilise the resultant information to prevent similar accidents. The model developed should re-actively identify risks and control measures required to contain risks, as well as to identify pro-active measures by utilising it as a risk assessment tool.

This research will aim to determine how to achieve preventative results from an accident investigation system in the South African mining industry by selecting the best elements from accident investigation techniques in other countries as well as sectors of the local mining industry that are performing well, and then to adapt them to suit the South African mining industry as a whole. These practices and procedures will then be converted into a workable analytical model for conducting accident investigations or pro-active risk assessment procedures.

1.4. FORMULATING THE PROBLEM

1.4.1. FIELD OF RESEARCH

The research in this paper is a subsection of sustainability management. The safety management area of this field will, in particular, be researched.

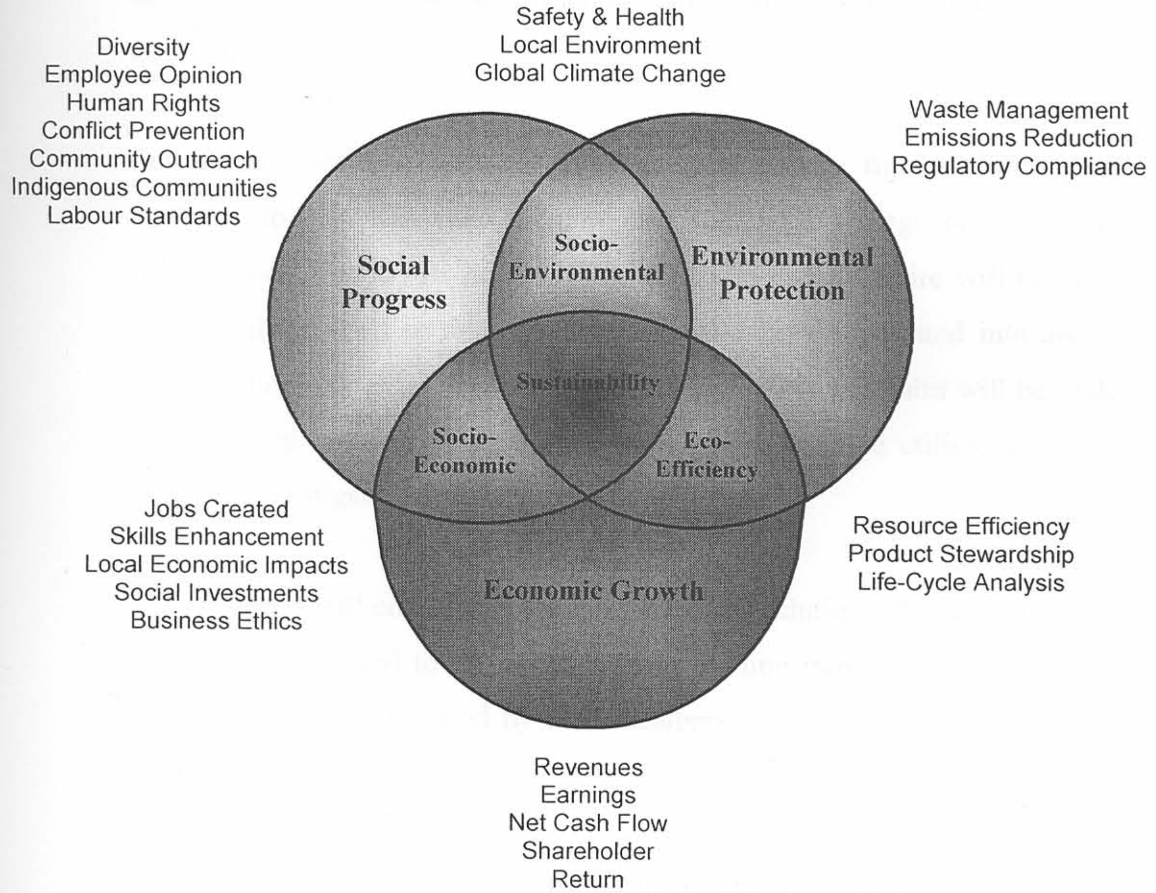

Figure 1.1 - Graphic representation of the main components of sustainability
(Adapted from "Sustainable Reporting Guidelines on Economic, Environmental and Social Performance" by the Global Reporting Initiative Secretariat - June 2000)

With reference to Figure 1.1 depicting the graphic representation of the main components of sustainability, the safety component can be isolated in the sector where environmental protection intersects social progress.

Specific research will be carried out regarding the South African mining industry by adapting world best practice in accident investigation techniques for this industry. To achieve this it is envisaged to establish what is considered nationally and internationally to be the elements of an accident for the purpose of predictive accident investigation.

Further, the accident statistics of the South African mining industry will be analysed to establish two or more comparable groupings based on accident performance. Once this has been established a questionnaire will be developed which will be used to determine what should be incorporated into an accident investigation model for the industry. During the study the aim will be to develop an analytical accident investigation model that could be utilised as a basis for accident investigations.

This research will combine the most successful techniques from around the world in a way best suited to the South African mining industry in a format that will produce results, to be used by line managers and supervisors to prevent similar accidents.

In order to determine ways of applying the proposed accident investigation system, and of applying the results it should generate various existing accident investigation techniques would be identified and evaluated.

Current accident investigation systems will be analysed for effectiveness as well as user friendliness. A selection will be made from the components of the various techniques used and trusted by leading investigators.

To ensure that the complex survey data is correctly interpreted, the results will be evaluated by means of the multivariate analysis technique.

1.4.2. PURPOSE

It is the purpose of this research to develop an analytical accident investigation model for mines in South Africa. This model will then be utilised to develop an accident investigation technique for this industry.

The accident investigation technique so developed will be presented to the Chief Inspector of Mines with the aim or motivating a revision of the current Government Directive (D1) guiding the accident investigation process for Inspectors of Mines. The revision should incorporate the elements of accident investigation identified during this study.

It should be possible to prevent accidents and reduce consequent suffering by implementing the recommendations resulting from the use of the model during accident investigation, into workable solutions.

A proper accident investigation approach would also ensure that a documented, verifiable and repeatable accident prevention programme could be implemented. Current accident investigation systems do not allow this.

During the development phase, the new model will be tested on a number of accidents on different mines, in order to ascertain the practicality of the system. Ideally a pilot programme will be run to verify that the model does achieve the desired results.

1.4.3. RESEARCH METHOD

It is planned to first do an in-depth literature study of accident investigation techniques used by world-class industrial organisations. Elements of the different successful accident investigation techniques will be isolated.

Based on these elements, a questionnaire will be developed, to include all the elements identified in accident investigation techniques.

The results of the questionnaire will then be analysed to establish which of the identified contributing factors should be included in the analytical accident investigation model.

The ideal subject population for the study of an accident investigation system best suited to the South African mining industry would naturally be a group of knowledgeable people. For the purpose of this study the sample will not specifically include mine managers as the author believe that it will prove difficult to get busy managers to spend time on completing lengthy questionnaires, probably resulting in a very low response rate.

The target population from which the sample will be selected will consist of persons accepted as candidates for the Mine Overseer Certificates of Competency as well as the Mine Manager's Certificates of Competency. The reason for selecting this group is that any individual who applies for acceptance as a candidate for a certificate of competency that would limit him/her to work in a specific industry, is committed to that industry.

In addition, the target population is selected from the middle management echelons with at least the following qualifications and experience:

In terms of Minerals Act Regulation 28.18.1 to 28.18.2 a Mine Overseer's Certificate Candidate:

Must have attained the age of 22 years,

Produce evidence of his/her sobriety and general good conduct,

Is the holder of an appropriate permanent blasting certificate and either:

Has at least 4 years practical experience gained in the workings of a mine, or

Holds either a mining engineer's degree, a mechanical or electrical engineer's certificate of competency for mines or any other degree, certificate or diploma acceptable to the Chief Inspector of Mines and has at least 2 years practical experience gained in the workings of a mine.

In terms of Minerals Act Regulation 28.14.2(A) a Mine Manager's Certificate Candidate for the final part of the certificate of competency:

Must have attained the age of 23 years,

Produce evidence of his/her sobriety and general good conduct,

Is the holder of an appropriate permanent blasting certificate and either:

Has at least 5 years practical experience gained in the workings of a mine, or

Holds either a mining engineer's degree, a mechanical or electrical engineer's certificate of competency for mines or any other degree, certificate or diploma acceptable to the Chief Inspector of Mines and has at least 2 years practical experience gained in the workings of a mine.

Although the sampling method will not be perfect, the method used in selecting the group will produce reliable and meaningful results as was found from a similar approach followed by Larrèchè and Montgomery (1997).

According to Caulcutt (1983) the cost of the investigation is normally directly proportional to the sample size while the amount of information obtained from the sample, increase only to the square root of the sample size. It is therefore important to have the optimal sample size that will allow the necessary confidence in the results.

The questionnaires will be sent out under the cover of an official government letter signed by the Chief Inspector of Mines, requesting the selected individuals to submit completed questionnaires. It is anticipated that this approach will increase the response rate substantially.

1.5. STRUCTURE OF THE THESIS

Chapter 1 covers an introduction, a description of the problem as well as an overview of the envisaged research methodology.

An in depth literature study of accident investigation techniques used in world-class companies follows in Chapter 2.

Chapter 3 will consist of a description of the methods used to during the empirical study to verify the information obtained during the literature study. This will be followed by a description of the developing of the questionnaire. A description of the data collection process and the collection plan will complete this chapter.

The interpretation of the results obtained during the empirical investigation will be described in chapter 4.

In Chapter 5 the information obtained during the empirical investigation will be analysed and applied to form an analytical accident investigation model for the South African mining industry. The accident investigation model and a graphical representation of the model are used to explain the interaction of the various components of accident investigations. A detailed description of the steps involved in conducting an accident investigation will also be related.

Chapter 6 describes the results of the pilot study utilising the analytical accident investigation technique based on the model, including the recommendations resulting from it.

Chapter 7 contains the interpretation and evaluation of the results. Conclusions reached during the research process are explained. Recommendations considered necessary conclude the thesis.