THE RELATIONSHIP BETWEEN HEALTH AND SAFETY AND HUMAN RISK TAKING BEHAVIOUR IN THE SOUTH AFRICAN ELECTRICAL CONSTRUCTION INDUSTRY

By

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SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF
PHILOSOPHIA DOCTOR IN CONSTRUCTION MANAGMENT

IN THE FACULTY OF CONSTRUCTION MANAGMENT
AT THE
NELSON MANDELA METROPOLITAN UNIVERSITY

SUPERVISOR: PROFESSOR JOHN SMALLWOOD

January 2012

DECLARATION

I, Willem Johannes du Toit, student number 20429694, hereby declare that this thesis 'The relationship between health and safety and human risk-taking behaviour in the South African electrical construction industry' for the degree of Philosophiae Doctor in Construction Management is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

Willem Johannes du Toit 24 January 2012

ACKNOWLEDGEMENTS

The successful completion of this study would not have been possible without the support, advice, assistance, encouragement and mentorship of others. My sincere and grateful thanks go to all those individuals and organisations that contributed to the accomplishment of this study. In particular the assistance of the following is acknowledged:

- My mother, Dr Quarta du Toit, who always supported and believed in me;
- Prof. John Smallwood, my promoter, for his professional and constructive guidance and advice;
- Bev Wren for the tremendous help with typing and technical assistance with the contents;
- The support from the NMMU library at Saasveld, specifically Hildè van Wyk;
- The statistician, Dr Jacques Pietersen, for his help and advice;
- The respondents to the questionnaires who took time out from busy schedules to assist with the research data needed, and
- Last, but not least, my family and friends for the patience and longsuffering through the many hours that I was unavailable while I was studying.

Thank You

“Security is mostly a superstition. It does not exist in nature nor do the children of men as a whole experience it. Avoiding danger is no safer in the long run than outright exposure. Life is either a daring adventure or not.”

Helen Keller

ABSTRACT

Mankind, and the development of people, exists due to risk-taking behaviour. It is not that humans should not take risks, but rather the ability to identify the magnitude of risk exposure in order that mankind's actions would be so selected as to mitigate exposed risk factors, that no harm should befall them.

The approach to health and safety (H&S) has always been to manage H&S environmental factors that could have a negative impact on people, capital, and organisational systems. However, the critical component of human risk-taking behaviour that would have a far greater impact has rarely been acknowledged as part of the drivers that increase risk exposure.

Human behaviour is a major contributing factor in accident causation. Although human error cannot be completely eliminated, it should be identified and correctly managed according to each individual's risk-taking profile. The reason people decide to take certain risks under certain conditions and the effect it has on H&S management systems is a key component to managing organisational risk exposure.

To quantify the value of individual risk-taking behaviour could provide management with better opportunities of lowering the organisational risk exposure. Human risk-taking behaviour is influenced by each individual's perception of risk. Such perception of risk will influence decisions on risk-taking behaviour, which in turn is influenced by the individual's psychological profile and environmental factors, including character and the impact of a cultural environment.

The electrical construction and maintenance industry differs from other similar industries in that the physical entity of electricity requires not only sensory perception for the identification and evaluation of risk factors, but also requires specialised knowledge and testing equipment to evaluate the parameters of electrical installation, plant or equipment. Without such competence, direct exposure to most electrical installations could be fatal.

The optimum human resource (HR) solution for managing the risk potential of high risk-taking behaviour is the rating and allocation of specific job tasks that can match and limit the individual potential for risk-taking behaviour and the impact on organisational incident statistics.

Maintaining and optimising employee job performance enables organisations to better achieve pre-set goals and missions. Such improvements being a catalyst for better job performance by setting limitations on high risk-taking behaviour, that will improve H&S performance by lowering incident rates.

KEY WORDS

Human risk-taking behaviour, health and safety, electrical engineering, and human resource management.

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PREFACE

Why any person would take a risk that could compromise not only his own H&S, but also the H&S of others and cause possible damage to assets is the question that motivated this research. To understand the impact of human risk-taking behaviour on organisations, it is necessary to first recognize the evaluation and understanding of the impact and the role that an individual's perception of risk plays in influencing them to take certain unacceptable risks. Undesirable risk-taking behaviour should be managed and taken into account by H&S management systems, but the unfortunate situation is that in most instances provision is made only for the management and control of environmental factors, and not the impact of human behaviour.

This study aims to identify: those factors that influence individual human risk-taking behaviour and how they impact on the electrical engineering, construction and maintenance environments; the implications that risk-taking behaviour have on the management of H&S and the impact of existing dogma related to the management of H&S, and to what extent the electrical engineering environment differs to that of similar other construction and maintenance environments in terms of individual risk-taking behaviour profiles and environmental factors. The study further aims to provide guidelines for a model that will address high risk-taking behaviour profiles and job tasks.

The research problem and the associated sub-problems are addressed by the relevant literature survey with data from a mixture of journals, publications, papers and media publications as well as different web sites.

Various questionnaire surveys were conducted targeting the electrical engineering fraternity of managers, engineers, electrical contractors, and workers. Specific electrical incident case studies were also surveyed with responses from the injured and management supervisors. Human resource (HR) managers provided personal opinion on different aspects in relation to recruitment and appraisal of electrical workers and the need for a model that will address high risk-taking behaviour to lower incident statistics.

The data obtained from the literature survey and the empirical research indicates that there is a need for the scrutiny of human risk-taking behaviour to be incorporated in existing H&S management systems.

The research study sequence is as follows:

- In chapter one the introduction and aim of the research, the main problem and sub-problems and the hypotheses are presented;
- The review of the literature relevant to the main problem addressing risk and risk-taking behaviour, the electrical engineering industry, the psychology of human behaviour, health and safety (H&S) and the human resource management (HRM) environment are surveyed in chapter two;
- The research design and methodology is presented in chapter three, with an expansion on the research methodology, validity and research type. The review of the data relative to the sub-problems and the questionnaire surveys presented;
- In chapter four the empirical research findings are presented in various tables designed from the raw data;
- Chapter five presents the testing of the hypotheses, and the interpretation and analysis of the empirical research consisting of the principal questionnaire survey, the survey of incident case studies and the HR survey;
- In chapter six a description with formulae for a model that addresses risk-taking behaviour to specific job task matching is presented, and
- The final chapter, chapter seven, presents conclusions and recommendations on the main and subsidiary research questions.

The literature survey, the empirical research findings and the model presented in chapter six provides a resolution for managing individual risk-taking behaviour by integrating HR management functions to that of H&S management, by evaluating and matching individual risk-taking behaviour profiles to that of high risk job tasks.

ABBREVIATIONS USED

AMEU	Association of Municipal Electrical Undertakers
CR	Construction Regulations
DoL	Department of Labour
ECA (SA)	Electrical Contracting Association of South Africa
ECSA	Engineering Council of South Africa
EIR	Electrical Installation Regulations
EMR	Electrical Machinery Regulations
Eskom	Electricity Supply Commission
FEMA	Federated Employers Mutual Assurance
NOSA	National Occupational Safety Association
H&S	Health and Safety
ICMEESA	Institute of Certificated Mechanical and Electrical Engineers SA
ILO	International Labour Organisation
OH&S	Occupational Health and Safety Act, Act 85, 1993
OH&S	Occupational Health and Safety
SAFHE	South African Federation of Hospital Engineers
SAIEE	South African Institute of Electrical Engineers
WCA	Workman’s Compensation Act
WCC	Workmen’s Compensation Commissioner

CHAPTER 1: INTRODUCTION AND PROBLEM STATEMENT

1.1 INTRODUCTION

The Bill of Rights of The Constitution of South Africa, Section 24, states that everyone has the right to an environment that is not harmful to their health or well-being. This is confirmed by the preamble of The Occupational Health and Safety Act (OH&S), Act 85 of 1993, the purpose of which is to provide for the health and safety (H&S) of persons at work and for the H&S of persons in connection with the use of plant and machinery. This indication not only refers to the environment as an entity that holds risk, but also refers to the activities of people.

The ability of an individual to judge risk, in relation to a work environment, is an inherent psychological trait that should form part of any H&S management system. However, the current approach, in most organisations, is based on conformance to standards such as internal work procedures and external legislative standards only, that relies heavily on knowledge and where very little cognisance is given to the human behavioural component.

Personal traits of individuals such as attitude, motivation, perceptions and personality, affect the attitude of each individual. Forman and Hunt (2006) postulate that when individuals are faced with making decisions they are more willing to take risks to avoid losses, and less willing to forgo gains. All of this assumes a steeper value function in the loss domain than in the domain of gain. According to Smallman (2003), what is important in decision-making around risk, are individual perceptions and beliefs. It is the ability to make sense of potential scenarios in shaping response to any potential threat. The understanding of what causes people to decide to take certain risks under certain conditions and the role such an individual’s perception of risk plays, will and can, to the better, affect processes in any H&S management system.

Although strong guidance and empirical evidence exists on the variability in human resource management, organisations continue to view the human component as an entity with fixed parameters that can be manipulated and expected to perform exactly as required from fixed inputs. This approach has an indirect effect on H&S as these requirements are transferred to H&S management systems. This unfortunately results in required performance not being met.

The impact of individual risk-taking behaviour, intentionally or due to negligence, is one of the main contributing factors of incidents. Ayers and Kleiner (2002) state that work injuries continue to be a major issue for employers economically due to the direct costs, such as medical costs, and the indirect costs of lost work time, replacement workers and administrative costs. These factors contribute to decreased productivity and therefore increase costs within an organisation.

It would thus be to the advantage of organisations to invest in any systems and processes, such as human risk-taking behaviour, that can decrease incident rates. Ayers and Kleiner (2002) found that human factors need to be considered in any programme to prevent accidents brought about by human error. Studies indicate that more than 85% of workplace injuries and accidents can be linked to the human errors of commission or omission. Although such human factors should be taken into consideration when managing H&S, the unfortunate circumstances in the electrical engineering environment of South Africa are that standards alone are enforced and that no cognisance is given to the individual's perception of risk and the resultant risk-taking behaviour.

H&S in the workplace is an issue that is taken lightly by those who do not practice or research healthy as well as safe working conditions, and is a serious issue for victims, and relatives of victims, of sub-standard management. It remains one of the bastions of inequality of work worldwide. The intent of governments in endeavouring to reinvigorate the suppression of workplace injury and illness is motivated by both social and economic imperatives (Hart, 2010).

Motivation for organisations is not fully understood, as there is no obvious business imperative, should organisations understand and obtain scientific justification for investment in H&S management then governmental tasks would be made easier.

Cambraia, Formoso and Saurin, (2005) found human error to be a major contributing factor in accident causation both in construction and in the manufacturing industry. They postulate that human error cannot be eliminated, since human beings have adaptive behaviour patterns. In dynamic work systems, such as construction sites, many degrees of freedom are left for adaptive modifications of procedures. Therefore, people may be pushed to work in risky circumstances and they must be helped to develop and apply their judgment to avoid accidents.

Decisions relating to H&S, that affect individuals' H&S, are usually not made under the supervision of competent management, especially on South African construction sites. Given that risk perception is argued to be quantifiable, an increasing number of studies have focused on the existence of cultural and national differences in risk perception. Studies have focused on eastern and developed nations, but developing countries on the whole have largely been ignored (Thomson, Onkal and Guvenc, 2003). The increase in serious accidents that are related to risk-taking behaviour, especially in the electrical engineering industry of South Africa, as statistical data shows, is indicative of the need for research relative to this critical component of H&S management.

Further impacts on incident statistics, are due to cultural influences that South Africa, due to a diverse cultural, political and historical background has, that resulted in a greater difference in risk perception due to the diverse population groups. Such diversity has a far greater impact on H&S management than is currently afforded. It is thus imperative that the management of human resources, in the electrical engineering environment, are aware of each individual's attitude toward risk-taking behaviour as influenced by cultural and personal circumstances and backgrounds. HR managers must strive to quantify the value of individual risk-taking behaviour, find psychological causes for workers' incorrect perception of risk, and incorporate such values in HR management systems related to recruitment, performance evaluation and appraisals.

Risk perception and the individual's attitude towards H&S is related to a tendency of responding in a given situation in a particular way and, by not taking this into consideration, the current approach of forcible compliance with standards creates a tendency to resistance that negatively impacts on incident statistics.

1.2 HEALTH AND SAFETY (H&S)

The primary legislation applicable to H&S is the Occupational Health and Safety Act (OHSA), Act 85 of 1993. The custodian for the policing and implementation of relevant regulations incorporated into this Act is the South African Department of Labour (DoL). However, Geminiani (2008) states that it appears that the South African DoL's Inspectorate is not effective in conducting the necessary duties. With such inadequate effectiveness and policing, H&S has become reliant on business ethical principles and the achievement of quality ratings, rather than the fear of prosecution.

The preamble to the OHSA states: "To provide for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery; the protection of persons other than persons at work against hazards to health and safety arising out of, or in connection with, the activities of persons at work; to establish an advisory council for occupational health and safety; and to provide for matters connected therewith."

In OHSA certain duties are placed on employers. The term 'reasonably practicable' implies that an employer does not necessarily have to comply with specific legislation if it can be proven in a court of law that compliance was not reasonably practicable.

The approach in newer legislation, however, is not only to involve the employer and employee, but also to make the initiator of work such as the client, responsible for overseeing that H&S standards are followed, that appropriate management systems are in place and that the function of such will ensure compliance with relevant legislation.

Prosecution for contraventions of the sections and regulations of the OH&S Act relies on proof that an action was intentional or due to negligence.

In legal terms, a contractor, or any employee of such contractor, can be held liable for his actions based on the standard of a reasonable man, in legal terms *bonus paterfamilias*. For the purposes of liability, *culpa* or fault arises if a diligent *paterfamilias* in the position of the defendant could have foreseen the reasonable possibility of his conduct injuring another, in his person or property, and causing him patrimonial loss; and would take reasonable steps to guard against such occurrence.

1.3 H&S STATISTICS

The National Occupational Health and Safety Policy (2003) points out that occupational accidents and diseases impose an enormous cost on the South African Economy at an estimated 3.5% of National Gross Domestic Product (GDP).

At the World Day for Safety Work, Eastern Cape, on 09 May 2008, the Minister of Labour, Minister Mdladlana, referred to incident statistics and articulated that: “It is clear that the strategies that are being employed are either ineffective or there is a need for efforts to be consolidated in order to achieve the expected results.”

The Minister’s strong view on current H&S strategies employed again emphasises the critical need for intervention to lower the current level of incidents.

Statistics on work related incidents can be obtained from the administrative entities that transact under license for certain work groups for the Workmen’s Compensation Commissioner. The Federated Employer’s Mutual Assurance Company Limited (FEMA), was established as a mutual insurer in 1936 and on the introduction of the Workmen's Compensation Act 1941 was granted a licence to continue to transact workmen's compensation insurance for the building industry. Its business operations are essentially confined to the insurance of employers against liabilities under the Compensation for Occupational Injuries and Diseases Act of 1993.

FEMA is acting as the Workman’s Compensation Commissioner for the engineering sector and as such the statistical data for the past three years give a clear indication of incident patterns in the engineering sector, which includes the electrical environment.

The Compensation for Occupational Injuries and Diseases Act provides for compensation for disablement caused by occupational injuries or diseases sustained or contracted by employees during the course of their employment, or for death resulting from such injuries or diseases; and to provide for matters connected therewith (Department of Labour, 2008).

FEMA

Cause	% of Accidents	Number of Accidents	Fatal Accidents	Permanent Disabilities not resulting in Pensions	Permanent Disabilities resulting in Pensions	Lost Days	Average cost per Accident (Rand)
Accident type N.E.C.	1.23	38	0	16	0	0	30,735
Caught in, on, between	7	217	1	4	0	217	10,746
Contact with electric current	0.58	18	1	0	0	0	27,299
Contact with temp extremes	1.32	41	0	3	0	67	12,312
Fall onto different levels	12.74	395	2	10	0	1,035	23,404
Fall onto same level	4.26	132	1	1	0	90	9,074
Inhalation, absorption, ingestion	1.13	35	0	0	0	6	6,841
Motor vehicle accident	12.55	389	11	10	2	475	33,910
Slip or over-exertion	8.77	272	0	0	0	250	6,604
Striking against	10.87	337	1	2	0	282	7,379
Struck by	39.45	1,223	2	14	2	1,414	12,276
Unclassified-insufficient data	0.1	3	2	0	0	0	172,229
	100.00	3,100	21	60	4	3,836	15,543

FEMA

Cause	% of Accidents	Number of Accidents	Fatal Accidents	Permanent Disabilities not resulting in Pensions	Permanent Disabilities resulting in Pensions	Lost Days	Average cost per Accident (Rand)
Accident type N.E.C.	1.8	162	3	64	2	422	33,457
Caught in, on, between	7.42	667	1	57	2	5,066	13,472
Contact with electric current	0.52	47	1	6	0	497	60,006
Contact with temp. Extremes	1.5	135	1	7	0	807	16,472
Fall onto different levels	12.94	1,164	9	67	6	14,545	31,930
Fall onto same level	5.6	504	1	16	0	3,037	8,841
Inhalation, absorption, ingestion	0.99	89	2	2	0	74	21,127
Motor vehicle accident	10.89	979	62	42	8	10,040	49,753
Slip or over-exertion	7.36	662	0	16	0	2,300	8,718
Striking against	11.05	994	1	27	0	3,585	6,601
Struck by	39.89	3,587	10	106	2	15,794	8,564
Unclassified-insufficient data	0.03	3	0	0	0	54	8,594
	100%	8,993	91	410	20	56,221	17,206

FEMA

Cause	% of Accidents	Number of Accidents	Fatal Accidents	Permanent Disabilities not resulting in Pensions	Permanent Disabilities resulting in Pensions	Lost Days	Average cost per Accident (Rand)
Accident type N.E.C.	2.13	220	5	62	1	1,088	23,962
Caught in, on, between	7.58	782	2	91	4	9,810	14,907
Contact with electric current	0.57	59	1	2	1	553	38,891
Contact with temp. Extremes	1.36	140	1	8	0	1,100	16,963
Fall onto different levels	13.18	1,359	9	84	9	22,371	24,940
Fall onto same level	5.58	576	0	21	0	3,576	10,164
Inhalation, absorption, ingestion	1.16	120	2	2	3	193	26,081
Motor vehicle accident	9.2	949	31	38	7	12,766	36,192
Slip or over-exertion	6.55	676	0	16	0	3,637	7,714
Striking against	12.05	1,243	1	23	0	4,900	3,859
Struck by	40.61	4,188	20	115	7	26,485	8,707
Unclassified-insufficient data	0.02	2	0	0	0	0	0
	100%	10,314	72	462	32	86,479	14,088

Table 1.1 FEMA - Accident causes in the engineering environment.
(Screen data statistics generated on 2011-08-31).

According to FEMA (2011), the statistics presented in Table 1.1 indicate that contact with electrical incidents represents only 0.58% of incidents, yet the related fatality rate was 4.76% of all fatal incidents in 2011. Should motor vehicle accidents be taken out of the equation, then the percentage of incidents related to contact incidents would be 10% of the total. This indication of the serious consequences of electrical incidents warrants a different H&S management intervention than that of other environments.

Although the accident descriptions related to contact with extreme temperatures, fall onto different levels, fall onto same level, slip or over exertion or striking against an object can all be related to electrical construction and maintenance incidents, specific particulars of such incidents are required to confirm the statistics.

1.4 PROBLEM DEFINITION

The approach to H&S in South Africa should be expanded to take into account human behaviour factors related to the individual's psychological profile in relation to their capacity for analysing risk factors in a work environment.

Training is perhaps the most effective aspect that can influence and alter risk-taking behaviour and would be the most valuable tool that organisations can use to influence incident statistics. Challenges in training occur because even when large amounts of money are allocated towards H&S training, managers often do not consider whether or not training procedures and programmes are appropriate for the people being trained. It is important to consider these factors because training results are affected by peoples' cultural backgrounds and trainers' cultural knowledge.

Unfortunately, the same approach of inefficient H&S training programmes by South African organisations continues to occur, with inefficiencies, planning and service delivery across all Sector Educational and Training Authorities (SETAs) (Nzimande, 2010).

Organisations are not only exposed to risks that are due to negligence of employees, but are also exposed to intentional risk-taking behaviour that exists due to risk-taking behaviour from incorrect decisions made, and reasoning by individual employees, who believe their actions will bring higher gains than losses, and where such decisions or actions are outside the framework of the organisation's policies and procedures or the allowable scope of authority in decision making of such individual.

This type of risk-taking behaviour is perhaps more prevalent in third world countries than in the Western world. Perez and Gonzales (2007) indicate that maintaining H&S operations in third world countries is more challenging than in the developed world.

The role government departments and related governmental organisations play in influencing risk-taking behaviour are by means of creating legislation that would affect H&S performance. Previous involvement in H&S related organisations by the South African government was by means of funding, as in the case of the National Occupational Safety Association (NOSA), which funding ceased at the end of the 2001/2 financial year, and there is minimal interaction with this now privately owned organisation (NOSA, 2008).

According to Holton (2004), risk perception is a condition of an individual that is self-aware. Organisations, companies and governments are not self-aware so they are incapable of taking risks; rather, they are conduits through which individuals take risks.

Manager’s roles as examples of correct behaviour are critical where managers need to interact more directly with workers to influence risk-taking behaviour tendencies. Rogachev (2007) postulates that managers are primarily concerned with the risk of events that are very unlikely to occur, but could lead to catastrophic losses. Management would indirectly gain more from understanding individual risk-taking behaviour as it is the actions of individuals that can be conducive to major incidents.

The use of standards alone is no guarantee that an organisation’s H&S management system will reduce instances of loss. Standards used in South Africa in relation to H&S are usually developed or obtained from other sources such as the International Labour Organisation (ILO) where the ILO has numerous H&S standards and also provides further guidance by means of resolutions, codes of good practice and educational manuals.

The intention is that countries should use these documents as guidelines to formulate policies on H&S management (Mare, 2001; ILO, 2008). Regrettably these standards are usually used purely in a legislative enforcement process without any further management guidance for human factors.

The electrical construction environment is faced with unique problems, which in totality reflect on the wider problems facing construction in South Africa. Skills shortages due to a change in legislation and funding of apprentices, technicians and engineers and the ineffective implementation of training by selective SETAs has resulted in a shortage of trained engineering staff. Due to these factors and the ineffective management of applicable legislation and standards, the quality of services is deteriorating.

A study conducted by Paivinen (2006) to determine risk perception of electrical tradesmen, determined that the possibility of electrocution was not rated as a serious risk compared to that of working at heights. Paivinen (2006) postulates that electrocution may be such a closely work associated risk that its danger is underestimated in risk analyses by electricians.

Due to the physical environment of electrical construction, the perception of danger is related to competence rather than the reliance on human sense. In South Africa, electrical construction organisations cannot expect to manage H&S in the same context as other developed countries due to external factors that include, but are not limited to:

- A low skilled workforce;
- An expanding economy;
- A unique cultural diversity;
- A low level of investment in human capital;
- A history of a large section of the population not being exposed to technology, and
- A workforce that is being exposed to complex technology at too fast a pace.

Hall and Sandelands (2009) found that the profile of the engineering and construction industry in South Africa has been enhanced and demands for related human capital and leadership talent has increased. The primary challenge, for South Africa, lies in the development of basic skills, the procurement and development of strategic and professional leadership, and the protection of experience.

According to Liu and Low (2009), projects in the construction industry are generally seen to be more complex, compared to manufacturing where the operating environment is more sterile and stable. Effective risk management thus becomes more critical.

The electrical industry exposes workers to tasks where hazards are not always easily judged and Smallman and Weir (2003) state that the biggest problem for individuals is the ability to cope with task demands generated by both uncertainty and complexity, and the limits that are often imposed by the time frame within which such uncertainty must be dealt with.

When humans perceive a situation to be a threat they will either take actions to mitigate the risk, or if possible, to avoid the risk completely. Renn and Klinke (2001) state that perception refers to people's judgement and evaluation of hazards that they are, or might be, exposed to, and research in this context is important to academics for two main reasons. The first reason relates to the communication of risks. Since risk communication is designed to arm ordinary people with the information they require to make informed decisions about risks to their health, safety and environment, such communication cannot be effective without a comprehensive understanding of how people perceive and evaluate risks and why risk perception varies so much within a society. The second reason is that it is vital to know what concerns people and why, so that these views can be incorporated into important decisions.

This study investigated the influence human perception of risk has on managing H&S in the electrical construction industry of South Africa. It is assumed that with a better understanding of the electrical construction worker’s psychological perception of their work environment, a model can be developed that will address H&S more effectively.

1.5 RESEARCH OBJECTIVES

The primary objective of this study is to identify what role perception of risk has on individual risk-taking behaviour and the influence such behaviour has on H&S management in the South African electrical construction industry.

Various questionnaire surveys targeting the engineering fraternity, including design, operational and actual construction and maintenance workers were conducted.

Statistical units of analysis such as ANOVA, Tukey's HSD test and Fisher's exact test were utilised to evaluate the raw data and find correlations between hypotheses and sub-questions posed.

1.6 KEY ASSUMPTIONS

It is assumed that the research of human risk-taking behaviour in the electrical construction industry would indicate the need for a model that would address a different approach to managing H&S than what is currently utilised. Such model would not only address H&S approach from an H&S legislative perspective, but would also address the psychological profile of electrical workers to accommodate specific job-task parameters.

1.7 THE PROBLEM STATEMENT

The current approach of managing H&S in the electrical construction industry, by only concentrating on the enforcement of H&S standards and not taking cognisance of people's influence on such a system due to individual perception of risk, will result in no change in the rate of incidents that occur.

1.7.1 Sub-problems

The following sub problems have been identified:

Sub–problem 1: To identify what role and influence training can have on individual risk-taking behaviour.

Sub–problem 2: To ascertain if electrical workers are more prone to perceive hazards than others, whilst exposed to the same dangers in a working environment, and if so, could it be possible to find distinguishing characteristics that allow for the profiling of such worker segment of the electrical field.

Sub–problem 3: To evaluate what weight and effect cultural diversity has on influencing risk-taking behaviour.

Sub–problem 4: To determine if H&S legislation and H&S standards have an influence in altering perception of risk and the impact on individual risk-taking behaviour.

Sub–problem 5: To identify what influence management competencies have on electrical incidents.

Sub–problem 6: To determine if management practises can influence risk-taking behaviour and the effect that such practices have on electrical incidents.

Sub-problem 7: To ascertain if incentives and other gains promote risk-taking behaviour.

Sub-problem 8: To evaluate if more stringent policing of H&S requirements will lessen or prevent risk-taking behaviour.

Sub-problem 9: To determine what influence competencies in terms of experience and knowledge have on risk-taking behaviour.

1.8 THE HYPOTHESES

The initial literature study revealed a number of factors influencing human risk-taking behaviour. Based on these factors, or variables, the following hypotheses are proposed:

Hypothesis 1: H&S management systems can have an influence on risk-taking behaviour in either being a positive motivation on behaviour required or a negative due to incorrect guidance or knowledge overload.

Hypothesis 2: There is a clear link between individual specific task knowledge and risk-taking behaviour.

Hypothesis 3: H&S management practices do not address H&S in totality as cognisance is not taken of individual's risk-taking behaviour patterns.

Hypothesis 4: South African H&S legislation lacks guidance and does not incorporate the management of human psychological behaviour.

Hypothesis 5: Job task allocation should make use of the individual's risk-taking behaviour parameters in the allocation of specific tasks.

Hypothesis 6: A culturally diverse workforce produces work dynamics that influence individual perception of risk directly and H&S management systems indirectly.

Hypothesis 7: There is a difference in individual risk perception with resultant higher exposure to hazards in the electrical construction industry.

Hypothesis 8: Organisational recruitment systems can make use of individual's historical risk-taking behaviour patterns in the correct selection of candidates for high risk job tasks.

Hypothesis 9: Management can influence and have an effect on an individual's risk-taking behaviour.

Hypothesis 10: Incident statistical indicators should be the key component to continuous improvement of H&S management systems and should form part of performance evaluation appraisal systems.

1.9 THE SIGNIFICANCE OF THE RESEARCH

The purpose of this research is the evaluation of the influence of H&S management systems on human risk-taking behaviour and management practices, by identifying the psychological factors that contribute to an increase in an individual's risk-taking behaviour. The current approach to H&S management does not take into account the variable nature of human behaviour. By not addressing this aspect of H&S required incident targets cannot be met.

During the literature survey most aspects related to the research, research material specific to risk-taking behaviour of electrical workers, were limited. No such material could be located that targets the South African electrical construction industry and the important aspect of maintenance workers' risk perception and risk-taking behaviour tendencies.

This research aims to develop a 'job task to individual profile matching' model that is imperative for implementation in the electrical industry which, due to macro environmental influences, is urgently needed to stem the tide of high incidents, especially in the electrical construction field.

1.10 DEFINITION OF TERMS

Accident:

An accident is an "event that happens unexpectedly and causes damage, injury, etc." to a person or property." (Cowie, 1989)

The Occupational Health and Safety Act, Act 85, 1993 defines an accident as "an event arising out of and in the course of an employee's employment and resulting in a personal injury, illness or the death of the employee."

Competent person:

A competent person is "any person who has the necessary knowledge, skills and experience to perform a certain task." (Cowie, 1989)

In terms of the General Machinery Regulation 2 (5) of the OH&S Act, "there is a difference between *a competent person* and *the competent person.* The competent person is defined as being: a) an artisan; b) a technician; c) a graduate engineer, or d) a certificated engineer. These persons are appointed to supervise electrical machinery from 1000 kVA to 3000 kVA and above, depending on the electrical consumption of an electrical supplying authority, that is solely used for the distribution of electricity." (Lexis Nexis, 2006)

Electrical engineering:

Electrical Engineering is a "section of engineering that deals with the practical application of scientific knowledge in the design, construction and control of electrical apparatus." (Cowie, 1989) Electrical engineering is an engineering discipline that deals with large scale electrical reticulation networks such as power transmission and motor control. Electrical engineers work with electricity in its many forms, from large scale magnetic fields to designing of new product; they construct, operate, and maintain a wide variety of electrical systems and equipment (Armani, 2009).

Hazards:

Hazards are defined as: "Situations, objects or people that can cause danger or risk." (Cowie, 1989) Various hazards exist in work environments where exposure to objects or entities can cause risk or danger. According to Edwards and Holt (2008) clear duties are imposed on employers regarding management of hazards, such duties being particularly relevant to the carrying out of construction, and they include the identification and assessment of hazards. The approach to managing hazards is the identification, evaluation and selection of appropriate methods to either remove or limit exposure or, if not possible, to develop engineering methods to prevent exposure. Administrative procedures include training and provision of personal protective clothing.

H&S:

The term H&S refers to the health of the human body where the OH&S Act, 85 of 1993 defines healthy as: "being free from illness or injury attributable to occupational causes." Safety refers to the environment where a person would be protected from danger or harm in such environment. The OH&S Act, 85 of 1993 defines safe as being: "free from any hazard."

Risk:

According to Cowie (1989), risk is defined as "the 'possibility' of meeting danger or suffering harm or loss."

Every aspect of life is related to risk and the possibility of suffering harm or loss and the exposure to danger. Powers (2010) and Chapman and Cotton (2010) indicate that risk can be defined as a consequence of uncertainty, and uncertainty is nothing more than the absence of information. It is for this reason that the studies of probability and statistics are central to the understanding and management of risk. Kmec (2011) defines risk as an outcome of an event (or events), which is worse than the outcome in the expected, standard or usual case.

Tummala and Schoenherr (2011) and San Martín, Camarero and San Josè (2011) found that risk can be defined as a combination of probability or frequency of occurrence of a defined hazard and magnitude of the occurrence. Risk involves uncertainty regarding the outcome of a decision and the cost that this decision might imply.

Risk-taking behaviour:

Risk-taking behaviour is the manner of “treating a situation or environment without considering the damaging consequences.” (Cowie, 1989)

Yordanova and Alexandrova-Boshnakova (2011) indicate that a decision makers' risk-taking behaviour will be consistent with individual risk propensity, where risk propensity is a key construct used to characterize the tendency of a decision-maker to take or avoid risks. Risk propensity is conceptualized as an individual trait that can be changed over time, rather than as a stable and constant dispositional characteristic.

Risk management:

Risk management is “a broad concept applicable to organisational losses of both financial and human resources.” (Gupta, 2011)

Effective risk management can improve organisational performance. According to Gupta (2011) risk management has undergone a paradigm shift. It has moved from being ‘hazard type’ to ‘strategic type’. Risks are now not perceived as threats, but as potential opportunities. The focus of risk management has thus changed from all risks to critical risks. The management of risk is now commonplace in large organisations, where safeguards need to be in place to lower potential losses arising from uncertainties (Thompson and McCarthy, 2008).

Risk perception:

Yordanova and Alexandrova-Boshnakova (2011) define risk perception as “a decision maker's assessment of the risk inherent in a situation.”

Hung, Shaw and Kobayashi (2007) and Mahon and Cowan (2004) found that the biggest factor affecting risk perception is past experience of hazards.

That any similar behaviour involves risk in the sense that any action of will produces consequences, which cannot be anticipated with certainty, some of which at least are likely to be unpleasant. However, misleading personal experience can lead to risks being misjudged, so past experience can have either a positive or negative impact on risk perception.

Risk propensity

Risk propensity is the “extent to which a person is willing to take chances with respect to risk and the possibility of loss, reflecting his risk-taking behaviour profile.” (Mahon and Cowan, 2004)

There are three determinants of risk propensity (Mahon and Cowan, 2004):

Risk preferences: the differences between individuals, whether they prefer calculated risk or treat risk with disdain;

Inertia: the individual's tendency to handle risk related situations in habitual or routine ways, and

Outcome history: the history patterns of success and failure in risk-taking.

1.11 PREVIOUS RESEARCH ON RISK-TAKING BEHAVIOUR

The relationship between H&S and human risk-taking behaviour in the South African electrical construction industry is without a doubt a timely and necessary research topic with international as well as South African relevance.

To date most risk perception related research has been directed towards European and North American countries. A few studies have focused on countries such as China and Japan, but developing countries on the whole have been ignored (Thomson *et al.*, 2003). Mainelli (2005) indicates that it is necessary to recognise that people are only in the early stages of research into risk management. Many accepted tools and techniques that are modern today will be shown in future to be useless, wrong, or even dangerous.

Attention should to be drawn to the need for developing more quantifiable indexes to evaluate risk-taking behaviour to job task risk values that would act as a mechanism for limiting and lowering incidents caused by human risk-taking propensity and human error.

Cambraia *et al.* (2005) indicate that additional research is necessary to clarify the nature and frequency of the different types of human errors that have a high impact in the construction H&S environment. Such data can be used to assess whether current H&S management best practices are adequate to control human error.

1.12 SCOPE OF THE STUDY

The main role players in the electrical construction and maintenance industry in South Africa are individual electrical contractors, the Electricity Supply Commission (Eskom), electrical design engineers and technologists and the local electrical supplying authorities. Eskom is the main electrical organisation involved in generation, transmission and distribution of electrical energy to local authorities, from large metropolitan to small rural municipalities (Eskom, 2010).

The empirical research was limited to Eskom and to a lesser extent, members of the South African Electrical Contractors Association (ECA (SA)), the South African Institute of Electrical Engineering (SAIEE), the Institute of Certificated Mechanical and Electrical Engineers of South Africa (ICMEE), the South African Federation of Hospital Engineers (SAFHE) and members of the municipal electrical engineers organisation, the Association of Municipal Electrical Undertakers (AMEU).

The people involved in all phases of the various questionnaire surveys were engineers, technicians and electricians who are members of engineering organisations including: ICMEE, ECA(SA), SAFHE, the hospital group Netcare members only, SAIEE, Southern Cape branch only and AMEU.

Eskom employees and Eskom contractors, in all distribution regions of South Africa, that had been involved in engineering related incidents for the past three years (2008 – 2010) and all Eskom HR managers.

Various South African organisations have in recent years identified that there is a need for better incorporation and management of individual human behaviour parameters in existing H&S systems, this especially due to the impact of different cultural behaviour patterns and beliefs. This study will attempt to identify such unique patterns that influence individual risk-taking behaviour in an attempt to present a model that can address these aspects in current H&S systems.

The research study sequence is as follows:

- In Chapter one the introduction and aim of the research, the main problem and sub problem and the hypotheses are presented;
- The review of the literature relevant to the main problem addressing risk and risk-taking behaviour, the electrical engineering industry, the psychology of human behaviour, H&S and the human resource management (HR) environment are surveyed in Chapter two;
- The research design and methodology is presented in Chapter three, with an expansion on the research methodology, validity and research type. The review of the data relative to the sub problems and the questionnaire surveys presented;
- In Chapter four the empirical research findings are presented in various tables designed from the raw data;
- Chapter five presents the testing of the hypotheses, and the interpretation and analysis of the empirical research consisting of the principal questionnaire survey, the survey of incident case studies and the HR survey;
- In Chapter six a description with formulae for a model that addresses risk-taking behaviour to specific job task matching is presented, and
- The final chapter, Chapter seven, presents conclusions and recommendations on the main and subsidiary research questions.

1.13 RESEARCH FINDINGS

The research findings of Chapter 5 concur with the hypotheses presented in respect of the influence H&S management systems have on individual risk-taking behaviour. Further, the influence individual risk-taking behaviour has on incident statistics is found to have a meaningful impact that warrants acknowledgement in any H&S management system. Such risk-taking behaviour profile is influenced by the individual's cultural paradigm, work H&S culture, management systems and unique individual psychological traits in relation to risk-taking.

The research proposes a ‘job task to individual profile matching’ model that will attempt to quantify values of individual risk-taking behaviour and risk profile matching of specific high risk job tasks to be able to find the best ‘fit’ that would allow an approach to a possibility for limiting hazards and incidents.

1.14 SUMMARY

Risk is a part of life and is an inter-grained concept in the subconscious mind. Every action humans take has a subconscious calculation on the risk involved and the possibility for gain or loss. Actions taken are based on the individual belief that such actions will be to the person’s advantage, and is influenced by the individual’s psychological and cultural background. By understanding such parameters of the individual, better planning can be embarked on to reduce the future risk individual behaviour poses to an organisation.

Various designed questionnaire surveys were conducted to determine the impact of individual electrical workers’ perception of risk has on specific risk-taking behaviour in relation to job tasks with the resultant influence on H&S management systems. The questionnaires expanded on issues that were identified in the literature survey.

The findings of the surveys indicated that individual risk-taking behaviour is influenced by each individual’s perception of risk and has a direct impact on H&S management systems. The findings highlighted the impact of culture, education and experience that influence the perceptions of electrical workers in the manner they perceive risk and how hazards are approached.

A separate questionnaire survey conducted among HR managers indicates the need for a different approach to managing risk-taking behaviour by acknowledging difference in risk profiles and the need to quantify such values during recruitment and appraisal stages

The managers of critical tasks in environments such as electrical engineering need to be especially aware of the threat high risk-taking behaviour employees pose to the organisation.

With reference to the FEMA statistics presented in this chapter it is clear that electrical engineering requires more attention, in terms of H&S intervention, than currently afforded.

Due to the nature of maintenance and construction work in this field, a lot of reliance is made on the individual decisions of staff and contractors in electrical engineering and as such the profile for a tendency to high risk-taking behaviour should be investigated.

Human behaviour as a risk factor cannot be eliminated and will always have an impact on required H&S system performance. Organisations need to acknowledge the threat and rather invest in systems and procedures that will manage this difficulty in their H&S chain, to their best advantage.

The Chapter that follows covers the literature survey, which attempts to address the main problem and the sub-problems of the study.

CHAPTER 2: REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

To research all aspects related to human risk-taking behaviour and the impact on H&S in the electrical engineering environment requires:

- The evaluation and research of the psychology behind human behaviour;
- The aspect of the H&S environment related to operational activities of H&S institutions, training and legislation applicable;
- The operational and institutional management of the electrical engineering fraternity, and
- HR management related to recruitment and assessment of electrical workers.

The management of risk is an inter-grained process of all large organisations, where safeguards need to be in place to lower potential losses arising from uncertainties. Risk from uncertain human behaviour poses an even greater potential for loss and requires the same amount of attention, as other risk management systems such as financial risk, to prevent indirect losses. According to Thompson and McCarthy (2008), quantitative methods for evaluating risks of various management systems do exist. Such approach to quantify the risk posed by human behaviour should provide management with better options in mitigating risk factors posed by incorrect human behaviour.

Losses caused by human risk-taking behaviour necessitates the understanding of how individuals value and evaluate risk and to what extent their environment has an influence on their behaviour. Such environmental influences not only extend to the socio-economic spheres, but also encompass the culture, values and norms imposed on such individuals. Further, there are certain unique human psychological traits that appear to affect individuals, and cause them to cognitively behave outside their control due to environmental stimuli.

The electrical engineering construction and maintenance environment differs from other engineering fields in that working with electricity requires very little sensory evaluation for the determination of risk, but relies on knowledge gained from both formal training and heuristic learning.

Further, specialised testing equipment is required rather than visual or hearing sensory input, to determine the potential hazards in a specific job task environment.

Business institutions' main goals are profit. By limiting any losses, institutions will reach their profit driven objectives sooner. The acknowledgement of human behaviour as an indirect driver that affects profitability would require more attention to ways and means of better understand the risk component of human behaviour. Nuñez and Villanueva (2010) argue that all H&S systems should combine organisational interventions with human actions and therefore organisations should facilitate and ensure the adequate intellectual and physical capabilities of workers. By correct HR intervention, candidates could, according to their risk-taking behaviour profiles, be allocated job tasks that will reduce the organisational risk exposure, due the individual tendency to behave in certain unacceptable ways.

2.2 RISK

Risk in totality to an organisation is the threat of loss of any of its assets. In terms of its most important asset, human resources, the threat of loss of individual employees injuring themselves or others is a serious risk that needs management intervention. Smallwood (2000) states: "The determination of risk involves human judgment about physical properties and probabilities." According to Mitchell (1999), as referred to by Miller (2007), an objective measure of risk may be difficult to obtain, but that is not to say that it does not exist. All that can be easily measured is subjective or perceived risk. Instinctively, there would be a link between risk management strategy and organisational behaviour (Miller, 2007).

Every day people are forced to make decisions based on asymmetric information and unknown risks. A simple task, such as crossing a road, requires complex and instant assessments of probabilities of the risk environment, profiling the exposed risk on an unconscious level. Risk is something that can be quantified by using probabilities (Davidson, 2010). Cowie (1989) defines risk as, “the possibility of meeting danger or suffering harm or loss.”

Almost all human activities carry some form of risk where the levels of risk exposure differ according to a specific activity. Any action decided upon might lead to, but is not guaranteed to, result in some form of loss. This implies that the individual’s choice will have an influence on the possibility and level of loss (Ackermann *et al*., 2007).

The concept of risk is composed of probability and severity of harm. It has been found that risk ratings are closely related especially to perceived probability of harm rather than severity of consequences (Sjöberg, 2002; 2004). Furthermore, demand for risk mitigation is only weakly correlated with risk per se. Risk is usually defined as the product of the likelihood of some event and the impact, value or utility of its outcome (Maule, 2004; Hansson, 2005). Risk is the distinction between reality and possibility, where risk can be related to the probability of an incident occurring. According to Ridley and Channing (1999), risk reflects both the likelihood that harm will occur and its severity and hence these factors should be taken into account when undertaking either qualitative or quantitative risk assessment.

Chih Tsai, Hua Liao and Han (2008) indicate that scientifically, risk is defined as a measure of the probability of occurrence and the severity of adverse effect. Adverse effect indicates an outcome that does not meet the desirable expectations from a failure or risk event.

Accordingly, given a sub-risk event (E_{ij}), the risk (r_{Eij}) is measured as the product of the probability of occurrence of the risk event (P_{Eij}) and its severity (w_{Eij}) as indicated, therefore:

$$r_{Eij} = (P_{Eij})\,(w_{Eij})$$

Jones (2005) postulates that risk has both a frequency and a magnitude component that applies equally in all domains of society. Risk analysis methodology is useful when it meets the needs of the people making the risk decisions. If an analysis provides information regarding the effectiveness of controls in an environment, but decision-makers are looking for information regarding the probability of incidents and losses, then the methodology isn't useful.

Likewise, if 'key risk indicator' metrics are provided, but there is no clear linkage between the conditions described by the metrics and the probability of loss, then the metrics become little more than window dressing. Jones (2005) sums up the definitions of risk as the 'probability' of uncertain future events.

2.2.1 Risk management

Risk management to organisations comprises in totality the managing of all risk posed to an organisation and includes, but is not limited to financial risk, security risk and risk to assets, which embraces the most important asset, that of the H&S of human resources.

In managing risk in the H&S environment of the electrical construction industry in South Africa the possibility of risk must be assessed and means found to mitigate risk factors.

2.2.1.1 Assessment of risk

By performing risk assessments, organisations address issues that they do not usually recognise. Mass workplace injuries or illnesses and psycho-social risks such as stress at work or bullying. "The risk-hazard distinction is huge and it has a lot of implications" says Nash (2005). One implication of using the risk assessment approach is that it allows companies to prioritise where they will spend money to improve the working environment. Where the risk or the hazard framework assessments are used more, international organisations are deciding on a global H&S management system (Nash, 2005).

Findings on assessment of risk factors need to be correctly communicated to workers. Maule (2004) contends that issues concerning the translation of knowledge of risk, at an organisational level, depends on the identification, assessment and management of hazards within the workplace, so that the impact of communicating such risk factors will allow employees to act in ways that will minimise the occurrence of hazards. In such situations, effective knowledge translation of hazards depends, to a large extent, on effective communication from those assessing the risks to those exposed to them, in such a way that work behaviour reflects the changes by the information of these risks.

2.2.1.2 Risk mitigation

Demand for risk mitigation has been found, to be most strongly related to severity of consequences (Sjöberg, 2002; 2004). The term ‘risk’ is used when decisions or choices have to be made between different alternatives with uncertain future consequences. Edwards and Holt (2008) found that the probability of occurrences for some risks may increase or decrease with the passing of time; as may the impacts.

The increasing complexity of the modem world introduces multiple risks to humans, environmental safety and economic development. Mitigation is known as both the most efficient conceptual framework and most effective tool at the core of risk management, which incorporates hazard identification, analysis and evaluation of the treatment of risk and risk communication (Porfiriev, 2004).

The concepts of hazard, risk, hazard identification and risk management are fundamental to managing H&S, and environmental impacts. Therefore, it is important to understand that there are aspects of ‘impacts’ that are described as hazards or risks. Also, it is important to understand what hazards are; where the possible risks to exposed individuals are likely to come from; who are more vulnerable to these hazards and risks, and how the hazards or risks should be mitigated, eliminated, controlled or managed (Makin and Winder, 2009).

Mitigation or alleviation of hazard, in a risk environment, refers to the probability for limiting harmful consequences. Mitigating risk enables H&S issues to be considered from the point of view of institutional readiness and capacity to actively address the hazards associated with endeavours (Shepperson, 2008).

2.2.1.3 Risk of accidents

The actions required to be taken, emanating from an accident and the consequence of direct and indirect loss to an organisation or an individual needs planning. Bellamy, Geyer and Wilkinson (2008) found that when viewing the results across all accidents and failure patterns, the main impacts on human performance are due to socio-technical failures. These elements were evident in accidents and the repeated failure patterns (Slovic, 1997).

Four key themes were identified that best explained how accidents arose:

- Failure to provide people that can manage hazards, and who understand risk control requirements related to such activities;
- Failure to provide competent people to carry out tasks;
- Failure to prioritise, attend to and communicate the design of jobs, equipment and environment for specific tasks, and
- Failure to monitor whether risk control objectives are being met, to retain knowledge and memory about risk control, and to learn and adjust in order to prevent deviations or actions that could lead to loss of control.

The traditional view of industrial accidents reflects that accidents are produced by technological as well as individual human failures. Accidents are caused by a dynamic interaction of factors in the social and physical environments, that is, characteristics of the individual and the organisation as well as technical forces that have an influence in such environments (Bjerkan, 2010).

2.3 HUMAN RISK-TAKING BEHAVIOUR

Human behaviour relates to factors affecting psychology, sociology, and the anthropology of humans. Individual human factors that affect decision-making in taking or rejecting risks relates to both the external socio-environment as well as the individual's beliefs. Mahadevan (2009) argues that human behaviour patterns are the chains that still bind man from achieving goals. Mahadevan (2009) continues and states: "More than a hundred years ago it was said that people have nothing to lose, but their chains. Now the chains are, of course, not of their hands, but the chains of their brains."

According to Stranks (1994), human behaviour patterns affecting H&S are defined as a wide range of issues that include:

- The perceptual, physical and mental capabilities of individuals;
- The influence of equipment and system design on such person's performance, and
- The organisation's characteristics that influence such individual behaviour.

Human risk behaviour is dependent on various parameters, for instance, the differences in the behaviour of genders and the view of risk to oneself and to others. Women have been found to show a greater difference between personal and general risk than men, reducing the often quite large gender difference in ratings of general risk (Sjöberg, 2002). People on the other hand are more concerned about the risks to others than to themselves (Sjöberg, 2002).

We have to conceptualise this as a difference between personal and general risk; personal risk being the perceived risk to one's own person, and the general risk to others.

To determine what motivates an individual to either intentionally or unintentionally behave in a certain risk-taking manner there is a need to understand human motivational analysis. According to Domingo and Santiago (2008), the optimum amount of risk a person is prepared to take depends not only on uncertainty, but also on the person's risk preferences.

McClelland (1985) states that human motivation has to do with the ‘why’ of behaviour, as contrasted with the ‘how’ or ‘what’ of behaviour. A further criterion, such as boredom or job dissatisfaction, also influences attitudes towards risk and subsequent safety-related behaviour (Game, 2007).

When in threatening situations, people behave to protect themselves psychologically by denying unpleasant situations. Psychological denial is very common during the first moments of a fire when people find reassuring and benign explanations for the cues they see, smell, and hear. Avoidance explains why a person delays recognising the threat and spends long minutes ignoring the situation (Mitchell, 1999).

According to Mitchell (1999) risk is most commonly conceived as reflecting variation in the distribution of possible outcomes.

The role of unintentional actions in incidents, or as Sigmund Freud names it 'unconscious intent’, is a factor contributing to incidents that is not always taken into account. According to McClelland (1985) Freud‘s early work showed that peoples’ motives for what they do in everyday life are often unconscious. Human risk behaviour thus involves more than mere action or impulses.

The application of human behavioural factors requires an understanding of human capabilities and fallibilities so as to recognize the relationship between work demands and human capacities when considering human and system performance. The aim is to eliminate or reduce the chance of adverse behavioural outcomes that can lead to harm through accidents or chronic exposure to conditions adverse to health (Bellamy *et al*., 2008).

No person intentionally behaves in a manner that would cause him injury, but rather takes a risk based on a personal estimation or calculation that no harm will befall him. Individual risk behaviour is influenced by a person’s psychological and physiological make up, as well as environmental influences. The behaviour of a group of people, taking risks, is influenced by the way individuals in the group transfer beliefs to the group as a whole.

The individual's psychological make-up affects their attitude and behaviour towards H&S management in either acceptance or rejection of standards imposed on them. To understand why people accept certain risks and reject others there is a need to understand the psychological process that leads to either rejection or acceptance of risk (Trimpop and Zimolong, 2006).

Individual risk-taking behaviour is affected to the extent that the individual's abilities allow him certain actions. Navare (2003) says that behavioural aspects transcend all boundaries, in that people seek to manage the initiative and ability of those involved or affected by incidents, irrespective of boundaries.

Human H&S behaviour standards, incorporated in various legislation, have the aim of creating procedures that will limit or prevent any unhealthy or unsafe acts. Smallwood (2000) states that underwater diving accidents occurred because divers were so well trained in procedures that obvious, simple, and immediate solutions were forgotten or ignored. Professionalism, when superseded by a system, clouds an individual's initiative and judgment. The effect of standards in contributing to incidents by creating confusion and limiting 'common sense' is not always taken into account in legislation. The initial approach to H&S management was that sound controls and management of the physical environment could override human incompetence.

According to Navare (2003), focus on human behaviour rather than on procedures is not a new feature of risk management. In 1959, Heinrich introduced two views of risk management and control; the engineering view and the human-relations view. The former related to the physical causes of accidents while the latter required human action to be taken into consideration as most of the accidents were recorded as being related to human failure.

Individual risk-taking behaviour differs according to personalities and characters of persons resulting in high to low risk-taking behaviour. Aucote and Dahlhaus (2010) found that efforts to educate the public about high risk rock-falls in general may be insufficient when trying to change the behaviour of high risk individuals.

Thompson and McCarthy (2008) found that the most-utilised approach to the study of risk perception has been the psychometric paradigm, which originated in the work of the 'Oregon Group' in the 1980's. As defined recently by Pojasek (2007), the psychometric approach encompasses a theoretical framework that assumes that risk is subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional and cultural factors ... [and] with appropriate design of survey instruments. Many of these factors and their inter-relationships can be quantified and modelled in order to illuminate the responses of individuals and societies to the hazards that confront them.

Borgia, Segal and Schoenfeld (2005) found that many cognitive models explain motivation according to Vroom's 1964 expectancy framework. The Vroom model explains that an individual will choose among alternative behaviours by considering which behaviour will lead to the most desirable outcome.

If risk management is one of behavioural management then it is the behaviour that is the risk that needs to be managed (Navare, 2003).

2.3.1 Perceptions of risk

Sjöberg (2002) indicates that risk perception is not a question of emotion. The judgement of the size of a risk is an intellectual one, having only a weak relationship to an emotional dimension such as worry. With non-professionals the nature of risk perception is greatly affected by the level of their self-esteem, (i.e. how competent they consider themselves and how they estimate their own skills). Those who are uncertain and do not feel competent generally overestimate risk (Verez, 2009).

Behaviour is linked to perception of risk. Gstraunthaler and Day (2008) found that the greater the individual's perception of risk the higher the likelihood of action to reduce that risk. They proposed that the state of mind and emotional condition affected the individual's risk-taking behaviour. This is supported by the evidence that happier decision makers tend to be less risk seeking in situations where a meaningful loss may diminish their positive emotional state (Gstraunthaler, 2005).

According to Edwards and Holt (2008), construction managers assigned a greater risk index than did H&S managers. In view of construction managers' regular ‘contact’ with these risks at site level a person might consider what this observation signifies. For example, are construction managers over-reacting to the risks? Perhaps H&S managers should better communicate with their site-based counterparts in seeking to reconcile this apparent difference in risk perceptions, especially when deciding upon risk controls? (Jackson, Williams and Zainuba, 2003)

Alternatively, if training was embraced more often by construction professionals, then perception of risk and understanding of the subject would be more balanced among all who administer and deliver constructed facilities. Dey (2001) found that the probability and severity of risk factors are determined through active involvement of the experienced persons from the field in an interactive environment.

Trimpop and Zimolong (2006) conclude, from factor–analytical studies and interviews, that risk is assessed differently by the dimensions of controllability, voluntarism, dreadfulness and whether the types of risks are known. However, the relationship between causal inference and judgment of risk is dependent on the decision maker's point of view (Forman and Hunt, 2006).

Edwards and Holt (2008) found that a variety of reasons for human acts or omissions and their relationship to H&S failings in construction have been proffered, including, but not limited to: worker apathy; ignorance, which in turn can result from inadequate or absence of training and instruction; pressure to get the job done as quickly as possible, and lack of supervision. Swift (2009) found that people who believe that smoking does not have a harmful effect on their health, or that exposure to smoke in the environment did not bother or affect them, had a higher chance of smoking. These findings correlated with high risk-taking behaviour in a cognitive, self-convincing, approach to limit perceived risk in order to take such risk.

Aucote and Dahlhaus (2010) postulate that, **i**n combination with perceived severity and perceived susceptibility; perceived benefit significantly predicted previous high-risk behaviour of individuals.

How people evaluate, classify and value risk affects their decisions to either ignore, take action or avoid the circumstance a risk environment poses (Aucote and Dahlhaus 2010). Sjöberg (2002) found that high-risk takers were mostly found among those who had the lowest level of education. In the context of lowly educated construction workers it is assumed that risk-taking behaviour will predominate.

This correlation between competence and risk-taking behaviour indicates lack of knowledge rather than intent on risk taking. Edwards and Holt (2008) found that the aspect of appropriate training, education and instruction frequently found in construction literature must be a pre-requisite to achieving human H&S 'compliance'.

People's perception of risk related to a specific event is closely correlated to exposure to such events as shown below.

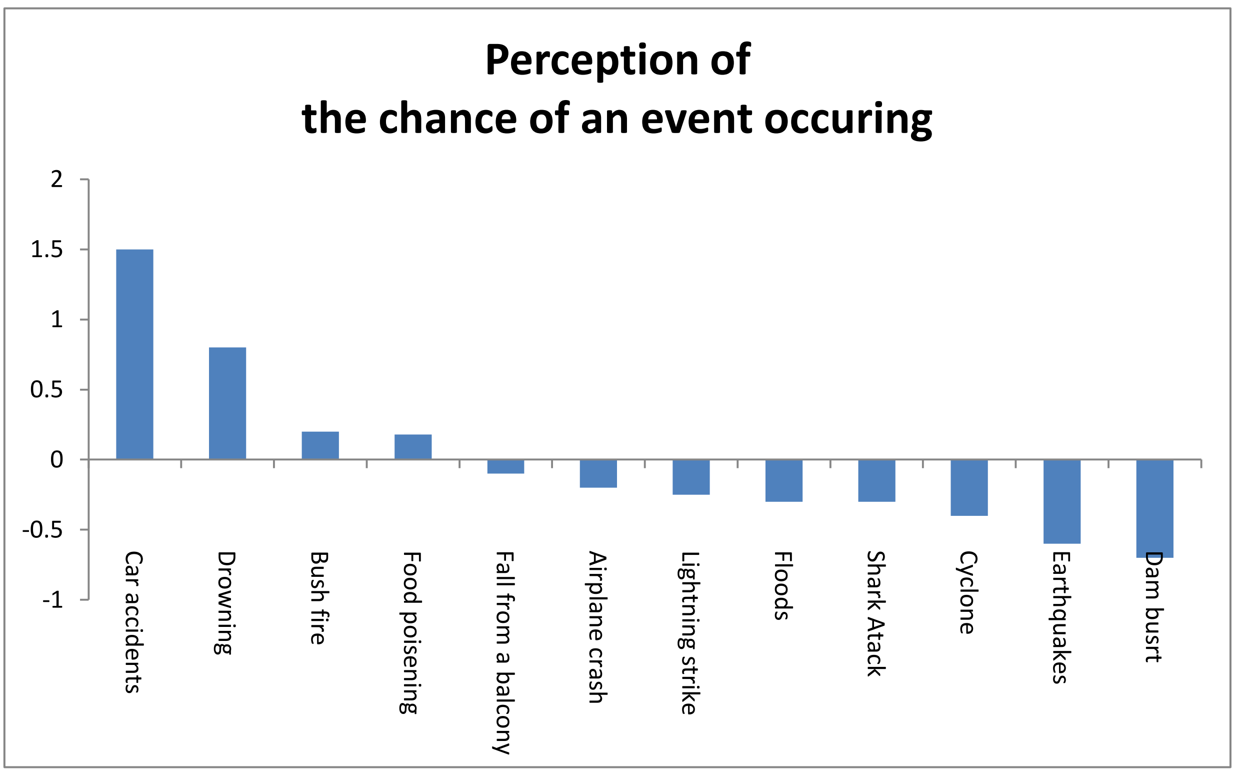

Figure 2.1 Perception of the chance of fatalities caused by each event
(Adapted from Aucote and Dahlhaus, 2010)

Figure 2.1 indicates that perception of the chance that a person will be involved in a fatal car accident is much higher than the fear of a shark attack, which relates to a higher daily interaction with events related to use of road transport.

2.3.1.1 Electrical workers' perceptions of risk

Electrical risk differs from other engineering risk in that sensory perception alone does not suffice for detecting electrical hazards. The use of specific test instruments and training are required to interpret the value of the risk entailed in relation to the values of voltage and potential electrical current that can flow.

The human 'feeling' of being 'safe', which is enforced by sensory confirmation of the environment, is not applicable in electrical engineering work as reliance must be made on the analysis and interpretation of technology measurements of electricity parameters that should then be accepted by the electrical worker. According to Wilde (Trimpop and Zimolong, 2006), people adjust their risk-taking behaviour towards their target level of perceived risk. This means that people will behave more cautiously and accept fewer risks when they feel threatened and conversely, they will behave more daringly and accept higher levels of risk when they feel safe and secure, or less threatened. Trust in instrumentation and the cognitive interpretation of an H&S work environment is crucial to electrical maintenance and construction workers performing job tasks in a safe manner.

2.3.2 Cultural influence on risk-taking behaviour

The effect and influence that culture has on the individual's decisions is of such significance that no decision is made without a subconscious cognitive process that will have an influence on such individual's decision being made.

The study of culture is helpful for understanding when and why people behave in a safe manner at work. According to Smallwood (2000), cultural values affect personal views about risk. Cultural values affect the way that people think and behave when faced with a safety-related issue.

Perez (2009) indicates that culture is a learned set of values that may take form in an organisation’s set of practices being interpreted through rules and norms of behaviour.

The effect of exposure to different cultures has dramatically increased with globalisation resulting in more inter-culture dynamics that organisations need to deal with. Lorenzo, Esqueda and Larson (2010) argued that multinational companies should localise H&S practices to address the important asymmetries between different regions of the world regarding social, cultural and infrastructural issues.

Those multinational companies are in a better position than national governments to identify, analyse and propose actions on certain transnational challenges that are better managed in developed countries.

Cultures are not limited to specific groups or organisations, but also to nationalities. A combination of specific nationalities results in a national culture that has shared behaviours, norms and values because it covers such large population groups that individual coherent beliefs are most strongly presented during threats to the nation in environments of war or in national sport activities. Societal perception of risk has its roots in social, cultural and moral acceptability factors. These factors influence the way people perceive risk and may ignore the possibility of an event's occurrence. Misleading personal experience can lead to risks being misjudged, so past experience can have either a positive or negative impact on the response of potential victims (Hung *et al*., 2007).

The impact of exposure to different cultures in an organisation will influence individuals to concentrate on the goals and objectives of the organisation rather than to concentrate more on individual cultural differences. The effect of different cultural interaction also influences attitudes towards a common organisational objective.

Cheng and Li (2006) proposed that it is likely that different cultural exposure experiences will result in different cultural and work values. Smallman and Smith (2003) hypothesize that a cultural shift occurs at times of crisis, whereby hierarchists, egalitarians and even fatalists will converge towards more individualistic behaviour.

Previously strong group structures are broken down by a crisis event and in the case of hierarchists their ‘rule book’ becomes all but defunct.

According to Zabel (2005) cultural factors serve as another set of reference points. Consequently, actual human behaviour is seen as a result of the interaction of genetic predispositions, environmental influences, cultural factors and situational necessities. Cultural norms have a direct influence on the individual’s perception of risk and to what extent risks will be taken. People who perceive that they are vulnerable are more likely to respond to warnings and undertake better or more effective protective measures. Thus, understanding how people will perceive risk provides the opportunity to form strategies that can give guidance on managing and preventing accidents.

Once individuals have determined an assessment of a particular risk, their opinions can be difficult to change. This seems to particularly be the case if they feel they know something about the subject, yet people are more likely to be swayed by expert opinion in areas about which they know nothing. They respect expert or authority’s opinion of the risk (Hung *et al*., 2007).

While much can be gained from focusing on how individuals perceive and act in the face of risk, to understand responses to risk and the implications of these for knowledge translation research needs to extend the focus beyond individuals to consider social and cultural factors. From this perspective, perceptions and attitudes to hazards are assumed to be shaped by the culture and 'world-views' shared by the social groups to which individuals belong, orientating to dispositions that determine not only how people evaluate information, but also, which information is attended to (Maule, 2004).

One of the major influences on the individual’s perception of risk of a specific hazard comes from their cultural background. Such cultural impacts are even more poignant in South Africa between different races, ethnic groups and unique cultures, ranging from Eastern and African to puritan Western cultures. This diverse cultural influence could have a negative impact on required work behaviour due to perceived and subconscious aggression towards different cultures.

For instance, due to the legacy of apartheid, various race groups might find it offensive to be instructed by, or supervised by, a different race group. This can result in deliberate erroneous actions.

Shepperson (2008) refers to 'The Leon Commission of Inquiry into Safety and Health in the Mining Industry' who stated: "Due to the unfortunate historical background of the country, the under-privileged section of the population has received a spotty, and in many instances, very inadequate education. These effects are compounded by the fact that the labour force on the mines is recruited from many national and cultural backgrounds. As a result the employees do not have a common language of communication, but speak several African and European languages." (Shepperson, 2008)

The deepest challenge confronting organisations with global H&S management systems is the tension between allowing for cultural differences and maintaining a common corporate philosophy and assessment tool. One way of balancing unity and diversity is to use general guidelines or more concrete corporate standards (Nash, 2005).

2.3.3 Sensory impact on risk-taking behaviour

The experience of man's immediate environment is the basis of information for their perceptions, however, perceptual attributes do not always correctly relate to the physical environment that people operate in or the interactive medium of their senses and the neurological sensory feed results in a unified perceptual experience (Dollard and Bakker, 2010).

Sensory impact on behaviour is to be alert or to pay attention to a specific task being performed. The correlation between lack of attention and incidents is well documented and also relates to overload of information or being distracted from being attentive to a specific task (Dollard and Bakker, 2010).

Human sensory functioning is a neuroscience process by which the human brain processes information of the environment through the input from its senses, and is the fundamental driver for concentration, emotions, learning, relationships, and productivity. It is an unconscious and unknown part of human behaviour, locked in the primitive brain (Lombard, 2011).

Shabha (2006) found that visual perception has been identified as playing a pivotal role in memory attention and learning. A distinction has to be made between sensory impairments and sensory perceptual impairments. The former refers to losing sight or hearing either partially or fully, whereas the latter is much more complex as it encompasses almost all the senses entirely. Although an individual may be able to see and hear perfectly well, their perception may be delayed and distorted, that is, their sensory inputs are mixed.

2.3.4 Ergonomic influence on risk-taking behaviour

Ergonomics is derived from the combination of two Greek words; 'ergon' (work) and 'nomos' (natural laws). It is a discipline involving the arrangement of a work environment to fit the people in it. The ergonomic process is basically aimed at prevention of work place illness and development of best possible workplace design.

Ergonomics is concerned with designing jobs by integrating socio-technical factors of the job and characteristics of the job holder. It is the science of balancing between employees and the work they do, providing a safer and more comfortable workplace solution for increased efficiency and enhanced productivity. The principle of ergonomics is to improve machine systems so that an employee can perform the job effectively. In a work place, human characteristics must match the machines and tools that people have to use (Naidu and Ramesh, 2011).

Technology and advancements in the workplace have their negative impact on the physical work environment. Employees see their jobs becoming increasingly dehumanized, which results in alienation and frustration.

In order to keep employees motivated, organisations would do well to start looking after the human needs at the workplace. Efforts must be made at improving working environments and conditions such as H&S, for this to happen the work environment should be made free from hazards or any other factors detrimental to the H&S of employees (Naidu and Ramesh, 2011).

Watson and Scott (2005) found that the approaches to improving H&S in the workplace should focus on the work environment itself, making it physically safer. The major thrust in this approach has been to revise policies, redesign jobs, and engineer ergonomically designed tasks with the human factor in mind. In recent studies, the importance of these factors has received increased attention commensurate with the surfacing of cumulative trauma disorders, such as carpel tunnel syndrome.

2.3.5 Competency and risk-taking behaviour

Individual decision for risk-taking behaviour relies on the competency of such individual, which is related to his experience of certain incidents and knowledge regarding risk factors related to a specific hazard.

In order to increase individual competency for better decision-making when exposed to a specific hazard the individual needs to be empowered with knowledge regarding the risk factor of such a hazard. Such knowledge empowerment would ultimately impact on the individual’s competency and has a direct relation to their risk-taking behaviour.

2.3.5.1 Knowledge and risk-taking behaviour

The more knowledgeable a person is regarding an exposed hazard the better options are available to mitigate or avoid the risk posed by such hazard. Humans do not want to close their eyes to hazards, they regard hazards to be in need of being mitigated, on the contrary, people are more interested in hazards from a sense of how spontaneous stimulation of emotions functioned, it was (albeit weakly) negatively correlated with perceived risk.

People apparently do not repress or suppress threatening information, they attend to it. This is in line with the current analysis of memory and trauma (Sjöberg, 2007).

How knowledge is gained and remembered regarding certain risk depends on various personal factors. A large body of findings indicates that individuals use a phonological code, such as speech or sound, to maintain information in short-term memory. For example, memory span is smaller for lists of phonologically similar words, or rhyming words, than for phonologically dissimilar words and smaller for lists of multi-syllable words than for single-syllable words. These effects hold irrespective of whether the lists are presented by auditory or visual means (Martin, 2005).

2.3.5.2 Experience and risk-taking behaviour

Experience carries a strong heuristic impact on the individual's decisions of specific behavioural responses when exposed to similar hazards than before. The psychological effect of an event to be remembered at the time of recall can vary. This variability increases as temporal distances increase, just as a drop of red wine in a tub of water diffuses.

The rate at which this variability increases with temporal distance predicts one of the two characteristics of the forgetting function and the characteristic of the level of accuracy of the event (Geoffrey, 2002). Depending on the intensity of the experience, time since the experience, the individual capabilities and the decisions made during such experience, correct future decisions can be made on exposure to similar hazards.

Heuristic learning is the process of learning by experience. Maule (2004) found that heuristic availability involves using the ease with which one can remember a hazard occurring in the past as the basis for determining the likelihood of it occurring again in the future. This heuristic knowledge gained from the experience has some face value, since events that have occurred more frequently in the past are, all other things being equal, both more likely to occur in the future and more readily remembered.

Offering a viable and relatively accurate way of assessing risk, either when no formal risk assessment information is available, or when people choose not to use such information because they are unwilling or unable to do so.

People often misinterpret risk statistics due to the use of heuristic thinking strategies and by taking account of qualitative factors of the hazard associated with its dread and unknown aspects.

2.3.6 Psychology of risk-taking behaviour

The link between psychology and individual risk-taking behaviour relates to those individual traits that manifest in specific behaviour. Accident causation models recognise the presence of an interactive or reciprocal relationship between psychological, situational and individual behavioural factors.

The common thread that can be found is the implicit or explicit recognition of the interactive relationship between psychological, behavioural and organisational factors. The organisational culture is reflected in the dynamic relationship between members' perception about, and attitudes towards, the operation of organisational goals and the presence and quality of the organisations systems and sub-systems to support the goal. The social cognitive theory suggests a good framework for analysing organisational and H&S culture, which assesses personal psychological factors and external observable factors in a dynamic environment (Järvis and Tint, 2009).

The impact of people's socio-economic environment on their attitude towards taking risk manifests itself through psychological behaviour traits. Underlying socio-economic differences in H&S behaviour are the differences in attitudinal and psychological variables of people.

People of lower socio-economic position have been found to be more pessimistic and have stronger beliefs in the influence of chance on affecting H&S issues. They are inclined to give greater weighting to present threats over future outcomes than people of higher socio-economic position.

Within affluent populations there are marked socio-economic gradients in H&S behaviour, with people of lower socio-economic position smoking more, exercising less, having poorer diets, complying less well with therapy, using medical services less, ignoring H&S advice more, and being less health-conscious overall, than their more affluent peers (Nettle, 2010).

The impact of a psychosocial H&S climate including, policies, practices, and procedures for the protection of worker psychological H&S relates to the freedom from psychological and social risk or harm. A low psychosocial H&S climate pre-emanates psychosocial risk factors at work capable of causing psychological and social harm through its influence on other psychosocial risk factors (Dollard and Bakker, 2010). The impact that transgressed to the work environment of the psychological paradigm of people of a lower socio-economic status cannot be ignored and needs to be taken account of in H&S management systems.

2.3.6.1 Neuropsychological

The view that workers' behaviour can only be linked to their inherent psychological predisposition and not to a physical condition results in various HR disciplines being incorrectly managed. The possibility of a neurological disease is not that uncommon in comparison to other recognised physical disabilities and has a direct impact on worker performance.

Neuropsychology attempts to measure deficits in cognitive functioning the ability to think, speak, reason. Neuropsychological tests may be recommended by a psychologist or psychiatrist when other tests indicate an unusual pattern of cognitive functioning, which would not ordinarily result from emotional or situational factors, or where the pattern points to possible neurological disease (Jay and Aletky, 2007).

According to CuiWei and Jun-fuGrey (2011), neuropsychology tries to explain the relationship between the brain and mental activity, or the relationship between the brain and individual behaviour. In theory, neuropsychology is the key to elucidate ‘psychology as the function of brain’; in practice neuropsychology provides methods and a basis for clinical diagnosis and therapy of behaviour affecting individual performances.

The tests used by neuropsychologists are specifically designed to measure psychological functions known to be linked to a particular brain structure or pathway.

Most psychological tests in current use are based on traditional psychometric theories, indicating that a person’s raw score on a test is compared to a large general population normative sample, which should ideally be drawn from a comparable population to the person being examined. That means they should have similar data in age, level of education, and so on. However, this is impossible in neuropsychological studies.

CuiWei and Jun-fuGrey (2011), state that neuropsychological studies try to develop theories that could give a reasonable explanation for behaviour of both patients and other people. In this process, the key part is to identify the damaged and the normal parts of a patient’s neuropsychological system.

Neuropsychology indicates that human behavioural evidence alone is inadequate for scientific progress since appearances of modularity can be thoroughly deceptive, obscuring both the dynamic processes of neural development and the end state of the individual’s real cognitive systems.

2.3.6.2 Psychophysics

Psychophysics is the study of the relationship between the characteristic of a specific experience and a physical stimulus. Such stimuli can be positive towards correct risk behaviour or have a negative influence (Dollard and Bakker, 2010).

The aim of psychophysics is to measure the subjective experience of a physical event. Psychophysical methods were developed early in the history of psychology and are used to measure the subjective experience of present events.

For example, a psychophysical approach to studying response to the outdoor temperature might be to measure the tendency to seek shade.

The action taken in response to a given temperature depends on current experience, which may be influenced by events that occurred in the past (Geoffrey, 2002).

People take account of the qualitative aspects of hazardous situations that are not included in formal risk assessments. These aspects, which are crucial in determining perceptions and attitudes to risk, can be classified into two general categories, labelled 'dread' and 'unknown'. Dread is associated with hazards that include such aspects as a perception of uncontrollability and having the potential to kill many people, as a threat to future generations and as associated with irreversible effects. The unknown factor is associated with hazards that are perceived to be unfamiliar and unobservable, where negative effects are delayed or unknown to science (Maule, 2004).

2.3.6.3 Emotional state

Disregarding changes and the psychological effect a worker's emotional state has in affecting their predisposition for risk-taking behaviour allows for increased possibility of incidents. The assessment capabilities of a person are greatly affected when in a good mood after just having been exposed to a serious incident. Sjöberg (2007) postulates that if emotion is driven by appraisal, it is reasonable to conclude that perceived risk gives rise to emotional reactions, and not the other way round. Emotions have frequently been assumed important in decision-making and risk perception. Of all emotions, the emotion that proved to be the most important in influencing an emotional state was anger, not fear. Fear and satisfaction (hedonic response) were about equally important, and clearly less so than anger.

The reason that people are involved and active with something is usually that they are interested and are in an emotionally positive state about their actions. In one sense or another, this is not as absurd as it may sound.

Even if a hazard is regarded as a threat, people may feel positive about acting on it, feeling hopeful that something is done to mitigate the risk, and increasing their self-esteem, especially if acted upon over an important societal issue. Hence, interest may be positively related to risk perception and risk attitudes (Sjöberg, 2007).

2.4 ELECTRICAL ENGINEERING RISK

Risks in the electrical engineering environment are unique, but also relate to other activities in construction and maintenance. Electrical workers are thus exposed to similar risks as in a construction and maintenance environment, but with the extra hazards associated with electricity.

Eskom General Instructions governing the operating and maintenance of high voltage systems, which apply to all high voltage apparatus, has the purpose of "ensuring the safety of all persons and to safeguard both apparatus and the continuity of supply." (Bizior, Sadler and Ferguson, 2010)

2.4.1 Electrocutions

Deaths caused by electrocution are usually accidental and rarely suicidal. The amount of current flow is the most important factor in deciding the degree of electrical injury, which may range from transient muscle tremors to death.

Most people think of electrical hazards primarily in terms of electrical shock and the related cardiac failure that can occur from prolonged contact with high voltages in alternating current circuits. The main effect, depending on 'Ohms' law is the amount of current that will flow through a person's body. This depends on the contact surfaces, the internal body resistances and the resistances of contact to a circuit return path (earth or neutral conductor). The corresponding current that can flow usually varies as the source in most installations can deliver very high currents in terms of the low currents the human body can withstand.

These low currents are measured in milliamperes (mA) rather than amperes (Amps) and their physiological effect can vary with each individual (Coyle, 2003).

2.4.1.1 Effects of electrical shock on a 68-kg person.

Current Level	Physiological effect	Likely Injury
1 - 10 mA	Perception threshold	Startle injury or fall
10 - 30 mA	Muscle paralysis	Inability to let go; respiratory test
75 - 250 mA	Cardiac fibrillation	Heart failure
4 - 5 A	Heart paralysis	Failure to restart (unlikely)
> 5 A	Tissue burns	Dependant on current path

Figure 2.2 Effects of electrical shock on a 68-kg person
(Adapted from Coyle, 2003)

Table 2.2 shows the effects of varying levels of shock on a typical 68 kg person.

Currents in the range of 75 to 250 mA, taking a path through the heart, may induce cardiac fibrillation by interfering with the normal electrical nerve activity that regulates the heart-beat. In a large facility, industrial or construction sites, exposure to voltages of 400V (volts) and above can produce higher levels of current that can burn human tissues as they pass through the body.

Extent of injury in these instances depends on the path the current takes through the body and the duration of contact. If vital organs are involved, these burns may be fatal; if not, they can still result in extensive muscle damage (Coyle, 2003).

Current follows the least-resistance path of muscles, blood vessels and nerves, often leaving only minor entry and exit wounds while causing extensive internal organ damage, which has the greatest effect on the cardio-vascular and nervous system.

For electrical contacts at primary voltage (over 600V), burns are almost the exclusive cause of injury and death from electric arcing, which can “reach out and touch you”, causing severe burns without any contact (Coyle, 2003).

2.4.2 Arc flash burns

Arc flash may be the greatest, yet least understood hazard that electrical workers face. Its danger is not just the risk of electrocution when maintaining switchgears, but also the equally deadly concussive blast effects and exceptionally high temperatures that instantly occur with a short circuit. In some instances all three effects occur in chorus further dropping the survival rate (Coyle, 2003).

The typical arc flash occurs in fractions of a second and without warning when electrical current, designed to move along a particular path, short-circuits either through the air to the wrong conductor, or to a ground path. The arc flash that results has been compared to looking directly at the noonday sun, and the temperature of the arc can be as high as that near the surface of the sun, about 5500 degrees Celsius (Coyle, 2003). Arc flash burns at high-voltage installations usually result in third degree burns with a high mortality rate due to the shock from such burns.

Secondary effects, to short-circuit conditions, usually include explosions, with perhaps shrapnel damage, and an intense sound pressure wave. To counteract such effects the trend is to install high-voltage switchgear in enclosed rooms, the results are that when an incident occurs the blast, flash, and temperature effects are further magnified. In older plants, where switchgear is sitting in open bays and standing on the turbine room floor gratings, the blast cone can reach out and ‘touch’ plant staff several floors away (Coyle, 2003).

Manufacturers design circuit-breakers, especially those that have to clear large fault currents, with special shots to ensure that when they operate on a fault the electrical arc is shot away from the operator.

A 10-year study by Électricité de France found that arcing caused 77% of all recorded electrical injuries. Similarly, one corporation noted that up to 80% of its electrical injuries involved thermal burns due to arcing faults. The US National Institute of Occupational Safety and Health (NIOSH) tabulated 44 363 electrical-related lost-workday cases from 1992 to 2001. Arc flash burns accounted for 39% of those cases (Coyle, 2003).

2.4.3 Working at heights

An inherent design of electrical installations and distribution reticulation systems are that such installations are constructed and installed at heights, demanding that electrical workers use various engineering and personal equipment to reach their working areas. The further impact of the risk of working at heights, for electrical workers, demonstrates the high demand certain job tasks place on the capabilities of such workers.

The Construction Regulations 8 (4) (b) incorporated in The Occupational Health and Safety Act, (Act 85 of 1993), state: “no person may work in an elevated position, unless such work is performed safely as if working from a scaffold or ladder”; where a scaffold is defined as any temporarily elevated platform and supporting structure used for providing access and supporting workmen or materials or both (Lexis Nexis, 2006). McGeer (2007) states: “any person working at a height of greater than 2m or at risk of falling 2m or more from one level to the next must be protected.”

The hierarchy of control, implemented after a risk assessment, demands that the first step is to try to engineer out the need to work at heights. Only when there is no alternative, should the last option, for the provision of personal protective equipment (PPE), such as safety harnesses, be considered.

Selecting the correct equipment to be used when doing regular inspection and maintenance or training employees are all critical issues when electrical workers work at heights.

The two common systems for fall protection are fall-restraint and fall-arrest systems:

- In fall-restraint systems the employee is prevented from reaching the position where a fall may be possible, and
- Fall-arrest systems are needed where the fall protection system must assume that a fall is possible. Even when using a restraint system, all equipment should be fall arrest rated.

Electrical workers, doing maintenance only and not involved in construction, can affect and endanger workers assisting on the ground, or other people in the vicinity, due to maintenance equipment falling.

Salentine (2011) found that a tool falling from any height is a problem. When a tool falls several hundred meters equipment and personnel below are in considerable danger. The worker who dropped the tool endangers everything and everyone below. Even a screwdriver that hits someone after being dropped just three meters may cause serious injury. A larger, free-falling tool, such as a cordless drill, could kill a person.

2.4.4 Vehicles and construction equipment

Motor vehicles and construction equipment such as a basket crane or hydra ladder, for aerial work are involved in most accidents relating to electrical work, as indicated in Table 2.1 of the FEMA statistics: Causes of incidents in the engineering environment, falling from heights in 2011 was 12.74% of all incidents and motor vehicle accidents 12.55 % of all incidents.

Electrical maintenance and construction workers are not only exposed to the dangers of vehicles they use, but also of other construction vehicles and equipment where such vehicles may endanger them, whilst busy with installation work above public roads or construction vehicles on sites. Further, most electrical workers spend a considerable period of their work time on public roads to reach work areas, resulting in a further risk exposure due to the dangers of vehicle accidents.

2.5 THE SOUTH AFRICAN ELECTRICAL INDUSTRY

70% of South Africa’s population have access to electricity, well above the SADC average of around 20 %, however nearly half of rural households in South Africa do not have power yet.

The supply of electricity in Southern Africa is dominated by the state owned utility of South Africa, Eskom, where Eskom generates around two thirds of the electricity produced in the whole of Africa and provides about 95% of South Africa's electrical power.

In South Africa power generation is still dominated by coal fired generating plants with a small capacity from hydro electricity and nuclear power.

The legislative control of the aspects related to generation, transmission, distribution and final usage are assigned to various government departments and are controlled by various legislation, quality management systems, and H&S standards (MBendi Information Services, 2011).

2.5.1 Electricity generation and distribution

Electricity is managed on a three-tier basis: generation, which includes all power stations of local and national generating authorities; transmission, which is the reticulation network that runs over South Africa and other African countries to final bulk users that includes local municipalities for towns and cities; and distribution, which is the final reticulation distribution network to end-users of electricity, including domestic, commercial and industrial users.

2.5.1.1 Electrical power generating organisations

The generation of electrical power poses similar and different risk to other maintenance and engineering activities, although H&S in the electrical engineering work environment is more regulated, due to better engineering management options.

Ensuring H&S compliance in relation to maintenance and construction of new generating facilities has the same risk exposure as the rest of the industry.

In South Africa, all independent electrical power generators must obtain a licence from the Department of Energy. The main power generator in South Africa is Eskom who generates approximately 95% of the electricity used in South Africa and approximately 45% of the electricity used in Africa (Creamer, 2011).

Eskom's main purpose is the generation, transmission and distribution of electrical power to industrial, mining, commercial, agricultural, and residential customers and redistributors (Creamer, 2011).

Eskom also buys and sells electricity to the countries of the Southern African Development Community (SADC). The future involvement of Eskom in African markets outside South Africa, to countries in Africa that are connected to the South African electrical grid, is limited to projects that have a direct impact on ensuring electrical supply for South Africa (Eskom, 2010).

The National Energy Regulator (NERSA) is a regulatory authority established as a juristic person in terms of Section 3 of the National Energy Regulator Act, 2004 (Act No. 40 of 2004), with a mandate to regulate the electricity industries in terms of the Electricity Regulation Act, 2006 (Act No. 4 of 2006). NERSA provides all independent power producers, including Eskom, with a license to supply electricity (Creamer, 2011).

The accessibility of other independent power producers (IPP), apart from Eskom, increased in August 2011, when the Department of Energy (DoE) published a request for proposals (RFP) for the first tranche of 3725 MW of renewable energy that is required to be in service by 2016 (Creamer, 2011).

This service will be provided by IPP where Eskom has been excluded from bidding on any of the renewable energy projects, its role was confined to that of buyer and to connecting the projects to its grid. Preferred IPP would need to conclude a power purchase agreement with Eskom, finalise a connection agreement with either Eskom or a local municipality and sign an implementation agreement with the DoE.

Wind energy projects constituted about 50% of the capacity, with the balance being solar power projects, including two concentrating solar plants, and one small hydro-power project. Projects are required to be delivering power to the grid by 2014, with the exception of the concentrating solar plant that has been given until 2016 to achieve delivery (Creamer, 2011).

2.5.1.2 Distribution and transmission of electricity

Electricity generation and construction in South Africa evolved into its current form as a result of historical developments and the need for energy. Initially, municipalities were responsible for generation and distribution to industrial and domestic users.

With the founding of a national electricity generator, the Eskom, few local authorities continued to generate electricity and Eskom became nearly the sole generator, apart from a few municipalities and large industries, to generate and manage the national electricity grid through its transmission network section. Metropolitan and other municipalities are now only responsible for distribution to consumers in their areas. In terms of ensuring that these municipal networks are managed in a safe manner, municipalities, in terms of The General Machinery Regulations of the Occupational Health and Safety Act, are compelled to appoint competent engineers (Oke and Omogoroye, 2007).

Today, in most instances, electrical distribution to consumers is the responsibility of local municipal suppliers who purchase bulk electricity from Eskom distribution and distribute it through the network to top domestic and industrial end users.

The AMEU is the main organisation representing municipal electrical engineers with stake-holders that have a direct interest in the electricity supply industry in Southern Africa. The AMEU promotes quality of service and management excellence amongst its members in the field of electricity supply, and facilitates communication between its members and between members and the technical, economic and political environment, in order to influence that environment.

In the interest of H&S for electricity distributors the AMEU provides an advisory service to its members and the customers of its members.

While every workplace is accident prone, there is a special status given to industries, such as electrical distribution, where the consequence of an accident has far reaching effects on the economy, the environment and public safety. Such installations are regarded as high-risk technology plants and H&S is of paramount importance to all stakeholders of such concerns (Oke and Omogoroye, 2007). The electrical industry, due to its strategic role in the South Africa economy, is of extreme economical importance and the effect of large scale power failures in 2008 was proof of the importance of this industry.

2.5.2 Training

Training is not a luxury, but a necessity that every employer faces. Skills development of human resources is not only critical in terms of being able to provide quality services and products to customers, but also to ensure employees are up-to-date with new developments in technology, in order for the organisation to stay competitive (Higgins, 2011).

The training of engineering staff in the electrical engineering industry encompasses artisans and technicians responsible for the maintenance and installation of plant, equipment and networks to that of design and project management engineers.

2.5.2.1 Apprenticeship

Apprenticeship programmes require both classroom and on-the-job training. Apprentices must demonstrate what they have learned through written tests and practical application, under less than perfect circumstances, demonstrating capabilities for real job-site performance. This ‘field experience’ means that apprentices must also know the appropriate H&S precautions and project management skills, not just have a basic knowledge of the task at hand (Higgins, 2011).

Digre (2011) stated that the electrical contracting industry is facing a critical skills shortage for a number of reasons. The skills shortage is due to many understandable factors such as the cost of training, the lack of encouragement to get young people to enter the industry and, most of all, the government and the relevant SETA‘s that are not really supporting the industry in skills development. The critical impact of this is the exposure of staff to unknown electrical hazards without correct or sufficient training.

The Minister of Higher Education and Training, Blade Nzimande, said that despite “significant work” having been done, “the economy remains constrained by a severe lack of skills, and so the skills development system as a whole has not yet achieved what was expected.” (Bonham-Colby, 2011)

Currently, the average age for registered electricians (i.e. installation electricians and master installation electricians) is 45 – 55 years. Accordingly, there is a great need for artisan training programmes and continual increase in qualified electricians. Lorraine Molapisi, national training manager for the ECA (SA), asserted that “when there is less training, the skills level of an industry decreases and this can affect the quality of work throughout that industry adversely.” (Digre, 2011)

According to Bonham-Colby (2011), training apprenticeships are tangible evidence of how management and labour, sometimes traditionally at opposite ends of the bargaining table, have joined forces to cultivate collaborative relations and streamline the worker's path from training and education to stable and lucrative employment.

The need for qualified electricians and related trades will only increase in the near future resulting in installation work that is not safe, not up to required standards and that poses a risk to users and technical personnel that will maintain such installations. Further, the H&S systems, applicable for safe installation work, are not being adhered to. The reasons for the lack of skills is the mismanagement of SETA‘s discretionary grants for employers not being paid out or delayed (Digre, 2011).

One of the major adverse effects of this downward trend is the diminishing interest of employers in indenturing apprentices for training.

It is a known fact that one of the major challenges holding back the skills development objective is the unavailability of workplaces that offer apprentices the opportunity to gain workplace experience and so complete their training. Having more and more employers discouraged from providing their workplaces for training and development presents a serious threat to achieving the set goals for skills development (Digre, 2011). Employee performance is directly influenced by the skills they have.

Companies should be concerned about their employee performance at work, which is expected to directly affect organisational performance (Cheng and Li, 2006).

2.5.2.2 Engineers and technician training

The main difference in training between the three categories in electrical engineering, namely electrical engineers, technicians and artisans, is that engineers usually complete a degree course at a university of a minimum of four years that consist mainly of theoretical classroom lecturers. Technicians study at Universities of Technology usually completing a three year diploma, but can also complete a 4 year B.Tech degree. These courses are not only theoretical in nature, but also consist of on-the-job training.

According to Garson (2011), Technikons offer more vocation-oriented education than the universities and their entrance requirements are less stringent. Technikons focus more on the technical study fields with an enhanced practical stance on training, as one third (e.g. one year) of the study period consists of on-the-job training and experience.

Artisans receive their theoretical training at technical colleges that are of a highly practical nature, where the practical hands-on component of the training outweighs the theoretical section of training in time spent in a class room. The training is usually in periods of 3 months, after which a relevant certificate is received.

2.5.2.3 Sector Training and Education Authorities

In March 2000, the then Minister of Labour, Membathisi Mdladlana, formally established 23 SETAs. These SETAs were to be concerned with learnerships, internships, unit based skills programs and apprenticeships.

The SETAs were established to ensure that every industry and occupation in South Africa was covered, with one of the primary objectives being to collect skills levies from employers within each sector, in terms of the Skills Development Levies Act, and make the money available within the sector for education and training.

This was to go to employers and training bodies, and to learners in the form of discretionary grants and bursaries.

In November 2009, Mr. Thabo Mashongoane (Skills Education Training Authority of South Africa) acknowledged in a statement that:

- There were negative perceptions about the performance, management and governance of the SETAs, and
- There was an inadequate alignment of industry needs relating to the provision of training and skills development, particularly in relation to artisans and technicians.

The effect of inefficient SETAs impacts negatively on artisans available in the electrical engineering environment. The SETA responsible for the electrical industry is the Energy and Water Sector Education and Training Authority (EWSETA) whose primary focus is to ensure the collection of information on skills development needs and to analyse such needs and develop appropriate qualifications and learning programs (EWSETA, 2010).

2.5.3 Engineering institutes and organisations

Engineering institutes in South Africa cover the different engineering disciplines and are controlled by means of registration on different levels of expertise.

2.5.3.1 The Engineering Council of South Africa

The body responsible for assessing competence of engineers and to register them according to specific categories is the Engineering Council of South Africa (ECSA). This statutory body was founded in terms of the Engineering Profession Act, 2000 (Act No. 46 of 2000). Following the repeal of the Engineering Profession of South Africa Act, 1990 (Act No. 114 of 1990), a new Act called the Engineering Profession Act, 2000 (Act No. 46 of 2000) was promulgated on 26 November 2000. The Act became fully effective on 28 August 2001.

ECSA (2011) sees itself as being in partnership with the State and the engineering profession to promote a high level of education and training of practitioners in the engineering profession, so as to facilitate full recognition of professionalism both locally and internationally. It enjoys full autonomy although it is accountable to the State, the profession and the public for the fair and transparent administration of its business in the pursuit of its goals. However, in pursuing these goals, ECSA has an implied responsibility to ensure that the interests of the profession (the practitioners) are also promoted. The interest of the public and the country can only be served properly if a profession is healthy and strong. For this reason ECSA promotes the well-being of the voluntary societies that are active in engineering. Since the societies are the instruments through which the interests of the practitioners are served, a good balance between 'public interests' (ECSA) and 'own interests' (society) should be maintained.

In terms of the Act (Act No. 46 of 2000) Section 18(1), as quoted below, the Act empowers ECSA to register persons in certain prescribed Categories of Registration: Professionals, Candidates and Specified Categories as expanded below (ECSA, 2011).

The categories in which a person may register in the engineering profession are:

(a) Professional, which is divided into:

(i) Professional Engineer;

(ii) Professional Engineering Technologist;

(iii) Professional Certificated Engineer, or

(iv) Professional Engineering Technician, or

(b) Candidate, which is divided into:

(i) Candidate Engineering Technologist;

(ii) Candidate Certificated Engineer, or

(iii) Candidate Engineering Technician, or

(c) Specified Categories, prescribed by the council.

Signatories of the following international education agreements have agreed to recognise:

- Washington Accord and recognition of B.Eng-type programmes;
- Sydney Accord and recognition of B.Tech programmes, and
- Dublin Accord and recognition of National Diploma Programmes (ECSA, 2011).

2.5.3.2 The Institute of Electrical Engineers

The main electrical engineering organisation representing electrical engineers in South Africa is the South African Institute of Electrical Engineers (SAIEE). The institute strives to be a leading and respected, learned society, of electrical engineers through the promotion of electrical science and its applications for the benefit of its members and the Southern African community, to have close contact with appropriate national and international organizations related to electrical engineering while recognizing achievement by advancement of individual members to higher grades of membership within the Institute and thereby enhancing the status of the profession (SAIEE, 2010).

2.5.3.3 The Consulting Engineers of South Africa

The Consulting Engineers of South Africa (CESA) is a voluntary organisation that promotes engineering work and provides quality assurance of engineering work done for clients. The quality assurance implicit in membership is underwritten by a programme of internal peer reviews, adherence to quality management systems, and the basic tenets of commercial viability, on which CESA members' businesses depend. Member firms are committed to continuous education, and to the 'uplifting' of their staff and the communities they serve. CESA members carry a required level of professional indemnity insurance, which provides clients with financial recourse in the event of non-performance, insufficient design, failure or neglect caused by the engineer (Pirie, 2011).

2.5.3.4 The Electrical Contractors' Association of South Africa

The Electrical Contractors' Association of South Africa (ECA (SA)) is a registered employer organisation registered in terms of the Labour Relations Act (LRA). The ECA (SA) is a non-profit entity with the focus to serve the industry and only generate funds to sustain it. Established in 1950, the ECA (SA) represents members and their interests in the labour relations arena and in the technical and regulatory mechanisms governing the electrical industry.

The membership of the ECA (SA) comprises approximately 3 000 electrical contractors, manufacturers and distributors of electrical components and equipment. The membership consists of over 50% of employers in the industry that in turn employs over 70% of the industries employees. With offices in the major centres throughout South Africa, the ECA (SA) is well placed to provide a wide range of essential services designed to assist contractors and enable them to offer their clients work that is guaranteed, competitive, professional and safe. Among others, the ECA (SA) offers ongoing advisory and support services on matters such as technical, labour relations, legal, contractual and marketing. Additionally, the ECA (SA) offers a wide range of training products for electricians, learners and contractors (ECASA, 2011).

Engineering practices in different countries might not be the same due to differences in standards and electrical contractors may usually not work in another country without being re-registered. The regulators in each country have different definitions of what the various classes of registered people can do (Fissenden, 2011).

2.5.3.5 The South African Bureau of Standards

The South Africa Bureau of Standards (SABS) is a statutory body that was established in terms of the Standards Act, 1945 (Act No. 24 of 1945) and continues to operate in terms of the latest edition of the Standards Act, 2008 (Act No. 29 of 2008) as the national institution for the promotion and maintenance of standardization and quality in connection with commodities and the rendering of services (SABS, 2010).

SABS publishes national standards that it prepares through a consensus process in technical committees and provides information on national standards of all countries as well as international standards.

Activities of the bureau, related to the electrical engineering environment include:

- Production of tests and certification for products and services to set standards;
- The development of technical regulations (compulsory specifications) based on national standards and monitors, and enforces compliance of such with technical regulations;
- Monitors and enforces legal metrology legislation;
- Promotes design excellence, and
- Provides training on aspects of standardization.

With a view to maximising its service delivery to the industries it serves, SABS recently aligned its activities with seven different industry sectors, each housing the whole range of SABS services pertinent to a particular industry. This change ensures easy access to products, faster reaction and turn-around times, and the creation of centres of knowledge excellence, such as electro-technical, that will be easily available to clients (SABS, 2010).

2.5.3.6 The South African National Accreditation System

The South African National Accreditation System (SANAS) is recognised by the South African Government as the single National Accreditation Body that gives formal recognition of competency of test facilities for Laboratories, Certification Bodies, Inspection Bodies, Proficiency Testing Scheme Providers and Good Laboratory Practice (GLP) and certifies them to be proficient test facilities (SANAS, 2011). SANAS certificates and their accompanying schedules are a formal recognition that an organisation is competent to perform specific tasks.

SANAS Acronyms:

- GLP - General Laboratory Practice;
- IAF - International Accreditation Forum;
- IEC - International Electro-technical Organisation;
- ISO - International Standards Organisation, and
- OECD - Organisation for Economic Co-operation and Development.

SANAS is responsible for the accreditation of Medical Laboratories to ISO 15189:2007, Certification bodies to ISO/IEC 17021:2006, ISO/IEC 17024:2003 and 65:1996 (and the IAF interpretation thereof), and laboratories (testing and calibration) to ISO/IEC 17025:2005. Inspection Bodies are accredited to ISO/IEC 17020:1998 standards. GLP facilities are inspected for compliance to OECD GLP principles (SANAS, 2011).

2.5.4 Consumers

Consumers of electrical appliances and services are, to a large extent, exposed to weighty marketing strategies and are usually not knowledgeable about the inherent dangers or threats to their H&S of the appliances or the usages of electricity.

2.5.4.1 Services and equipment

Due to a mostly uneducated, and in some instances third world, approach of South Africa's consumers, the quality and safety of appliances in the market need to be regulated to provide protection, especially to the vulnerable, such as children and consumers without specific technical knowledge. Products must not only be safe to use, but must also provide the user with inherent protection should such appliance or equipment be used incorrectly (Smith and Keeney, 2005).

Consumers should assess the advantage against the trade-off risk of using certain products. Usually their beliefs are in complete trust of authoritarian control in ensuring safe and healthy products in the marketplace.

Evaluating risk to an individual's H&S and life and to support decision-making about investments in H&S, the decision maker's ability to adjust consumption over time in response to changes in expectations about H&S, results in a trade-off between financial gains or losses and improvements or reductions in H&S (Smith and Keeney, 2005).

2.5.4.2 Equipment and appliance manufacturers

Consumers, due to their limited knowledge on the technical risks related to electrical appliances are exposed to possible injuries from electrocution and mechanical aspects, when using such appliances. They therefore need to be assured that under normal usage and operation appliances should hold no risk to their H&S.

The Consumer Protection Act, 2008 (CPA) came into effect on 1 April 2011. This Act regulates the supply of goods and services to consumers, and provides for a range of protection and rights to which suppliers of goods and services must give adherence. In terms of this new act, consumers of electrical services and goods are protected in the event of harm caused by defective products and the act gives rights to claimants seeking damages for harm caused by defective products (Bowman Gilfillan, 2011).

Section 56 of the CPA provides for an implied warranty of quality in respect of goods supplied to a consumer, in that each of the producer, importer, distributor and retailer of a product gives an implied warranty of quality in respect of a product in any transaction or agreement for the supply of those products (Bowman Gilfillan, 2011).

2.6 THE H&S ENVIRONMENT

The role players in the H&S environment are the creators of standards, legislation and guidance notes, the consultant's trainers and conveyers of such information, the end users in industry and the wider public (Bowman Gilfillan, 2011).

H&S covers all aspects of society and is intertwined in all actions of all people. It relates not only to the physical environment, but also to the psychological disposition of people that might have an impact on H&S.

The view of policing to a self regulatory H&S environment should depend on the severity of outcome due to human error. The competence of conveyors of H&S knowledge such as H&S consultants and officers, is important, as such people need to not only have knowledge of H&S legislation and standards, but also of the specific field they operate in.

2.6.1 H&S organisations

Various H&S organisations operate in South Africa and internationally with the aim of creating a platform where their members could get access and be exposed to pertinent and relevant H&S information.

2.6.1.1 International H&S organisations

The International Labour Organisation (ILO) guidelines on occupational safety and health (OSH) management systems (ILO-OSH, 2001) were adopted at a tripartite meeting of experts in April 2001.

These guidelines are more flexible than an ISO standard, because “people have to respect existing local approaches” according to ILO H&S expert Seiji Machida (Nash, 2005).

In 1999, the British Standards Institution (BSI), an ISO member, began work on an assessment specification for Occupational Health and Safety Management Systems, but because this effort competed with the ILO, it provoked some opposition and the standards haven’t won official ISO approval. Still, the BSI standards, Occupational Health and Safety Assessment Series (OHSAS) 18001 and 18002 are now available, and some companies are using them (Nash, 2005).

Various H&S organisations operated in western and eastern countries specialising in certain aspects of H&S. The Institution for Occupational Safety and Health (IOSH) is seen as one of the biggest professional H&S membership organisation.

The International Commission on Occupational Health (ICOH) is a world leading international scientific society in the field of occupational health, whose aims are to foster the scientific progress, knowledge and development of occupational H&S in all its aspects (ICOH, 2010).

2.6.2 Legislation

The Occupational Health and Safety Act (OHSA), Act No. 85 of 1993, replaced the Machinery and Occupational Safety Act, Act 6 of 1983 and came into operation in January 1994. The objectives of the OHSA are to provide for the H&S of persons in connection with the use of plant and machinery and the protection of persons other than persons at work, against hazards to H&S arising out of, or in connection with, the activities of persons at work, and to establish an advisory council for occupational H&S (Swanepoel, Erasmus, van Wyk and Schenk, 2003). In the context of the electrical environment, H&S can be seen as the protection of people from electrical and mechanical hazards attributed to the work environment of electrical construction. Incidents in the electrical construction environment usually have more direct and immediate consequences than those in other industries.

OHSA differs from many areas measured by managers because success results in the absence of an outcome in the form of accidents or illness, rather than the presence of well-managed incidents (Swanepoel *et al*., 2003).

The OH&S Act defines a 'healthy person' as being free from illness or injury attributable to occupational causes, and 'safe' as being free from any hazards (Lexis Nexis, 2006).

Barack Obama is quoted as saying: "A good piece of legislation is like a good sentence or a good piece of music. Everybody can recognise it. They say it works. It makes sense." (Hirsch, 2001)

In the past South Africa relied heavily on importing and adopting the H&S standards of other countries.

According to the safety standard in the South African National Standards (SANS) 10142, the wiring of premises for low voltage installations is based on a similar British wiring standard. Hirsch (2001) postulates that by uncritically adopting complex, untested regulations that are not properly adapted to man's needs and requirements, South Africa can become in danger of being swamped by imported over-regulations.

Waring (2002) postulates that an alternative to prescriptive H&S legislation is legislation that affords more self-regulation, with industry policing it rather than governmental inspectors. The latter has been the approach in South Africa with the establishment of more approval of independent inspection authorities. These authorities indicate that although it has been argued that the principle of self-regulation, which has underpinned the UK's H&S legislation in general, has failed. Australia has now also adopted a self-regulatory H&S framework similar to that of the UK, and Singapore are also scheduled for change from prescriptive to more self-regulatory legislation.

2.6.2.1 Policing H&S

The two South African Government departments involved in H&S legislation are the Department of Labour (DoL) and the Department of Mineral and Energy Affairs (DMEA).

In South Africa mining deaths consistently exceed 160 per annum. The DMEA's strategy is to place more emphasis on rigorous enforcement of the Mine Health and Safety Act with an aggressive drive to prosecute employers for H&S lapses (Badenhorst, 2011).

Based on a comprehensive literature review and documentary analysis, it was found that current predominant management discourse and practices focusing on diversity and H&S management systems resonate well with government and corporate preference for the business case and self-regulation. However, the centrality of individual rather than organisational factors in diversity and H&S management means that systemic discrimination and inherent workplace hazards are downplayed, making it less likely that employers will initiate the structural remedies needed for real change. Thus, reliance on the business case in the argument for self-regulation is problematic.

In terms of government policy and management practice, the business case needs to be supplemented by strong, pro-active legislation, and worker involvement (Badenhorst, 2011).

Hare and Cameron (2011) found a linear relationship between H&S performance and the time the H&S manager spent on site; those always on site had the lowest accident rates, those occasionally on site rated higher, and those not on site, were rated the highest.

2.6.3 Management systems and H&S

In recent years, the quality of H&S requirements in many countries has become more stringent. Pressures have led to the enacting of new H&S legislation and H&S standards.

Many organisations in the Americas, Europe and Asia Pacific regions have adopted H&S management practices to control hazards and risks better and to resolve workplace problems and accidents. These H&S management practices may vary with the types of organisation and the stages of organisational development. Badenhorst (2011) argues that H&S management practices help organisations to manage H&S risks and comply with H&S legislation. Ineffective H&S policies can contribute to the causes of accidents, it is therefore necessary for an organisation to install a set of H&S management practices and to be capable of foreseeing the potential risks.

Use of self-regulation, safety charters and benchmarking are among the common approaches of H&S management practices in industry. Many organisations also employ international and national H&S standards as guidance to develop their own H&S management systems (Badenhorst, 2011).

There has been a move to self-regulating in occupational H&S management. Many organisations are heading a trend towards the establishment of a set of H&S standards for various disciplines.

OHSAS 18001 is the specification standard for development, maintenance and improvement compatible with ISO 9001:1994 (Quality) and ISO 14001:1996 (Environmental) management systems standards, in order to facilitate the integration of quality, environmental and occupational H&S management systems (Badenhorst, 2011).

The concepts and philosophy of total quality management (TQM) have gained worldwide acceptance. Many studies have reported that TQM has helped many companies to increase their competitiveness, effectiveness and productivity. The philosophy has sparked improvement in specific areas, such as customer relations and participation, process control and teamwork (Badenhorst, 2011). Badenhorst (2011) claims that other authors also argue that TQM success can produce H&S management success. H&S management can be combined with quality management to create a synergy.

An occupational H&S management system is a set of interrelated elements that establish occupational H&S policy and objectives, and mechanisms to achieve those objectives in order to continually improve performance (Lyon, 2005).

Beckmerhagen, Berg, Karapetrovic, and Wilborn (2003) indicate that the basic framework of H&S management includes four processes:

- Definition of the H&S requirements of the organization;
- Planning, control and support;
- Implementation, and
- Audit, review and feedback.

Ultimately, the objective of an H&S management system is to provide assurances that there is protection of individuals, public and the environment.

Beckmerhagen *et al*. (2003) proposes that due to the proliferation of ISO 9000, ISO 14000, BS (British Standards) 8800 and other function-specific Management System Standards (MSS), a need has emerged to somehow integrate them in order to reduce costs and redundancies. At the same time, it has become imperative for organisations to continuously improve their overall quality, environmental H&S and even public accountability performance.

Construction sites rarely progress as originally planned. Worker teams are engaged through local labour supply and workflow is frequently affected by weather conditions and the availability of local labour (Beckmerhagen *et al*., 2003). Furthermore, building projects are very complex, involving thousands of parts and components. Building parts and components are mostly made or assembled on site, and standardisation is rather low, often causing adjustments during the construction phase, without any report of the adjustment on the original building plans. Consequently, the management of construction sites is complex and fatal accidents are not uncommon (Giretti, Carbonari, Naticchia and De Grassi, 2009). According to du Toit (2005), performance measurement of occupational H&S systems differs from many other areas being measured by managers, because results are not given in an outcome value in the form of an accident or illness.

A low accident or ill-health rate, even over a period of years, is no guarantee that risks are being controlled, or that they will not lead to accidents or disease in the future. This is particularly true in organisations where there is a low probability of accidents, but where major hazards are present. The historical records of illnesses can be deceptive indicators of H&S performance.

2.6.4 Performance measurement within H&S systems

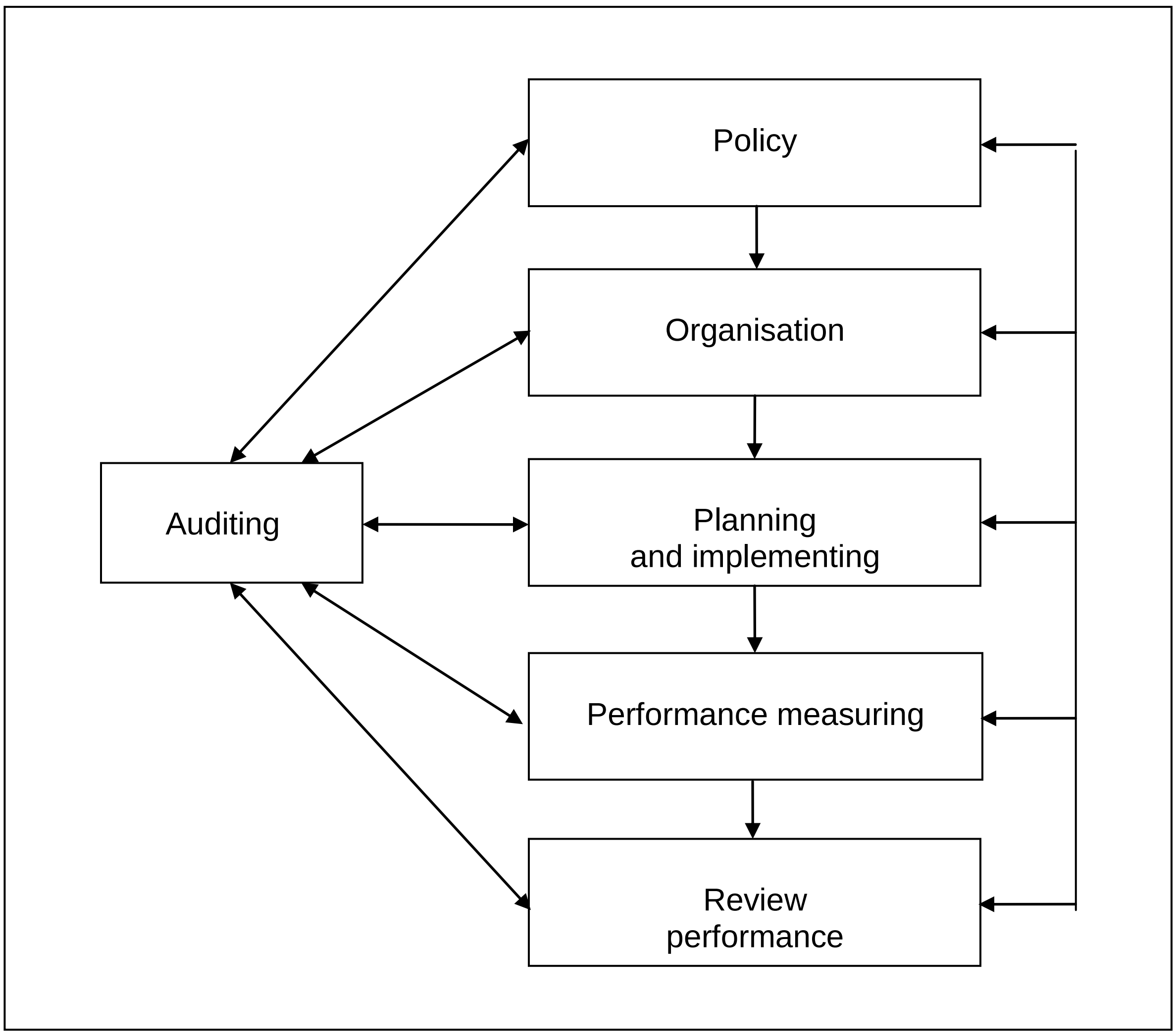

Figure 2.3 Performance measurement within H&S systems
(Source: Adapted from HSE, 2001)

Figure 2.3 indicates the interaction of an organisation’s policy on H&S, and the auditing process of such a policy for its successful implementation in the work environment. The importance of measuring performance and the review is indicated in the figure.

Continuous improvement is a critical requirement for optimal functioning of an H&S system. According to Lyon (2005), a continuous improvement cycle generally consists of the PDCA model: Plan, Do, Check and Act. This means planning policy (Plan), implementing policy (Do), assessing and reviewing policy (Check) and making necessary adjustments or corrections (Act).

2.6.5 Management by expertise

Due to the complex nature of specialised task planning and organisation, H&S management systems must take into consideration the requirements of new specialist areas that are being established.

Management models for H&S provide opportunities for limiting organisational loss of resources. A specific model, ‘management by expertise’, as developed by the author, du Toit (2005), is indicated in Figure 2.4 below. The model is based on the legislative requirements for the functioning of the H&S management system as stipulated in the Occupational Health and Safety Act, (Act 85 of 1993) Section 19, with input given by experts in a medical environment.

A few years ago company technical services largely consisted of a maintenance team responsible for plant and building maintenance, including the electro/mechanical interface with plant and equipment, and − to a lesser extent − for the management of specialised equipment.

The aim of the model 'management by expertise' is:

- To make use of expertise in specialist fields that are available in organisations;
- To assist the legislative management framework of an established H&S committee, and
- To identify clear managerial functions of an H&S management systems in order to indicate the position and functions of the manager of such a system in relation to the chair of an H&S committee.

Should the requirements of the Occupational H&S Act not be taken into consideration, as is the case in small enterprises with fewer than 20 employees where an H&S committee is not a requirement, management alone would be responsible for ensuring a healthy and safe environment. Many valuable and practical ideas originate from operating personnel, and they may more readily accept new policies and procedures if these procedures arise from other operating personnel. The one-sided approach of managing H&S only with the expertise of management thus has the disadvantage of enforced compliance.

2.6.5.1 Occupational H&S management by expertise

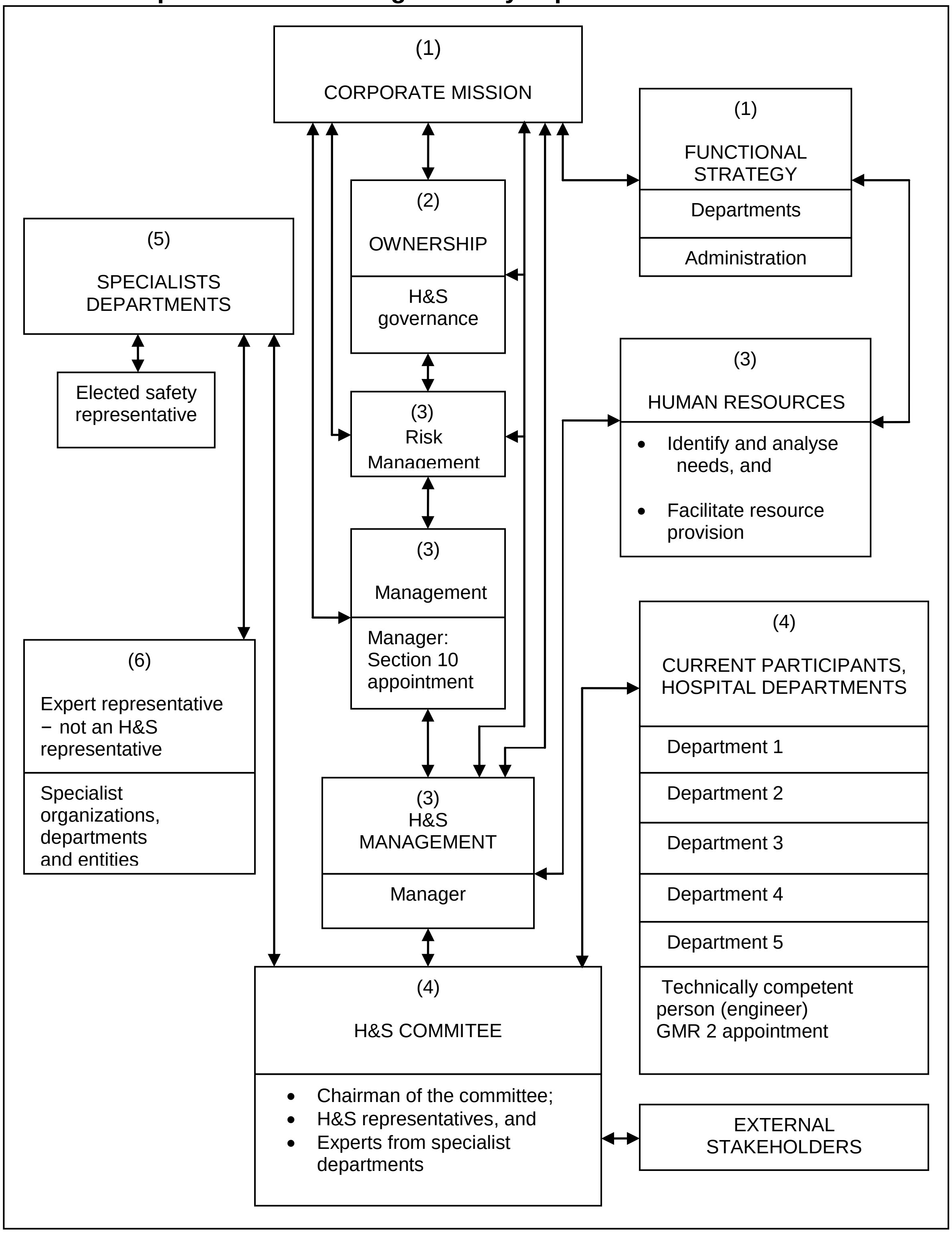

Figure 2.4 Occupational H&S management by expertise

(Source: Flowchart developed by researcher).

As shown in Figure 2.4, the model is based on the legislative requirements for the functioning of an H&S management system as stipulated in the Occupational H&S Act, (Act 85 of 1993), Section 19. The input given by experts is due to their specific knowledge of their working environment. The experts do not need to be H&S representatives, but they could perform this function as well.

It must be noted that expert input into the H&S committee is not dependent on their attendance at meetings. Rather, they can channel their specific knowledge and experience into the work of the H&S committee.

2.6.5.2 Procedure for implementing management by expertise

As illustrated in Figure 2.4 the model creates a framework for the inclusion of expert knowledge. The model is interactive: each step permits both exchange of data and feedback where the model can be implemented by any organisation that has specific departments with unique expertise.

As indicated in Step 5 of the model, specific departments or fields of expertise need to be identified. The importance of correctly identifying such distinct fields must be based on their uniqueness of procedure and work method. The correct identification of field expertise will prevent interference from other specialists.

After the identification of these fields of expertise, they should be evaluated against the influence they have on H&S, and at what level in the institution. Should their input be negligible, such fields could become part of another closely related field.

This model should assist institutions with clear guidance on H&S management. In so doing, it will assist the overall risk management process. Organisations with a dynamic environment that are constantly being exposed to external forces, should factor this into their use of the model.

The various steps for implementation of management by expertise (Figure 2.2) are as follows:

Step 1: Corporate Mission

The mission should be the identification of services offered to the primary target group, as well as the organisation's managerial philosophy and the image that it wants to create in relation to H&S. The organisation's H&S policy should give clear guidance to sub-departments on how to implement the policy. The understanding of the functional strategy of the organisation's core departments in supporting and needing H&S intervention should be evaluated.

Step 2: Ownership of H&S

The identification of the specific section or department, in the organisation, that will take ownership and be responsible for managing H&S.

Step 3: Management

The clear identification of a specific position, which can be shared with other job descriptions, for the management of H&S; the evaluation of the role that hospital management and risk management play in giving support and guidance to the management position of H&S, and the need for human resources intervention and assistance in making the correct appointments and developing job descriptions.

Step 4: Compliance with legislative requirements

Ensure the compliance and establishment of an H&S committee and relevant appointments in line with H&S legislation.

The creation of channels to receive expert input.

All external stakeholder requirements to be evaluated, and means found to satisfy their requirements in relation to H&S.

Step 5: Specialist departments and fields of expertise

Identify departments or specific fields of expertise that need to give input to the H&S committee.

Step 6: Identification of experts

Identify individuals who are willing to give input into the H&S committee. Create appropriate channels for input and feedback in relation to H&S aspects from the identified experts.

The representative from a specific field should be competent and be capable of:

- Identifying hazardous circumstances in his area;
- Evaluating any hazards;
- Knowing where to find assistance to assess any hazard;
- Implementing control methods, and
- Giving input into the H&S committee related to hazards affecting the institution.

2.6.5.3 International H&S management systems

Occupational Health and Safety Assessment Series (OHSAS) 18001 and 18002 standards is a British based system. OHSAS 18001:2007 (Occupational Health and Safety Management Systems) outlines the requirements to establish an occupational H&S management system for an organisation by providing a framework for identifying, assessing and managing workplace H&S risks (Standards Development, 2008).

American National Standard for Occupational Health and Safety Management Systems (ANSI) have a specific standard related to H&S known as ANSI/AIHA Z10-2005. This newly developed OH&S management system voluntary consensus standard provides critical management system requirements and guidelines for improvement of occupational H&S (Standards Development, 2008).

Organisations that have implemented the ANSI (American National Standards Institute) ZI0:2005 standard will be able to effectively manage workplace risk. The main reason to move forward with OHSAS 18001:2007 is for an organisation that needs third-party certification registration to that standard, or more alignment and integration with the ISO 14001 environmental management system. Standards such as ANSI ZIO and OHSAS 18001 carry out the same guidelines (Standards Development, 2008).

The most important aspects of OHSAS 18001 are that the employer must:

- Make a commitment that the H&S of the worker is as important as any other aspect of the organisation and convey this to all managers and employees. This includes committing resources such as time and money, to identify and correct risks found;
- Identify and prioritize risks using sound risk analysis techniques. When properly executed, efforts and available resources must be concentrated on those risks that have greater potential and/or potential loss, thus getting more 'bang for the buck'. There is less reason to spend effort and training on confined space entry if you have no confined spaces, but do have many flammable solvents;
- Involve all employees in the process. After all, who knows more about stress and underlying problems than the people who are exposed to them every day? More than once, employees have indicated that supervision was unaware of 'fixes' that would have taken time and money to engineer, and
- Communicate. Keep employees apprised of progress made and actions taken. If a project cannot be initiated or completed for whatever reason, let the employees know and tell them what actions are being taken as an Interim measure until resources can be obtained. By concentrating efforts where they are most needed, the company reduces or even eliminates the worst risks that result in harm to employees and the resulting loss of their service and associated medical and compensation costs (Standards Development, 2008).

2.6.5.4 Quality management systems

According to Beckmerhagen *et al*. (2003) the existence of a QMS (quality management system) does not in itself guarantee that there is an effective H&S system, since there is a requirement to ensure that the necessary arrangements for H&S have been identified and implemented. QMS interaction with H&S systems are supportive in assuring that the products or services provided are at required standards, which usually necessitate that such products or services are produced taking into account requirements of H&S.

Everyone expected things to change when companies began to adopt management systems such as ISO 9001 (quality management), ISO 14001 (environmental management) and OHSAS 18001 (occupational H&S management). It was assumed that these systems would encourage companies to measure and manage the factors that were driving up costs. Regrettably, however, these changes have not occurred (Pojasek, 2007).

Certification based on international standards boosts confidence and facilitates access to world markets and remains popular today. Despite the numerical success of ISO 9000, a great deal of criticism of the certification exists, as it is not a risk-free undertaking. Literature indicates that organisations often lack flexibility in the design and implementation of quality management systems and show a low utilisation of employees' skills and knowledge. This is because organisations usually approach this process of implementation in an empirical way. ISO 9000 certification can deliver business benefits, but managers of organisations should study issues on developing an ISO 9000 implementation strategy (Pojasek, 2007).

A mature quality management system should consider critical success factors for ISO 9000 certification benefits from the early phases of their planning and designing processes. In this respect, it should be realised that aligning quality programs with a business strategy is needed to ensure that efforts reflect the long-term goals of the organisation. It should be realised that the more mechanistic and explicit the knowledge the more organisations will experience tensions arising from lack of 'fit'.

A critical point in this effort is the commitment of top management to set priorities in appropriate resource allocation during the design and implementation of an ISO 9000 quality system (Beckmerhagen *et al*., 2003).

A strong relationship between the company's certification motivation factors and the corresponding results was revealed. As an external motivation factor, ISO 9001 certification is mainly used as a marketing tool. Customer pressure is also one of the key motivation factors to achieve ISO 9000 certification mentioned by companies. The analysis showed that the major reasons for certification, unlike benefits, concern firstly the internal business environment and then the external one. Organisations that see certification as an opportunity to improve external processes and systems will get broader positive results from ISO 9000 certification (Kaziliūnas 2010).

According to Beckmerhagen *et al*. (2003), the existence of a QMS does not in itself guarantee that there is an effective H&S management system, since there is a requirement to ensure that the necessary arrangements for H&S have been identified and implemented.

2.6.5.5 Environmental management

A way to increase producers' interest to raise customers' and dealers' confidence in quality products and to influence 'competitive advantage' is the implementation and certification of quality systems according to ISO 9000. It was also noticed that the increase in the preoccupations of producers for environmental and H&S problems, materialised by the implementation of specific environmental management systems (EMS) based on ISO 14001 (Popescu, Mocuta and Vartolomet, 2009).

2.6.5.6 Engineering and construction management

H&S in engineering and construction environments becomes more complex when the dangers of heights and electrical shocks are added to H&S factors in other organisations.

The construction industry is one of the largest employment sectors. It is also one of the most hazardous. The industry exceeds the all-industry average rates with respect to musculoskeletal disorders; occupational dermatitis; 'mesothelioma', asbestosis, diffuse pleural thickening and work related hearing loss, with vibration related disorders only being surpassed by the extractive industries (HSE, 2009).

Managers at construction level cannot always preside over ongoing construction activities. According to European Council Directive 92/57/EEC it can be inferred that the practical application of the prescriptions required by the H&S plan is left up to the workers. In addition, even the coordinator's continuous presence on construction sites would not be sufficient deterrent to prevent accidents occurring on vast sites, as the coordinator is, in any case, incapable of performing ubiquitous control. This situation often leads to scarce application of H&S requirements, which could be the cause of dramatic accidents. Presently, a set of new technologies could provide a solution (Giretti *et al.,* 2009).

It should be asked whether the fact that H&S is seen by construction people to be a different management entity, that is not their problem, does not indirectly create an H&S risk. Many recent studies advocated that H&S functions should be integrated into the activities to increase the chances of reaching H&S goals in organisations. An H&S management system contains a number of elements including H&S policy, job hazard analysis, and H&S awareness, etc. This provides guidance for enterprises to manage risks and improve the H&S performance. H&S management systems facilitate occupational H&S management by providing systematic approaches for continual identification, evaluation and control of hazards and risks (Law, Chan and Pun, 2006).

2.6.6 H&S culture

H&S culture is a sub-unit of organisational culture, which affects members' attitudes and behaviour in relation to an organisation's ongoing H&S performance (Järvis, and Tint, 2009).

As can be seen from many industrialised countries, where it took over a century to build a solid H&S culture, the progressive integration of H&S principles and reflexes is a fundamental prerequisite for any improvement in the reduction of occupational and H&S accidents, and it is important for an organisation to have the continued implementation of a H&S culture, which helps reduce the cost of overall health care delivery while increasing general productivity (Law *et al.,* 2006).

Dollard and Bakker (2010) refer to Cooper (1997) who argues that if the government and the population demand a high standard of H&S, those within the company will give H&S a higher priority and vice versa (Dollard and Bakker, 2010). Du Toit (2005) recommends that organisations should re-examine their H&S strategies in such a way that they can create an environment that will be conducive to the development of a strong H&S culture.

In general, organisational climate refers to 'shared' perceptions of organisational policies, practices, and procedures. Climate measures should be specific to the predicted outcome, for example, a 'climate for service' or a 'climate for H&S'. In such a framework, a psycho-social H&S climate is a facet-specific component of the organisational climate, a climate for psycho-social H&S, which is expected to precede working conditions (Dollard and Bakker, 2010).

A healthy work organisation has been defined as one where culture, climate and practices create an environment that promotes worker well-being as well as H&S standards in the workplace, and encourages organisational effectiveness (Bjerkan, 2010).

The H&S culture concept is mainly concerned with norms, values and beliefs specifically related to H&S, such as hazard management. It has been conceptualised as a set of prevailing indicators and values in relation to H&S culture that should not, however, be regarded as something separate from, or in addition to, but rather as an integrated part of this culture (Bjerkan, 2010).

Beckmerhagen *et al*. (2003) found that organisations that have a strong H&S culture will have an effective H&S system with the support and ownership of all staff. However, the H&S system has a broader role in that it provides a framework, by means of which the organisation ensures good H&S performance throughout the planning, controlling and supervision of H&S related activities. The H&S system, in turn, provides a vehicle that the organisation can use to promote and support a strong H&S culture. In particular, the system will shape the environment in which people work and thus influence their behaviour and attitude toward H&S.

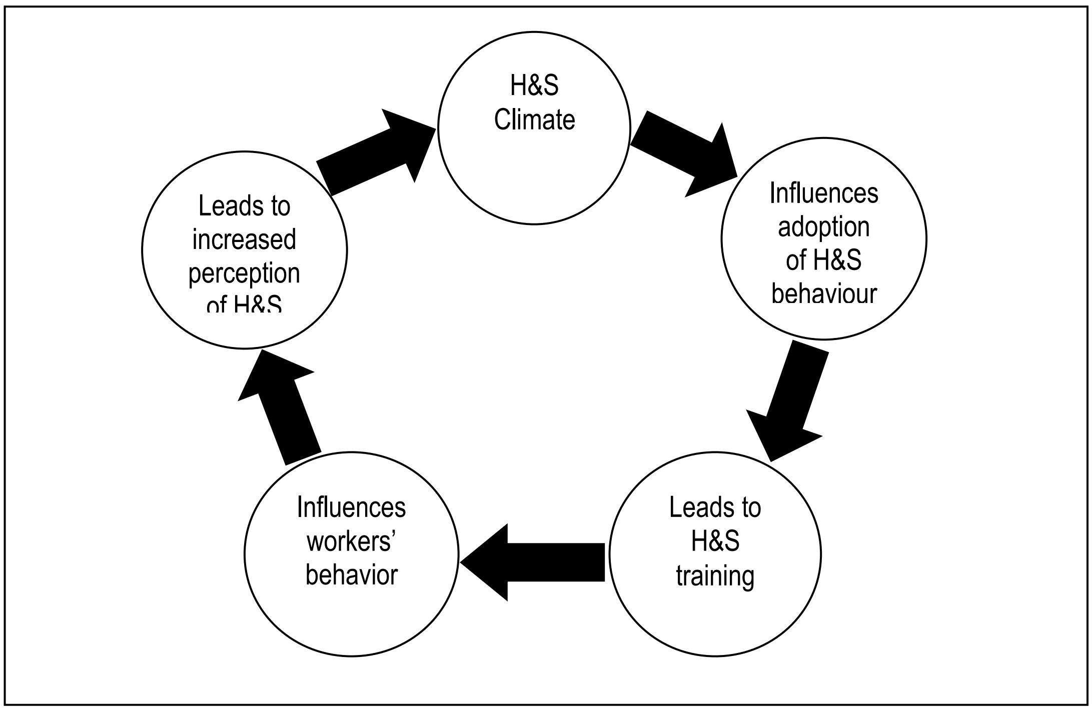

Figure 2.5 The influence of an H&S climate

(Source: Adapted from Gershon *et al.*, 2000)

Gershon, Karkashian, Grosch, Murphy, Escamilla-Cejudo, Flanagan, Bernacki Kasting and Martin (2000) indicate that evidence has shown that in organisations that are serious about safe work practices and creating an H&S climate, employees will be more likely to comply with H&S requirements as shown in Figure 2.5.

Oke and Omogoroyo (2007) established that as an organisational H&S climate improves; managers and employees are likely to agree more about the causes of safe / unsafe behaviour patterns and workplace accidents, ultimately increasing their ability to work in unison to prevent accidents and to respond appropriately when an incident does occur.

The effect of trusting supervisory decisions from different cultural backgrounds would influence the success of most H&S systems due to increasingly diverse work forces. Costigan, Insinga, Berman, Ilter, Kranas, and Kureshov, (2007) found that, from the perspective of the supervisor, cognition-based trust refers to the supervisor's rational decision to trust, or to withhold trust, of a subordinate employee.

2.6.6.1 Behavioural–based safety

Behavioural-based safety (BBS) addresses unsafe behaviour in a formal management system. Many organisations spend a lot of time and effort improving H&S, by addressing hardware issues and installing H&S management systems. These efforts tend to produce dramatic reductions in accident rates, however, a plateau of minor accidents often remain that appear to be stubbornly resistant to all efforts to remove them. Although many of these are attributed to human carelessness, or poor H&S attitudes, most are triggered by deeply ingrained unsafe behaviour patterns (Behavioural Safety Now, 2009). BBS not only covers programs that analyse human behaviour in the context of H&S aspects, but also provides research to support intervention strategies.

According to Behavioural Safety Now (2009), behavioural safety, or what is sometimes referred to as behaviour-base safety (BBS), is simply the use of behavioural psychology to promote H&S at work and at home. Behavioural safety typically involves creating a systematic, ongoing process that clearly defines a finite set of behaviour patterns that reduce the risk of injury within an organisation, collects data on the frequency and consistency of those behaviours, and then ensures feedback and reinforcement to ensure support of the behaviour.

In a behavioural process, employees usually conduct observations and provide feedback on H&S practices within their work areas (Groover, 2006).

These observations provide data that is used as the basis for recognition, problem-solving, and continuous improvement.

2.6.6.2 Behavioural safety maturity ladder

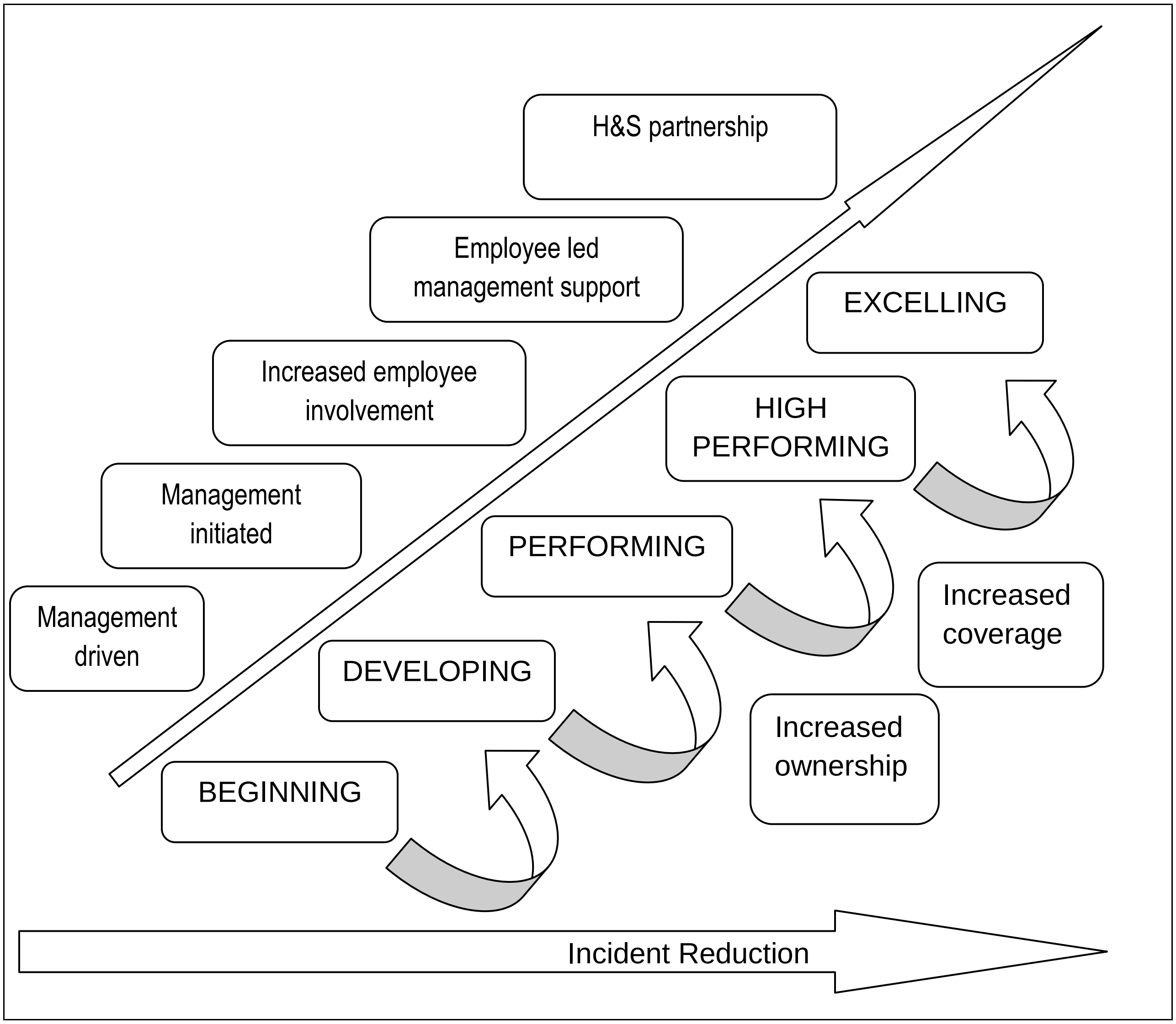

Figure 2.6 Behavioural Safety maturity ladder

(Adapted from Behavioural Safety Now, 2011)

Figure 2.6 shows the ’Behavioural safety maturity ladder’ indicating that an increasing ownership and coverage leads to greater injury reduction. Each level has been shown to exert an ever-increasing impact on injury rates.

2.6.6.3 H&S capital

As with all other forms of capital, H&S capital in organisational knowledge, embedded and created in the organisational OH&S system, is a long term asset into which OH&S resources can be invested, with the expectation of an uncertain future flow of benefits in the form of gains in worker's protection and H&S (Nuñez and Villanueva, 2010).

According to Nuñez and Villanueva (2010), most of the OH&S interventions are related to the structural component of knowledge and skills. The traditional preventative activity is based on the design of the H&S rationale of the working process and, consequently, is driven by the organizational knowledge and skills possessed by the enterprise. Thus, the basic H&S knowledge is identifiable in norms and proceedings that the firm keeps as a part of its intangible assets. Our paper shows that this traditional picture is incomplete. All H&S systems should always combine organizational interventions with human actions and, therefore, the company will have to facilitate the adequate intellectual and physical capabilities to its workers. Hence, it is argued that the human component of safety capital is related to the training and health control activities.

Recent literature on H&S management provides theoretical and empirical support for the growing relevance of intangible resources and assets in occupational H&S. Traditional prevention methods, despite improvement of the physical environment through the twentieth century, had limited impact. Nuñez and Villanueva (2010) propose to address the H&S system and culture as intangible assets to current H&S theory and practice. Most H&S interventions are related with the structural component of knowledge and skills.

The traditional preventative activity is based on the design of the H&S rationale of the work process and, consequently, is driven by the organisational knowledge and skills possessed by the firm. Thus, the basic H&S knowledge is identifiable in norms and proceedings that the enterprise keeps as a part of its intangible assets.

Nuñez and Villanueva (2010) argue that all H&S systems should combine organisational interventions with human actions and, therefore, will have to facilitate the adequate intellectual and physical capabilities of its workers. The human component of the safety capital is related to training and health control activities. The existing dynamism of markets and environments has increased the value of the social component of safety capital.

Coordination in networks with other firms and administration contributes to increasing the external dimension of social capital while effective communication channels of networking in teams are internal resources devoted to the creation of internal social safety capital.

Nuñez and Villanueva (2010) postulate that safety capital concepts will have an immediate impact on industry and H&S practitioners as a potential guide to H&S and research in business administration.

2.6.7 H&S training

H&S training begins with induction and should be continued throughout the life cycle of employment. An induction manual is the written means of imparting information to the prospective employee in the familiarisation of various aspects of company policies and work programmes (Wren, 2006). Local induction and training is specific to the local workplace and needs to include all H&S information. A nominated and trained staff member would normally carry out induction, continuous assessment and training in H&S.

Hare and Cameron (2011) found that although H&S training for line managers is seen as an effective method of improving competence and influencing behaviour and that specific training per month has been linked to lower accident rates.

H&S qualifications are numerous, offered in many vocational forms, from short duration courses provided by independent training organisations, to full-time higher education qualifications. Such qualifications need to be tailored for the specific job task.

2.6.8 Occupational health

Occupational health is the discipline that addresses the health impact of the work environment on workers and does not only address the medical impact, but also includes psychological health, occupational stress, professional burnout, acculturation, and social support within the organisational context (Yergler, 2010).

Environmental exposures may cause adverse effects on occupational health of exposed workers. The effects range from reversible conditions, such as slight respiratory irritation, to irreversible and serious conditions. In addition to the previously well-known work-related diseases, less described ones, such as stress-related disorders, hypersensitivity problems, and various psychosocially related disorders, have emerged during the last few decades as occupationally induced diseases (Torén and Sterneow, 2003).

The value afforded to occupational health practitioners, in recruitment and maintenance of employees to decide on the suitability and the performance of such candidates, usually supersedes that of other specialities. Jay and Aletky (2007) found that occupational medicine is ordinarily given more weight in an employment case than any other specialty, as it is presumed by some arbitrators that the occupational psychologist or physician has the greatest knowledge of the requirements of a position. Occupational health risk management needs to be more widely recognised as a business priority.

Taylor (2007) states: “In many organisations, the links between line management, H&S and human resource functions may not be sufficiently developed for all persons to fully appreciate the occupational health input into each other’s role. As a result, line management may not receive clear advice and may fail to deal effectively with the issues as part of their normal managerial responsibilities.”

The answer is that a more integrated risk management approach needs to be introduced into the business structure and processes of many organisations.

Where hazards are identified, the business should amalgamate occupational health advice more effectively with that of specialists in H&S and HR, so that risks arising from particular business operations and the health of the workforce can be proactively managed (Taylor, 2007).

2.7 MANAGEMENT

Management are that component of a business that plan, lead, organise and control all aspects of an organisation to ensure that the objectives of the organisation are achieved. To limit risk factors that will impact on achieving such objectives covers all aspects of an organisation’s activity and is included in all management levels. H&S as part of risk management needs the same, if not more, attention from management as the impacts are far greater than other organisational entities and the impacts can be so devastating as to impact the organisation’s very existence.

2.7.1 Management concepts

The concept of management covers various aspects that have a direct effect on the management of human behaviour in relation to the impact of organisational goals on risk issues. Management is the function of implementing the aspects of planning, leading, organising and control of all organisational resources including the human component by means of HR management principles.

2.7.1.1 Leadership

Leadership involves more than delivering on organisational objectives; it includes taking a stance on ethical principles. In terms of H&S the indirect effect of work place injuries on families requires strong leadership interventions.

According to Watson and Scott (2005), injuries and death resulting from workplace accidents remains one of the most costly factors, both personally and financially, in transacting business today.

In 2001, there were over 3.9 million disabling injuries and 5 300 deaths in American work-places (National Safety Council, 2003) costing over US $132 billion.

2.7.1.2 Controlling and organising

To deliver on the goals and achieve the objectives of management, organisational resources must be organised and controlled optimally and correctly. The impact of H&S on the goals of the organisation should be managed in such a way that it is not seen as a constraint, but rather as a tool that, when complied with, will assist an organisation in achieving its goals and specific objectives.

2.7.2 Managerial role in H&S management

According to Waring (2002), many organisations have weak H&S management, relative to the standards required by legislation, where many directors and senior managers are ignorant of H&S management principles and do not appreciate the cost of accidents in human, social and financial terms.

One reason may be the lack of H&S management - or, indeed, any kind of risk management - built into business and management courses. Many managers regard H&S as just another risk topic among many.

H&S management is about managing, steering, and controlling H&S to choose arrangements and measures so as to obtain a high H&S performance level.

Management H&S tools depend on the actual phase that they are in. In the early planning phase, the conceptual planning phase, alternative concepts should be compared and evaluated. Risk analysis should be performed on the various concepts to present a crude risk picture of risk exposure (Aven, Vinnem, and Willy, 2006).

Hallowell (2010) found a statistically significant difference in the risk tolerance between workers and managers. He found that the level of current perceived risk is approximately five times higher than the tolerable risk value, for workers who are most dissatisfied having the frequency and high severity of injuries. Hare and Cameron (2011) found that construction organisations with superior H&S performance are such organisations where management ensure that:

- Senior management are committed to H&S;
- H&S inductions and training are implemented;
- Stable employment conditions prevail, and
- Incentive schemes and employment goals are implemented.

2.7.2.1 Capacity to influence risk-taking behaviour

Management role in communicating risk factors has two different, and somewhat independent, subfields of application: technology policy and health behaviour. The typical problems are very different in the two cases. Health behaviour is typically seen as not prudent enough, and experts attempt to stimulate people towards quitting smoking, healthier food habits, and testing their homes for radon. The problem here is that people see the risk as true mostly for others and the campaigns as less relevant to themselves.

With technology risks experts often assume a reassuring role, but these risks tend to be seen as more personal by members of the public, and the idiosyncratic approach needed to address personal concerns is hard or impossible to administer on a large scale.

Hence the dilemma of risk communication; when individual behaviour is in focus, people are mostly worried about others, and when they are worried for their own sake, as with some technology concerns, reassuring measures can hardly be fitted to the situation of each individual (Sjöberg, 2003).

2.7.2.2 Influence on H&S culture

According to Zabel (2005), human behaviour is regarded as the result of three constituting components: cultural shaping (cultural artefacts, education, socialisation, and enculturation), genetic predisposition (such as pattern recognition based on instincts, needs and drives) and situational correctives.

Basically, human behaviour is determined by natural, cultural and situational impulses. According to the theory of planned behaviour, internal determinants have to be taken into account as well. The theory states that intentions play a fundamental role in the initiation of observable behaviour. Intentions, however, are seen to be determined by subjective norms (e.g. values, rules of conduct, habits and role expectations) and personal attitudes (e.g. personal desires, wants and strategies). The theory reflects very profoundly on the cultural factors as well as on the individual attitudes and beliefs that influence the conduct of human behaviour (Zabel, 2005).

People’s skills and creativity are difficult to copy. Mankind needs to be innovative in what they do, but there is a real tension with two other imperatives: the need to develop pragmatic solutions and at the same time to reflect best practice (Florance, 2010). Well-being and self-esteem are strongly inter-related. Several studies are cited that report high correlations between measures of self-esteem and well-being (and happiness) (Stenseng and Dalskau, 2010).

2.7.2.3 Management competence and H&S

Management role in H&S must be seen as the intervention required on a moral, business and legislation base for managing the risk posed to the organisation's resources. Meaningful management learning occurs where concepts meet experiences through inner and outer reflection, therefore management education needs to encompass and go beyond teaching of the business functions and into a more natural way to organise learning, based upon the 'zone' where thoughtful thinking meets practical doing (Erella-Shefy and Sadler-Smith, 2006).

2.7.2.4 Principles for management development

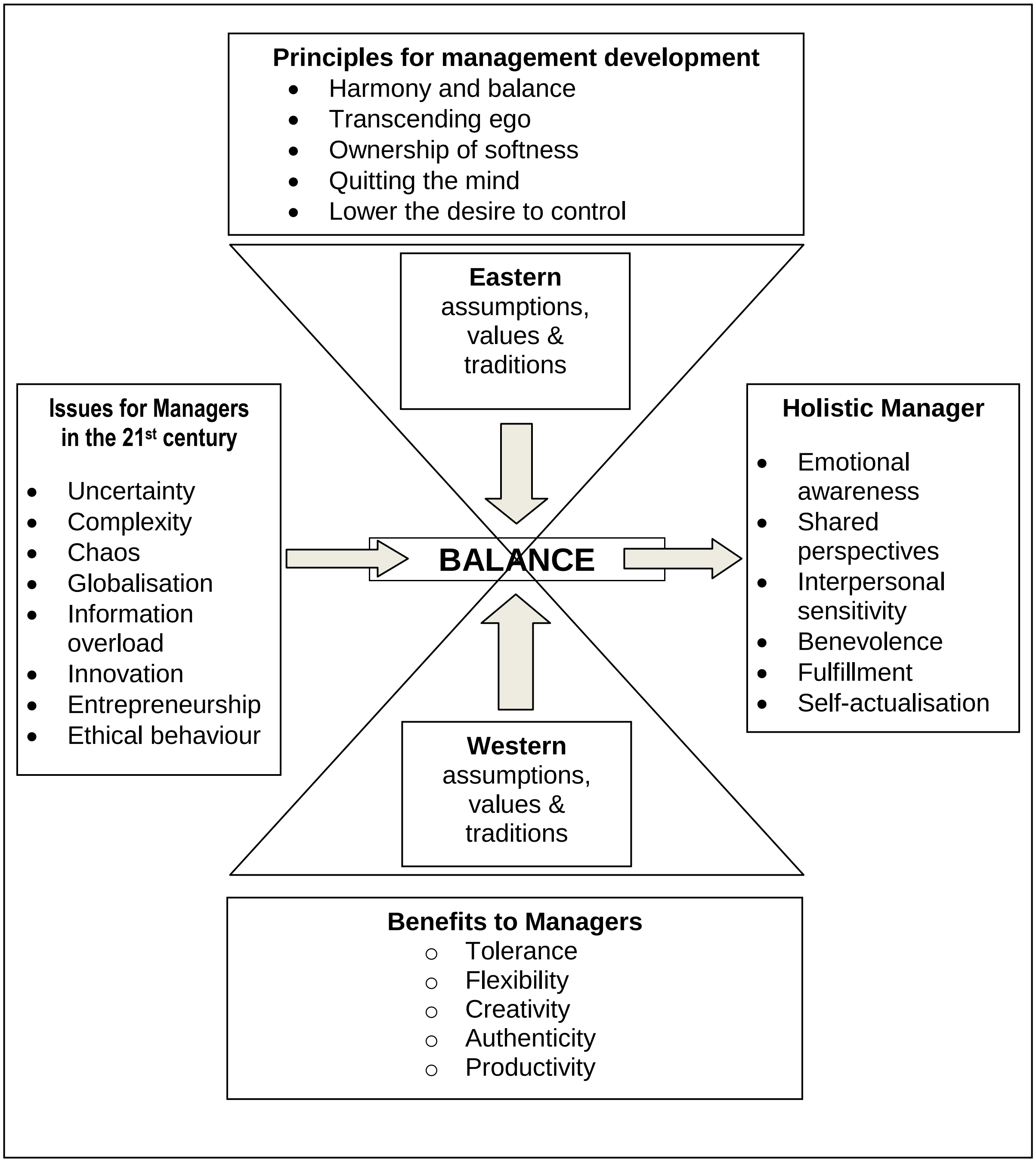

Figure 2.7 Principles for management development

(Adapted from: Erella-Shefy and Sadler-Smith, 2006)

Management cannot be seen as a constant, but needs continuous updates to adapt to a changing environment. Continuous management development and competency evaluation should be made against relevant individual goals and scorecards.

Figure 2.7 displays six guiding principles for managerial experience development as:

- Inner values of emotional awareness;
- Shared perspectives;
- Interpersonal sensitivity;
- Benevolence;
- Fulfillment, and
- Self-actualization.

These qualities are core values that a manager can bring to a complex, dynamic and uncertain workplace and are linked to holistic principles that serve specific, individual, management developmental goals (Erella-Shefy and Sadler-Smith, 2006).

Western principles and values have a tendency to predominate organisational life. The development of the holistic manager requires a far greater recognition of non-Western assumptions and values in order to become more 'centred' and for organisations to become more focused.

Risk management has been described in terms of decisions taken by an organisation in anticipation of, or as a consequence to, foreseen losses and the selection of appropriate responses. In effect, the suggestion is that there is a mistaken presumption that people feel they can anticipate better than they actually do.

What emerges from these observations is that the complexity of socio-technical systems makes it difficult to ensure full efficacy of hindsight and foresight, and behaviour, whether it is based on past experience or adaptability to future uncertainties, is not effectively considered (Navare, 2003).

According to Erella-Shefy and Sadler-Smith (2006), it appeared that exposure to various activities described in Figure 2.7 created a change in the way of thinking and acting in holistic managers.

2.8 HUMAN RESOURCE MANAGEMENT

Focus on human behaviour rather than on procedures is not a new feature of risk management. Risk management not only relates to the impact of engineering activities, but also the human aspect of the work environment. The former related to the physical causes of accidents while the latter required human action to be taken into consideration as most of the accidents were recorded as related to human failure (Navare, 2003).

2.8.1 Recruitment

BuŞe (2009) concludes that one of the most important activities of the human resource function is the recruitment process. Recruitment represents the decisions that exert a major and sustainable influence on an organisation.

Attention to workplace environment and work regulations can positively affect staff recruitment and maintenance. If organisations can ascertain and understand those factors that overshadow job satisfaction, they can use an effective management to recruit staff (Najafi, 2011). Staffing is a time-consuming necessity that needs significant planning (Raphael, 2010).

According to Cowett (2009), comparisons between hiring and attrition show that experience is the least reliable predictor of success in a new job. There are five areas recruiters need to examine; intellect, values, motivation, behaviour and experience.

Levi (2007) indicates that electrical contractors should stop looking for skills and hire the right attitude. To help identify the best candidates an extensive job application and detailed checklist should be used. The application form should include things like job description, salary and benefits, special skills, physical requirements, advancement opportunities, required licenses, training class schedules and working hours.

2.8.1.1 Psychological evaluation and psychometric testing

Psychologist aims are to identify the development potential of a candidate in the selection process. Development potential of the candidate can be identified by testing four areas or plans; skills, intellect, motivation and character-values. According to these plans one should then make a prognosis for each candidate (BuŞe, 2009).

Psychological tests are used as part of an evaluation or assessment. In turn, the assessment occurs in a context, often with specific questions to be addressed. It is the context that will inform the selection of test instruments. Thus, a referral question regarding personality tendencies, mood issues, addiction issues, dangerousness, or specific areas such as memory function and various aptitudes will lead the evaluator to different tests (Jay and Aletky, 2007).

Psychometrics was developed as a discipline to conduct psychological tests that measure different characteristics such as aptitude, ability, IQ and personality. It was stated by Geoff Davey (co-founder of FinaMertica, provider of psychometrics-based risk tolerance questionnaire for advisor use with clients) that risk tolerance forms part of personality characteristics that will stay static throughout life unless faced with the experience of a major event impact. He continues that the root of risk tolerance lies situated in an individual's psyche, which can be explained as the location where one would find the balance between receiving a return from the risk taken and suffering a loss (Swift, 2009).

Psychometrics, which means 'to measure the brain', has been used for more than a century to assess candidates' abilities or personalities using standardised methods (Dean, 2008). Psychometric testing involves looking closely at the psychological profile of a job candidate and examining their personality, their reactions in different situations and their specific skills (Lepper, 2009), although employees sometimes view psychometric tests as an annoying part of the selection process. Examiners should take special care with this section because here they distil their findings to specific recommendations that will affect the employee‘s life and career.

Although no standard model for expressing this exists, it is one protocol of alternatives that is both psychologically valid and practical (Meacham, 1999).

According to Simons (2009), psychometric tests are being used by organisations in order to not only save themselves time and money, but also as an aid to achieving a cultural match between the applicant and the job position, which grants them a competitive advantage in the market. Psychometric testing becomes essential to any organisation's success, with the applicant pool increasing over time due to the decrease in supply of employment opportunities. It is also of essential necessity when faced with the situation of multiple applicants possessing identical skill sets and the decision will then need to be based on behavioural style or aptitude (Simons, 2009).

Kevin Kerrigan, of psychometrics specialist SHL Group (Garrett, 2006), explained that the term psychometrics refers to mental measurement. Kerrigan also states that psychometric tests would typically measure cognitive abilities, personality traits, personal interests and motivations. It is used as a tool that is able to predict the capability of an individual to succeed at a particular job according to their score on the test. It is of utmost importance that the test used has validity, which is the appropriateness of the test for the specific trait being tested for. HR employees should posses the necessary skills and knowledge to administer the tests as well as interpreting the results and providing feedback to the individual being tested.

Feedback is beneficial in that it provides those being tested with the knowledge of their strengths and weaknesses, as well as the tasks and jobs they are most suited to performing. However, it is important that a psychometric test is not used in isolation, but in association with other assessment tools in order to make a completely accurate decision when hiring an applicant for a specific job (Garrett, 2006).

2.8.1.2 Performance appraisal

Maintaining and optimising employee job performance enables organisations to be better able to achieve their preset goals and missions. Improving and sustaining such job performance involves well planned employee evaluation criteria performance assessments (Cheng and Li, 2006). Engellandt and Riphahn (2011) postulate that, where job complexity is high, individual productivity is hard to measure and compliance with the norms of firm culture, is considered to be part of individual performance.

Post-hiring psychological issues arise most often involving questions about an employee's continued fitness for duty (Jay and Aletky, 2007).

2.8.1.3 Motivation

Motives that directly influence staff are the availability of opportunities to participate in the organisational activities, to achieve such motivation one needs to take into account the morale, award and punishment system, supervision, and training of an organisation (Najafi, 2011).

If people think they're being treated fairly, they'll be more productive and be more motivated. Performance appraisal should be a driver for productive management of people (Florance, 2010).

Engellandt and Riphahn (2011) found that employees respond positively to surprise bonus payments. Similarly, employees provide more effort or productivity if their supervisors re-evaluate their performance anew from year to year as opposed to leaving individual positions unchanged over time.

According to Chandler (2007), the best way to find out exactly what would get an employee motivated is to ask them in what way they would like you to recognize them for something of significance they accomplished. Google realised that younger workers with the best talent desire time off, so Google gives them the flexibility to set their own hours.

The only requirement is that they get their work accomplished properly and on time. The time they save by being great at what they do becomes time off with compensation / pay and is one of their highest rated benefits and strongest motivational tools.

2.8.2 Influence of H&S legislation

Ai Lin Teo, Yean Yng Ling and Sern Yao Ong (2005) indicate that positive reinforcement motivates workers to perform their jobs in a safe manner and is desirable above negative reinforcement even though the same outcome may be achieved, a negative climate would be created. In fact, HR researchers and practitioners expect new OSHA regulations regarding ergonomics to influence the way jobs are done in several major industries (Watson and Scott, 2005).

2.8.3 Disciplinary procedures

Fitness for duty questions often arise in conjunction with disciplinary decisions. Some cases involve discipline of an employee for insubordination in refusing psychological evaluation. Questions of fitness often arise based on behaviour, which may itself be a reason for discipline (Jay and Aletky, 2007).

2.8.3.1 Legislation applicable

In terms of H&S, the main legislation that has an impact and which is applicable to the recruitment and appointment of staff are the Labour Relations Act (LRA) (Act 69 of 1999) and the Basic Conditions of Employment Act (BCEA) (Act 75 of 1997). Wren (2006) refers to a white paper issued by the Office of the President in 1995 where the purpose of the LRA is stipulated as being 'to advance economic development, social justice, labour peace and the democratisation of the workplace by fulfilling the primary objectives of regulating fundamental rights'. The object of the BCEA is to lay down minimum conditions of employment to protect employees in the absence of collective agreements regulating such conditions (Swanepoel *et al*., 2003).

These two acts govern the process for recruitment (advertisements) and also take into account South Africa's 'affirmative action' policies that are now tabled in the Employment Equity Act (EEA) (Act 55 of 1998).

It should be noted that risk profiling of candidates and psychometric testing should not be seen as discriminative, but rather the evaluative and performance appraisal of a specific candidate's competency. Taken in the light of the constitution, that requires H&S for all employees, this should rather be seen as the strengthening of such requirements in ensuring H&S, relevant to a candidate's correct placement that will ensure a lowering of potential work incidents.

2.8.3.2 Impact of H&S contraventions

In terms of H&S, the major impact of labour legislation will be in the domain of re-employment of staff in different positions and the indirect discrimination for correct risk behaviour profile matching to high-risk job tasks. Good job descriptions are the cornerstone for correct employment. Sadly, many managers fail to spend sufficient time on this important task, not comprehending the value of correctly compiled job descriptions that will result in the correct correlation with job task risk behaviour profile matching.

The process of disciplinary action when there is intentional risk behaviour with a resultant incident is to treat the disciplinary hearing as any other disciplinary hearing in line with the prescripts of legislation.

It is recommended, but not mandatory, that each work place has a disciplinary code of conduct that each employee should signify an understanding of. The disciplinary code of conduct should specify the various types of misconduct and poor work performance and the standard of measures for dealing with each (Wren, 2006).

2.8.4 Training

Interventions over workers' behaviour intended to highlight risk prevention are usually based on specific training programmes. These programmes are generally devoted to increasing workers' knowledge of job hazards and promoting safer work behaviours. However, worker behaviour regarding risk prevention is influenced by other factors besides proper training, and these factors should be evaluated and their relative effects on worker behaviour measured in order to develop integral programmes for workplace hazard control.

Organisational factors related to H&S at work, including management's policies and practices regarding occupational risk prevention, have been shown to affect implementation of worker H&S training (Garcia, Boix and Canosa, 2004).

2.9 SUMMARY

The electrical engineering work surroundings is characterised by skilled employment in a high risk work environment. To understand the impact of H&S on such workers and the wider use of electrical services begs a better understanding of all aspects related to the HR, workers profiles and the characteristics of job tasks. It is important to prevent people from leaving the labour market, due to workplace incidents, and to create conditions that uphold the Universal Declaration of Human Rights of 1948, article 23: ‘‘Everyone has the right to work, to a free choice of employment, to just and favourable conditions of work and to protection against unemployment.’’ One way to counteract the increase in incapacity is early intervention (Fenger and Kramer, 2007).

The impact of correct management in ensuring an optimal H&S environment by correct management principals and HR strategies will not only ensure that organisational goals are achieved, but also result in worker’s H&S being maintained.

Although the literature survey covers most aspects related to the research, material specific to risk-taking behaviour of electrical workers was inadequate, and then only as mentioned for other countries. A lack in literature was found where very limited material could be located that targets the South African electrical construction and maintenance workers’ risk perception and risk-taking behaviour tendencies.

Najafi (2011) found a significant relationship between work achievement and staff maintenance in an organisation. Management skills and HR management skills must be honed to ensure that the brightest and most effective employees are located and retained (Raphael, 2010).

In summation, the literature review found a strong link to an H&S impact as a result of the individual electrical worker’s psychological profile and a tendency for inappropriate risk-taking behaviour.

Chapter 3, which follows, presents the research findings of the empirical research.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter addresses the methodology used in the empirical study where the primary qualitative research was based on case study analyses evaluated by means of various questionnaire surveys.

The research questions, as noted in Chapter 1, are addressed in greater depth. This chapter comprises the methodology used in the empirical study with descriptions on the methodology-applied in the study to arrive at the empirical results. The primary research methodology focuses on a qualitative research approach with mixed methodology, using elements from both quantitative and qualitative research, to contribute to the solution of the main problem. The 'mixed-methods' approach to research combines and integrates quantitative and qualitative methodologies and methods (Glogowska, 2011).

The mixed method used, will limit the reliance on statistical data. Jogulu and Pansiri (2011) found that by employing mixed methods, researchers can reduce over-reliance on statistical data to explain social occurrences and experiences that are mostly subjective in nature. Mixed methods research is widely used in order to answer research questions and to investigate research problems and are helpful where the phenomenon studied is complex (Kettles, Creswell and Zhang. 2011).

Östlund, Kidd, Wengström and Rowa-Dewar (2011) indicate that the integration of qualitative and quantitative approaches continues to be one of much debate. The analytical approaches (i.e. parallel, concurrent or sequential) used in mixed methods studies, exemplifies the use of triangulation as a methodological metaphor for drawing inferences from qualitative and quantitative findings originating from such analyses.

The consistency between the experiences of participants in relation to their social settings and life course, which are statistically described in questionnaires, is matched with their subjective interpretations and explanations of those experiences in interviews.

Therefore, mixing the data collection techniques will only enhance the findings so that researchers can make inferences with confidence (Jogulu and Pansiri, 2011).

3.2 RESEARCH DESIGN

In evaluating the research questions to determine what to study, how to obtain and collect related data and how such data will be analysed, the framework of the research design is formulated. Flexible qualitative research design in the form of case studies and fixed quantitative design for non experimental research using correlation and comparative studies will be used in the research design (Adèr, Mellenbergh and Hand, 2008).

Research design relates to the evaluation and testing of the hypotheses that addresses specific formulated research questions. Craig, Duffy and Gillin (2011) indicate that no research question or hypothesis can have any validity unless the relationship of the subject and the object is postulated between environmental and social factors. Every social question must be traced back to lead to a physical consequence. Every question about research design itself must be traced back to a social requirement. Without these connections the data collection is meaningless.

For researchers, the core issue is not related to choice of methodologies, but related to acknowledgement of the research paradigms. Essentially, ontology is ‘reality’, epistemology is the relationship between that reality and the researcher, and methodology is the technique used by the researcher to discover that reality. The four paradigms of science are positivism, realism, constructivism, and critical theory (Sobh and Perry, 2006). These four paradigms will be addressed later in this chapter.

3.3 RESEARCH TYPE

This section presents the type of research and research problem addressed in this study. In order to combine the collection and analysis of quantitative and qualitative data - a mixed method research type will be used.

Research related to management systems, including such systems as related to H&S is becoming increasingly complex and intricate and requires techniques for examining research problems and analysing data to explain and clarify social phenomena, such as human risk-taking behaviour. Although quantitative dichotomy is dominant in management studies and has been a reasonably unquestioned method for exploring social and behavioural sciences, qualitative research as an alternative approach to a quantitative method is gaining interest. Qualitative methods - with a focus on interpretive and narrative analysis of information gathered through communication and observation - is gaining interest and provides an option to the numerical confidence attached to a quantitative style. A mixed research method is known to be a profoundly comprehensive technique for research in social sciences through integration of thematic and statistical data (Jogulu and Pansiri, 2011).

Mixed methods as a research design is linked to two fundamental issues:

- The theoretical concern related to any particular discipline in management, that is, the capacity for mixed methods to benefit a variety of research disciplines such as strategic alliances, human resources, psychology and sociology, and
- The extent to which the research questions determine the research approach, and whereby a rational justification is made for choosing a particular method or methods, which would ensure reliability and validity of the overall research findings (Jogulu and Pansiri, 2011).

The next sections relate to the justification of the research method that will validate the research.

3.4 VALIDITY OF THE RESEARCH

Literary data were obtained from various scientific journal papers, newspaper articles, academic publications, legislation standards, targeted organisational policies and procedures, and various library publications.

Data applicable to the empirical research were obtained from incident statistics, and various questionnaire surveys that include e-mail surveys and personal questionnaire interviews. Data so obtained provides a justifiable cover of relevant literature related to the research and the empirical data collected presents a qualitative and quantitative view of the sample stratums in relation to the Hypotheses proposed.

The statistical techniques used include: *ANOVA,* which is a *statistical model* in which the observed *variance,* in particular questions posed, is partitioned into various components attributed to different sources of information in the form of ICMEE, SAIEE, AMEU, SAFHE and ECA (SA) members of variation. ANOVA *tests* whether or not the *means* of several groups are all equal or not, and to what extent, and therefore generalises the'*t-test'* to more than two groups.

The *Fisher's exact test* is used to analyse the contingency of a table's data when the sample size is very small. It is an exact test that indicates the significance of deviation from the null hypothesis. The test examines the significance of the association between two different classifications to determine their association.

Tukey's 'honestly significant difference' (HSD) test results in the various independent variables and Table 5.15.1 presents the single sample '*t'* Test for the principle questionnaire survey while table 5.15.2 presents the single sample *'t'* Test for the incident case studies.

The importance of having reliable data is that it will allow for correct testing of the hypotheses and will provide end users of such research with results. In practice such research can be validated. Brennan, Voros and Brady (2011) postulate that validity as an idea is separable from a particular philosophical stance.

To improve the validity of the theoretical propositions, and to obtain a more complete (less biased) picture of the phenomenon under study than is possible with a narrower methodological approach, a mixed method research is proposed (Ihantola and Kihn, 2011).

The validity and reliability of quantitative and qualitative work has an impact on mixed methods studies during the research design, data collection, and/or data analyses stages. Ihantola and Kihn (2011) found that quantitative and qualitative studies are designed to draw on the value of multiple data-collection methods, both quantitative and qualitative data analyses and interpretation, drawing together multiple perspectives on evidence.

The degrees to which measures of different constructs are distinct from one other are the discriminate validity, and this is achieved when measures of such dimension converge on their corresponding true scores. In other words, it is the degree to which a theoretical dimension in a theoretical system differs from other dimensions in the same system. Measures of different constructs should share little common variance for discriminate validity (Roy, Nagpaul and Mohapatra, 2003). Ihantola and Kihn (2011) indicate that reliability generally refers to the extent to which a variable, or set of variables, is consistent in what it is intended to measure. When multiple measurements are taken, reliable measures will all be consistent in their values.

Reliability of research data will improve the validity of the research. If measured results are not reliable, it becomes more difficult and precarious to test hypotheses or to make inferences about the relations between variables in quantitative research.

Ihantola and Kihn (2011) indicate that the following issues represent some serious threats to reliability during data collection:

- Lack of clear instructions: ambiguous description of items so that they are misinterpreted and/or abstract concepts that are not measured with enough indicators of equal kind;
- Lack of pre-testing: the questions are not presented in the proper order, the questionnaire is too long or hard to read, and/or the interview takes too long;
- Failure to answer questions: giving several answers to the same question and comments in the margin may all indicate lack of reliability, and
- Random sources of error: typographical errors and other errors in data collecting, saving and analysis.

Validity and reliability of case study research is of paramount importance for academia as well as practitioners that will make use of the research. A high degree of validity and reliability provides not only confidence in the data collected, but most significantly, trust in the successful application and use of the results for managerial decision-making.

The four design tests of construct validity, internal validity, external validity and reliability are commonly applied to the theoretical paradigm of positivism. Similarly, however, they can be used for the realism paradigm, which includes case study research as shown in the following table (Riege, 2003).

3.4.1 Tests and techniques for establishing validity and reliability

Case study design test	Corresponding design test	Case study techniques	Qualitative techniques	Quantitative techniques	Phase of research in which techniques occur
Construct validity	Confirm (corresponding to objectivity and neutrality of positivism)	Use multiple sources of evidence	Conformability audit (examine the data findings, interpretation and recommendation)	Establishes appropriate operational measurers for concept being research	Data collection Report writing and Data analysis
Internal validity	Credibility	Within case analysis: Explanation building assurance, Internal coherence of findings and concept relation	Triangulation (sources, investigation and methods), Peer debriefing Research assumptions, Worldwide theoretical orientation	Cause -and-effect relationship. Constructing an internal valid research process (credibility of phenomena in case studies)	Data collection Data analysis and Design research
External validity	Transferability	Use replication logic in multiple case studies Define scope and boundaries	Predetermined questions Broad description (develop case study data base) Cross case analysis Specific procedures for coding and analysis	Questionnaire surveys at statistical generalisation of particular findings to a broader theory (empirical results of case studies)	Research design Data collection and Data analysis
Reliability	Dependability	Give full account of theories and ideas Assure congruence between research issues and future of study design Develop and refine case study protocol Use multiple research methods Use case study protocol	Dependability audits examine and document the process of inquiry Clarify researchers theoretical position and biases	Demonstrate that research can be repeated by others with similar findings.	Research design to data analyses and Research framework

Table 3.0 Tests and techniques for establishing validity and reliability

(Adapted from Riege, 2003)

Table 3.0 indicates tests and techniques for establishing validity and reliability in case study research. The design tests include ‘Construct validity’, ‘Internal validity’, ‘External validity’ and ‘Reliability’ tests.

3.5 QUALITATIVE AND QUANTITATIVE RESEARCH

Qualitative research concentrates on smaller samples with in-depth analysis and understanding of a specific behaviour, whereas quantitative research concentrates on a large sample base targeting a specific population with questionnaires to obtain numerical data that will answer a specific question.

Retrospective analysis of an incident is one of the key indicators of the effectiveness of an H&S management system. Incident analysis will indicate critical management areas not dealt with previously and will guide the adaptation of management objectives in relation to H&S. Objectives of H&S analysis should include: guidance on the adaptation of the environment to prevent re-occurrence; and corrective action to existing H&S system failures (du Toit, 2005).

3.5.1 Qualitative approach

Qualitative research methods produce information on particular cases studied. General conclusions are presented as propositions or assertions.

In qualitative research a phenomenon or attribute related to a specific case needs to be captured. Ihantola and Kihn (2011) indicate that in qualitative research, ‘contextual validity’ refers to the ‘credibility’ of case study evidence and the conclusions drawn.

The primary focus of such research is to capture ‘authentically’ the ‘lived’ experiences of people and to represent them in a ‘convincing’ text, that demonstrates that the researcher fully understands the case.

Similarities and differences between qualitative research and case study research go to the core of how a case study research differs from other qualitative methods. There are several distinguishing factors when comparing qualitative methods:

- First - whereas the main objective of case study research is the development and construction of theory, in-depth interviews concentrate on obtaining rich and detailed information, convergent interviews on narrowing down the research focus, and focus groups on group interaction;
- Second - case studies require a medium to high level of prior theory, which is not the case for in-depth and convergent interviews, which require little or no prior theory;
- Third - the process and content of case studies is usually (semi-) structured and follows standard procedures, whilst other methods are more flexible, with in-depth interviews ranging from being unstructured to structured, and focus groups and convergent interviews being very unstructured, and
- Fourth - whereas the main strength of case study research as well as in-depth interviews lays in its replication, ‘convergent interviews’ strength is its progressive and iterative nature, and ‘focus groups’ strength is the synergistic effect of a group setting (Riege, 2003).

3.5.2 Quantitative approach

In relation to incident case studies the aim of the analysis of quantitative data would be to formulate tables that can be analysed in relation to trends, and to compare these to the results of a survey research (Hunter and Leahey, 2008).

Statistical analysis of quantitative data presents the opportunity to summarise large amounts of data and to make predictions about future trends. The fundamental guideline for using data is the interpretation thereof by the researcher. This will affect the meaning that the data reveals. Every researcher must have a clear, logical rationale for the procedures used to arrange and organise such data (Leedy and Ormrod, 2005).

Quantitative research is one of the most essential manifestations of validity. In quantitative research, the ultimate question is whether valid conclusions can be drawn from a study, given the research design and controls employed.

To an extent, it is about the logic between a portion of research and an existing theory. The use of statistical control variables is also important in survey research (Hunter and Leahey, 2008: Ihantola and Kihn, 2011).

External validity is a key criterion in quantitative research. It determines whether one can draw more general conclusions on the basis of the model used and data collected, and whether results may be generalized to other samples, time periods and settings (Hunter and Leahey, 2008).

The following three typical problems may threaten the external validity of a quantitative study: population, time and environmental validity.

- ‘Population validity’ refers to whether inferences can be drawn from a study of a given population. The questions analysed concern, for example, whether a relationship between two variables also exists in the population at large, and not only in the sample selected. Further, will the validity of the population be affected if the sample of the population size is too small? According to Ihantola and Kihn (2011), if the sample size is inadequate and/or the sample is not random, the estimates may be meaningless because the sample may not faithfully reflect the entire population. In such cases generalizations should not be made to the target population (Ihantola and Kihn, 2011);
- ‘Time validity’ shows the extent to which the results of a particular study at a given point in time can be generalised in relation to other time periods, and
- ‘Environmental validity’ lies in the evaluation and analysis of compound causational reasons of environmental factors that contribute to specific incidents in case study history (Ihantola and Kihn, 2011).

3.5.3 Limitations of the research

Limitations in the research were experienced due to the small sample size of electrical incident case studies, affecting the ability to make *statistical inferences* from the selected sample stratum.

Further, the results were affected by the ability of electrical engineering staff to understand some of the concepts psychological and technical concept, especially at the lower-class work level.

Due to difficulties in the ability to obtain more electrical incident data, probability sampling techniques were not fully utilised.

Future research could overcome the limitations in the findings by incorporating improved qualitative research techniques and investigating observation studies that would offer better insight into the psychological aspect of risk-taking behaviour in the context of electrical engineering work, taking into account the physical entity and danger of electricity.

3.6 RESEARCH METHODOLOGY AND SELECTION

The value of case study history lies in the evaluation and analysis of compound causational reasons of environmental factors that contribute to specific incidents. The capacity of case studies to draw from different data sources, in order to allow several levels of simultaneous analysis of the dynamics in a single setting, creates the potential for a richer understanding of organizational phenomena than can be conveyed by statistical analysis (Lee, Collier and Cullen, 2007).

Riege (2003) indicated that case study methods are robust enough to take into account inevitable debates between several points of view. Not only is each case study a record of a situation involving different interests, but cumulatively similar case studies can be assembled to become a means of compiling, comparing and learning from multiple precedents.

The following brief section describes four different paradigms to research methodology:

- Positivism;
- Realism;
- Critical theory, and
- Constructivism.

3.6.1 The positivist approach

Positivists believe that natural and social sciences are composed of a set of specific methods for trying to discover and measure independent facts about a single apprehensible reality, which is assumed to exist, driven by natural laws and mechanisms. The aim of science is to build up objective and commensurable causal relationships showing how constructs of discrete elements work and perform from a relatively secure base, taking a broad view. Positivism is commonly characterised by a deductive method of inquiry seeking for theory confirmation in value-free, statistical generalisations (Riege, 2003).

The Positivist Paradigm is the nature of knowing and reality. It provides an objective reality against which researchers can compare their claims and ascertain truth. The empirical verification of positivism assumes the reliance on perceptions of the world to provide accurate data. Such research should be assumed to be value-free. Research will be free of subjective bias and objectivity will be achieved (Angen, 2000).

The positivist position is grounded in the theoretical belief that there is an objective reality that can be known to the researcher, if they use the correct methods and apply those methods in a correct manner (Angen, 2000).

3.6.2 Realism

Realists believe that natural and social sciences are capable of discovering and knowing reality, although not with certainty. Realists acknowledge differences between the real world and their particular view of it.

Realists try to construct various views of this reality and aim to comprehend phenomena in terms of which of them are relative in a particular place and time.

In contrast to positivism, realism does not rely as much on deductive research inquiries, but sees more appropriate research methods in those that have an inductive nature for discovering and building theory rather than testing theory through analytical generalisations (Riege, 2003).

Qualitative methods such as case studies commonly follow realistic modes of inquiry, for the main objectives are to discover new relationships of realities and build up an understanding of the meanings of experiences rather than verify predetermined hypotheses (Riege, 2003).

3.6.3 The critical approach

Critical theory assumes apprehensible social, political, cultural or economic realities incorporating a number of virtual or historic structures of these realities that are taken as real. Researchers and their investigated subjects are linked interactively, with the belief system of the researcher influencing the inquiry, which requires a dialogue between researcher and subject. Hence, no objective or value-neutral knowledge exists as all claims are relative to the values of the researcher (Riege, 2003).

The critical approach to research investigation questions the assumptions, interest and ways of proceeding within research paradigms.

Critical research models have not been widely accepted as valid or legitimate. The power game in academic environments about what is ‘properly produced’ knowledge has effectively restricted the expansion and recognition of critical – sometimes revolutionary – research and its results (Valero and Zevenbergen, 2004).

3.6.4 Constructivism

The essence of constructivism is multiple apprehensible realities, which are socially and empirically based, and intangible mental constructions of individual persons. Similar to critical theory, assumptions are subjective, but the created knowledge depends on the interaction between and among researcher and respondent(s), aiming at increasing an understanding of the similarities and differences of constructions that both the researcher and respondent(s) initially held, in order to become more aware of, and informed about, the content and meaning of these constructions.

All constructivists believe that knowledge is theory driven. A separation of researcher and research subject/object is not feasible, as is the separation between theory and practice.

The methodology of critical theory's and constructivism's paradigms is dialectical, that is, it is focused on an understanding and reconstruction of the beliefs that individual people initially hold, trying to achieve a consensus while still being open to new interpretations as information and sophistication improves (Riege, 2003).

3.7 REVIEW OF DATA RELATIVE TO THE SUB-PROBLEMS

This section evaluates and indicates how data in relation to the various sub problems was obtained and interpreted.

3.7.1 Data relative to the first sub-problem

Data Required	Data location	How obtained	Interpretation
Policy and procedures for induction and retraining regarding re-evaluation and training interventions.	Eskom internal regulations (e.g. High voltage operating regulations)	Obtained from Eskom.	Existence and procedures for training interventions.
Individual view of training interventions on preventing risk- taking behaviour. H&S training influence on preventing repetitive risk-taking behaviour.	Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors	Incident case studies analysis. Questionnaire surveys. Incident data analysis.	Evaluated the effectiveness of training to prevent high risk-taking behaviour. Interaction of H&S training systems on risk-taking behaviour.

Table 3.1 Data relative to the first sub-problem

Data relative to the first sub-problem is to identify what role and influence training can have on individual risk-taking behaviour.

3.7.2 Data relative to the second sub-problem

Data Required	**Data location**	**How obtained**	**Interpretation**
Competence: Knowledge and experience related to the specific incidents. Individual view and perception of hazards in the electrical engineering, construction and maintenance environment. Profile of electrical worker's knowledge and experience. Specific job task knowledge. Years of experience per specific job task involved related to the incident. Organisational systems and H&S systems impact on incidents.	Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors	Incident case studies analysis. Questionnaire surveys. Incident data analysis.	Evaluate and find correlation between electrical workers profile and their competencies (knowledge and experience). Job task knowledge correlation against individual involvement in incidents and disciplinary procedures related to accidents.

Table 3.2 Data relative to the second sub-problem

Data relative to the second sub-problem is to determine if electrical workers are more prone to perceive hazards than others, whilst exposed to the same dangers in a working environment, and if so, could it be possible to find distinguishing characteristics that allow for the profiling of this worker segment of the electrical field.

3.7.3 Data relative to the third sub-problem

Data Required	Data location	How obtained	Interpretation
Profile of cultural background of electrical construction and maintenance worker. Specific culture's view of risk perception and risk-taking behaviour. Profile of incident statistics.	Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors • Eskom incident case studies.	Incident case studies analysis. Questionnaire surveys. Incident data analysis.	Culture's different views on risk perception and risk- taking behaviour. Comparisons of individual electrical workers cultural profile to incident statistics.

Table 3.3 Data relative to the third sub-problem

Data relative to the third sub-problem is to determine what weight and effect cultural diversity has on influencing risk-taking behaviour.

3.7.4 Data relative to the fourth sub-problem

Data Required	Data location	How obtained	Interpretation
H&S legislation and standards applicable to the electrical engineering work. H&S legislation applicable to specific incident case studies. Individual view of H&S legislation as a motivational factor in altering risk-taking behaviour.	H&S legislation and electrical engineering standards incorporated in H&S legislation. Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors	Literature survey. Incident case studies analysis. Questionnaire surveys.	Correlation between H&S legislation applicable and incident statistics. Individual incident history in relation to perception of the effectiveness of H&S legislation. H&S as a motivation for improving H&S culture.

Table 3.4 Data relative to the fourth sub-problem

Data relative to the fourth sub-problem is to determine if H&S legislation and H&S standards have an influence in altering perception of risk and the influence on individual risk-taking behaviour.

3.7.5 Data relative to the fifth sub-problem

Data Required	Data location	How obtained	Interpreted
View of management competencies to influence H&S systems by electrical workers. Management's involvement in H&S management. Management role in electrical incidents.	Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors	Literature survey. Incident case studies analysis. Questionnaire surveys.	Management influence on electrical incidents. Comparison of management training to electrical incidents.

Table 3.5 Data relative to the fifth sub-problem

Data relative to the fifth sub-problem is to identify what influence management competencies have on electrical incidents.

3.7.6 Data relative to the sixth sub-problem

Data Required	Data location	How obtained	Interpreted
Management competencies (knowledge and experience). What management practices influence safe behaviour? Management's role in electrical incidents.	Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors	Literature survey. Incident case studies analysis. Questionnaire surveys.	Comparisons of management capabilities to incident statistics. Correlation between Management practices and the view of electrical workers to unsafe behaviour.

Table 3.6 Data relative to the sixth sub-problem

Data relative to the sixth sub-problem is to determine if management practices can influence risk-taking behaviour and the effect such practices have on electrical incidents.

3.7.7 Data relative to the seventh sub-problem

Data Required	Data location	How obtained	Interpreted
The role of incentives in incident statistics. Incident case studies. View of advances or gains in risk-taking behaviour.	Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors	Incident case studies analysis. Questionnaire surveys. Incident data analysis.	Analysis of incident case studies to determine the correlation to gains for parties involved in such incidents.

Table 3.7 Data relative to the seventh sub-problem

Data relative to the seventh sub-problem is to determine if incentives and other advances promotes risk-taking behaviour

3.7.8 Data relative to the eighth sub-problem

Data Required	Data location	How obtained	Interpreted
Government policing as a motivation to prevent risk taking behaviour. Prosecution statistics related to electrical incidents. Statistics on DOL attendance to electrical complaints.	DoL statistics Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors	Request to DoL for statistics. Literature survey. Incident case studies analysis. Questionnaire surveys.	View of financial gain or other advances as a motivation for unsafe behaviour. Comparison between the relationship of incident statistics and H&S inspections and prosecutions recommended by the DoL.

Table 3.8 Data relative to the eighth sub-problem

Data relative to the eighth sub-problem is to determine whether or not more stringent policing of H&S requirements will prevent risk-taking behaviour

3.7.9 Data relative to the ninth sub-problem

Data Required	Data location	How obtained	Interpreted
Electrical worker's knowledge and experience related to a specific incident. Statistics on incident data. Electrical worker's experience and training per specific job task related to an incident.	Members of: • AMEU • SAFHE • SAIEE • ECA(SA) • Eskom employees • Eskom contractors	Literature survey. Incident case studies analysis. Questionnaire surveys.	Correlation between incidents and formal qualifications of electrical workers. Correlation between specific experience per job task and incident case studies.

Table 3.9 Data relative to the ninth sub-problem

Data relative to the ninth sub-problem is to determine what influence competencies in terms of experience and knowledge have on risk-taking behaviour.

3.7.10 Interpretation of general remarks from respondents

Discussion of raw data regarding general remarks obtained from respondents during the questionnaire survey and the impact on the research findings are presented in figures 4.1 to 4.7 in the following chapter.

3.8 RESEARCH QUESTIONAIRE

The aim of the research questionnaire was to address the aspects related to the sub-problems that could be statistically analysed to determine whether the hypotheses are supported or not.

An attempt was made to obtain the following data from questionnaire surveys related to specific Eskom incident data. The questionnaires targeted both the injured involved in such incidents and their supervisors.

3.8.1 RATIONALE FOR QUESTIONNAIRE CONTENTS

The questionnaires used in all the different phases of the research had the primary objective of determining the individual's view of risk-taking behavioural impact on H&S in relation to their organisations and specific incidents. The questionnaires were designed to obtain demographic detail of respondents in order to evaluate risk-taking behaviour patterns in relation to incident case studies and current electrical work environments. The rationale was to determine patterns of the impact risk-taking behaviour would have on H&S management systems.

A. The Injured - Variables in Case Studies

Competence: (Knowledge and experience related to the specific incident).

- Level of qualification;
- Task specific training received;
- Years of experience, and
- Years of experience per specific job task involved - related to the incident.

Human behaviour:

- Cognitive Heuristics – How injured learned risk of task for himself;
- Involvement in previous related incidents;
- Profile of injured to comply with authority, previous disciplinary action;
- Risk-taking profile of injured party, and
- Judging risk (evaluation of gauging risk related to task).

Management:

- View of management capabilities to prevent incidents, and
- Decision making level of injured.

From incident investigation:

- Who was responsible for the incident;
- Any disciplinary action taken, and
- Recommendations for corrective action.

Environment:

- Place;
- Time of day;
- Day of week, and
- Time since work day started (overworked, time of day).

Physical condition of injured:

- Any impairments of the injured;
- Ergonomics of job (Comfortable chair versus working from a harness);
- Drug or alcohol abuse (intoxicated, medical condition, diabetes etc.), and
- Food and liquid intake (when last did injured eat or drink).

Gain versus loss:

- Gains for completing task sooner;
- Avoidance of repetitive process;
- Uncomfortable environment (complete task to leave sooner);
- Social needs / responsibility (e.g. need to get back to family);
- Date of week (Different work perception e.g. Friday versus Monday);
- Environmental condition (Weather, indoor outdoor activity), and
- Workload (other tasks to be performed).

B. Supervision - Variables in Case Studies

Competence: (Knowledge and experience related to the specific incidences):

- Level of qualification of site supervisor;
- Supervisors specific training received;
- Years of experience, and
- Years of experience per specific job / task involved related to the incident.

Human behaviour:

- Cognitive heuristics – How supervisor learned for himself;
- Involvement in previous related incidents;
- Previous disciplinary action taken against supervisor, and
- Risk taking profile.

Physical condition:

- Any impairments of the supervisor;
- Time since work day started (overworked);
- Ergonomics of job, and
- Drug or alcohol abuse – hangovers.

Gains from task management:

- Gains for completing sooner;
- Avoidance of repetitive process;
- Leave Uncomfortable environment sooner;
- Need to get back to family;
- Leave for weekend;
- Stormy/ Rainy weather, and
- Other tasks to be performed.

3.9 RESEARCH PHASES

The section considers the various phases of the research, indicating the target population, the sample stratum and the response rate.

Response rate in the electrical engineering environment are usually not well-presented due to the work environment and work-load of engineering workers that do not always afford them the luxury of access to communication mediums and time, resulting in a low response rate. Further, the impact of organization privacy policies and the fear of victimisation in relation to specific incidents deter a response on questionnaires.

The statistical analysis used the ‘Fisher Exact Test’ due to the low sample stratum as the most adequate analysis tool for low sample strata. It is an exact test that indicates the significance of the deviation from the null hypothesis.

3.9.1 Phase 1 - Response rates for the sample strata

The sample stratum in phase 1 concentrated on various institutions and organisations whose members are involved in the electrical engineering activities. Such activities include design, project management and supervision of maintenance and installation projects.

Structured questionnaire to ICMEE, SAFHE, ECA(SA), SAIEE			
Stakeholder	**Analysed (No.)**	**Sample stratum (No.)**	**Response rate (%)**
ICMEE	12	145	8.0
ECA(SA)	11	450	2.0
SAFHE	10	42	24.0
SAIEE	8	364	2.0

Table 3.10 Phase 1 - Response rates for the sample strata

In Phase 1 a structured questionnaire was forwarded by e-mail to the Western Cape branch of ICMEE, ECA (SA), SAFHE of the hospital group Netcare members only and SAIEE Southern Cape branch only.

The highest response rate was received from the Federation of hospital engineers that are involved in specialised electrical installations including such installations as those in specialised areas, theatres, casualty, and intensive high care units.

To counter-act response bias by respondents answering questions in the way they think was required from them, or in such a way that they wish to avoid being incriminated or discriminated against, especially related to incident case studies the respondents were assured that no reference will be made of their personal details.

Questions were worded in such a way that no leading opinion or any information related to organisational or personal views were expressed. To ensure a statistical representation of the sample the one top one telephonic interviews target the whole group and persisted in obtaining response from nearly all respondents with an 87% response rate for employee supervisors and a 50 % response rate for the injured employees.

3.9.2 Phase 2 - Response rates for the sample strata

The sample stratum in phase 2 targeted members of the municipal electrical engineering organisation. These municipal electrical engineers were all members of the AMEU.

Structured questionnaire to municipal engineers - AMEU			
Stakeholder	**Analysed (No.)**	**Sample stratum (No.)**	**Response rate (%)**
Municipal Engineers	8	30	27.0

Table 3.11 Phase 2 - Response rates for the sample strata

In Phase 2 a structured questionnaire was e-mailed to electrical engineers who are members of the AMEU in the Southern Cape and Western Cape. The small strata of municipal engineers are due to the shortage of qualified engineering personnel employed by local municipalities. The response rate of 27% was obtained by direct communication and by means of e-mail questionnaires forwarded.

3.9.3 Phase 3 - Response rates for the sample strata

The phase 3 sample strata represents employees and contractors injured and their supervisors involved in Eskom electrical incidents.

First structured questionnaire to Eskom			
Stakeholder	**Analysed (No.)**	**Sample stratum (No.)**	**Response rate (%)**
Employee supervisors	1	89	1.0
Employee Injured	2	89	2.0
Contractor Supervisor	2	36	6.0
Contractor Injured	3	36	8.0

Table 3.12 Phase 3 - Response rates for the sample strata

In Phase 3, a questionnaire survey was e-mailed to Eskom employees and Eskom contractors, in all distribution regions of South Africa that had been involved in engineering related incidents for the past 3 years (2008 – 2010). Unfortunately due to no direct contact details of staff involved in these incidents, the questionnaires were forwarded via various channels resulting in an extremely low response rate.

3.9.4 Phase 4 - Response rates for the sample strata

In phase 4 a second structured questionnaire was completed by employees and contractors injured and their supervisors involved in Eskom electrical incidents.

Second structured questionnaire to Eskom			
Stakeholder	**Analysed (No.)**	**Sample stratum (No.)**	**Response rate (%)**
Employee supervisors	15	13	87.0
Employee Injured	12	6	50.0

Table 3.13 Phase 4 - Response rates for the sample strata

In Phase 4 specific Eskom (Distribution) incidents were targeted and interviews were held on a one on one basis either telephonically or by means of personal interviews. The excellent responses were achieved through consistent requests and setting up of specific dates for such telephonic and one on one personnel interviews.

3.9.5 Phase 5 - Eskom incident data analysis

In Phase five, incident data with related descriptions of 89 incidents in Phase 3 were analysed to determine correlation between:

- Human error and environmental influence as the cause of the incident;
- If risk-taking behaviour was due to the individuals intended action or due to negligence;
- What affect organisational or the individual’s culture had on the incident, and
- Contributory factors of organisational and / or H&S system failures.

Although more data would have resulted in a more comprehensive data analysis, it is however a risk behaviour observational study that does indicate the tendencies in relation to cause of incidents, risk behaviour, cultural influence, and management system failures.

3.9.6 Phase 6 - Response rates for the sample strata.

The sample stratum in phase 6 concentrated on HR managers employed by Eskom.

Eskom HR Managers Survey			
Stakeholder	**Analysed (No.)**	**Sample stratum (No.)**	**Response rate (%)**
Eskom HR Managers	8	37	22.0

Table 3.14 Phase 6 - Response rates for the sample strata

In Phase 6 a structured questionnaire was forwarded by e-mail to all Eskom HR managers requesting their input and viability of HR inclusion of risk behaviour profiles as an intervention in recruitment and evaluations processes.

3.10 SUMMARY

In this chapter the research methodology was presented and the process of data collection explained.

Data applicable to the empirical research were obtained from incident statistics, and various questionnaire surveys that include e-mail surveys and one on one questionnaire interviews. Data so obtained provided a justifiable cover of relevant literature related to the research and the empirical data collected presents qualitative and quantitative views of the sample stratums in relation to the proposed hypotheses.

The primary data as used in the research was obtained from the analysis of incident data obtained from the electricity utility company, Eskom. The population assessment in the survey with response rates was presented. The low percentage response rate in Phase 3, even though incident descriptive data was available was improved on by direct and telephonic interviews, where e-mail and postal requests for responses to questionnaire surveys was low.

The Chapter that follows presents the empirical research related to the data collected in Phases 1 to 5.

CHAPTER 4: RESEARCH FINDINGS

4.1 INTRODUCTION

This Chapter evaluates the data obtained from the various questionnaire surveys and incident data analyses. The main aspects were addressed in a principal questionnaire survey that included predominantly 'Likert' scale type questions. Data associated with the population profile and risk-taking behaviour patterns related to specific case studies are presented in table format. The data obtained is illustrated in various tables and graphs indicating the differences of various aspects of individual risk taking behaviour, cultural and other environmental influences.

From the various literature surveys of several studies that address related research hypotheses, a common measure of the effect were identified and relevant questionnaire surveys designed to address pertinent issues related to the hypotheses. Various statistical analysis methods were employed to determine deviation from the null hypothesis and their independence. Due to the size of the population surveyed the use of specific tests, such as Fisher's exact and Tukey's HSD test, were appropriately employed.

The phases in the principal questionnaire survey were:

- Phase 1 - was based on a questionnaire survey forwarded to members of electrical engineering and electrical contracting and related organisations. These include the SAIEE, AMEU, SAFHE, ICMEE(SA) and ECA(SA);
- Phase 2 - relates to a survey conducted among AMEU members that were interviewed using a structured questionnaire;
- Phase 3 - involved a questionnaire survey that was e-mailed to Eskom employees and Eskom contractors in all distribution regions of South Africa, that have been involved in engineering related incidents for a three year period (2008 – 2010);
- Phase 4 - pertains to incidents related to the distribution section of the electrical power generator Eskom. These surveys were conducted through an e-mail survey;
- Phase 5 - incident data with description of incidents from Phase 3 were analysed, and
- Phase 6 - a structured questionnaire was forwarded to all HR managers of Eskom to determine their view with respect to HR interventions, in relation to risk taking behaviour, during the recruitment and appraisal processes.

4.2 INCIDENT PROFILE VERSUS RISK-TAKING BEHAVIOUR

The following data relates to the incident samples surveyed in Phases 3 and 4 in relation to specific incidents of Eskom that target the injured and the supervisors involved.

4.2.1 Profile of the incident sample

The incident profiles of the injured and their supervisors, in relation to specific accidents, conducted as part of the principal questionnaire survey, relate to:

- Years of work experience at the time of the incident;
- Formal qualification at the time of the incident;
- Specific training received for the job task that was performed during the incident;
- How knowledge applicable to the specific job task, at the time of the incident, was obtained;
- How often the specific job task was performed prior to the incident;
- How often the injured and their supervisors were previously involved in work accidents, and
- How often the injured and their supervisors were disciplined for work misconduct or poor work performance.

4.2.1.1 Years of work experience at the time of the incident

Years of work experience in the electrical engineering field gained during the incumbent's work career. This experience is not related to specific job task, but to engineering work in general.

Employee category	**Years of work experience at the time of the incident (%)**				
	< 1 year	**1 to 5 year**	**5 to 10 years**	**10 to 20 years**	**> 20 years**
Supervisors	0.0	0.0	23.1	15.4	61.5
Injured	0.0	16.6	16.7	16.7	50.0

Table 4.1 Years of work experience at the time of the incident

The statistics in Table 4.1 portray the amount of experience of the injured and their supervisors prior to the incident. The table illustrates that the supervisors had more work experience in the specific engineering environment. It is notable that 50% of the injured have more than 20 years work experience, 16.7% more than 10 years and 16.7% more than 5 years.

4.2.1.2 Highest formal qualification at the time of the incident

The highest formal qualifications of supervisors and injured are presented, such qualifications would correlated the aspect of knowledge in relations to specific incidents.

Employee category	Highest formal qualification at the time of the incident (%)				
	Primary school	**Secondary school**	**Qualified in a trade**	**Diploma / Degree**	**Professional registration or M / D degree**
Supervisors	0.0	0.0	30.8	69.2	0.0
Injured	16.6	16.7	50.0	16.7	0.0

Table 4.2 Highest formal qualification at the time of the incident

The statistics in Table 4.2 represent the comparison of formal qualifications between the injured and their supervisors. Although most of the tasks being performed were of a physical nature, the high formal qualification in terms of a diploma / degree as possessed by 69.2% of supervisors and 16.7% of the injured, and in terms of a trade certificate as possessed by 50% of the injured, indicates the involvement of formal qualified people.

4.2.1.3 Specific training received for job task

The specific training that the incumbents received at the time of the incident in relation to the job task involved are presented, with an aim of extrapolating the link between specific job task knowledge and risk taking behaviour.

Employee category	Specific training received for job task (%)				
	On-site training	**1 day training**	**2 to5 days training**	**Formal certificate**	**Degree or diploma**
Supervisors	30.8	15.4	15.4	30.8	7.6
Injured	16.7	16.7	33.3	33.3	0.0

Table 4.3 Specific training received for job task

Table 4.3 presents specific training received in relation to the job task.

Supervisors have a balanced training portfolio of on-site training and a formal certificate where the injured in only 16.7% of incidents analysed received on-site training. This indicates a lack of practical training instruction in job tasks.

4.2.1.4 Knowledge applicable to the specific job task skills

Table 4.4 presents the medium that knowledge were gained for the specific job task skill required in relation to electrical incidents.

Employee category	Knowledge applicable to the specific job task skills (%)				
	Formal training	Trial & error	Repetitive processes	Observation	Experience
Supervisors	92.3	0.0	7.7	0.0	0.0
Injured	66.7	0.0	0.0	33.3	0.0

Table 4.4 Knowledge applicable to the specific job task skills

Table 4.4 indicates how knowledge applicable to the specific task at the time of the incident was obtained. The indication in both the injured and the supervisors are that most of their knowledge applicable to the job task was obtained from formal training and not from on-site observation or from experience. There is thus a need for practical between formal training and actual on-site performance.

4.2.1.5 Experience related to the task involved in the incident

The years of experience in relation to the specific job task involved at the time of the accident is presented.

Employee category	Experience related to the task involved in the incident (%)				
	Never	1 to 5 times	5 to 20 times	20 times to 10 years	10 years or more
Supervisors	7.7	0.0	0.0	69.2	23.1
Injured	0.0	0.0	33.3	16.7	50.0

Table 4.5 Experience related to the task involved in the incident

Table 4.5 indicates how often the specific job task related to the incident was performed prior to the incident. It indicates that in 50% of the cases the injured had more experience than their supervisors. The fact that supervisors were involved less than 20 times in the job task at the time of the incident, requires evaluation of competency of the supervisors, or the effectiveness of fast tracking, qualified staff without the necessary job task experience.

The indication is that 50% of the injured had more than 10 years experience related to the job task as opposed to the supervisors of whom only 23.1% had more than 10 years experience.

4.2.1.6 Previous involvement in work related accidents

The number of previous work related accidents shows the correlation between accident records and the propensity for future accident involvements.

	Previous Involvement in work related accidents (%)				
Employee category	**No Accidents**	**Less 2 Accidents**	**2 to 4 Accidents**	**More 4 Accidents**	**Debilitating Accidents**
Supervisors	46.2	53.8	0.0	0.0	0.0
Injured	0.0	100.0	0.0	0.0	0.0

Table 4.6 Previous involvement in work related accidents

Table 4.6 indicates how often the incumbents and their supervisors were involved in previous accidents. The fact that all of the injured were previously involved in work related accidents. This emphasises the need for correct worker’s risk behaviour profiling including history of accidents. That half of the supervisors were involved in accidents previously, relates not only to risk-taking behaviour, but also to job task and work experience.

4.2.1.7 Involvement in disciplinary procedures

Involvement in disciplinary procedures is an indication of risk-taking behaviour tendency of individuals, providing an opportunity for advancing risk behaviour profiles.

Employee category	Involvement in disciplinary procedures (%)				
	Never	Once	1 to 5 times	5 to20 times	More than 20
Supervisors	69.2	30.8	0.0	0.0	0.0
Injured	83.3	16.7	0.0	0.0	0.0

Table 4.7 Involvement in disciplinary procedures

Table 4.7 indicates how often the incumbent and their supervisors were disciplined for misconduct in line with their work. The correlation between low disciplinary procedures taken against the injured who were previously involved in accidents is a reflection of either incorrect incident investigations or exposure of the injured to environmental aspects out of their control. This indicates the vulnerability of the injured and an ineffective H&S system.

4.2.2 Risk-taking behaviour profile of the incident samples

The findings of the principle questionnaire survey in Phases 3 and 4 highlight the risk-taking differences between the supervisors and the injured employees, in relation to specific incidents of Eskom that target the injured and the supervisors involved.

The risk-taking behaviour profile, of the injured and the supervisors, in relation to specific incidents, conducted as part of the principal questionnaire survey, relates to:

- Gambling patterns;
- Work related incident patterns;
- Vehicle incident patterns;
- The influence of the individuals cultural background on perception of risk;
- The influence of trust in management on risk-taking behaviour;
- Involvement in unsafe behaviour patterns;
- Individual motivation and perception of risk, and
- H&S legislative influence.

4.2.2.1 Gambling patterns

Gambling patterns	Employee category (%)	
	Supervisors	**Injured**
Previous gambling experience	69.2	83.3
Gambled for financial gain, this year	0.0	16.7

Table 4.8 Gambling patterns

Table 4.8 displays the employees' propensity for gambling for financial gain. From the literature survey, gambling has a clear link to the individual's risk-taking behaviour profile. The high involvement of the injured in previous gambling relates to a tendency for higher risk-taking behaviour than that of their supervisors, indicating the need for correct job task allocation.

4.2.2.2 Work related incident patterns

Work related incident patterns	Employee category (%)	
	Supervisors	Injured
Pattern of accidental, self injury at work	23.1	50.0

Table 4.9 Work related incident patterns

The expected higher rate of a history of self injury at work, reflected in Table 4.9, again emphasises the correlation between the injured employee's propensity for risk-taking behaviour patterns and a profile of risk-taking behaviour.

4.2.2.3 Vehicle incident patterns

Vehicle incident patterns	Employee category (%)	
	Supervisors	Injured
Involved in motor accident as the driver	76.9	66.7
Received speeding fines	92.3	83.3
Believe in keeping the speed limit	92.3	83.3

Table 4.10 Vehicle incident patterns

The higher involvement of the injured at 76.9% previous history of motor vehicle accidents as a driver as opposed to that of the supervisors 66.7% is indicative of a higher risk behaviour profile for the injured.

4.2.2.4 Cultural influence on risk perception

Cultural influence on risk perception	Employee category (%)	
	Supervisors	Injured
Have European cultural background	69.2	16.7
Culture's attitude towards risk-taking: Moderate to High	61.5	16.7
Would take a calculated risk to complete a job faster	30.8	16.7

Table 4.11 Cultural influence on risk perception

Table 4.11 indicates that a large percentage of the work force in supervisory capacity are from a European background and the indication that this group perceived themselves as high risk takers is significant as it indicates a link, as confirmed in the literature survey, of a direct correlation between risk-taking behaviour as influenced by a specific cultural background.

4.2.2.5 Trust in management

Trust in management	Employee category (%)	
	Supervisors	Injured
Believe in Health and Safety policies and procedures	84.6	83.3
Believe that workers are responsible for accidents	84.6	66.7
Influenced by management behaviour	15.4	50.0

Table 4.12 Trust in management

Table 4.12 reflects the respondents' belief in management's competency to ensure a healthy and safe environment. The individual's risk-taking behaviour, and his motivation for taking a risk or not is influenced by fear of disciplinary action, and also a transfer of belief in that the individual's H&S is ensured by competent management.

It is noted that there is a stronger trust in H&S policies and procedures from the supervisors than that of the injured.

This would correlate with the higher risk-taking tendency of the injured who, due to a lower trust in H&S, would rather rely on their own judgement than that of existing H&S management policies.

4.2.2.6 Unsafe behaviour patterns

Unsafe behaviour patterns	**Employee category (%)**	
	Supervisors	**Injured**
There is no difference in an unsafe act at work or at home	94.0	100.0
Would not be more inclined to take risks at work rather than at home	92.3	83.3
Would report unsafe behaviour	100.0	83.3

Table 4.13 Unsafe behaviour patterns

The clear indication in Table 4.13 of the injured party's beliefs that an unsafe act at home is different to an unsafe act at work indicates the need for education that a similar hazard at home would have the same effect as at work. This categorisation by the injured and not by the supervisors indicates a strong H&S culture at work for the injured, but unfortunately, not an understanding of the scientific implications of specific hazards. Further, the high inclination to rather not take risks at work is an indication of a motivation either of a fear of disciplinary action or rewards. Although a high percentage of the injured indicated that unsafe behaviour would be reported at work, it is not yet 100% as in the case of supervisors, indicating a lack of trust in management.

4.2.2.7 Individual motivation and perception of risk

Individual motivation and perception of risk	Employee category (%)	
	Supervisors	Injured
Fear of penalty and/or injury as a motivation not to take risks	92.3	83.3
Believe in taking calculated risk	46.2	33.3

Table 4.14 Individual motivation and perception of risk

Table 4.14 indicates that the fear of penalty and injury is a motivation not to take risks. This correlates with the cognitive behaviour paradigm. This is notable as different motivational aspects need to be evaluated to prevent individual high risk-taking behaviour.

4.2.2.8 H&S legislative beliefs

H&S legislative beliefs	Employee category (%)	
	Supervisors	Injured
Believe in all of the laws in South Africa	0.0	66.7
Believe that management and authority in SA set good examples	0.0	16.7
I am Influenced by management behaviour	15.4	50.0

Table 4.15 H&S legislative beliefs

The low influence on supervisors by management, reflected in Table 4.15, is an indication of a higher reliance by supervisors on their own managerial capabilities. In contrast the injured believe in legislation were significant.

4.3 ANALYSIS OF THE PRINCIPAL QUESTIONAIRE SURVEYS

4.3.1 Likert analysis of principal questionnaire survey

The interpretations of the findings are tabulated in terms of mean score.

Parameter	ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1. Cultural impact	4.22	1	3.00	4	2.50	5	2.94	3	4.13	1	3.36	2
2. Perception of risk	3.39	2	3.25	1	3.30	2	3.71	2	3.50	2	3.43	1
3. Motivational incentives	2.83	3	3.00	4	2.83	4	2.81	5	3.19	3	2.93	3
4. Managerial Influence	2.61	4	3.13	2	2.93	3	2.88	4	2.25	5	2.76	5
5. Role of H&S legislation	2.44	5	2.00	5	3.70	1	3.44	1	2.58	4	2.83	4

Table 4.16 Degree of importance of various parameters

Table 4.16 indicates the degree of importance to respondent's organisations of five different parameters in terms of a mean score ranging between 1.00 and 5.00, based upon percentage responses to a scale of 1 (not important) to 5 (very important).

It is notable that the mean scores of only the impact of culture and perception of hazards are above the midpoint score of 3.00, which indicates that in general the respondents can be deemed to perceive these parameters as important. Given that the mean score for the impact of culture and perception of hazards is > 3.40 ≤ 4.20, the respondents can be deemed to perceive them to be between important to more than important / more than important. Given that the mean scores for motivational incentives and the influence of management are > 2.60 ≤ 3.40, the respondents can be deemed to perceive them to be between less than important to important / important. It is significant that the impact of risk culture and perception of risk are ranked first and second. Furthermore, it is notable that the role of H&S legislation in altering risk-taking behaviour is ranked last with a mean score of 2.44, which indicates that the current legislative approach is not seen as a motivation for better H&S management.

4.3.1.1 Statistical mean scores and ranking of importance

Aspect		ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1	Training can alter risk taking behaviour of electrical maintenance workers	4.44	1	4.25	1	3.50	2	4.50	1	4.25	1	4.19	1
2	Electrical workers will perceive hazards differently	3.78	3	4.00	3	3.00	3=	3.75	4=	4.00	3	3.71	2
3	Existence of different cultures perception of risk	4.22	2	4.13	2	2.50	4=	2.88	10	4.13	2	3.57	3
4	The influence of H&S standards on risk perception	3.00	6	3.00	6=	4.50	1	3.63	6	3.00	6=	3.43	4
5	Electrical accidents are relates to management incompetence	3.11	5	2.25	10=	2.25	5=	3.50	7	2.25	10=	2.67	8
6	Management competency is related to risk taking behaviour	3.56	4	3.00	6=	3.00	3=	3.88	3	3.00	6=	3.29	5
7	The framework of legislation, prevents risk taking behaviour	2.67	8=	2.75	8=	2.50	4=	3.75	4=	2.75	8=	2.88	7=
8	Safe work procedures differ among electrical maintenance workers	3.00	6	3.50	4	2.25	5=	3.25	9	3.50	4	3.10	6

Aspect		ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
		Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
9	Financial gain or other advances result in unsafe behaviour	2.67	8=	3.38	5	1.00	9	2.00	13	3.38	5	2.49	9
10	Management training is not the solution to risk-taking behaviour	2.00	12=	1.75	14	1.50	7=	2.50	11	1.75	14	1.90	12
11	Better government policing will prevent risk taking behaviour	2.67	8=	2.75	8=	2.25	5=	4.00	2	2.75	8=	2.88	7=
12	H&S legislation can alter risk perception of unsafe acts	2.00	12=	2.25	10=	1.75	6	3.38	8	2.25	10=	2.33	10
13	Unsafe behaviour is the norm for general electrical workers	2.33	11	2.25	10=	1.25	8	2.25	12	2.25	10=	2.07	11
14	Management practices do not promote safe behaviour	1.78	11	2.00	10=	1.50	8	1.88	12	2.00	10=	1.83	13

Table 4.17 Statistical mean scores and ranking of importance

Table 4.17 indicates the impact of risk perception in the electrical construction industry in terms of a mean score ranging between 0.00 and 5.00, based upon percentage responses on a scale of 1 (minor) to 5 (major). Given that, effectively, a six-point scale ('no impact' linked to a five-point) was used, and that the difference between 0.00 and 5.00 is five, ranges with an extent of 0.83 (5 / 6) are used to discuss the degree of central tendency. Firstly, it is noted that the mean scores for ten of the fourteen aspects are above the midpoint score of 2.50, which indicates that in general the related aspects can be deemed to be prevalent.

4.3.1.2 Training and risk-taking behaviour

Aspect one -Training and risk-taking behaviour data.											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
4.44	1	4.25	1	3.50	2	4.50	1	4.25	1	4.19	1

Table 4.18 Training and risk-taking behaviour

Aspect one shows that training can alter risk-taking behaviour of electrical maintenance workers and has the highest mean score (4.19) indicating that this method is believed to be the most appropriate intervention that can alter risk taking behaviour of electrical construction workers. The mean score > 4.17 ≤ 5.00 - between a near impact to impact / impact, is discussed first. The importance attributed to training in altering the risk-taking behaviour of electrical construction workers is a significant indication of the need for knowledgeable construction workers.

4.3.1.3 Electrical workers' perceptions of hazards

Aspect two - Electrical workers will perceive hazards differently											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
3.78	3	4.00	3	3.00	3=	3.75	4=	4.00	3	3.71	2

Table 4.19 Electrical workers' perceptions of hazards

Aspect two indicates that electrical construction workers' environments differ from other skills as they would perceive risks related to specific hazards of electrical construction work differently. The mean score is > 3.33 ≤ 4.17 - between impact and near major impact / near major impact. The finding that electrical workers will perceive hazards differently than in other industries is significant in terms of the view of the electrical engineering environment in acknowledging their unique work setting and the different profile of worker required to perform electrical job tasks.

4.3.1.4 Difference in cultural perception of risk

Aspect three - Existence of different cultures' perception of risk											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
4.22	2	4.13	2	2.50	4=	2.88	10	4.13	2	3.57	3

Table 4.20 Difference in cultural perception of risk

The indication in aspect three that different cultures have a different perception of risk is validated in the literature survey. The mean score > 3.33 ≤ 4.17 - between an impact to near major impact / near major impact, indicates the influence culture can have on risk perception and the importance of acknowledging this in H&S management systems. The relationship between an individual's risk taking behaviour and their cultural background needs to be acknowledged in job task assignments.

4.3.1.5 The influence of H&S standards on risk perception

Aspect four - The influence of H&S standards on risk perception											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
3.00	6	3.00	6=	4.50	1	3.63	6	3.00	6=	3.43	4

Table 4.21 The influence of H&S standards on risk perception

The influence that H&S standards have on risk perception, aspect four, reiterates the importance of knowledge in altering risk taking behaviour and the influence on individual risk perception. The mean score > 3.33 ≤ 4.17 - between an impact to near major impact / near major impact, indicates the importance of the influence the legislative environment can have in altering perception of risk and influencing risk taking behaviour.

4.3.1.6 Management’s role in incidents

Aspect five - Electrical accidents as related to managerial incompetence											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
3.11	5	2.25	10	2.25	5	3.50	7	2.25	10	2.67	8

Table 4.22 Management’s role in incidents

Aspect five, ranked eighth, indicates the relationship between competent management and risk taking behaviour.

The mean score > 2.69 ≤ 3.09 - between a near minor impact to impact / impact, is significant as the importance and relationship between management competencies and accidents is underscored and is indicative of the need to not only address worker capabilities, but also management competency.

4.3.1.7 Managerial influence on risk-taking behaviour

Aspect six – Managerial influence on risk-taking behaviour											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
3.56	4	3.00	6=	3.00	3=	3.88	3	3.00	6=	3.29	5

Table 4.23 Managerial influence on risk-taking behaviour

The high rank of aspect six is an indication of the effect management can have in influencing risk taking behaviour. Given that the mean score for the influence of management is > 2.70 ≤ 3.50, the respondents can be deemed to perceive managerial influence to be between important to more than important / more than important. Management competency related to risk-taking behaviour is nevertheless an indication of the need for competent management, including both experience and relevant knowledge.

4.3.1.8 Legislative influence on risk-taking behaviour

Aspect seven- Legislative influence on risk-taking behaviour											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
2.67	8	2.75	8	2.50	4	3.75	4	2.75	8	2.88	7

Table 4.24 Legislative influence on risk-taking behaviour

Aspect seven indicates that the framework of legislation, which prevents risk-taking behaviour, is ranked seventh, which is lower than the aspect of the influence of H&S standards (2.88), which is 11% lower.

This indication relates to more exposure to H&S standards incorporated in H&S legislation than day to day usage of legislation. This is significant as the influence on risk taking behaviour of electrical construction workers will be based on H&S standards rather than legislation.

4.3.1.9 Differences in H&S work procedures

Aspect eight – Differences in H&S work procedures											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
3.00	6	3.50	4	2.25	5	3.25	9	3.50	4	3.10	6

Table 4.25 Differences in H&S work procedures

Aspect eight indicates that electrical workers' ranking of H&S work procedure differs among electrical workers. This is significant as an indication that more than half of the workers see such practices as real. This is quite critical as the need to coordinate work in the same manner, and guidance to uniformity in work procedures, is paramount to ensure H&S of electrical workers. With mean scores between > 2.70 ≤ 3.50, the respondents can be deemed to perceive this aspect to be important to more than important / more than important.

4.3.1.10 Hazardous behaviour due to financial gain

Aspect nine – Financial gain or other advances result in hazardous behaviour											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
2.67	8=	3.38	5	1.00	9	2.00	13	3.38	5	2.49	9

Table 4.26 Hazardous behaviour due to financial gain

Aspect nine, financial gain or other advances resulting in unsafe behaviour, is ranked lower, which indicates that aspects such as training and cultural influences ranked first and second, have a greater impact on risk taking behaviour.

This low indication of motivation for unsafe behaviour is indicative of the difference in electrical workers when compared to other fields in construction work.

4.3.1.11 Management training and risk-taking behaviour

Aspect ten – Management training is not the solution to preventing risk-taking behaviour											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
2.00	12=	1.75	14	1.50	7=	2.50	11	1.75	14	1.90	12

Table 4.27 Management training and risk-taking behaviour

Table 4.27 indicates that twelfth ranked management training will not be the solution to risk-taking behaviour. It is ranked below management competency, which is related to risk-taking behaviour, ranked fourth, effectively 33.2% lower than the latter, indicating the need for competent management that are equipped with both experience and relevant knowledge.

4.3.1.12 Policing legislation and risk-taking behaviour

Aspect eleven - Better government policing will prevent risk-taking behaviour											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
2.67	8=	2.75	8=	2.25	5=	4.00	2	2.75	8=	2.88	7=

Table 4.28 Policing legislation and risk-taking behaviour

Intervention by better policing of legislation as a deterrent to risk-taking behaviour is rated only 4.2% higher than the belief in the framework of legislation, aspect seven, indicating that with better policing of H&S legislation, which is categorised as having a near minor impact to impact / impact.

It is noted that there is a mean score of 4.00 for members of SAFHE, which indicates the strong belief in legislation in this environment compared to the other sample stratum.

4.3.1.13 H&S influence on unsafe acts

Aspect twelve – H&S legislation can alter perception unsafe acts											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
2.00	12=	2.25	10=	1.75	6	3.38	8	2.25	10=	2.33	10

Table 4.29 H&S influence on unsafe acts

The mean score (2.00) of the twelfth ranked aspect, namely that H&S legislation can alter risk perception of unsafe acts, is notable in that legislation is not viewed as a driver in altering risk perception. This low ranking reinforces the review of the literature, which indicates that human risk perception is a complex phenomenon incorporating a variety of personal, cultural and environmental aspects rather than prescriptive legislative rules.

4.3.1.14 Tendencies to unsafe behaviour

Aspect thirteen – Unsafe behaviour is the norm for general electrical workers											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
2.33	11	2.25	10=	1.25	8	2.25	12	2.25	10=	2.07	11

Table 4.30 Tendencies to unsafe behaviour

The implication of the mean score (2.07) and ranking of thirteenth aspect unsafe behaviour is the norm for general electrical workers, can be interpreted as the tendency and belief of the industry not to accept unsafe behaviour.

This indicates that wilful unsafe behaviour is not a tendency in the electrical engineering industry, but that incidents are rather related to unsafe behaviour due to incorrect perception of risk, related to specific electrical job tasks.

4.3.1.15 Promotion of H&S behaviour by management

Aspect fourteen – Management practices do not promote H&S behaviour											
ICMEE		SAIEE		AMEU		SAFHE		ECA(SA)		Mean	
Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
1.78	11	2.00	10=	1.50	8	1.88	12	2.00	10=	1.83	13

Table 4.31 Promotion of H&S behaviour by management

The finding that management practices do not promote H&S behaviour, is significant as the implication is that management does promote H&S behaviour, but as per the aspect, management competency is related to risk-taking behaviour ranked sixth, ranked 34.6% higher, management does not score as having the necessary competency.

4.4 PRINCIPAL QUESTIONNAIRE ANALYSIS OF INCIDENT CASE STUDIES

The principle questionnaire survey in Section 4.3.1 was conducted as part of specific incident case study analysis. The interpretation of the independent views of injured electrical workers in relation to supervisors of such incidents emphasises the differences in the roles of supervisory management to that of the individual risk-taking behaviour and the impact of specific H&S standards applicable.

4.4.1 Incident case study analysis of risk perception

	Aspect	Injured		Supervisors		Total	
		Mean Score	Rank	Mean Score	Rank	Mean Score	Rank
1.	Training can alter risk-taking behaviour of electrical maintenance workers	3.00	4=	3.62	5	3.31	5
2.	Electrical workers will perceive hazards differently	3.50	3=	3.15	6	3.33	4
3.	Existence of different cultures' perception of risk	1.83	9	1.77	12	1.80	14
4.	The influence of H&S standards on risk perception	3.67	2=	2.77	8	3.22	6
5.	Electrical accidents are related to management incompetence	2.17	7	2.54	9	2.35	11
6.	Management competency is related to risk taking behaviour	2.67	5	3.69	4	3.18	7
7.	The framework of legislation, prevents risk taking behaviour	3.67	2=	3.77	3	3.72	2
8.	H&S work procedures differ among electrical maintenance workers	2.00	8	1.92	11=	1.96	13
9.	Financial gain or other advances results in unsafe behaviour	1.67	10	2.85	7	2.26	12
10.	Management training is not the solution to risk-taking behaviour	2.33	6	4.38	2	3.36	3
11.	Better government policing will prevent risk-taking behaviour	3.00	4=	1.92	11=	2.46	10
12.	H&S legislation can alter risk perception of unsafe acts	3.50	3=	2.38	10	2.94	8
13.	Unsafe behaviour is the norm for general electrical workers	3.67	2=	1.62	13	2.64	9
14.	Management practices do not promote H&S behaviour	4.50	1	4.54	1	4.52	1

Table 4.32 Incident case study analysis of risk perception

Table 4.32 portrays a comparison of risk perceptions of injured workers versus supervisors and indicates the impact of risk perceptions of injured electrical workers and supervisors involved in specific incidents in terms of a mean score ranging between 0.00 and 5.00, based upon percentage responses to a scale of 1 (minor) to 5 (major). Given that effectively a six-point scale ('no impact' linked to a five-point) was used, and that the difference between 0.00 and 5.00 is five, ranges with an extent of 0.83 (5 / 6) are used to discuss the degree of central tendency.

The only aspects falling within the upper range of mean scores > 4.17 ≤ 5.00 - between an near major impact to major impact / major impact, is management practices do not promote H&S behaviour with a mean score of 4.52. It is an indication of the strong view from both the supervisors and the injured towards managerial performance in relation to H&S. This highlights and indicates the need for a change in management practices.

The aspects falling within the second range of mean scores > 3.33 ≤ 4.17 - between the impact to near major impact / near major impact of the aspect 'management training is not the solution to risk taking behaviour', is significant as it implies a need for the transfer of responsibility for risk-taking behaviour to the individual. The ranking of aspect two, electrical workers will perceive hazards differently, correlates with the principal questionnaire survey of engineering organisations' view of the difference in the electrical engineering work environment. The agreement between the injured and supervisors of the effect of legislation on risk taking behaviour emphases the strong effect correct H&S legislation can have in altering behaviour.

The third range of aspects, those with mean scores > 2.50 ≤ 3.33 - between a near minor impact to impact / impact, signifying that training can alter risk-taking behaviour of electrical maintenance workers, although ranked fifth, it correlates with the stance of engineering organisations who ranked this aspect the highest. There is an agreement between the injured and the supervisors on the impact of H&S standards although the injured view the role of such standards higher than the supervisors. This could manifest itself in incorrect perceptions of instructions from supervisors.

The consensus of the impact management competency can have on risk behaviour emphasises the need for strong management interventions to prevent incorrect risk behaviour.

The major difference in the view that unsafe behaviour is the norm for general electrical workers is indicative of supervisory management not being aware of the risk-taking behaviour of workers.

The last range of aspects, those with mean scores > 1.67 ≤ 2.50 - between a minor impact to near minor impact / near minor impact, displays a 36% difference of opinion between the injured and their supervisors on the aspect that 'better government policing will prevent risk-taking behaviour', which is indicative of the difference in view of authority in altering individual risk-taking behaviour. The near agreement of the supervisors and the injured and low ranking at 11 for the aspect that electrical accidents are related to management incompetence is notable in the stance and acceptance of individual responsibility in electrical incidents.

The mean score of the twelfth ranked aspect, namely that financial gain or other advances results in unsafe behaviour, is significant in that the electrical workers and the supervisors involved in incidents do not view gain or other advances as a motivation for unsafe behaviour. The view that 'H&S work procedures differ among electrical maintenance workers' is notable, in comparison to the view of supervisors who do not agree with this aspect, which is a further indication of the difference in perception of risk-taking behaviour of electrical workers. The last ranking of existence of differences in cultural perception of risk is indicative of the impact cultural impact has on risk-taking behaviour in relation to incidents.

4.5 HR SURVEY

An HR questionnaire survey was conducted to determine the view of HR managers with respect to an intervention at HR recruitment level and performance appraisal stages. The survey endeavoured to obtain data related to:

- Individual behaviour profiling at recruitment stage;
- The need for job task to employee profile matching;
- The view of a difference in individual risk behaviour profiling;
- The value of psychometric tests to identify risk behaviour tendencies;
- The need for a model that will lower H&S incidents due to risk taking behaviour, and
- The need for job task allocation adjustments according to incident profiles.

The intention behind the survey questionnaire was to obtain the view of HR managers on pre-appointment evaluations of risk profiles to facilitate correct candidate placements or 'fit' for high risk engineering tasks, and to highlight the need for continuous employee appraisal according to incident profiles, in order to 'smooth' the progress of adjustments in job task allocations.

4.5.1 HR application of statistical data and tables

4.5.1.1 HR application aspects

The table indicates whether the HR managers agree or disagree with the following statements.

	Statement	Strongly disagree (%)	Strongly agree (%)
1.	Human behaviour risk analysis should form an important part of a job applicant's evaluation	0.0	100.0
2.	History of risk-taking behaviour can be analysed to form part of a job applicant's interview analysis	12.5	87.5
3.	Job task - employee profile matching should be standard for high risk engineering tasks	0.0	100.0
4.	It is possible to match a candidate's risk profile to a specific job task	25.0	75.0
5.	There is definitely a difference in each individual's risk taking behaviour profile	0.0	100.0
6.	Competency, knowledge and skills should not be the only criteria for job task matching, but also the individual's risk-taking behaviour profile	12.5	87.5
7.	Psychometric testing during job interviews should incorporate values that can identify risk behaviour tendencies of individuals	0.0	100.0
8.	A model that can be incorporated and used in job interviews for the correct selection of employees that will lower H&S incidents due to risk-taking behaviour would be ideal	0.0	100.0
9.	Continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations.	0.0	100.0
	Mean Average	5.55	94.4

Table 4.33 HR application aspects

The response to the HR questionnaire survey (Table 4.33) was overwhelmingly positive with a high mean average score of 94% of the HR managers being in agreement with the questionnaire statements.

The overall view is that there is an urgent need for a model that will address risk-taking behaviour according to job task, and employee profile matching for high risk engineering tasks that will bring about a reduction in incident rates.

4.5.1.2 Risk analysis for job applications

HR aspect one **Human behavioural risk analysis for job applications**	**Strongly disagree (%)**	**Strongly agree (%)**
Human behaviour risk analysis should form an important part of a job applicant's evaluations.	0.0	100.0

Table 4.34 Risk analysis for job application

The strong belief that behaviour risk analysis should form an important part of a job applicant's evaluation, HR aspect one, is a further indication of the need to incorporate such behaviour characteristics in job applicant reviews.

4.5.1.3 Job applicant risk-taking history

HR aspect two **Analysis of job applicant's historical risk-taking behaviour**	**Strongly disagree (%)**	**Strongly agree (%)**
History of risk-taking behaviour can be analysed to form part of a job applicant's interview analysis.	12.5	87.5

Table 4.35 Job applicant risk-taking history

87.5% of the HR managers agreed that the history of individual risk-taking behaviour can be analysed and form part of job applicant's interview, reflects the analysis foreseen in obtaining such history profile.

4.5.1.4 Job task to profile matching

HR aspect three **Job task profile matching**	**Strongly disagree (%)**	**Strongly agree (%)**
Job task - employee profile matching should be standard for high risk engineering tasks.	0.0	100.0

Table 4.36 Job task to profile matching

The strong agreement with the statement of aspect three, that employee profile matching to specific job tasks should be standard for high risk engineering tasks, is indicative of support for extra interventions related to high risk engineering tasks.

4.5.1.5 Matching correct profile to job task

HR aspect four **Possibility of matching correct profile to job task.**	**Strongly disagree (%)**	**Strongly agree (%)**
It will be possible to match correct candidates to their risk profile for specific job tasks.	25.0	75.0

Table 4.37 Matching correct profile to job task

HR Managers aggress that it will be possible, with the right management tools, to match candidates to specific job task.

4.5.1.6 Individual risk-taking behaviour profiles

HR aspect five **Differences in individual risk-taking behaviour profiles**	**Strongly disagree (%)**	**Strongly agree (%)**
There is definitely a difference in each individual's risk-taking behaviour profile.	0.0	100.0

Table 4.38 Individual risk-taking behaviour profiles

The unanimous agreement of the HR managers of the difference in individual risk-taking behaviour profiles is indicative of the need to manage this variable aspect that has mostly been ignored and viewed as a constant.

4.5.1.7 Criteria for assessing job tasks

HR aspect six **Assessing job task criteria**	**Strongly disagree (%)**	**Strongly agree (%)**
Competency, knowledge and experience should not be the only criteria for job task matching, but also the individual's risk-taking behaviour profile.	12.5	87.5

Table 4.39 Criteria for assessing job tasks

Table 4.39 shows that only 12.5% of HR managers believe that only competency (knowledge and experience) should be considered for matching an individual to a job task and not to include their risk taking behaviour profile. This level of concurrence might stem from a lack of understanding of the concept of individual risk-taking behaviour in relation to competencies.

4.5.1.8 Psychometric testing

HR aspect seven Psychometric testing	Strongly disagree (%)	Strongly agree (%)
Psychometric testing during job interviews should incorporate values that can identify risk behaviour tendencies of individuals.	0.0	100.0

Table 4.40 Psychometric testing

The strong view for the inclusion of risk behaviour evaluations with psychometric testing during job interviews as indicated in HR aspect seven is a further indication of the need for an optimum model from which such systems could be developed that will address risk-taking behaviour profiling in terms of correctly designed psychometric tests.

4.5.1.9 Correct employee selection

HR aspect eight Model for correct employee selection	Strongly disagree (%)	Strongly agree (%)
I would welcome a model that can be incorporated and used in job interviews for the correct selection of employees that will lower H&S incidents due to risk-taking behaviour patterns.	0.0	100.0

Table 4.41 Correct employee selection

The unanimous support for HR aspect eight, that essentially reflects the need for systems that will lower incident rates, is indicative of the need for a model that can be used for correct employee selection to appoint the candidate that will have the best risk profile for the best ‘fit’ for the job task.

4.5.1.10 Continuous evaluations and risk-taking profiles

HR aspect nine Continuous evaluations and risk-taking profiles	Strongly disagree (%)	Strongly agree (%)
Continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations.	0.0	100.0

Table 4.42 Continuous evaluations and risk profiles

The unanimous support for continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations is further support for a model that will match risk behaviour profiling to specific job tasks.

4.6 GENERAL REMARKS OBTAINED FROM RESPONDENTS

The following comments emanate from a request for comments in general.

4.6.1 General remarks related to management

The following comments can be categorised as specific remarks on the performance of management in either a direct or indirect management of H&S

- "Managers need to be more kind in handling incidents and must work together with employees to find solutions";
- "Some people do not know what is happening in the field and then they want to make recommendations when they don't know what is happening in the field";
- "Managers must not just put out papers they must go to the people and explain";
- "The manager or initiator must explain documents properly and not leave the supervisors to interpret them, it is a big problem";
- "Some of the managers and guys that lead us in the work need more leadership training and inter-personal relationship skills. They must be able to make their comments easier and reduce the problem of being misunderstood. Some of the leadership/supervisors don't have the skills to lead the people";
- "When employees plan for an operational activity and things go wrong, they do not think why it happened and plan again, they just continue doing the same thing", and
- "Managers overlook things that go wrong then other employees believe they can also be brave, they don't care, and they take risks and shortcuts".

Figure 4.1 General remarks related to management

There is an overall lack of trust in management capabilities in relation to basic management skills. Communication channels are not functioning properly, which can have dire consequence in terms of conveying H&S policies and the creation of an effective H&S culture.

Management needs to create channels whereby grievances that might affect operational risk behaviour be identified at earlier stages, ensure that the conduit for communication is appropriate and effective and that such grievance be resolved.

4.6.2 General comments and remarks in relation to risk-taking behaviour

The following remarks categorised the comments made in relation to risk-taking behaviour of electrical workers.

- "Electrical incidents are caused because monkey see, monkey do";
- "The risk is when a document is taken out alone without technical instructions and the documents are not interpreted as they should be";
- "The authorised guys won't take shortcuts, but the workload causes shortcuts to be taken";
- "The main cause of incidents is attitude problems, people do not think before they do things";
- "Some of the contractors work from past experience and don't know all the hazards, but neither will untrained people react in the correct way";
- "When I was busy and thought I could get finished quickly I took a chance", and
- "The new guys are not well trained and they rush and get injured".

Figure 4.2 General comments and remarks in relation to risk-taking behaviour

Incidents relating to risk-taking behaviour are viewed in relation to high workloads, not following instructions to get job task completed sooner and lack of competence. Lack of competencies in relation to skills indicates inadequate training resulting in job tasks being performed from a task being learned whilst working rather than in a formal environment without correct skills evaluations. An evaluation of existing job skills requirements and the compliance with such requirements per job task needs to be implemented.

4.6.3 General comments and remarks in relation to cultural paradigms

- "BEE employees do not work well together. Everybody thinks they are better";
- "With different cultures there is quite a problem. The background and knowledge of what happens is not always clear to everybody, even though they've had the same training";
- "There is major lack in competency between cultures", and
- "I think the problem is that some of the guys have been here a long time. There has been a lot of change and they do not adapt to the changes easily. When forced it becomes a problem".

Figure 4.3 General comments and remarks in relation to cultural paradigms

Incorrect communication, due to a difference in cultural communication mediums and skills, regarding tasks to be performed, can have a major impact on incidents. Further, mistrust when needing to work together will hinder job tasks from being completed correctly and will add to the possibility of high risk-taking behaviour as individuals will rather act on their own decisions than to trust co-workers from a different culture. Employees that do not adapt to required changes or that do not act on instructions from management from a different culture than their own will become a high risk liability and must be identified in order for interventions to be implemented.

4.6.4 General comments and remarks on training

- "More training and exposure in the field is needed before subcontractors should be allowed to contract";
- "They are not ready after all the training and they do not remember what they've learned and cannot do it practically";
- "We should also look at courses that will help people to understand where they are, taking control and knowing what to do, but they don't implement what they have learned or enforce it";
- "There is too much on-the-job training that I feel is not explained properly", and
- "Let the younger ones with more qualifications learn from the experienced persons. Skills transfer is not as effective as it was before".

Figure 4.4 General comments and remarks on training

The overall view of training was that skills learned should be practically explained in field work. Assistance with skills transfer from experienced staff can only take place if new employees work under the supervision of staff members that have the experience for a specific job task, even if such new worker has a higher qualification. There are also indications of a lack of management control, this can be detrimental especially where supervisors do not know how to plan and control their work environment.

4.6.5 General comments and remarks on rules and regulations

- "The culture of accountability is going out the window";
- "Work fewer hours as directed by the law, but still there are not enough people to do operating work even if we have to work through the night";
- "H&S must not be used against employees", and
- "There are a lot of challenges in the field and a more human approach is needed with more support for the workers".

Figure 4.5 General comments and remarks on rules and regulations

The negative view of H&S rules and regulations and the worker perceiving such as a disciplinary tool to be used against them is notable as this is an aspect of an H&S culture not functioning properly.

The high ranking of the influence of H&S standards in the main questionnaire survey, aspect 4 (Section 4.3.3.4) confirmed the influence such standards have on workers.

4.6.6 General comments and remarks on workload

- "I don't believe the amount of tasks from supervisors is right. They are supposed to be given weight properly";
- "Too many outputs for the time allocated";
- "I don't feel in control and not managing the whole operation efficiently – not enough time and resource";
- "Before this incident happened I warned management about shortage of staff. Warned them additional staff was needed. We were waiting for an incident to happen", and
- "The technician was exhausted. He'd worked 41 hours overtime in one week. There was nobody to take over from him".

Figure 4.6 General comments and remarks on workload

The high risk task of some electrical engineering work requires optimal human sensory and physical performance. With a high continuous workload this will definitely affect workers' capabilities for risk assessment and affect their risk behaviour. Apart from labour legislation contraventions, with too-long work hours, organisations are exposing them to more harm due to the possible occurrence of incidents.

Organisations should investigate the reasons for capacity shortages and find management solutions to such problems rather than risking the possibility of serious accidents.

4.6.7 General comments and remarks on H&S management

- "I think the H&S is of a very high standard and the support we get from H&S department is more than acceptable";
- "There are many experienced H&S officers, but too many new employees that need more exposure and training";
- "A lot of audits are more of a paper trail. There should be more 'on-the-job' audits";
- Most of the field staff has a problem with H&S";
- "Another problem is that some of the guys that are involved in an incident lie about it to get themselves out of trouble, then recommendations are made on false statements";
- "You get measures about how good an area performs. It is always between KPI (key performance indicators) and H&S. At the end of the day they get more money for more KPIs";
- "The H&S departments do not know exactly what's happening on technical side";
- If a chairperson is a finance person investigating an incident, they are not familiar with the technical side and they make wrong recommendations";
- "H&S department reporting does not add value, they just attach pictures. Feedback on incidents is not often discussed";
- "At the moment H&S management is part of KPI and most of the people are isolated from that", and
- "H&S is every employee's responsibility and at this stage the workers are looking towards management for their H&S, but they should be responsible themselves".

Figure 4.7 General comments and remarks on H&S management

There is a general view that H&S management is a one-sided approach with the H&S manager not understanding the technical requirements of certain job tasks.

This might relate to H&S managers not having the experience or knowledge of the electrical engineering environment and purely acting on existing H&S system requirements without integrating the technical requirements of specific electrical work into consideration.

The H&S managers should update themselves more with the view of workers on the ground and should employ people with not only H&S experience and qualifications, but also people with strong engineering and electrical worker skills.

4.7 SUMMARY

The various surveys conducted were presented in this chapter as part of the empirical survey findings. The results obtained correlate with the findings of the literature survey and highlight the need for H&S system interventions in acknowledging human risk-taking behaviour as a driver in incidents. The need for HR intervention at recruitment and appraisal stages is highlighted by the responses of the HR managers surveyed. The empirical results in this chapter form part of an attempt to resolve the main and sub-problems posed. Apart from the presentation of all the ‘mean’ mean scores and answers to questions posed, a discussion on general comments and remarks obtained from the respondent questionnaires is also presented.

Triangulation is a powerful technique that facilitates validation of data, it refers to the application and combination of several research methodologies in the study of the same phenomenon (Bogdan & Biklen, 2006). The triangulation method of making use of more than two research methodologies to validate data through cross verification will be employed for the analysis and interpretation of results obtained. These are presented in a tabulated format in Chapter 5.

Chapter 5, which follows, presents the interpretations and analysis of the empirical findings by testing the hypotheses.

CHAPTER 5: INTERPRETATION AND ANALYSIS OF EMPIRICAL FINDINGS

5.1 INTRODUCTION

In this chapter the hypotheses presented in Chapter 1 are tested with the data obtained from the empirical research findings and literature review, to determine the validity and support for the hypotheses presented for the research. The findings are presented in a tabulated format with correlation to relevant questionnaire surveys of the principle survey and the incident case studies. By testing the hypotheses, and the sub-hypotheses, correlation and agreement with the research findings is determined.

The aspects that relate to the main questionnaire survey are presented, in relation to the relevant hypotheses, with overall mean scores and rankings.

The percentage agreement from the HR survey as support for the hypotheses and related survey are also presented. The relationship between specific behavioural aspects and the profile of the injured in the targeted strata of the questionnaire survey are evaluated.

The strong need for acknowledgment of human risk-taking behaviour as a driver in incident statistics and the further need for a model that will address these aspects manifest in strong support for the hypotheses presented.

5.2 ANALYSIS AND INTERPRETATION OF THE RESULTS

The results obtained from the various surveys conducted were interpreted and are presented in this chapter as part of the empirical survey findings. The results correlate with the findings of the literature survey and highlight the need for H&S system interventions in acknowledging human risk-taking behaviour as a driver in incidents. The need for HR intervention at recruitment and appraisal stages is highlighted by the responses of the HR managers surveyed. The empirical results form part of an attempt to resolve the main and sub-problems posed. Triangulation techniques were employed to facilitate the validation of data. Triangulation refers to the application and combination of several research methodologies in the study of the same phenomenon (Bogdan & Biklen, 2006). The triangulation method of making use of more than two research methodologies to validate data through cross verification was employed for the analysis and interpretation of results obtained.

5.2.1 The main problem statement

The main problem was to determine what role perception of risk has on individual risk-taking behaviour and the influence such behaviour has on H&S management in the South African electrical construction industry.

5.2.2 Analysis of results to test hypothesis one

Hypothesis 1: H&S management systems can have an influence on risk-taking behaviour in either being a positive motivation on behaviour required or a negative due to incorrect guidance or knowledge overload.

The aspects presented in the table below relate to hypothesis one.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
14. Management practices do not promote H&S behaviour	1.81	13	X	<0.05	>0.05		X
6. Management competency is related to risk-taking behaviour	3.28	5	X	<0.05	>0.05		X
*p-value less than 0.05 - indicates significant at the less than 5% level.							

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
14. Management practices do not promote H&S behaviour	4.52	1	X	<0.05	>0.05		X
6. Management competency is related to risk-taking behaviour	3.18	7	X	>0.05	>0.05		X
*nd = not determined *p-value < 0.05 - indicates significance at less than 5% level.							

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
Human behaviour risk analysis should form an important part of a job applicant's evaluation	100	X		X
A model that can be incorporated and used in job interviews for the correct selection of employees that will lower incidents due to risk-taking behaviour would be ideal	100	*nd		X
Continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations.	100	X		X
*nd = not determined				

D. Relationship between behavioural aspect and profile of injured	Relationship	Fisher's exact test p-value	% Agreement with statement	Review of literature	Inconclusive	Statistically significant	Hypothesis is not supported
4.2.2.5 (1) Believe in H&S policies and procedures	Injured	<0.05	83.0	X		N	X
4.2.2.8 (3) I am influenced by management behaviour	Injured		50.0	X			
4.2.2.7 (1) Fear of penalty and injury as a motivation not to take risk	Injured	>0.05	83.0	X		Y	X
4.2.2.8 (3) I am influenced by management behaviour	Injured		50.0	X			
4.2.2.6 (3) Would report unsafe behaviour	Injured	<0.05	83.0	*nd		N	X
4.2.2.8 (2) Believe that management and authority in SA set good examples	Injured		17.0	*nd			
*nd = not determined							

Table 5.1 Analysis of results to test hypothesis one

Relationship of aspects to the principal questionnaire survey

Given that the mean score of the engineers (1.81) for the aspect 'Management practices do not promote H&S behaviour' is < 3.00, the engineers can be deemed to perceive that management practices do promote H&S behaviour. The p - value < 0.05 further substantiates the above statement. Conversely, the mean score of the injured (4.52) is > 3.00, and therefore it can be deduced that there is a difference in opinion of management and workers regarding management practices to promote H&S behaviour. This is substantiated by the p-value being < 0.05.

Given that the mean score for engineers (3.28) and the injured (3.18) are > 3.00 for the aspect 'Management competency is related to risk-taking behaviour' supports the contention that management and management systems will influence risk-taking behaviour.

HR management survey

100% of HR managers agreed with the proposal of risk-taking behaviour profiling, in job interviews, and continuous employee evaluations according to job task allocations. This constitutes unanimous support for the hypothesis pertaining to the influence that H&S management systems can have on risk-taking behaviour.

Specific aspects related to the injured

83% of the injured indicated that they believe in H&S policies and procedures compared to 50% that indicate that they are influenced by managerial behaviour. The association between the two aspects is considered to be statistically significant.

The relationship between fear of penalty and fear of injury as a motivation, and the influence of management, is an indication that H&S management systems could influence behaviour by indirect penalties for non-compliance with H&S policies and procedures. The association between the two aspects is considered to be statistically significant.

The strong agreement (83%) of the injured, that unsafe behaviour would be reported and that management and authority in South Africa set good examples, shows a correlation between managerial behaviour and trust in management. The association between the two aspects is considered to be not statistically significant.

Table 5.1 indicates that the aspects support the hypothesis. The response from HR managers supports the need for management intervention. The specific aspects related to the injured indicate the strong impact of H&S policies and procedures (83%), the fear of penalty (83%) as a motivation and the low belief (17%) in the example set by management. The statistical inferences therefore support hypothesis one that management and H&S management systems will influence risk-taking behaviour either negatively or positively due to incorrect guidance or knowledge.

The first hypothesis is therefore supported.

5.2.3 Analysis of results to test hypothesis two

Hypothesis 2: There is a clear link between individual specific task knowledge and risk-taking behaviour

The aspects presented in the table below relate to hypothesis two.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
1. Training can alter risk-taking behaviour of electrical maintenance workers	4.19	1	X	<0.05	<0.05		X
2. Electrical workers will perceive hazards differently	3.69	2	*nd	<0.05	>0.05		X
13. Unsafe behaviour is the norm for general electrical workers	2.06	11	*nd	<0.05	<0.05	X	
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Tests**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
1. Training can alter risk-taking behaviour of electrical maintenance workers	3.31	5	X	<0.05	>0.05		X
2. Electrical workers will perceive hazards differently	3.33	4	*nd	>0.05	>0.05		X
13. Unsafe behaviour is the norm for general electrical workers	2.64	9	*nd	<0.05	>0.05	X	
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
It is possible to match a candidate's risk profile to a specific job task	75.0	*nd		X
There is definitely a difference in each individual's risk taking behaviour profile	100	X		X
A model that can be incorporated and used in job interviews for the correct selection of employees	100	X		X
*nd = not determined				

D. Relationship between behavioural aspect and profile of injured	Relationship	Fisher's exact test p-value	% Agreement with statement	Review of literature	Inconclusive	Statistically significant	Hypothesis is not supported
4.2.2.6 (1) There is no difference in an unsafe act at work or at home	Injured	<0.05	83.0	X		Y	X
4.2.2.2 (3) Involvement in more than 2 accidents at work	Injured		50.0	X			
4.2.2.6 (2) Would not be more inclined to take risks at work than at home	Injured	>0.05	83.0	X		N	X
4.2.1.3 (1) Specific formal job task training received	Injured		33.0	X			
4.2.1.2 (1) Have post high school qualification	Injured	<0.05	83.0	*nd		Y	X
4.2.2.7 (2) Believe in taking calculated risk	Injured		17.0	*nd			
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

Table 5.2 Analysis of results to test hypothesis two

Relationship of aspects to the principal questionnaire survey

Given that the mean scores for the engineers (3.69) and the injured (3.33) are > 3.00 for the aspect 'electrical workers will perceive hazards differently', supports the opinion of electrical workers' differences in perception of hazards is supported. The p-value being < 0.05 further substantiates this statement. The significantly lower mean scores for the engineers (2.06) and the injured (2.64) support the aspect that 'unsafe behaviour is the norm for general electrical workers' and points to the aspect as being not effective.

The mean scores for the engineers (4.19) and the injured (3.31) for the aspect 'training can alter risk-taking behaviour of electrical maintenance workers' supports the contention that 'training and knowledge transfer' can alter risk-taking behaviour. The p - value < 0.05 indicates significance at a level of less than 5%, which provides further support.

HR management survey

The unanimous support for the opinion on the difference of individual risk-taking behaviour profiles, and that such can be matched to a specific job task, is indicative of HR management's attitude in support of the link between specific task knowledge and risk-taking behaviour. The proposal that a model can be incorporated and used in job interviews for the correct selection of employees supports the hypothesis in that evaluation of task knowledge can be used for profile job task matching with a link to risk-taking behaviour.

Specific aspects related to the injured

83% of injured respondents support the proposal that there is no difference in an unsafe act at work or at home, while 33% of the injured indicate that they have been involved in incidents at work, this correlates to the link between knowledge and risk-taking behaviour. The association between the two aspects is considered to be statistically significant according to the 'Fisher's exact test'.

Given that the impact of 83% of the injured support the view that a hazard at work or at home poses the same danger presents knowledgeable insight, in the light of electrical installations that electrical workers are exposed to at work and at home, supporting the hypothesis on the link of knowledge to risk-taking behaviour. The association between the two aspects is considered to be not statistically significant.

The low risk-taking behaviour of 33% of the injured and 67% of the injured having a post-school qualification correlates to the impact of knowledge on risk-taking behaviour. The association between the two aspects, according to the 'Fisher's exact test', is considered to be very statistically significant.

Table 5.2 and the statistical inferences support the hypothesis of a link between knowledge and risk-taking behaviour.

The second hypothesis is therefore supported.

5.2.4 Analysis of results to test hypothesis three

Hypothesis 3: H&S management practices do not address H&S in totality as cognisance is not taken of individual human risk-taking behaviour.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
14. Management practices do not promote H&S behaviour	1.81	13	X	<0.05	>0.05		X
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
14. Management practices do not promote H&S behaviour	4.52	1	X	<0.05	>0.05		X
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
Human behaviour risk analysis should form an important part of a job applicant's evaluation	100	X		X
Job task to employee profile matching should be standard for high risk engineering tasks	100	*nd		X
A model that can be incorporated and used in job interviews for the correct selection of employees that will lower incidents due to risk taking behaviour would be ideal	100	X		X
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.				

D. Relationship between behavioural aspect and profile of injured	Relationship	Fisher's exact test p-value	% Agreement with statement	Review of literature	Inconclusive	Statistically significant	Hypothesis is not supported
4.2.2.8 (2) Believe that management and authority in SA set good examples	Injured	>0.05	17.0	X		N	X
4.2.2.5 (2) Believe that workers are responsible for accidents	Injured		17.0	X			
4.2.2.5 (1) Believe in H&S policies and procedures	Injured	>0.05	83.0	X		N	X
4.2.2.5 (3) Influenced by management behaviour	Injured		50.0	X			
*nd = not determined							

Table 5.3 Analysis of results to test hypothesis three

Relationship of Aspects to the Principal questionnaire survey

Given that the mean scores for the injured (4.52) is > 3.00 and the engineers (1.81) is < 3.00 for the aspect 'management practices do not promote safe behaviour' indicates the differing perspectives of workers and engineers, the latter usually being in managerial positions. This difference supports the argument that improvements in management practices are required and that not all practices take cognisance of human risk-taking behaviour. The p–value being < 0.05, indicates the statistical significance of the aspects.

HR management survey

HR management's unanimous support for the proposal that human risk-taking behaviour analysis should form an important part of a job applicant's evaluation, and that job task to employee profile matching should be standard for high risk engineering tasks, supports the hypothesis that management practices related to H&S do not take cognisance of human risk-taking behaviour.

Specific aspects related to the injured

Given that only 17% of the injured believe that workers are responsible for accidents and that 17% believe that management and authority in South Africa set good examples is indicative of the hypothetical opinion that management practices do not address H&S and is indicative of the need for improvement in H&S management practices.

Given that 83% of the injured believe in H&S policies & procedures, but only 50% indicate that they are influenced by managerial behaviour implies a lower influence of management practices than the impact of H&S policies & procedures.

The statistical inferences in Table 5.3 support the hypothesis of H&S management practices not taking cognisance of individual risk-taking behaviour.

Table 5.3 indicates that all four of the aspects support the hypothesis.

The third hypothesis is therefore supported.

5.2.5 Analysis of results to test hypothesis four

Hypothesis 4: South African H&S legislation lacks guidance and does not incorporate the management of human psychological behaviour.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
7. The framework of legislation, prevents risk-taking behaviour	2.87	7	*nd	>0.05	>0.05	X	
12. H&S legislation can alter risk perception of unsafe acts	2.31	10	*nd	<0.05	<0.05		X
11. Better government policing will prevent risk-taking behaviour	2.88	7	X	>0.05	<0.05		X

*nd = not determined
*p-value < 0.05 - indicates the significance at less than 5% level.

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVAANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
7. The framework of legislation, prevents risk-taking behaviour	3.72	2	*nd	<0.05	>0.05	X	
12. H&S legislation can alter risk perception of unsafe acts	2.94	8	*nd	>0.05	>0.05	X	
11. Better government policing will prevent risk-taking behaviour	2.46	10	X	>0.05	>0.05		X

*nd = not determined
*p-value less than 0.05 - indicates significant at the less than 5% level.

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
Job task to employee profile matching should be standard for high risk engineering tasks	100	*nd		X
Competency, knowledge and skills should not be the only criteria for job task matching, but also the individual's risk-taking behaviour profile	87.0	X		X

*nd = not determined

D. Relationship between behavioural aspect and profile of injured	Relationship	Fisher's exact test p-value	% Agreement with statement	Review of literature	Inconclusive	Statistically significant	Hypothesis is not supported
4.2.2.5 (1) Believe in H&S policies and procedures	Injured	>0.05	83.0	X		N	X
4.2.2.6 (3) Would report unsafe behaviour	Injured		83.0	X			
4.2.2.5 (1) Believe in H&S policies and procedures	S/visors	>0.05	85.0	X		N	X
4.2.2.6 (3) Would report unsafe behaviour	S/visors		100	X			
4.2.2.7 (1) Fear of penalty and injury is a motivation not to take risks	Injured	>0.05	83.0	*nd		N	X
4.2.2.8 (1) Believe in all of the laws in South Africa	Injured		17.0	*nd			
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

Table 5.4 Analysis of results to test hypothesis four

Relationship of aspects to the principal questionnaire survey

Given that the mean scores for the engineers (2.31) and the injured (2.94) are < 3.00 for the aspect 'H&S legislation can alter risk perception of unsafe acts' it can be inferred that H&S legislation is ineffective as a means to impact on risk-taking behaviour.

Given that the mean score for the engineers (2.87) is < 3.00 and the injured (3.72) is > 3.00 for the aspect 'the framework of legislation prevents risk-taking behaviour', it can be deduced that the aspect is significant and that the hypothesis from the view of the injured is effective.

Given that the mean scores for the engineers (2.88) and the injured (2.46) are < 3.00 for the aspect 'better government policing will prevent risk-taking behaviour' presents the view of ineffective policing of legislation by government and thus having a low impact on risk-taking behaviour.

The p-value < 0.05 further substantiates this statement and supports the contention that the psychological aspect should be taken into consideration in legislation on risk-taking behaviour.

HR management survey

87% of HR managers support the proposal that competency, knowledge and skills should not be the only criteria for job task matching, but that the individual's risk-taking behaviour profile should also be considered. 100% of the HR managers support the proposal that job task to employee profile matching should be standard practice for high risk engineering tasks, which presents the need for acknowledging the risk-taking behaviour profile of the individual.

Specific aspects related to the injured

Given the response of the 83% of the injured and 100% of the supervisors that they would report unsafe behaviour, as opposed to only 85% of supervisors and 83% of injured that believe in H&S policies and procedures, alludes to the lack of guidance in H&S legislation.

Given that 67% of the injured believe in all of the laws in South Africa and that the fear of penalty and injury (83%) is a higher motivation for improved risk-taking behaviour, indicates the impact of human psychological motivational aspect, as having more importance than H&S legislation.

The statistical inferences in Table 5.4 support the hypothesis that H&S legislation does not acknowledge the impact of human psychological behaviour.

The fourth hypothesis is therefore supported.

5.2.6 Analysis of results to test hypothesis five

Hypothesis 5: Job task allocation should make use of individual risk-taking behaviour parameters in the allocation of specific tasks

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
9. Financial gain or other advances results in unsafe behaviour	2.48	9	X	<0.05	<0.05	X	
2. Electrical workers will perceive hazards differently	3.69	2	*nd	<0.05	>0.05		X
13. Unsafe behaviour is the norm for general electrical workers	2.06	11	*nd	<0.05	>0.05	X	
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
9. Financial gain or other advances results in unsafe behaviour	2.26	12	X	<0.05	<0.05	X	
2. Electrical workers will perceive hazards differently	3.33	4	*nd	<0.05	<0.05		X
13. Unsafe behaviour is the norm for general electrical workers	2.64	9	*nd	<0.05	>0.05	X	
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
Job task - employee profile matching should be standard for high risk engineering tasks	100	*nd		X
It is possible to match a candidate's risk profile to a specific job task	75.0	*nd		X
There is definitely a difference in each individual's risk taking behaviour profile	100	X		X
Continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations.	100	X		X
*nd = not determined				

D. Relationship between behavioural aspect and profile of injured	Relationship	Fisher's exact test p-value	% Agreement with statement	Review of literature	Inconclusive	Statistically significant	Hypothesis is not supported
4.2.2.7(2) Believe in taking calculated risk	Injured	<0.05	33.0	X		Y	X
4.2.1.4(1)Task skills obtain through formal training	Injured		50.0	X			
4.2.2.2(2) Pattern of accidental, self injury at work	Injured	>0.05	50.0	X		N	X
4.2.1.3 (1)Specific formal Job task training received	Injured		33.0	X			
*nd= not determined							

Table 5.5 Analysis of results to test hypothesis five

Relationship of aspects to the principal questionnaire survey

Given that the mean scores for the engineers (3.69) and the injured (3.33) are > 3.00 for the aspect ‘electrical workers will perceive hazards differently’ it can be inferred that there is a difference of risk perception with resultant difference in risk-taking behaviour of electrical workers. The p-value < 0.05 further substantiates this statement.

Given that the mean scores for the engineers (2.06) and the injured (2.64) are < 3.00 for the aspect ‘unsafe behaviour is the norm for general electrical workers’, it can be deduced that unsafe behaviour is not the norm for electrical workers, which is further substantiated by the p-value < 0.05.

The mean scores for the engineers (2.48) and the injured (2.26) are < 3.00 for the aspect ‘financial gain or other advances results in unsafe behaviour’ shows support for the contention that electrical workers’ are not influenced by financial gain or advances as a motivation for unsafe behaviour, which is further supported by the p-value < 0.05.

HR management survey

The unanimous support by HR managers for the proposal that job task and employee profile matching should be standard for high risk engineering tasks supports the hypothesis. Although only 75% of HR managers indicate it is possible to match a candidate's risk profile to a specific job task, they agree that there is a difference in each individual's risk-taking behaviour profile giving a strong support for the hypothesis for job task allocation making use of individual risk-taking behaviour parameters for the allocation of specific tasks.

Specific aspects related to the injured

The opinion of the injured addressed in the specific aspects are supported given that 33% believe in taking calculated risks and 50% obtained task skills through formal training highlights the need for matching risk-taking behaviour with specific high risk tasks. The association between the two aspects is considered to be statistically significant according to the 'Fisher's exact test'.

The correlation between 50% of the injured having a pattern of accidental, self injury at work to 33% having received specific formal job task training, supports the hypothesis of job task allocation according to individual risk-taking behaviour parameters.

The statistical inferences in Table 5.5 support the hypothesis that job task allocation should make use of the individual's risk-taking parameters in the allocation of specific job tasks.

The fifth hypothesis is therefore supported.

5.2.7 Analysis of results to test hypothesis six

Hypothesis 6: A diverse cultural workforce produces work dynamics that influence individual perception of risk directly and H&S management systems indirectly.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
3. Existence of different cultural perception of risk	3.57	3	X	<0.05	<0.05		X

*nd = not determined
*p-value less than 0.05 - indicates significant at the less than 5% level.

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
3. Existence of different cultural perception of risk	1.80	14	X	<0.05	>0.05		X

*nd = not determined
*p - value less than 0.05 - indicates significant at the less than 5% level.

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
Psychometric tests during job interviews should incorporate values that can identify risk behaviour tendencies of individuals	100	X		X
A model that can be incorporated and used in job interviews for the correct selection of employees that will lower incidents due to risk taking behaviour would be ideal	100	X		X

*nd = not determined

D. **Relationship between behavioural aspect and profile of injured**	**Relationship**	**Fisher's exact test p-value**	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Statistically significant**	**Hypothesis is not supported**
4.2.2.4(1) Have European cultural background	Injured	>0.05	17.0	X		N	X
4.2.2.3(3) Believe in keeping the speed limit	Injured		83.0	X			
4.2.2.4(2) Culture's attitude towards taking risks is Moderate to High	Injured	>0.05	17.0	X		N	X
4.2.2.7(2) Believe in taking calculated risk	Injured		33.0	X			
*nd = not determined							

Table 5.6 Analysis of results to test hypothesis six

Relationship of aspects to the principal questionnaire survey

The mean score for the engineers (3.57) being > 3.00, is indicative of the opinion of engineers (management) that cultural differences exist and the impact of risk-taking behaviour due to differences of cultural perceptions of risk. The mean score of the injured (1.80), being < 3.00 highlights the differing perceptions between management and workers regarding the impact of cultural perceptions. The opinion of the workers does not correlate with the literature survey on difference in cultural perception of risk-taking. The p-value of < 0.05 substantiates the above statement.

HR management survey

HR managers' acceptance of the proposal that psychometric tests during job interviews should incorporate values that can identify risk-taking behaviour tendencies of individuals, will identify specific cultural traits in the differing perception of risk-taking, this should present alternative risk-taking behaviour patterns. Such psychometric tests can form part of a model that could be used in job interviews to aid in the correct selection of employees to job tasks, with resultant lowering of incidents. The aspect of applicants' cultural background and the influence of that culture on the individual perception of risk will be reflected in these psychometric tests.

Specific aspects related to the injured

Given that 17% of the injured have a European cultural background and 83% of the injured believe in rules, in that they would keep to the speed limit and thus limit risk-taking behaviour, correlates to cultural perception of risk and the compliance with rules. 83% of the injured that will comply with traffic safety rules are non-European.

17% of the injured have a cultural attitude towards taking risks that is moderate to high, while 33% believe in taking calculated risk, presenting a difference in the cultural view of risk perception that will influence their risk-taking behaviour.

The statistical inferences in Table 5.6 support the hypothesis that a diverse cultural workforce influences the individual perception of risk due to their cultural background affecting risk-taking behaviour and thus directly affecting H&S management systems.

The sixth hypothesis is therefore supported.

5.2.8 Analysis of results to test hypothesis seven

Hypothesis 7: There is a difference in individual risk perception with resultant higher exposure to hazards in the electrical construction industry.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
2. Electrical workers will perceive hazards differently	3.75	2	*nd	<0.05	>0.05		X
9. Financial gain or other advances results in unsafe behaviour	2.67	8	X	<0.05	<0.05	X	
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
2. Electrical workers will perceive hazards differently	3.33	4	*nd	>0.05	>0.05		X
9. Financial gain or other advances results in unsafe behaviour	2.26	12	X	>0.05	>0.05	X	
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
Job task to employee profile matching should be standard for high risk engineering tasks	100	*nd		X
There is definitely a difference in each individual's risk- taking behaviour profile	100	X		X
Continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations	100	X		X
*nd = not determined				

D. Relationship between behavioural aspect and profile of injured	Relationship	Fisher's exact test p-value	% Agreement with statement	Review of literature	Inconclusive	Statistically significant	Hypothesis is not supported
4.2.1.1(1) More than one year of work experience related to job task	Injured	>0.05	83.0	X		N	X
4.2.2.6(1) There is no difference in an unsafe act at work or at home	Injured		100	X			
4.2.2.2 (1) Pattern of accidental, self injury at work	Injured	>0.05	50.0	X		N	X
4.2.2.6(2) Would not be more inclined to take risks at work than at home	Injured		83.0	X			
*nd= not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

Table 5.7 Analysis of results to test hypothesis seven

Relationship of aspects to the principal questionnaire survey

Given that the mean scores for engineers (3.75) and the injured (3.33) are > 3.00 for the aspect 'electrical workers will perceive hazards differently', the hypothesis that there is a difference in individual risk perception is supported.

Given that the mean scores for engineers (2.67) and the injured (2.26) are < 3.00 for the aspect 'financial gain or other advances results in unsafe behaviour', the contention that financial gain or other advances has a low impact in affecting risk-taking behaviour is supported.

HR management survey

HR managers agree with the proposal that there is a difference in each individual's risk-taking behaviour profile that provides evidence that such differences can be accommodated in job task and employee profile matching for high risk engineering tasks and continuous employee evaluations should be made according to incident profiles for adjustments in job task allocations.

Specific aspects related to the injured

83% of the injured had more than one year of work experience in relation to a specific job task. The unanimous belief that there is no difference in an unsafe act at work or at home that implies that the perception of risk exposure is the same when exposed to an unsafe act at home or at work. The association between the two aspects is considered to be not statistically significant according to the ‘Fisher’s exact test’.

50% of the injured had an historical pattern of accidental self injury at work, and 83% indicated that they would not be more inclined to take risks at work rather than at home highlighting the difference in individual risk perception that could result in higher exposure to hazard in the electrical construction industry.

The statistical inferences in Table 5.7 support the hypothesis that there is a difference in individual perception of risk impacting on higher risk exposure.

The seventh hypothesis is therefore supported.

5.2.9 Analysis of results to test hypothesis eight

Hypothesis 8: Organisational recruitment systems can make use of individual historical risk-taking behaviour patterns in the correct selection of candidates for high risk job tasks.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
2. Electrical workers will perceive hazards differently	3.69	2	*nd	<0.05	>0.05		X
8. H&S work procedures differ among electrical maintenance workers	3.1	6	X	>0.05	<0.05		X

*nd= not determined
*p-value less than 0.05 - indicates significant at the less than 5% level.

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
2. Electrical workers will perceive hazards differently	3.33	4	*nd	>0.05	>0.05		X
8. H&S work procedures differ among electrical maintenance workers	1.96	13	X	<0.05	>0.05		X

*nd= not determined
*p-value less than 0.05 - indicates significant at the less than 5% level.

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
Human behaviour risk analysis should form an important part of a job applicant's evaluation	100	X		X
History of risk taking behaviour can be analysed to form part of a job applicant's interview analysis	87.5	X		X
Job task to employee profile matching should be standard for high risk engineering tasks	100	*nd		X
It is possible to match a candidate's risk profile to a specific job task	75	*nd		X
A model that can be incorporated and used in job interviews for the correct selection of employees that will lower incidents due to risk-taking behaviour would be ideal	100	X		X

*nd = not determined

D. Relationship between behavioural aspect and profile of injured	Relationship	Fisher's exact test p-value	% Agreement with statement	Review of literature	Inconclusive	Statistically significant	Hypothesis is not supported
4.2.2.5 (1) Believe in H&S policies and procedures	Injured	>0.05	83.0	X		N	X
4.2.2.3 (1) Have a history of motor vehicle accidents as driver	Injured		67.0	X			
4.2.2.5 (2) Believe that workers are responsible for accidents	Injured	>0.05	17.0	X		N	X
4.2.2.3 (2) Received speeding fines	Injured		83.0	X			
*nd = not determined							

Table 5.8 Analysis of results to test hypothesis eight

Relationship of aspects to the principal questionnaire survey

Given that the mean scores for engineers (3.69) and the injured (3.33) are > 3.00 for the aspect 'electrical workers will perceive hazards differently,' it can be inferred that electrical workers' perception of hazards differs individually with a resultant difference in historical risk-taking behaviour pattern.

Given that the mean score for engineers (3.10) is > 3.00 for the aspect 'H&S work procedures differ among electrical maintenance workers', and that the mean score for the injured (1.96) is < 3.00, the difference in opinion of the approach to H&S work procedures that electrical workers (the injured) adopt is highlighted. The non support of the injured of this aspect does not correlate with the findings of the literature survey, but rather presents the view of electrical workers regarding themselves as complying with H&S.

HR management survey

The unanimous support of the HR managers, for the proposal that human behaviour risk-taking analysis should form an important part of a job applicant's evaluation, and that 87.5% support the contention that the history of risk-taking behaviour of a job applicants can be analysed, amplifies the need for risk-taking behaviour profiling.

Further, all the HR managers support the contention that job task and employee profile matching should be standard for high risk engineering tasks, resulting in the conclusion that correct selection of employees will lower incidents due to lower risk-taking behaviour. These findings support the hypothesis.

Specific aspects related to the injured

Although 83% of the injured believe in H&S policies and procedures, 67% of the injured had a history of motor vehicle accidents as a driver, providing support for the proposed profile of history of risk-taking behaviour.

Only 17% of the injured believe that workers are responsible for accidents indicating the transfer of responsibility to organisational management, although 83% have received speeding fines, which is indicative of the individual history of risk-taking behaviour.

The statistical inferences in Table 5.8 supports the hypothesis that the historical risk-taking behaviour patterns of the individual could be used for the correct selection of candidates for high risk job tasks.

The eighth hypothesis is therefore supported.

5.2.10 Analysis of results to test hypothesis nine

Hypothesis nine: Management can influence and have an effect on an individual's risk-taking behaviour.

The aspects presented in the table below, relate to Hypothesis nine.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
5. Electrical accidents are related to management incompetence	2.69	8	*nd	<0.05	<0.05		X
6. Management competency is related to risk-taking behaviour	3.28	5	X	<0.05	>0.05		X
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
5. Electrical accidents are related to management incompetence	2.35	11	*nd	>0.05	>0.05		X
6. Management competency is related to risk-taking behaviour	3.18	7	X	>0.05	>0.05		X
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
Job task to employee profile matching should be standard for high risk engineering tasks	100	*nd		X
It is possible to match a candidate's risk profile to a specific job task	75.0	*nd		X
Continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations	100	X		X
*nd= not determined				

D. Relationship between behavioural aspect and profile of injured	Relationship	Fisher's exact test p-value	% Agreement with statement	Review of literature	Inconclusive	Statistically significant	Hypothesis is not supported
4.2.2.8 (3) I am Influenced by management behaviour	Injured	<0.05	50%	X		Y	X
4.2.2.7 (1) Fear of penalty and/or injury as a motivation not to take risk	Injured		83%	X			
4.2.2.8 (2) Believe that management and authority in SA set good examples	Injured	>0.05	17%	X		N	X
4.2.2.6 (3) Would report unsafe behaviour	Injured		83%	X			
*nd = not determined *p-value < 0.05 indicates significance at the less than 5% level.							

Table 5.9 Analysis of results to test hypothesis nine

Relationship of aspects to the principal questionnaire survey

The mean scores for the engineers (2.69) and the injured (2.35) are < 3.00 for the aspect 'electrical accidents are related to management incompetence' points to the aspect as not being effective. Given that the aspect 'management competency is related to risk-taking behaviour' achieved mean scores of 3.28 for the engineers and 3.18 for the injured (3.18), which are > 3.00, the importance of management competency, and the impact that such management competencies will have on risk-taking behaviour, is highlighted.

HR management survey

The unanimous support of the HR managers for the proposal that continuous employee evaluations can be made according to incident profiles in job task allocations indicates the effect that managerial influence could have on individual risk-taking behaviour.

Although only 75% indicate that it should be possible to match a candidate's risk profile to a specific job task, all support the proposal that job task to employee profile matching should be standard for high risk engineering tasks.

Specific aspects related to the injured

50% of the injured indicated that they are influenced by management behaviour and 83% that a fear of penalty and / or a fear of injury was a motivation not to take risks. This supports the contention of the importance of penalties as a motivation by management to alter risk-taking behaviour supporting the hypothesis of the influence management can have on risk-taking behaviour. The association between the aspects is considered to be statistically significant according to the 'Fisher's exact test'.

Although only 17% of the injured believe that management and authority in SA set good examples, 83% are influenced by management systems to report unsafe behaviour.

The statistical inferences in Table 5.9 support the hypothesis that management could influence and have an effect on the individual's risk-taking profile.

The ninth hypothesis is therefore supported.

5.2.11 Analysis of results to test hypothesis ten

Hypothesis 10: Incident statistical indicators should be the key component to continuous improvement of H&S management systems and should form part of performance evaluation appraisal systems.

A. Aspect related to the principle questionnaire survey of Engineers	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Kruskal-Wallis**	**Inconclusive**	**Hypothesis is supported**
2. Electrical workers will perceive hazards differently	3.69	2	*nd	<0.05	>0.05		X
8. H&S work procedures differ among electrical maintenance workers	3.10	6	X	>0.05	<0.05		X
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

B. Aspect related to the principle questionnaire survey of incident case studies (Injured)	**Overall mean score**	**Rank**	**Review of literature**	**p-value *t* Test**	**p-value ANOVA Mann-Whitney**	**Inconclusive**	**Hypothesis is supported**
2. Electrical workers will perceive hazards differently	3.33	4	*nd	>0.05	>0.05		X
8. H&S work procedures differ among electrical maintenance workers	1.96	13	X	<0.05	>0.05		X
*nd = not determined *p-value less than 0.05 - indicates significant at the less than 5% level.							

C. HR management survey	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Hypothesis is supported**
It is possible to match a candidate's risk profile to a specific job task	75.0	*nd		X
There is definitely a difference in each individual's risk taking behaviour profile	100	X		X
Continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations	100	X		X
*nd = not determined				

D. Relationship between behavioural aspect and profile of injured	**Relationship**	**Fisher's exact test p-value**	**% Agreement with statement**	**Review of literature**	**Inconclusive**	**Statistically significant**	**Hypothesis is not supported**
4.2.2.5 (1) Believe in H&S policies and procedures	Injured	>0.05	83.0	X		N	X
4.2.2.2 (2) Pattern of accidental, self injury at work	Injured		50.0	X			
4.2.1.6 (1) Involvement in more than 2 work accidents	Injured	>0.05	100	X		Y	X
4.2.2.6 (3) Would report unsafe behaviour	Injured		83.0	X			
*nd = not determined.							

Table 5.10 Analysis of results to test hypothesis ten

Relationship of aspects to the principal questionnaire survey

Given that the mean scores for the engineers (3.69) and the injured (3.33) are > 3.00 for the aspect 'electrical workers will perceive hazards differently', the aspect can be deemed as being effective.

The mean score for the engineers (3.10) is > 3.00, and for the injured (1.96) < 3.00 for the aspect 'H&S work procedures differ among electrical maintenance workers' is indicative of the difference in opinion between the engineers as management and the injured, which could assist in the improvement of H&S management systems.

HR management survey

Although only 75% of the HR managers believe that it is possible to match a candidate's risk profile to a specific job task, the HR managers indicated unanimous support for the proposal that there is a difference in each individual's risk-taking behaviour profile, and that continuous employee evaluations need to be made according to incident profiles for adjustments in job task allocations, supporting the need for statistical indicators to improve H&S management systems.

Specific aspects related to the injured

Given that 83% of the injured believe in H&S policies and procedures, only 50% had a pattern of accidents or self injury at work indicating the possibility of a correlation between incident statistics and the need for improvement to H&S management systems.

Although 100% of the injured were involved in more than 2 work accidents, only 83% indicated that they would report unsafe behaviour, highlighting the need for statistical indicators that would improve H&S management systems, to be incorporated in performance evaluation appraisal systems. The association between the aspects is considered to be statistically significant according to the 'Fisher's exact test'.

The statistical inferences in Table 5.10 support the hypothesis that incident statistical indicators should be the key component to continuous improvement of H&S management systems and should form part of performance evaluation appraisal systems.

The tenth hypothesis is therefore supported.

5.3 STATISTICAL ANALYSIS

The data collected from the various surveys was analysed and interpreted to determine the value of independence of the variables. The following tables are presented.

Table 5.11 is descriptive of the statistical breakdown of the principle questionnaire.

Table 5.12 presents a statistical breakdown of data related to the incident case studies.

Table 5.13 gives a description for the ANOVA for the principle questionnaire survey as presented in the table, providing the outcome for the non-parametric 'Kruskal-Wallis' test.

Table 5.13 also presents the outcome of the ANOVA for the incident case studies and the ‘Mann-Whitney U test’ (non-parametric) results.

Table 5.14 presents Tukey's ‘honestly significant difference’ (HSD) test results of the various independent variables and Table 5.15.1 presents the single sample *t* Test for the principle questionnaire survey and table 5.15.2 presents the single sample *t* Test for the incident case studies.

Table 5.16.1 to 5.16.23 presents the different ‘Fisher’s exact test’ results.

5.3.1 Descriptive statistics breakdown of incident case studies

The responses to the questions posed to the incumbents during the incident case-studies are tabled below.

Heading legends

- Mean = Average value for sample
- N = Sample size
- Std Dev = Standard deviation

Principle questionnaire

Organisation	Q1 Mean	Q1 N	Q1 Std.Dev.	Q2 Mean	Q2 N	Q2 Std.Dev.	Q3 Mean	Q3 N	Q3 Std.Dev.
ICMEE	4.4	12	0.5	3.8	12	1.1	4.3	12	0.6
SAIEE	4.3	8	0.7	4.0	8	0.8	4.1	8	0.8
AMEU	3.5	8	0.5	3.0	8	1.1	2.5	8	1.2
SAFHE	4.5	10	0.7	3.7	10	0.9	2.8	10	0.9
ECA(SA)	4.3	11	0.6	4.0	11	0.9	4.2	11	0.8
All Groups	4.2	49	0.7	3.7	49	1.0	3.6	49	1.1

Organisation	Q4 Mean	Q4 N	Q4 Std.Dev.	Q5 Mean	Q5 N	Q5 Std.Dev.	Q6 Mean	Q6 N	Q6 Std.Dev.
ICMEE	3.0	12	0.6	3.2	12	1.1	3.6	12	1.0
SAIEE	3.0	8	0.8	2.3	8	0.9	3.0	8	0.8
AMEU	4.5	8	0.5	2.3	8	1.0	3.0	8	0.8
SAFHE	3.6	10	0.8	3.5	10	1.0	3.8	10	0.6
ECA(SA)	3.0	11	1.0	2.3	11	0.6	3.0	11	0.9
All Groups	3.4	49	0.9	2.7	49	1.1	3.3	49	0.9

Organisation	Q7 Mean	Q7 N	Q7 Std.Dev.	Q8 Mean	Q8 N	Q8 Std.Dev.	Q9 Mean	Q9 N	Q9 Std.Dev.
ICMEE	2.7	12	0.9	3.0	12	1.0	2.7	12	0.9
SAIEE	2.8	8	1.0	3.5	8	0.9	3.4	8	0.9
AMEU	2.5	8	1.2	2.3	8	0.7	1.3	6	0.5
SAFHE	3.7	10	0.7	3.2	10	0.6	2.0	10	0.8
ECA(SA)	2.7	11	0.9	3.5	11	0.7	3.4	11	0.9
All Groups	2.9	49	1.0	3.1	49	0.9	2.6	47	1.1

Organisation	Q10 Mean	Q10 N	Q10 Std.Dev.	Q11 Mean	Q11 N	Q11 Std.Dev.	Q12 Mean	Q12 N	Q12 Std.Dev.
ICMEE	2.0	12	1.0	2.7	12	1.2	2.2	11	1.0
SAIEE	2.0	7	0.8	2.8	8	1.0	2.3	8	0.9
AMEU	1.7	7	0.8	2.3	8	1.0	2.0	7	0.8
SAFHE	2.8	9	0.7	4.0	10	0.7	3.3	10	0.8
ECA(SA)	1.9	10	0.7	2.7	11	1.1	2.3	11	0.9
All Groups	2.1	45	0.8	2.9	49	1.2	2.4	47	1.0

Organisation	Q13 Mean	Q13 N	Q13 Std.Dev.	Q14 Mean	Q14 N	Q14 Std.Dev.
ICMEE	2.3	12	0.9	1.9	11	0.7
SAIEE	2.3	8	1.0	2.0	8	0.8
AMEU	1.4	7	0.5	1.7	7	0.8
SAFHE	2.2	10	0.8	2.0	9	0.7
ECA(SA)	2.3	11	0.9	2.0	11	0.6
All Groups	2.1	48	0.9	1.9	46	0.7

Table 5.11 Descriptive statistics breakdown of incident case studies

Table 5.11 represents all the questions posed to the incumbents during the incident case-studies.

5.3.2 Analysis of variance (ANOVA)

The various questions posed in the principal questionnaire survey to the electrical engineering fraternity (Section 4.3) and the same questions posed to incumbents of incident case studies (Section 4.4) were exposed to a statistical ANOVA survey to determine the effect of the questions posed and if they were significantly different and thus independent and their means different.

5.3.2.1 ANOVA for the principal questionnaire survey

Table 5.12 presents a statistical breakdown of data related to the incident case-studies.

Q	SS Effect	df Effect	MS Effect	SS Error	df Error	MS Error	F	p-value	Non-parametric Kruskal-Wallis test p-value
Q1*	5.432	4	1.358	17.098	44	0.389	3.49	0.0146	0.0278
Q2	5.650	4	1.413	40.350	44	0.917	1.54	0.2072	0.2447
Q3*	27.026	4	6.757	32.361	44	0.735	9.19	0.0000	0.0003
Q4*	14.988	4	3.747	26.400	44	0.600	6.24	0.0005	0.0018
Q5*	14.203	4	3.551	39.348	44	0.894	3.97	0.0078	0.0175
Q6	5.891	4	1.473	30.517	44	0.694	2.12	0.0938	0.0941
Q7	8.817	4	2.204	38.448	44	0.874	2.52	0.0544	0.0653
Q8*	9.438	4	2.360	27.827	44	0.632	3.73	0.0106	0.0194
Q9*	24.431	4	6.108	30.420	42	0.724	8.43	0.0000	0.0004
Q10	5.760	4	1.440	25.884	40	0.647	2.23	0.0834	0.0894
Q11*	16.641	4	4.160	47.848	44	1.087	3.83	0.0094	0.0122
Q12*	10.071	4	2.518	33.418	42	0.796	3.16	0.0232	0.0382
Q13	4.316	4	1.079	31.663	43	0.736	1.47	0.2294	0.2051
Q14	0.467	4	0.117	20.338	41	0.496	0.24	0.9169	0.9031
*p-value less than 0.05 - indicates significant at the less than 5% level									

Table 5.12 ANOVA for the principal questionnaire survey

Table 5.12 presents the differences in the principal questionnaire. The ANOVA Kruskal-Wallis one way statistical test was employed to evaluate whether the questions have the same median. Questions 1, 3, 4, 5, 8, 9, 11 and 12 indicated their significance at a p-level of less than 5 % with questions 2, 6, 7, 10 and 14 at more than 5%.

Heading legends

- SS Effect = Sum of squares for the effect
- df Effect = Degrees of freedom for the effect
- MS Effect = Mean squares for the effect
- SS Error = Sum of squares for error
- df Error = Degrees of freedom for error
- MS Error = Mean squares for error
- F = Test statistic
- P-value = Probability value
- Kruskal-Wallis p-value = Kruskal-Wallis probability value

5.3.2.2 ANOVA for incident case studies

Table 5.13 presents a statistical breakdown of data related to the incident case-studies.

Q	Mean	Mean	Value	Value	Valid N	Valid N	Std. Dev.	Std. Dev.	Mann-Whitney U test (non-para metric)
	Inj.	Sup.	*t* Test	p-value	Inj.	Sup.	Inj.	Sup.	p-value
Q1	3.60	3.62	-0.02	0.9814	5	13	1.34	1.19	0.9161
Q2	3.50	3.15	0.63	0.5382	6	13	1.38	0.99	0.6171
Q3	2.20	1.77	0.79	0.4401	5	13	1.10	1.01	0.4573
Q4	3.67	2.77	1.26	0.2262	6	13	1.63	1.36	0.2348
Q5	2.17	2.54	-0.44	0.6662	6	13	1.60	1.76	0.8485
Q6	2.67	3.69	-1.09	0.2921	6	13	1.97	1.89	0.3050
Q7	3.67	3.77	-0.13	0.9006	6	13	1.63	1.64	0.9217
Q8	2.00	1.92	0.11	0.9170	6	13	1.55	1.44	0.6101
Q9	1.67	2.85	-1.62	0.1238	6	13	1.03	1.63	0.1221
Q10*	2.33	4.38	-2.77	0.0132	6	13	1.51	1.50	0.0190
Q11	3.60	1.92	1.77	0.0965	5	13	1.95	1.75	0.0581
Q12	3.50	2.38	1.18	0.2551	6	13	1.97	1.89	0.3050
Q13*	3.67	1.62	2.46	0.0248	6	13	2.07	1.50	0.0339
Q14	4.50	4.54	-0.07	0.9417	6	13	0.84	1.13	0.6912
*p-value less than 0.05 - indicates significant at the less than 5% level									

Table 5.13 ANOVA for incident case studies

Table 5.13 presents the statistical ANOVA Mann-Whitney U test to establish whether the results of the questions posed are independent. Questions 10 and 13 are the only questions that indicate significance at less than 5 %.

Heading legends

- Mean Inj = Average value for injured
- Mean Sup = Average value for supervisors
- *t* Test = Test statistic
- P-value = Probability value
- Valid n Inj = Number in the injured group
- Valid n Sup = Number in the supervisor group
- Std Dev Inj = Standard deviation for injured group
- Std Dev Sup = Standard deviation for supervisor group
- df = Degrees of freedom
- Mann-Whitney U test (non-parametric) p-value = Mann-Whitney probability value

Tables 5.12 and 5.13 refer to ANOVA, which is a statistical model in which the observed variance in particular questions posed, is partitioned into various components attributed to different sources in the form of ICMEE, SAIEE, AMEU, SAFHE and ECA(SA) members of variation. ANOVA tests whether or not the means of several groups are all equal or not and to what extent and therefore generalises *t*-test to more than two groups.

The tests performed reveal that the p-value, as shown in the above table, is less than <0.05 - indicates that the corresponding mean score is significant (at 5%) <3.00, which concludes that the hypothesis so indicated is supported.

The Kruskal–Wallis one-way ANOVA by rank is a non-parametric method for testing whether a group of samples originate from the same distribution. Two or more samples are compared to determine if they are dependant or if not related at all. The parametric equivalence of the Kruskal-Wallis test is the one-way ANOVA.

The null hypothesis shows that a population, from which a sample originates, has the same mean score. When the Kruskal-Wallis test results show a significant result, it indicates that at least one of the samples is different from the other samples.

The Kruskal-Wallis test and the ANOVA test, p value results, further relates to the validity of the result.

5.3.3 Tukey's HSD (Honestly Significant Difference)

5.3.3.1 Tukey's HSD test for principle questionnaire survey

Tukey HSD test; Variable: Q1	{1} M=4.4167	{2} M=4.2500	{3} M=3.5000	{4} M=4.5000	{5} M=4.2727
ICMEE {1}		0.977	0.019	0.998	0.981
SAIEE {2}	0.977		0.133	0.915	1.000
AMEU {3}	0.019	0.133		0.013	0.076
SAFHE {4}	0.998	0.915	0.013		0.918
ECA(SA) {5}	0.981	1.000	0.076	0.918	

Table 5.14.1 Tukey HSD test; Variable of Q1

ICMEE (4.4) differs significantly from AMEU (3.5): p=0.019.

SAFHE (4.5) differs significantly from AMEU (3.5): p=0.013.

Tukey HSD test; Variable: Q3	{1} M=4.2500	{2} M=4.1250	{3} M=2.5000	{4} M=2.8000	{5} M=4.1818
ICMEE {1}		0.998	0.001	0.003	1.000
SAIEE {2}	0.998		0.004	0.018	1.000
AMEU {3}	0.001	0.004		0.947	0.001
SAFHE {4}	0.003	0.018	0.947		0.005
ECA(SA) {5}	1.000	1.000	0.001	0.005	

Table 5.14.2 Tukey HSD test; Variable of Q3

ICMEE (4.25) differs significantly from AMEU (2.5): p=0.001, and from SAFHE (2.8): p=0.003.

SAIEE (4.125) differs significantly from AMEU (2.5): p=0.004, and from SAFHE (2.8): p=0.018.

ECE (4.18) differs significantly from AMEU (2.5): p=0.001, and from SAFHE (2.8): p=0.005.

Tukey HSD test; Variable: Q4	{1} M=3.0000	{2} M=3.0000	{3} M=4.5000	{4} M=3.6000	{5} M=3.0000
ICMEE {1}		1.000	0.001	0.382	1.000
SAIEE {2}	1.000		0.003	0.485	1.000
AMEU {3}	0.001	0.003		0.121	0.001
SAFHE {4}	0.382	0.485	0.121		0.402
ECA (SA) {5}	1.000	1.000	0.001	0.402	

Table 5.14.3 Tukey HSD test; Variable of Q4

ICMEE (3.0) differs significantly from AMEU (4.5): p=0.001.

SAIEE (3.0) differs significantly from AMEU (4.5): p=0.003.

AMEU (4.5) differs significantly from ECA (SA) (3.0): p=0.001.

Tukey HSD test; Variable: Q5	{1} M=3.1667	{2} M=2.2500	{3} M=2.2500	{4} M=3.5000	{5} M=2.2727
ICMEE {1}		0.229	0.229	0.922	0.176
SAIEE {2}	0.229		1.000	0.057	1.000
AMEU {3}	0.229	1.000		0.057	1.000
SAFHE {4}	0.922	0.057	0.057		0.037
ECA (SA) {5}	0.176	1.000	1.000	0.037	

Table 5.14.4 Tukey HSD test; Variable of Q5

SAFHE (3.5) differs significantly from ECA (SA) (2.27): p=0.037.

Tukey HSD test; Variable: Q8	{1} M=3.0000	{2} M=3.5000	{3} M=2.2500	{4} M=3.2000	{5} M=3.5455
ICMEE {1}		0.645	0.253	0.976	0.479
SAIEE {2}	0.645		0.024	0.931	1.000
AMEU {3}	0.253	0.024		0.105	0.009
SAFHE {4}	0.976	0.931	0.105		0.857
ECA (SA) {5}	0.479	1.000	0.009	0.857	

Table 5.14.5 Tukey HSD test; Variable of Q8

AMEU (2.25) differs significantly from SAIEE (3.5): p=0.024, and from ECA (SA) (3.55): p=0.009

Tukey HSD test; Variable: Q9	{1} M=2.6667	{2} M=3.3750	{3} M=1.3333	{4} M=2.0000	{5} M=3.3636
ICMEE {1}		0.374	0.025	0.371	0.302
SAIEE {2}	0.374		0.001	0.012	1.000
AMEU {3}	0.025	0.001		0.558	0.000
SAFHE {4}	0.371	0.012	0.558		0.006
ECA (SA) {5}	0.302	1.000	0.000	0.006	

Table 5.14.6 Tukey HSD test; Variable of Q9

AMEU (1.33) differs significantly from ICMEE (2.67): p=0.025, and from SAIEE (3.375): p=0.001, and from ECA (SA) (3.36): p=0.000.

SAFHE (2.0) differs significantly from SAIEE (3.375): p=0.012.

TukeyHSD test; Variable: Q11	{1} M=2.6667	{2} M=2.7500	{3} M=2.2500	{4} M=4.0000	{5} M=2.7273
ICMEE {1}		1.000	0.904	0.035	1.000
SAIEE {2}	1.000		0.872	0.103	1.000
AMEU {3}	0.904	0.872		0.008	0.861
SAFHE {4}	0.035	0.103	0.008		0.057
ECA (SA) {5}	1.000	1.000	0.861	0.057	

Table 5.14.7 Tukey HSD test; Variable of Q11

SAFHE (4.0) differ significantly from ICMEE (2.67): p=0.035, and from AMEU (2.25): p=0.008.

TukeyHSD test; Variable: Q12	{1} M=2.1818	{2} M=2.2500	{3} M=2.0000	{4} M=3.3000	{5} M=2.2727
ICMEE {1}		1.000	0.993	0.048	0.999
SAIEE {2}	1.000		0.982	0.114	1.000
AMEU {3}	0.993	0.982		0.039	0.969
SAFHE {4}	0.048	0.114	0.039		0.082
ECA (SA) {5}	0.999	1.000	0.969	0.082	

Table 5.14.8 Tukey HSD test; Variable of Q12

SAFHE (3.3) differ significantly from ICMEE (2.18): p=0.048, and from AMEU (2.0): p=0.039.

5.3.4 Single sample *t* Test

The single sample *t* Test is used to test whether the mean value average of a sample is statistically significantly different from a specified value. In the present situation the midpoint value of the five-point scale is 3.00.

The *t* Test indicates that the null hypothesis that was determined in each instance was that the mean was $\geq$ 3.00 or alternatively the mean was < 3.00.

If a sample mean is = 3.00 or higher than 3.00, the test is not performed since the research hypothesis of ‘not effective’ and is automatically rejected.

Mean $\geq$ 3.00 research values that are < 3.00 indicate that the research hypothesis is not effective.

When a *t* Test is performed, a t-value and a corresponding p-value are calculated. A p-value < 0.05 indicates that the sample mean is significantly < 3.00, at the 5% level of significance. In questions 1, 2, 3, 4 and 8 the significance can only be supported if the mean is > 3.00.

In question 5, 7, 9, 10, 11, 12, 13 and 14 the p-value is so small that they disagree with the statement significantly.

5.3.4.1 Single sample *t* Test for principle questionnaire survey

***t*- Test results obtained for all aspects.**

Question	Mean	Std.Dev.	N	Reference Constant	t-value	df	p (one-sided)
Q1*	4.22	0.69	49	3	12.51	48	0.00000
Q2*	3.71	0.98	49	3	5.11	48	0.00000
Q3*	3.63	1.11	49	3	3.98	48	0.00012
Q4*	3.37	0.93	49	3	2.77	48	0.00398
Q5*	2.73	1.06	49	3	-1.76	48	0.04254
Q6*	3.31	0.87	49	3	2.46	48	0.00876
Q7	2.88	0.99	49	3	-0.86	48	0.19600
Q8	3.12	0.88	49	3	0.97	48	0.16777
Q9*	2.64	1.09	47	3	-2.27	46	0.01394
Q10*	2.09	0.85	45	3	-7.21	44	0.00000
Q11	2.90	1.16	49	3	-0.62	48	0.27033
Q12*	2.43	0.97	47	3	-4.05	46	0.00010
Q13*	2.15	0.87	48	3	-6.76	47	0.00000
Q14*	1.93	0.68	46	3	-10.63	45	0.00000
*p - value less than 0.05							

Table 5.15.1 Single sample *t* Test for principle questionnaire survey

Heading legends

- Question = Question number
- Mean = Average value for sample
- Std. Dev. = Standard deviation
- N = Sample size
- Reference Constant = Specific value against which the sample mean is compared
- *t*-value = Test statistic
- df = Degrees of freedom
- P-one-sided = One sided probability value

5.3.4.2 Single sample *t* Test for incident case studies

Question	Mean	Std.Dev.	N	Reference Constant	t-value	df	p (one-sided)
Q1*	3.61	1.20	18	3	2.17	17	0.0223
Q2	3.26	1.10	19	3	1.05	18	0.1549
Q3*	1.89	1.02	18	3	-4.61	17	0.0001
Q4	3.05	1.47	19	3	0.16	18	0.4389
Q5	2.42	1.68	19	3	-1.50	18	0.0749
Q6	3.37	1.92	19	3	0.84	18	0.2071
Q7*	3.74	1.59	19	3	2.02	18	0.0295
Q8*	1.95	1.43	19	3	-3.20	18	0.0025
Q9	2.47	1.54	19	3	-1.49	18	0.0769
Q10*	3.74	1.76	19	3	1.83	18	0.0422
Q11	2.39	1.91	18	3	-1.35	17	0.0966
Q12	2.74	1.94	19	3	-0.59	18	0.2808
Q13	2.26	1.91	19	3	-1.68	18	0.0550
Q14*	4.53	1.02	19	3	6.52	18	0.0000
*p - value less than 0.05							

Table 5.15.2 Single sample *t* Test for incident case studies

Heading legends

- Question = Question number
- Mean = Average value for sample
- Std. Dev. = Standard deviation
- N = Sample size
- Reference Constant = Specific value against which the sample mean is compared
- *t*-value = Test statistic
- df = Degrees of freedom
- P-one-sided = One sided probability value

5.3.5 Fisher's exact test

The Fisher's exact test is used to analyse the contingency of a table's data when the sample size is very small. It is an exact test that indicates the significance of deviation from the null hypothesis. The test examines the significance of the association between two different classifications to determine their association. The data presented in Chapter 4 that has relevance to the study was exposed to Fisher's exact test.

Hypothesis 1

Injured	**Yes**	**No**	**Total**
4.2.2.5 (1)	5	1	6
4.2.2.8 (3)	1	5	6
Total	6	6	12
The two-tailed p-value equals 0.0801			
The association between rows (groups) and columns (outcomes) is considered to be statistically insignificant.			

Table 5.16.1 Hypothesis 1 - Q1

Injured	**Yes**	**No**	**Total**
4.2.2.7 (1)	6	0	6
4.2.2.8 (3)	1	5	6
Total	7	5	12
The two-tailed p-value equals 0.0152			
The association between rows (groups) and columns (outcomes) is considered to be statistically significant.			

Table 5.16.2 Hypothesis 1 - Q2

Injured	**Yes**	**No**	**Total**
4.2.2.6 (3)	5	1	6
4.2.2.8 (2)	1	5	6
Total	6	6	12
The two-tailed p-value equals 0.0801			
The association between rows (groups) and columns (outcomes) is considered to be not quite statistically significant.			

Table 5.16.3 Hypothesis 1 - Q3

Hypothesis 2

Injured	Yes	No	Total
4.2.2.6(1)	6	0	6
4.2.2.2(3)	0	6	6
Total	6	6	12
The two-tailed p-value equals 0.0022			
The association between rows (groups) and columns (outcomes) is considered to be very statistically significant.			

Table 5.16.4 Hypothesis 2 - Q1

Injured	Yes	No	Total
4.2.2.6(2)	1	5	6
4.2.1.3 (1)	5	8	13
Total	6	13	19
The two-tailed p-value equals 0.6047			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.5 Hypothesis 2 - Q2

Injured	Yes	No	Total
4.2.1.2(1)	13	0	13
4.2.2.7 (2)	2	4	6
Total	15	4	19
The two-tailed p-value equals 0.0039			
The association between rows (groups) and columns (outcomes) is considered to be very statistically significant			

Table 5.16.6 Hypothesis 2 - Q3

Hypothesis 3

Injured	Yes	No	Total
4.2.2.8(2)	1	5	6
4.2.2.5(2)	1	5	6
Total	2	10	12
The two-tailed p-value equals 1.0000			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.7 Hypothesis 3 - Q1

Injured	Yes	No	Total
4.2.2.5(1)	5	1	6
4.2.2.5(3)	3	3	6
Total	8	4	12
The two-tailed p-value equals 0.5455			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.8 Hypothesis 3 - Q2

Hypothesis 4

Injured	Yes	No	Total
4.2.2.5(1)	5	1	6
4.2.2.6(3)	5	1	6
Total	10	2	12
The two-tailed p-value equals 1.0000			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.9 Hypothesis 4 - Q1

Supervisor	Yes	No	Total
4.2.2.5(1)	11	2	13
4.2.2.6(3)	13	0	13
Total	24	2	26
The two-tailed p-value equals 0.4800			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.10 Hypothesis 4 - Q2

Injured	Yes	No	Total
4.2.2.7(1)	6	0	6
4.2.2.8(1)	4	2	6
Total	10	2	12
The two-tailed p-value equals 0.4545			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.11 Hypothesis 4 - Q3

Hypothesis 5

Injured	Yes	No	Total
4.2.2.7(2)	2	4	6
4.2.1.4(1)	12	1	13
Total	14	5	19
The two-tailed p-value equals 0.0173			
The association between rows (groups) and columns (outcomes) is considered to be statistically significant.			

Table 5.16.12 Hypothesis 5 - Q1

Injured	Yes	No	Total
4.2.2.2(2)	3	3	6
4.2.1.3 (1)	5	8	13
Total	8	11	19
The two-tailed p-value equals 1.0000			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.13 Hypothesis 5 - Q2

Hypothesis 6

Injured	Yes	No	Total
4.2.2.4(1)	1	5	6
4.2.2.3(3)	5	1	6
Total	6	6	12
The two-tailed P value equals 0.0801			
The association between rows (groups) and columns (outcomes) is considered to be not quite statistically significant.			

Table 5.16.14 Hypothesis 6 - Q1

Injured	Yes	No	Total
4.2.2.4(2)	1	5	6
4.2.2.7(2)	2	4	6
Total	3	9	12
The two-tailed P value equals 1.0000			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.15 Hypothesis 6 - Q2

Hypothesis 7

Injured	Yes	No	Total
4.2.1.1(1)	13	0	13
4.2.2.6 (1)	6	0	6
Total	19	0	19
The two-tailed p-value equals 1.0000			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.16 Hypothesis 7 - Q1

Injured	Yes	No	Total
4.2.2.2 (1)	4	2	6
4.2.2.6 (2)	5	1	6
Total	9	3	12
The two-tailed p-value equals 1.0000			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.17 Hypothesis 7 - Q2

Hypothesis 8

Injured	Yes	No	Total
4.2.2.5(1)	5	1	6
4.2.2.3(1)	6	0	6
Total	11	1	12
The two-tailed p-value equals 1.0000			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.18 Hypothesis 8 - Q1

Injured	Yes	No	Total
4.2.2.5(2)	1	5	6
4.2.2.3(2)	5	1	6
Total	6	6	12
The two-tailed p-value equals 0.0801			
The association between rows (groups) and columns (outcomes) is considered to be not quite statistically significant			

Table 5.16.19 Hypothesis 8 - Q2

Hypothesis 9

Injured	Yes	No	Total
4.2.2.8(3)	1	5	6
4.2.2.7(1)	6	0	6
Total	7	5	12
The two-tailed p- value equals 0.0152			
The association between rows (groups) and columns (outcomes) is considered to be statistically significant.			

Table 5.16.20 Hypothesis 9 - Q1

Injured	Yes	No	Total
4.2.2.8(2)	1	5	6
4.2.2.6(3)	5	1	6
Total	6	6	12
The two-tailed p-value equals 0.0801			
The association between rows (groups) and columns (outcomes) is considered to be not quite statistically significant.			

Table 5.16.21 Hypothesis 9 - Q2

Hypothesis 10

Injured	Yes	No	Total
4.2.2.5(1)	5	1	6
4.2.2.2(2)	3	3	6
Total	8	4	12
The two-tailed p-value equals 0.5455			
The association between rows (groups) and columns (outcomes) is considered to be not statistically significant.			

Table 5.16.22 Hypothesis 10 - Q1

Injured	Yes	No	Total
4.2.1.6(1)	0	6	6
4.2.2.6(3)	5	1	6
Total	5	7	12
The two-tailed p-value equals 0.0152			
The association between rows (groups) and columns (outcomes) is considered to be statistically significant			

Table 5.16.23 Hypothesis 10 - Q2

5.4 SUMMARY

The data analysis techniques used satisfied the assumptions presented in the various hypotheses presented.

The results of the Tukey's ‘honestly significant difference’ test indicated that the various questions posed, in relation to incident case studies, present proof of the independence of the various independent variables and to what extent such independence is classified according to the various Tables 5.14.1 to 5.14.8

The evaluation of the entire hypothesis and the testing of the data obtained from the empirical research findings were accomplished. The validity and support of the principle questionnaire survey related to engineers and the questionnaire survey related to incident case studies were tested for support of related specific hypothesis. Specific questionnaires related to the HR management survey were evaluated as support for the relevant Hypothesis as well as specific questions posed relative to the relationship between behavioural aspects and the profile of the injured. The testing of the hypotheses, and the sub-hypotheses, correlation and agreement with the research findings were determined and presented.

Chapter 6, which follows, presents a model that addresses the need for H&S and HR management interactive support to address the unknown factors of human risk behaviour that impact on H&S performance by risk taking behaviour profile matching to high risk tasks.

CHAPTER 6: THE JOB TASK TO INDIVIDUAL PROFILE MATCHING MODEL

6.1 INTRODUCTION

Should organisational systems and imposed legislation in the H&S environment continue to concentrate on the control of H&S environmental factors only, and not incorporate and acknowledge the role and influence human risk-taking behaviour has, the H&S incident statistics will continue to be unacceptable.

The electrical construction and maintenance industry, due to the current high demand for expansion in electricity capacity in South Africa, exposes workers to more risks than usual. Coupled to this is the unique environment of heuristic learning requirements and competencies rather than reliance on human sensory perceptual capabilities to identify and evaluate potential risk factors.

The physical entities of electricity pose unique risks to the human body and due to these factors electrical work should be managed differently than other construction activities. This places a higher demand for more competent electrical workers than what is currently available in South Africa. Such workers should not only be more knowledgeable about the threats of 'live' electrical installations, but should be more experienced or be supervised by experienced workers who, due to heuristic learning processes, can better evaluate and give guidance on risks involved in dangerous activities.

It is clear from the research that in this environment, H&S systems should acknowledge and incorporate the individual's psychological evaluation in assigning specific job tasks.

Such evaluation should take into account:

- Knowledge;
- Experience:
  - Heuristic;
  - Years of work experience, and
  - Job task experience, and
- Psychological behaviour (psychometric testing).

6.2 THE AIM OF THE MODEL

The approach to H&S in South Africa should be expanded to take into account human behaviour factors related to individual psychological behaviour in relation to the capacity for analysing risk factors in a work environment. Further, such psychological analyses should take into account South Africa's unique environment of different cultures and the effect change in economic expansions and technologies has on people. Weber and Hsee (1998) found consistent and reliable cross-cultural differences in risk perception and indicated that the effects of different cultural backgrounds of workers on H&S management are not always incorporated into H&S management processes.

Edwards and Holt (2008) postulate that non-compliance with H&S rules includes worker apathy and ignorance; that in turn can result from lack of or inadequate training and instruction, pressure to get the job done as quickly as possible and lack of supervision. This aspect of 'human acts or omissions' and their relationship to H&S failings in construction, is well documented.

The use of standards alone is no guarantee that an organisation's H&S management system will reduce incidents of loss. Standards used in South Africa in relation to H&S are usually developed or obtained from other sources such as the ILO. The ILO has, as one of its key functions, the creation of international standards on labour and social matters where such standards are contained in conventions and recommendations.

Regarding the issue of 'how' to address the human 'failure' element, one naturally looks toward lack of or inadequate training and instruction. This aspect of appropriate training, education and instruction being a pre-requisite to achieving human H&S 'compliance' appears frequently in construction literature (Edwards and Holt, 2008). Developing workers' competency by increasing their knowledge through training and by identifying individuals with low risk-taking behaviour for high risk tasks should form part of the H&S system processes.

Practical recommendations that will strengthen current H&S tools include:

Evaluation of specific job tasks:

- Job task related to high risk activities must be evaluated to identify specific tasks requiring individual decision-making, and
- An index that would indicate the possibility and severity of risk per job task must be allocated.

Individual link profile of risk behaviour:

- Development of a risk profile index in collaboration with a psychological testing department with specific psychometric tests, and
- HR departments to have an annual update of individual risk profiles.

6.3 THE BASIS FOR THE MODEL

The basis for the model is the need of H&S and HR management for support to address the unknown factors of human risk behaviour that impact on H&S performance. Organisations and individuals act in certain ways when exposed to a work hazard, in order to counteract undesirable responses management should ensure that certain systems are in place that will guide workers to act on incorrect responses or behaviour.

Individual decisions to act correctly are not always a clear choice, especially when the individual is exposed to unknown scenarios or where immediate decisions should be made.

6.3.1 The basis for the model

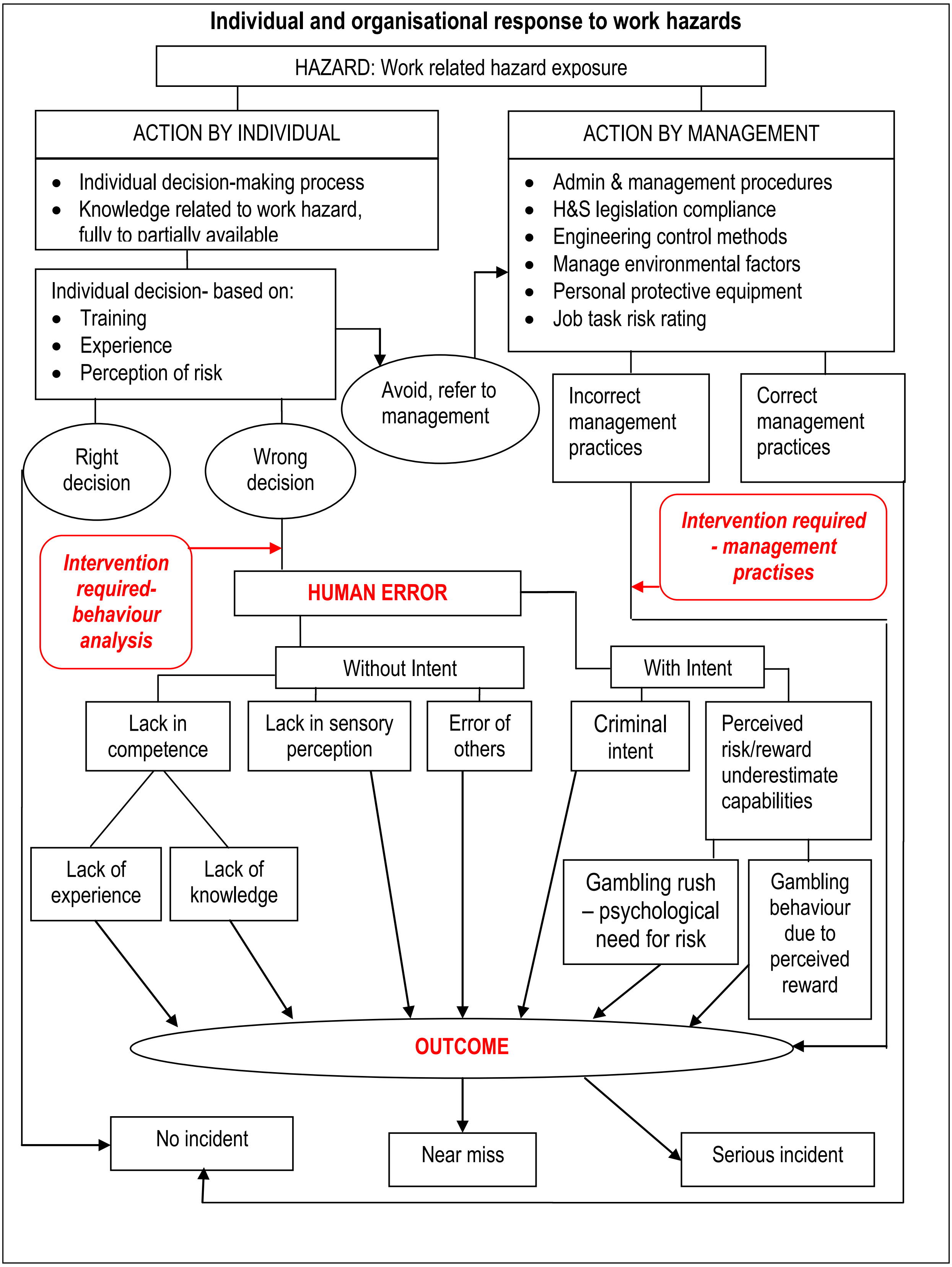

Figure 6.1 Basis for the model

(Flow diagram designed by author)

Figure 6.1 addresses the variables that are active, in the electrical engineering work environment, that have an impact on incidents where correct or incorrect behavioural decisions are made as influenced by each individual’s perception. Management have certain responsibilities in ensuring that the work environment complies with relevant legislation as well as the organisation’s quality management and internal policy and procedures. In order to comply with such requirements, management implement engineering methods and admin procedures and provide the relevant PPE to manage and mitigate identified risks.

The individual motivation to make certain decisions when exposed to hazards depends on various psychological and physical capability factors. It is at this stage that interventions are required for ensuring that individual decision-making correlates with H&S legislation and the organisation’s requirements to ensure zero incidents. Incorrect H&S management system functioning that does not ensure an H&S environment needs intervention that will guarantee the optimal functioning of such systems. Job task risk rating should form an integral part of this management function.

6.3.2 Model applications for incident evaluation

Should it be determined that an incident was caused by human error due to:

- Emotional state;
- High risk-taking behaviour with intent;
- Physical impairment due to incorrect human sensory functioning or physical tiredness, or
- The impact of motivation due to beliefs as influenced by a cultural environment and action for specific rewards.

6.3.3 Model applications performance appraisal relative to incidents

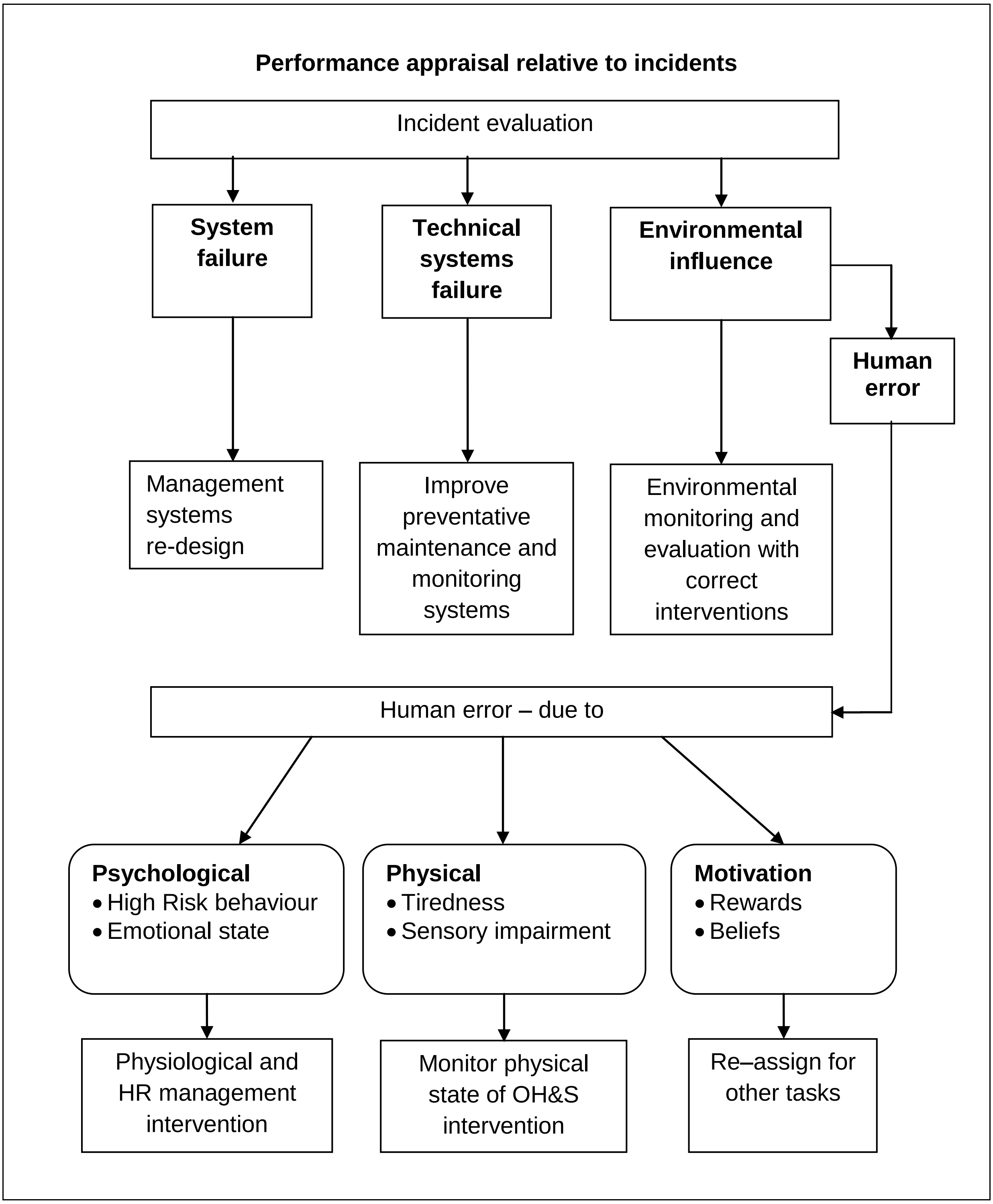

Figure 6.2 Model applications performance appraisal relative to incidents

(Source: the author)

6.3.4 Model applications for work system appraisal

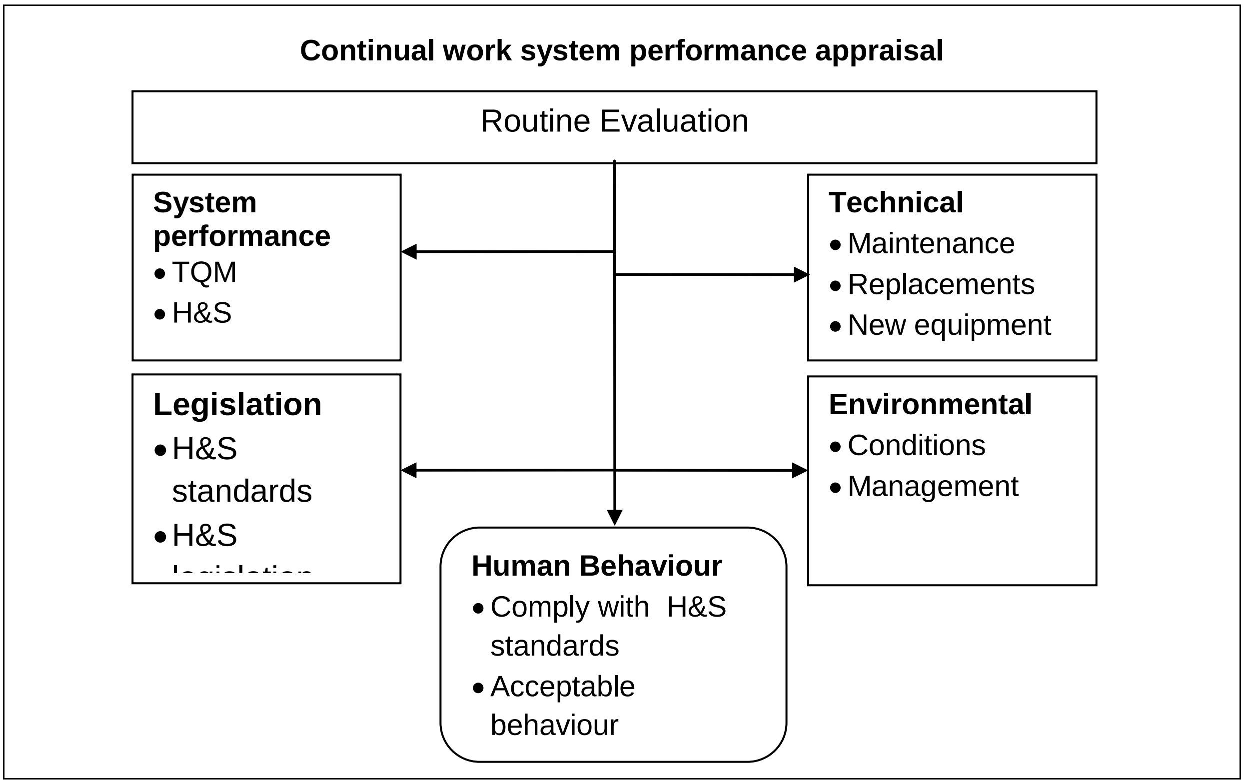

Figure 6.3 Model applications for work system appraisal
(Source: the author)

Figure 6.3 details routine system performance appraisal that can have an impact and influence H&S positively and should be seen as continuous maintenance of organisational systems to support the H&S environment. The intervention for monitoring and evaluation of such system performances depends on various operational factors of the organisation, but should take into account:

- The size of the organisation;
- Type of operations;
- Risk involved in job tasks;
- Operational time;
- Output demands;
- Management competence;
- Quality and competence of work force;
- Engineering systems employed, and
- Quality requirements of service or products produced.

6.4 JOB TASK RISK EVALUATION

The model aims to acknowledge the role that human risk-taking behaviour plays, as a variable entity, and the need to take cognisance of a qualified value as a prerequisite for performing job tasks with certain risk factors.

The principal aim of the model is to match a job task to a risk profile, which requires the evaluation of the job task and the individual risk behaviour profile.

6.4.1 Evaluations

The quantifying of risk profiles, for variables in a work environment, offers organisations information to better manage and control risk related to such environmental variables. The current concern of the H&S approach is on the risk profile related to a specific job task environment only, which from a technical perspective, constitutes a much easier method of H&S management.

Evaluation of the individual risk behaviour profile is complex as the field of psychological behaviour is specialised with specialist input required, with the result that smaller firms rarely afford acknowledgement to such aspects.

6.4.1.1 Evaluation to job task risk-profiling

Data on historical incidents related to job tasks not only provides details of possible failures in systems of the job tasks, but also indicates the extent to which variables could be managed.

The evaluation of the specific parameters of the job task, the physical capabilities and strength required of workers, history of job task performance and the level of decision-making required of individuals relates to further details in job task evaluations.

6.4.1.2 Job task risk evaluation flowchart

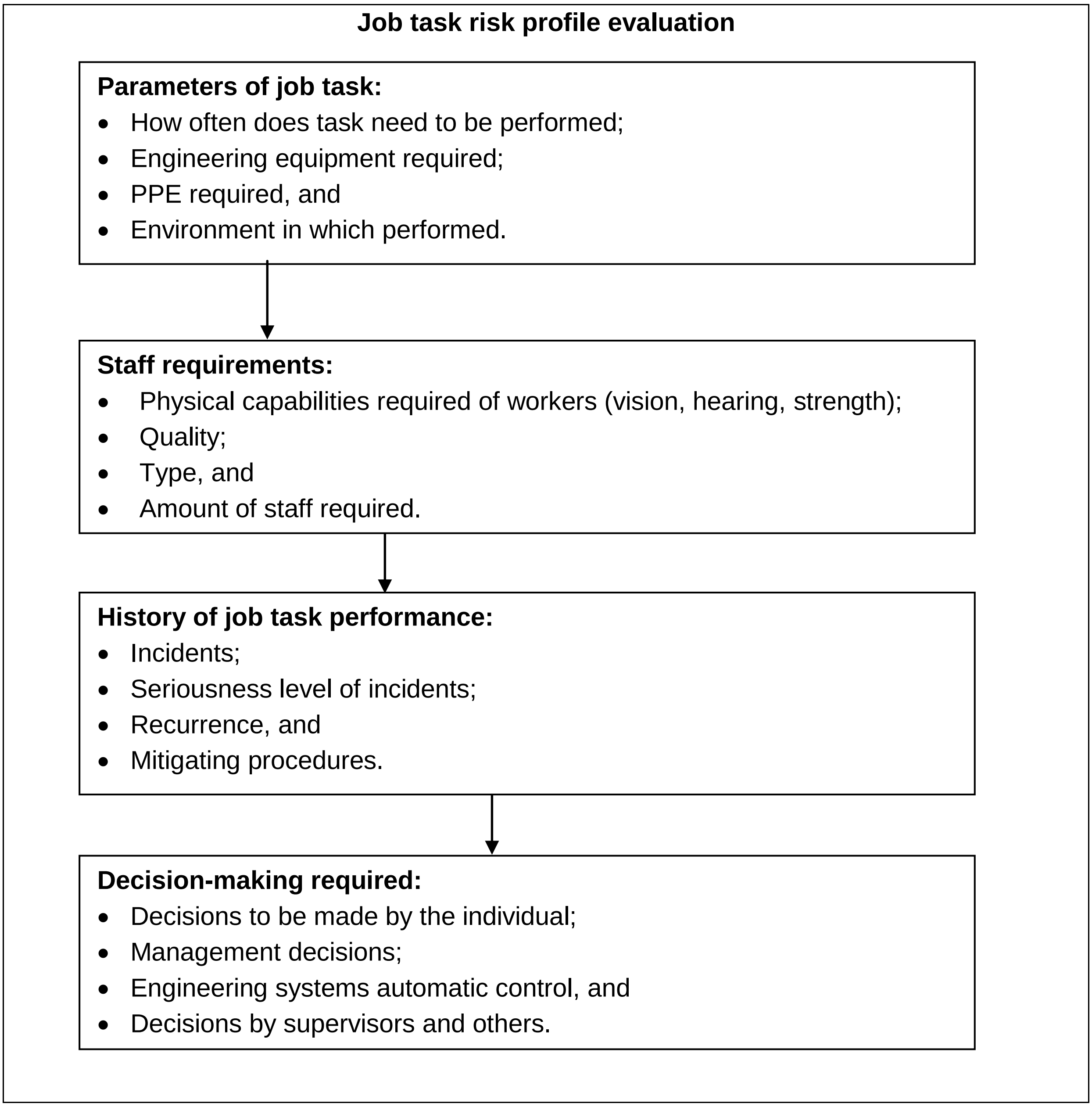

Figure 6.4 Job task risk evaluation flowchart

Figure 6.4 indicates the variables that need to be addressed to develop a profile of the risk related to a specific job task. The Variables related to the risk of a specific job task involves:

- Parameters and complexity of the job task;
- Staff requirements;
- History of job task performance, and
- Decision-making required.

6.4.1.3 Evaluation to individual risk profiling

From the literature survey and the empirical study, the complexity of profiling individual risk-taking behaviour relates to various parameters in relation to the psychology, the cultural paradigm and the specific training and experience of the individual being profiled. To quantify such risk behaviour profile requires detailed information on the individual's attributes.

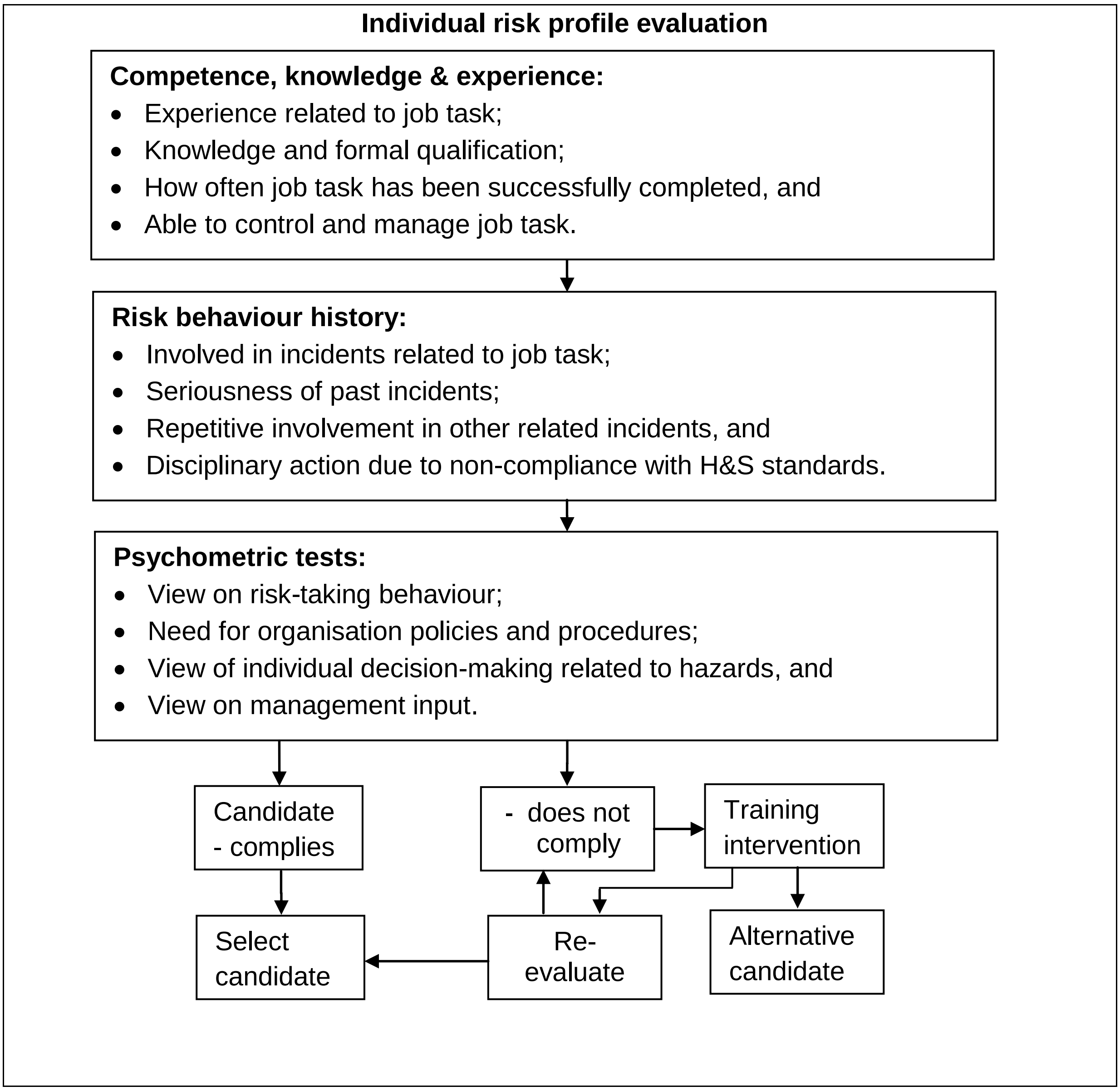

Figure 6.5 Individual risk profile evaluation flowchart

Figure 6.5 addresses the variables that need to be evaluated to develop a profile of the individual's risk behaviour.

The variables that need to be evaluated in order to determine an individual's tendency for high risk behaviour include: competency of the individual, a history profile of risk behaviour and specifically designed psychometric test evaluations.

6.4.2 The Model: Job task & individual profile matching

The most advantageous outcome of HR management is the recruitment and placement of candidates with a perfect profile 'fit' to a specific job category. Any risk to organisations from incorrect HR management practices should be limited by acceptable recruitment, placement and maintenance systems that will identify incorrect selection and behaviour in advance. Matching correct risk behaviour profiles to high risk tasks will need such requirements.

H&S risks, related to job tasks, as found in the literature review, requires correct evaluation and the creation of H&S standards and compliance with specific legislation to control the work environment in a way that will mitigate any hazards arising from risks related to a specific job task.

Matching the human risk behaviour profile intends to achieve the ultimate H&S goal of ensuring that correct candidate to risk behaviour profiles match specific risk related tasks. The outcome of which would be seen as lowering incident statistics.

6.4.2.1 The stages in the model

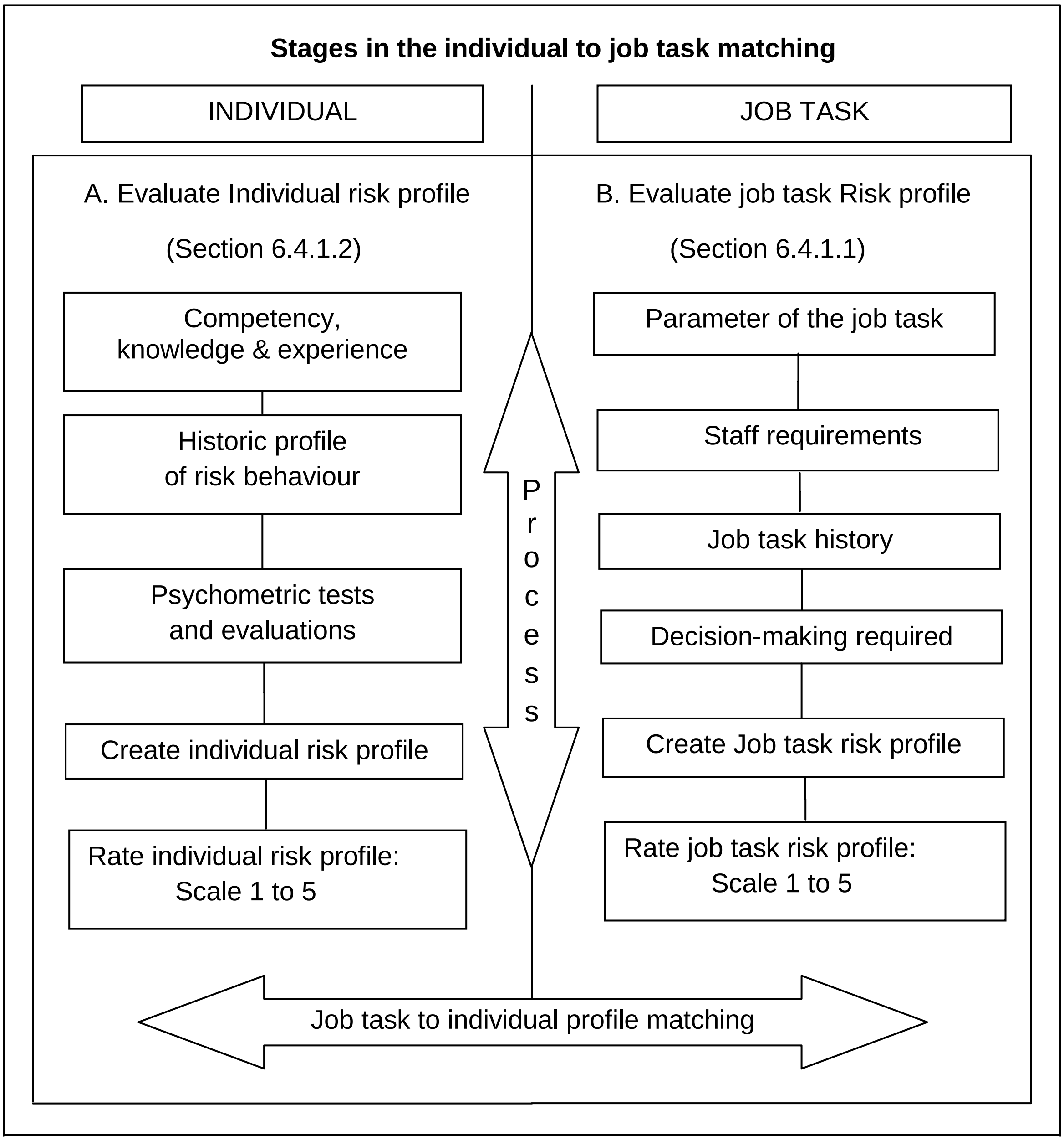

Figure 6.6 The Model: Job task to individual profile matching

The model for matching the individual risk behaviour profile to the risk rating of the job task (as described in Section 6.4.1.1) is presented in Figure 6.6. Values should be assigned for the various formulae according to the individual requirements of an organisation.

The practical aspects related to each stage of the model with the methods employed for analysis are discussed in detail in Section 6.5.

The next section proposes a rating index to be used for job task and individual profiling.

The data analysis techniques used satisfied the assumptions presented in the various sub problems presented.

6.5 RATING INDEX FOR JOB TASK AND INDIVIDUAL PROFILE

The aim of a risk rating for a job task to an individual profile is to obtain a mathematical index that will reflect the risk factor associated with each job task and the individual's risk profile that will afford the capacity for matching such profiles as per the proposed model in Figure 6.6. The rating index aims to quantify the values related to job tasks and individual profiles where such mathematical index will give better matching of the different profiles as presented in Figure 6.7.

BuŞe (2009) indicates that the recruitment of labour also takes into account the analysis of the job and the process of designing labour around the activities of the job task. The descriptions and specifications of the job tasks are essential in the staff recruitment process. This means that the person who recruits or hires has to have the necessary information regarding the characteristics of the job as well as the risk profile qualities of the future incumbent. In order to glean the information pertaining to risk-taking behaviour an evaluation method was developed for risk rating of job tasks and for individual risk behaviour profiling.

The aim of job task to individual risk profile matching is used for lowering risk to the organisation caused by unacceptable risk-taking behaviour in high risk tasks as indicated in the model proposed in Figure 6.6.

6.5.1 Application of job task to individual profile matching

Application of job task to individual profile matching		Acceptability
Individual risk behaviour profile	**Job task risk profile**	
Low	High	Optimum
	Average	Optimum
	Low	Optimum
Average	High	Acceptable
	Average	Optimum
	Low	Optimum
High	High	Unacceptable
	Average	Unacceptable
	Low	Acceptable

Figure 6.7 Application of job task to individual profile matching

The indication of acceptable risk exposure rated from optimum to acceptable to unacceptable as shown in Figure 6.7.

The job task to individual profile matching as shown in Figure 6.7 shows that optimum job to individual profile matching occurs with an index of low individual risk-taking behaviour to a high risk job task profile matching. An unacceptable matching would pose high risk in profile matching of high individual risk-taking behaviour to a high or average risk job task.

6.5.2 Rating index for job task

The rating index for job tasks, concentrate on four aspects according to parameters and training required; staff requirements and physical capability, the history of job task performance and the experience required for decision-making. Figure 6.7 provides a formula for a rating index for job tasks according to specific risk attributes of the job task where the value of the indexes will indicate the risk involved in performing a specific job task.

The higher the risk involved in the task the more stringent the requirements must be. The process of recruitment begins when new jobs are created in the organisation or when an existing designation becomes vacant due to transfer or retirement.

It starts with the detailed inventory of the needs, which is the job description, qualifications and necessary experience required for the job task (BuŞe, 2009). It is at this stage that a re-evaluation process of the job task in terms of the risk profile should be made.

The profile can be obtained by the following formula:

$$RIj = (Pj * w) + (Sj * w) + (Ej * w) + (Hj * w)$$

Figure 6.8 Rating index for job task

Description of symbols used

RIj - Rating Index for job task

Pj - Parameters and training required for job task

Sj - Staff requirements and physical capability for job task

Ej - Experience required for decision-making for job task

Hj - History of job task performance

w - Weight allocation

6.5.2.1 Weight allocation for variables

Variable	**Environment**	**Weight allocation**
P - Parameters and training required	High competency demand	High
	Average competency demand	Medium
	High competency demand	Low
H - History of job task performance	High competency demand	High
	Average competency demand	Medium
	High competency demand	Low
S - Staff requirements and physical capability	High competency demand	High
	Average competency demand	Medium
	High competency demand	Low
E - Experience required for Decision making	High competency demand	High
	Average competency demand	Medium
	High competency demand	Low

Figure 6.9 Weight allocation for variables

The weight allocated to each variable, as indicated in Figure 6.9, depends on the importance afforded due to the specific work environment.

6.5.2.2 Parameters on qualifications required (Pj)

Training received should value the qualifications required for the job task with a higher value rating according to related qualifications.

Qualifications required	Job task training time	Rating value
Degree or diploma	Less than 1 day	Low
Degree or diploma	2 days to 1 week	Medium
Degree or diploma	1 week to a month	High
Degree or diploma	A month or more	Very High
Certificate or trade required	Less than 1 day	Low
Certificate or trade required	2 days to 1 week	Medium
Certificate or trade required	1 week to a month	High
Certificate or trade required	A month or more	Very High

Figure 6.10 Parameters on qualifications required (Pj)

The importance of training in altering risk-taking behaviour and empowering individuals to make correct decisions requires a high weight rating of at least 20% (Figure 6.10).

6.5.2.3 Staff requirements and physical capability for job task (Sj)

Sensory capabilities	Fitness	Rating value
All senses required	Highly flexible and fit	Very High
All senses required	Moderate fitness	High
All senses required	Fitness not a requirement	Medium
Minor hearing impairment allowed	Moderate fitness	Low

Figure 6.11 Staff requirements and physical capability for job task (Sj)

Due to the low value that physical capacity will play in decision-making the weight allocated should be in the region of 15%, depending on the task.

Figure 6.11 portrays the possible physical requirements and the ‘ergonomical’ impact for workers to be:

- Highly flexible and fit (e.g. employee must be capable of climbing up steep poles and be flexible to work in harnesses from heights);
- Physically fit and have the endurance to work in uncomfortable situations for long periods, and
- Good sensory functioning – as evaluated by an Occupational Health Practitioner.

6.5.2.4 Experience required for decision-making in the job task (Ej)

Normally, the first question in qualifying a person's capability is to ascertain how much experience the person has. Generally, more years of experience may lead to the experience required before tasks may be performed and the employee has better-informed opinions. However, more recent training in certain specialties may be preferable, particularly where the field of knowledge is changing rapidly (Jay and Aletky, 2007).

Qualifications required	**Job task training time**	**Rating value**
Degree or diploma	Less than 1 day	Low
Degree or diploma	2 days to 1 week	Medium
Degree or diploma	1 week to a month	High
Degree or diploma	A month or more	Very High
Certificate or trade required	Less than 1 day	Low
Certificate or trade required	2 days to 1 week	Medium
Certificate or trade required	1 week to a month	High
Certificate or trade required	A month or more	Very High

Figure 6.12 Experience required for decision-making in the job task (Ej)

Experience and the impact of heuristic learning although providing the individual with the best base does not guarantee correct decision will be made and thus should not be afforded a weight index of more than 15% (Table 6.12).

6.5.2.5 Rating index for history of job task profiling (Hj)

Weight allocated to this section - out of 5 - is 1

$$Hj = (Y/2) \times (I^*) \times (S)$$

Figure 6.13 Rating index for history of job task profiling (Hj)

The rating value as shown in Figure 6.13 is calculated by means of the product of years the task has been performed by the amount of incidents by the seriousness of such incidents.

Description of symbols used.

Y - Years task has been performed. The time since the task was first performed by the incumbent for the organisation.

I - Incidents = how many incidents happened during this period.

S - Seriousness of the incident according to the following values.

6.5.2.6 Rating for seriousness of incidents

Seriousness of incident	Rating
Fatal	Very high
Permanent disability	High
Physician assistance required	Medium
First aid	Low
Minor scratch or burns	Very low

Figure 6.14 Rating for seriousness of incidents

As shown in Figure 6.14 ratings decrease as the severity of incidents decreases.

6.5.3 Rating index for individual risk behaviour profiling (RIi)

The rating of the individual risk behaviour profile is the sum of competency of the individual plus the history of risk-taking behaviour including task performance plus the outcome of specific psychometric tests.

$$RIi = (Hi * w) + (Pi * w) + (Ci * w)$$

Figure 6.15 Rating index for individual risk behaviour profiling (RIi)

Description of symbols used in figure 6.15.

RIi - Rating Index for individual risk behaviour profile.

Hi - History of individual incidents related to job task.

Pi - Psychometric testing of individual.

Ci - Competency of individual.

w - Weight allocation.

6.5.3.1 Weight allocation for variables of risk behaviour profiling

Variable	Environment	Weight allocation
Hi - History of incidents related to Job task	High competency demand	High
	Average competency demand	Medium
	High competency demand	Low
Pi - Psychometric testing of individual	High competency demand	Allocation determined by psychometric test developer
	Average competency demand	
	High competency demand	
Ci – Competency of individual	High competency demand	High
	Average competency demand	Medium
	High competency demand	Low
	Average competency demand	Medium

Figure 6.16 Weight allocation for variables of risk behaviour profiling

The weight allocated to each variable, as indicated in Figure 6.16, depends on the importance afforded due to the specific work environment

6.5.3.2 Rating index for history of risk behaviour profiling (Hi)

Cowett (2009) found that most organisations only look at experience, rather than the total profile of workers and what makes their existing people successful, and then explore these key criteria at the point of hire.

$$Hi = (Ni \times Ii \times We \times Wy)/2$$

Figure 6.17 Rating index for history of risk behaviour profiling (Hi)

Description of symbols used in Figure 6.17

Ni - Number of incidents involved in.

The number of incidents involved in relates to the amount and type of incidents that the incumbent have been involved in his work career.

Incidents per job category – if the person works half the period in admin and the other half in high risk technical environment, these should be evaluated separately and an average obtained.

Ii – Type of incident.

Seriousness of Incident	**Rating**
Fatal	Very high
Permanent disability	High
Physician assistance required	Medium
First aid	Low
Minor scratch or burns	Very low

Figure 6.18 Seriousness of incidents (Ii)

The type of incident the individual (Ii) has been involved in relates to the outcome of not only the incumbent, but also any other person involved in such an incident (Figure 6.18).

We – work environment

Work Environment	Rating
Industrial environment - requires various PPE	Very high
Outdoor environment - with PPE as required	High
Industrial environment - no PPE required	Medium
Outdoor environment - no PPE required	Low
Office environment - no PPE required	Very low

Figure 6.19 Work environment (We)

The work environment (We relates to the predominant work environment of the incumbent during his working career, related to the specific job task (Figure 6.19).

Wy – Years of work experience

Years of work experience	Rating
More than 10 years	Very high
More than 5 year less than 10 years	High
More than 1 year less than 5 years	Medium
Less than 1 year	Low
Less than 1 month	Very low

Figure 6.20 Years of work experience (Wy)

The years of work experience (Wy) gained in relation to the predominant work environment of the incumbent during his working career (Figure 6.20).

6.5.3.3 Psychometric testing (Pi)

Psychometric testing is useful in recruitment, but is only one part of the process of finding the right candidate (Lepper, 2009).

Dean (2008) cautions that psychometric tests should not be used as a substitute for other job selection techniques. Employers should not adhere slavishly to the results as, sometimes, more creative individuals and high-flyers do not score highly.

Dean (2008) states: “Tests should be used as part of a more rounded selection process. The most common mistake is to select tests or questionnaires that do not assess the right features.”

It is important that psychological assessment reports focus on specific abilities or concerns related to the work environment. There are countless people performing their jobs well although they may have depression, obsessive compulsive disorder or more severe mental illnesses, and one must remember that there are people who are dangerous and/or incompetent who display no psychiatric disorder (Jay and Aletky, 2007).

The basic areas of psychological tests are that measures should include general intelligence; cognitive functioning (e.g. attention, concentration, memory, and reasoning); personality; mood such as anxiety or depression; and existence of psychotic symptoms like delusions or hallucinations.

Some psychologists insert specific measures for malingering to gauge the subject’s truthfulness in self-reports and test responses. Psychologists should document both the actual test scores and their interpretation (Miller, 2007).

6.5.3.4 Formula for competency for risk behaviour profiling (Ci)

$$Ci = Tr + Tp + Ts$$

Figure 6.21 Formula for competency for risk behaviour profiling (Ci)

The formula for competency is presented in figure 6.21.

Tr - Time since training received for specific job task

Time since job task training received	Risk rating value
Less than 3 months ago since training received	Low
6 months ago since training received	Medium
1 year ago since training received	High
5 year ago since training received;	Very High

Figure 6.22 Time since training received for specific job task (Tr)

Figure 6.22 addresses the amount of time that has lapsed since the incumbent received training related to a job task.

Tp – Time since the job task was last performed

Time since job task last performed	Risk rating value
A week ago	Low
A month ago	Medium
A year ago	High
More than 5 years ago	Very High

Figure 6.23 Time since the job task was last performed (Tp)

Figure 6.23 provides a risk rating index for the time since the job task was last performed.

Ts - How often the same job task has been performed in the past.

Task performed successfully	Risk rating value
More than 50 times before	Low
More than 20 time before	Medium
More than 10 times before	High
More than 5 times before	Very High

Figure 6.24 Times that job task has previously been performed (Ts)

Figure 6.24 indicates how many times the same job task been successfully performed in the past.

6.6 SUMMARY

The variability in risk that human behaviour poses to organisations needs to be taken into account and managed in ways that can quantify the risk profiles of individuals. H&S management can no longer be seen as the management of environmental factors only, but must also take into account the critical component of individual behaviour. Such components relate to the capacity of influencing incident statistics, due to personal decisions made according to beliefs and psychological profiles. Organisations need to employ ongoing assessment processes in working towards and achieving set goals and targets. Such targets can only be achieved from lessons learned by previous incident experiences (Al-Qudah and Al-Momani, 2011).

The model proposed in Figure 6.6, ‘Job task to individual profile matching’, if implemented, provides an ideal opportunity for organisations to reduce incidents.

Chapter 7 which follows presents the conclusions and recommendations arising from the research.

CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

The purpose of this research was to explore the role and impact individual risk-taking behaviour has on H&S management systems with an emphasis on the electrical engineering environment.

The research problem stated in Chapter 1 was:

What role perception of risk has on individual risk-taking behaviour, and the influence such behaviour has on H&S management in the South African electrical engineering industry.

The research does not entail a psychological base, but rather an approach to management science with an emphasis on H&S, which not only concentrates on the subject of H&S, but also the disciplines of:

- Human resource management;
- The psychology of human behaviour;
- The electrical engineering environment, and
- The management of H&S.

The nine subsidiary questions necessary to conclude this research included:

- What role and influence can training have on individual risk-taking behaviour;
- Are electrical workers more prone to perceive hazards than others, whilst exposed to the same dangers in a working environment, and if so, could it be possible to find distinguishing characteristics that allow for the profiling of such worker segment of the electrical field;
- What influence and effect cultural diversity has on influencing risk-taking behaviour;
- What influence H&S legislation and H&S standards has on influencing and altering risk perception and risk-taking behaviour;
- What influence management competencies has on electrical incidents;

- Can management practices influence risk-taking behaviour and what effect such practices will have on electrical incidents;
- To determine if incentives and other advances promotes risk-taking behaviour;
- To determine if more stringent policing of H&S requirements will prevent risk-taking behaviour, and
- To determine what influence competencies in terms of experience and knowledge have on risk- taking behaviour.

The methodology employed for the research, in order to combine the collection and analysis of quantitative and qualitative data was of a mixed method research type. The research comprises of a review of appropriate literature, questionnaire surveys and case study analyses of specific electrical related incidents and a questionnaire survey of members of various organisations related to the electrical engineering fraternity.

7.2 FINDINGS OF THE SUBSIDIARY RESEARCH QUESTIONS

What role and influence training can have on individual risk-taking behaviour?

The influence of training in altering behaviour is achieved via the changed understanding of personal effect of taking specific risk when exposed to a hazard. The decision for correct action in either mitigating risks, or avoidance associated with a specific hazards, depends on knowledge obtained from heuristic learning processes, formal and informal training.

Are electrical workers more prone to perceive hazards than others, whilst exposed to the same dangers in a working environment, and if so, could it be possible to find distinguishing characteristics that allow for the profiling of such worker segment of the electrical field?

The environment of electrical work requires not only sensory perception, but specific knowledge and technology to identify risk factors of the scientific characteristics of electricity, resulting in a different perception of electrical hazards than other maintenance and construction workers. Profiling of the risk behaviour characteristics can be achieved as per the model developed.

What effect cultural diversity has on influencing risk-taking behaviour?

There is definitely a difference in cultural perception of risk. The cultural environment and transfer of beliefs related to specific risk affect the rating of such risk and transfer to specific identifiable behaviour of certain cultures.

Do H&S legislation and H&S standards have an influence in altering perception of risk and the impact on individual risk-taking behaviour?

The impact of H&S legislation and standards in altering and influencing risk perception is weak, as the bigger impacts on risk perception are achieved from heuristic learning experiences and training. The enforcement of penalties as a motivation have impacts, but not as a positive motivational factor.

What influence do management competencies have on electrical incidents?

Management competencies are viewed differently by workers and engineers, who are mostly in managerial capacities. With most injured workers indicating a low impact from management competencies to have an effect on incidents it is inconclusive whether or not management competencies have an influence on electrical incident statistics, but rather indicated bad management in the electrical industry.

Could management practices influence risk-taking behaviour? What effect do such practices have on electrical incidents?

Management practices of planning, leading, organising, and control should have a large impact on risk-taking behaviour. The views from engineering staff contradict that of electrical workers injured, again indicating incorrect management practices.

Do incentives and other gains promote risk-taking behaviour?

Incentives or other gains do have an impact in influencing risk-taking behaviour, as established during the literature survey. Electrical workers, due to their higher status of having more formal qualifications, are less influenced by financial or other gains to take specific risks that will compromise their H&S.

Will more stringent policing of H&S requirements lessen or prevent risk-taking behaviour?

Better and more stringent policing of H&S requirements will lessen and prevent risk taking behaviour as the fear of injury and penalties have a large impact on preventing high risk-taking behaviour.

What influence do competencies in terms of experience and knowledge have on risk-taking behaviour?

Increase in experience and knowledge afford electrical workers a better understanding of the risk factors that will affect their H&S. Such competencies provide workers with a better understanding of the scientific effect that exposure to electricity and electrical arcs will have on the human body. Such knowledge and the high potential for a fatal incident does not allow for high risk-taking behaviour.

7.3 SCHOLARY CONTRIBUTION TO KNOWLEDGE

The contribution of this research in adding to the body of knowledge of H&S management is in the identification of the high impact individual risk-taking behaviour has on accident causation. The development of a model of job task to risk behaviour profile matching provides the opportunity for H&S management to have a significant impact on reducing incident statistics.

7.4 FINDINGS OF THE MAIN RESEARCH QUESTIONS

An opinion survey was designed as discussed in Chapter 4, and conducted to determine what role perception of risk has on individual risk-taking behaviour and the influence such behaviour has on H&S management in the South African electrical engineering industry. The survey's aim was to substantiate issues that were identified in the literature survey and to expose additional issues related to the main and subsidiary questions.

The finding of the survey indicates that individual risk-taking behaviour of electrical workers is influenced by their perception of risk and has a direct impact on H&S management performance.

The impact of the individual's environment, culture, education and experience influences the perception of electrical workers in the manner they perceive risk and how hazards are approached, resulting in specific risk behaviour profiles.

An HR survey conducted among HR managers indicates the need for a model that can address human risk-taking behaviour that will result in lower incident levels.

7.4.1 Summary of the salient findings

The following summary in relation to the hypotheses presents the salient findings of the research:

- H&S management systems, due to their inherent design and interaction, do have an impact on individual risk behaviour profile;
- Knowledge and competency of a specific task are related to individual risk-taking behaviour patterns;
- H&S management systems, in the electrical engineering environment, do not address the aspect of individual risk-taking behaviour sufficiently;
- Management of human risk behaviour is not addressed in South African H&S legislation;
- Job task to risk behaviour profile matching is required for specific high risk tasks in the electrical engineering environment;
- Acknowledgement of the influence of cultural diversity on H&S management system performance needs to be made;
- Due to differences in individual risk perception, electrical construction and maintenance workers are exposed to different and more dangerous environmental factors;
- HR recruitment and HR maintenance systems have a need for systems that incorporate individual risk behaviour profile to job task matching in the correct selection of candidates for high risk job tasks, and
- Management and management systems have an influence and an effect on an individual's risk-taking behaviour.

7.5 THE RESEARCH PROPOSITION

The research proposition was explored through a literary study as well as an opinion questionnaire survey on case studies where the research proposition, that individual risk-taking behaviour is influenced by individual perception of risk and has a direct impact on H&S management system performance, was tested.

The findings indicate that differences in individual perception of risk are influenced by a variety of environmental, psychological personality traits and cultural factors, that each individual's risk behaviour profile differs and poses unique risk to organisations.

H&S management systems do not acknowledge or manage the risk posed by individual risk-taking behaviour.

The electrical construction and maintenance industry, due to their unique work environment, shows the need for knowledge rather than sensory capabilities to be able to analyse and do risk assessments, which requires a different approach to risk management than that of similar industries.

The contribution in adding to the body of knowledge of H&S management is in the identification of the high impact, individual risk-taking behaviour has in accident causation. The research and the ensuing model offers opportunities at HR management level to correctly allocate job tasks according to individual risk-taking behaviour profiles during recruitment and at performance appraisal stages. The impact on the approach to H&S management should be profound in that the current approach of managing environmental influences only and not taking cognisance of the human behaviour component will provide a different sphere in this specialised field with specific impact on the electrical engineering environment with a reduction of incidents.

7.5.1 Conclusions

The research elevated the need for H&S management to take cognisance of risk behaviour profiles and provide value to the understanding of the impact human risk-taking behaviour has on electrical incidents.

The model developed aims to provide an opportunity to reduce the number of electrical accidents experienced by electrical maintenance and construction workers.

The research highlighted the need for H&S management to take cognisance of risk-taking behaviour profiles and provide value to the understanding of the impact human risk-taking behaviour has on electrical incidents.

The research proves the value that the correct management of the human risk-taking behaviour component could add in the improvement of H&S management. The aim to quantify risk-taking behaviour profiles of individuals, as influence by various variables in the psychological make-up of such persons due to, inter alia, cultural, competence and knowledge would strengthen the proper management of such variable. The propose model addresses such risk taking behaviour profiles by linking high risk job tasks to specific individuals that endeavour to reduce incidents.

7.5.2 Recommendations for further research

It is recommended that further research be directed toward efforts to develop more specialised and quantifiable methods for the classification of human risk-taking behaviour profiles and to expand on the interaction of job task risk classifications.

Although overall consistencies were found in the literature survey, certain breeches were detected in that more literature is required in relation to the psychological impact of individual profiles in relation to H&S management. From the various observational literature studies and the empirical survey it can be deduced that human risk-taking behaviour in relation to H&S management requires psychological and HR expertise that any further studies should acknowledge and incorporate.

Regression analysis provides estimations for expected dependent variables where the independent variables, the questionnaire surveys, do not change and the target is to obtain a function of the independent variable namely the regression function.

Such regression analysis could indicate the causal relationship between the independent and dependant variables.

Due to misleading results that could be obtained from small sample regression analysis, such as linear regression, were not applied and will form part of future studies. Techniques for such regression of parametric and non parametric regression analysis relate to specific techniques depending on whether the functions are infinite dimensional or defined, will be explored.

7.6 CLOSURE

Human behaviour is complex and although individual profiles can be established, variables in psychological profiles are vast. The only reliable base for analysing and presenting quantifiable indices will be historical behaviour profiles coupled with developed psychometric testing.

The development of more quantifiable indexes to evaluate risk-taking behaviour and job task risk values should ultimately provide tools for limiting and lowering incident levels caused by human error, due to individual risk-taking behaviour, as a result of their perception of specific risk associated with a hazard.

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ANNEXURE I

PHASE 1 & 2

QUESTIONAIRE SURVEY

Structured questionnaire to engineering organisation's members

Please fax to 044 874 6992
or e-mail to admin@saftek.co.za or wdutoit@telkomsa.net
Post to PO Box 1880, George, 6530 or contact me on 082 820 7619.

PERCEPTION OF RISK IN
THE ELECTRICAL CONSTRUCTION AND MAINTENANCE INDUSTRY

1. On a scale of 1 (minor) to 5 (major), to what extent do you agree with the following statements?
(Please note the 'Unsure' option)

	Statement	**Unsure**	**Minor……………………..Major**				
			1	**2**	**3**	**4**	**5**
1.	The existence of ***H&S standards*** e.g. SANS 10142 ***influences*** electrical workers risk taking behaviour						
2.	***Unsafe behaviour*** in the electrical construction industry ***is the norm***						
3.	Current ***management practises***, of electrical construction projects ***does not promote safe*** behaviour						
4.	***The framework of legislation***, electrical installation and other related legislation e.g. the registration of electricians and the incorporation of H&S standards ***prevents risk taking behaviour***						
5.	If they can ***gain financially*** or be offered an incentive, then ***most electricians will perform unsafe tasks*** e.g. take risks related working on live electrical equipment or other unsafe acts						
6.	There is a clear ***difference between differing cultures*** of electrical construction workers in terms of perception of risk						
7.	Whilst exposed to the same dangers, different *electrical workers will perceive hazards differently* and accordingly act differently						
8.	Most electrical accidents are due to ***the incompetence of management*** in managing H&S						
9.	Because of their difference in perception of risk electrical workers' ***safe work procedures differ***						

10.	Management and ***management training is not the solution*** to risk taking behaviour of workers						
11.	***Better H&S legislation*** will alter risk perception of unsafe acts						
12.	***Management competency*** is directly related to individuals' perception of risk and risk taking behaviour						
13.	Better ***policing by government inspectors*** will prevent risk taking behaviour						
14.	Better and ***more training*** of electrical construction workers ***will increase their perception of electrical risk*** and alter their risk taking behaviour						

2. Do you have any comments in general regarding electrical construction workers' perception of risk and their risk taking behaviour?

____

____

____

____

Please record your details below to facilitate contacting you, in the event of any further queries. Please note that all data provided will be treated in strict confidence. Should you however wish not to divulge your details please complete and either fax to 044 8732235 or 8746992 or e-mail to admin@saftek.co.za or wdutoit@telkomsa.net. Post to PO Box 1880, George, 6530 or contact me on 082 820 7619.

NAME: ________________________ PHONE: ________________________

ORGANISATION: ________________________ FAX: ________________________

ADDRESS: ________________________ MOBILE: ________________________

____

____

ANNEXURE II

PHASE 1 & 2

RESULTS OF QUESTIONAIRE SURVEY

Results of questionnaire survey to members of engineering organisations

Principle questionnaire to engineers

R = Respondents from Organisations

ICMEE	Institute of Certificated Mechanical and Electrical Engineers of South Africa
SAIEE	South African institute of Electrical Engineers
AMEU	Association of Municipal Electrical Undertakers
ECA(SA)	South African Electrical Contracting Association
SAFHE	South African Federation of Hospital Engineers

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 1	ICMEE	4	5	4	5	5	4	4	4	4	4	5	5				145	12	4.42
	SAIEE	5	4	4	5	4	3	4	5									8	4.25
	AMEU	4	3	4	4	3	4	3	3								30	8	3.50
	SAFHE	5	5	5	3	5	4	4	5	4	5						42	10	4.50
	ECA(SA)	3	4	5	5	4	5	5	4	4	4	4					450	11	4.27

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 2	ICMEE	2	4	5	4	5	3	3	5	3	3	5	3				145	12	3.75
	SAIEE	5	3	4	5	4	4	3	4									8	4.00
	AMEU	4	2	3	3	2	3	5	2								30	8	3.00
	SAFHE	2	4	3	5	3	4	5	3	4	4						42	10	3.70
	ECA(SA)	3	5	4	3	3	5	4	4	5	3	5					450	11	4.00

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 3	ICMEE	4	3	4	5	4	5	4	4	4	5	4	5				145	12	4.25
	SAIEE	4	5	3	4	3	4	5	5									8	4.13
	AMEU	4	4	2	3	1	2	1	3								30	8	2.50
	SAFHE	2	3	3	3	4	2	4	3	1	3						42	10	2.80
	ECA(SA)	4	4	3	5	4	5	3	5	4	5	4					450	11	4.18

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 4	ICMEE	3	2	3	3	2	3	4	3	4	3	3	3				145	12	3.00
	SAIEE	4	3	3	2	4	3	3	2									8	3.00
	AMEU	4	5	4	5	4	4	5	5								30	8	4.50
	SAFHE	5	4	3	4	4	4	2	3	4	3						42	10	3.60
	ECA(SA)	4	3	3	2	3	2	3	4	2	2	5					450	11	3.00

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 5	ICMEE	2	2	3	4	3	5	3	5	2	2	3	4				145	12	3.17
	SAIEE	3	3	1	2	3	2	1	3									8	2.25
	AMEU	1	4	2	3	2	1	2	3								30	8	2.25
	SAFHE	3	2	3	3	4	5	4	3	5	3						42	10	3.50
	ECA(SA)	3	2	1	3	2	2	2	2	3	3	2					450	11	2.27

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 6	ICMEE	4	4	5	3	4	5	3	4	3	2	2	4				145	12	3.58
	SAIEE	4	4	3	2	3	2	3	3									8	3.00
	AMEU	3	3	2	3	2	3	4	4								30	8	3.00
	SAFHE	3	4	4	4	3	4	3	4	4	5						42	10	3.80
	ECA(SA)	3	3	2	3	3	1	4	3	3	4	4					450	11	3.00

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 7	ICMEE	3	4	3	2	3	1	2	2	4	3	2	3				145	12	2.67
	SAIEE	2	1	3	3	2	4	4	3									8	2.75
	AMEU	3	4	1	3	4	2	1	2								30	8	2.50
	SAFHE	4	3	4	3	5	4	3	4	4	3						42	10	3.70
	ECA(SA)	4	3	2	3	2	3	1	2	3	3	4					450	11	2.73

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 8	ICMEE	3	4	3	4	1	3	2	3	2	4	3	4				145	12	3.00
	SAIEE	4	5	4	2	3	3	3	4									8	3.50
	AMEU	3	2	1	2	2	3	2	3								30	8	2.25
	SAFHE	3	3	3	3	4	3	2	4	4	3						42	10	3.20
	ECA(SA)	4	3	4	3	4	3	4	5	3	3	3					450	11	3.55

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 9	ICMEE	3	4	1	2	4	2	3	2	3	2	3	3				145	12	2.67
	SAIEE	2	3	4	3	3	3	5	4									8	3.38
	AMEU	0	1	0	2	1	1	1	2								30	8	1.00
	SAFHE	1	1	2	3	2	1	2	3	3	2						42	10	2.00
	ECA(SA)	5	2	4	3	4	3	3	2	3	4	4					450	11	3.36

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question 10	ICMEE	4	1	3	2	3	2	2	1	2	1	2	1				145	12	2.00
	SAIEE	3	2	2	1	0	2	1	3									8	1.75
	AMEU	2	3	1	0	1	2	1	2								30	8	1.50
	SAFHE	3	0	3	2	3	2	3	3	4	2						42	10	2.50
	ECA(SA)	3	1	2	2	0	2	2	1	2	1	3					450	11	1.73

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question	ICMEE	3	1	4	2	2	2	5	2	4	3	1	3				145	12	2.67
11	SAIEE	3	4	2	3	4	2	3	1									8	2.75
	AMEU	3	2	2	1	3	4	2	1								30	8	2.25
	SAFHE	5	4	4	5	4	3	3	4	4	4						42	10	4.00
	ECA(SA)	4	3	2	1	2	1	3	3	4	4	3					450	11	2.73

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question	ICMEE	3	2	0	1	1	2	2	3	1	3	2	4				145	12	2.00
12	SAIEE	3	2	2	3	3	1	3	1									8	2.25
	AMEU	2	0	1	2	3	3	1	2								30	8	1.75
	SAFHE	4	3	3	3	2	4	3	3	5	3						42	10	3.30
	ECA(SA)	2	2	2	1	3	2	3	3	1	2	4					450	11	2.27

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question	ICMEE	1	2	4	3	2	3	2	2	1	2	3	3				145	12	2.33
13	SAIEE	2	3	1	2	2	4	3	1									8	2.25
	AMEU	2	1	2	1	0	1	2	1								30	8	1.25
	SAFHE	3	3	2	2	3	2	3	1	2	1						42	10	2.20
	ECA(SA)	1	3	2	2	2	2	1	3	2	4	3					450	11	2.27

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Stratum	Response	Mean
Question	ICMEE	1	2	3	2	3	2	1	2	0	2	1	2				145	12	1.75
14	SAIEE	2	2	1	2	3	1	2	3									8	2.00
	AMEU	1	2	1	0	1	2	3	2								30	8	1.50
	SAFHE	3	2	3	0	2	1	2	2	2	1						42	10	1.80
	ECA(SA)	2	2	3	2	2	2	2	1	1	3	2					450	11	2.00

ANNEXURE III

PHASE 3 & 4

QUESTIONAIRE SURVEY

Structured questionnaire to incumbents of incident case studies

Please fax to 0866910442 **or e-mail to wdutoit@saftek.co.za or wdutoit@telkomsa.net** **Post to PO Box 1880, George, 6530 or contact me on 082 820 7619.**

QUESTIONARE SURVEY
Eskom - Distribution

This questionnaire survey is part of a research to improve Health and Safety (H&S) Management. Please spend your valuable time to complete this questionnaire. Your input is very important to improve Health and Safety and make Eskom safer for everybody.

This questionnaire was completed by

The injured	Supervisor	Assistant (colleague)

INSTRUCTIONS

- The questionnaire should be filled in with reference to the attached incident
- Please complete all questions
- Complete the questionnaire by placing a tick in the appropriate block or by responding as the question may indicate
- Note the 'Unsure' response blocks
- The questionnaire should be completed by the injured and the supervisor at the time of the incident. Please indicate same above.

PART 1: DEMOGRAPHICS

1: Incident

Referring to the attached incident please provide the following details at the time of the incident

Date of incident	
Injured	
Supervisor	
Place	
Building, equipment or plant involved	
Description- indicate if you agree with attached description	

2: Qualifications

My formal qualification:

Professional registration, or an M or D degree	
Diploma/ First and honours degree	
Qualified Trades person	
Secondary School / Grade 12 and other Certificate	
Primary school / or No schooling	

3: Work experience

In relation to the incident Job task I have ……. year's experience:

More than 20yrs	
More than 10 yrs less than 20yrs	
More than 5 yrs less than 10yrs	
More than 1 yrs less than 5yrs	
Less than 1 year	

4: Task skills

The task(s) involved in the incident were

Learned from experience after a similar incident	
Learned from observation	
Learned from repetitive processes	
Learned from trial and error	
Learned task during formal training (formal and informal education)	

5: Specific training received

The task involved in the incident is part of the curriculum of a

Degree or Diploma	
Formal Certificate	
Formal training course 2 to 5 days	
1 hr to 1 day in class training	
Onsite training before task, maximum 1 hr.	
Not part of any qualification	

6: Experience per specific job/ task

I have performed the task related to the incident

Performed task on numerous occasions past 10 years	
Performed task more than 20 time before	
Performed task more than 5 time before	
Performed task only once before	
Never before the incident	

PART 2: RISK BEHAVIOUR

1: Profile

Apart from the incident in discussion have you previously been involved in other work related accidents?

Involved in serious fatal incidents or debilitating injury	
Involve in more than 4 incidents since employment	
Involve in more than 2 less than 4 incidents since employment	
Involved in less than 1 previous incidents since employment	
Not involved in any previous incident or near misses	

2: Disciplinary procedures

Were you ever involved or were you previously:

Dismissed due to work related incident	
Involved in more than 5 disciplinary actions or convictions	
Involved in less than 5 disciplinary hearings or convictions	
Involved in less than 2 disciplinary hearings or convictions	
No previous disciplinary action taken or convictions	

PART 3: OPERATIONAL

On a scale of 1 (minor) to 5 (major), to what extent do you agree with the following statements?

(Please note the 'Unsure' option)

	Statement	**Unsure**	**Minor……………………..Major**				
			1	**2**	**3**	**4**	**5**
	1: H&S SYSTEM						
1	H&S management is a separated entity that should be managed on its own.						
2	The current Eskom H&S management system does not take into account the unique South African environment of diverse cultures.						
3	There is no need for operational staff to get involved in H&S management.						

	2: MANAGERIAL INFLUENCE						
1	I continually receive appropriate feedback about my performance in relation to H&S performance.						
2	I am encouraged by my colleagues to report any H&S concerns I may have.						
3	Top management know the least about the H&S environment of workers.						
	3: MOTIVATION						
1	I am proud to work for Eskom.						
2	I am satisfied with my job. Eskom is a good place to work for.						
3	I feel healthy and safe doing any task because of the extensive H&S management system Eskom implemented.						
4	Errors are handled appropriately by immediately punishing the culprits.						
	4: PERCEPTION OF HAZARDS						
1	I did not perceive the task related to the incident to be dangerous.						
2	There is no consensus between employees if certain actions, related to tasks, are dangerous.						
3	In relation to the incident, if exposed to the same scenario, I would do exactly the same.						
4	Most of Eskom's employees involved in construction or maintenance understand the concepts of risk and risk mitigation.						
	5: PRODUCTIVITY						
1	When my workload becomes excessive, my performance is impaired.						
2	Training for H&S is seen as a luxury and to have time off from work.						
3	H&S policy and procedures are not practical and are ignored to get the job done sooner.						
4	H&S is a hindrance to productivity and the indirect cause job task take so long to complete.						

	6: OPERATIONAL						
1	Eskom's approach to H&S management of construction activities is the same way they manage maintenance activities.						
2	Eskom engineers, technicians, and artisans work well together, as a well-coordinated team, resulting in limited accidents.						
3	The incident was partly caused by external pressure to complete the task sooner or to a higher standard.						
4	Incentive schemes (time of, monetary etc) were contributory causes to the incident.						
5	The more detailed H&S documents are the healthier and safer a job task would be.						
	7: INTERVENTION						
1	There is no written work procedures for every aspect of the task involved in the incident.						
2	I have never seen an H&S plan.						
3	It is difficult to discuss errors I made with anybody in Eskom.						
4	H&S managers are rarely part of daily operational activities and do not understand engineering processes.						
5	I know the proper channels to direct questions regarding H&S.						
6	The culture in Eskom makes it easy to learn from the errors of others.						
7	Eskom management, does not knowingly, compromise the H&S of employees and contractors.						
8	More training is the answer to accident prevention.						
9	H&S appointments are important to identify who is responsible for what and to know who to prosecute in case of a serious incident.						
	8: INFLUENCES						
1	My mental state of mind or fatigue impairs my performance during urgent maintenance repairs or similar situations.						

2	Electrical incidents are caused by employees that do not understand the basic principles (e.g. voltage potential, induction, equal potential etc).						
3	H&S departments are contributing to incidents due to the falls view created that they can control all H&S aspects.						
4	I am more likely to make errors in tense or hostile situations.						
	9: INDICATORS						
1	Most incidences on site are due to incorrect application of site H&S and operational plans.						
2	The same incident will happen again because too much reliance is made on employees own judgment.						
3	Continuous feedback on incident statistical analysis helped to prevent similar incidents from happening again.						

2. Do you have any comments in general regarding H&S management related to Eskom's activities?

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Please record your details below to facilitate contacting you, in the event of any further queries. Please note that all data provided will be treated in strict confidence. ***Should you however wish not to divulge your details please complete*** and either fax to 044 8732235 or 8746992 or e-mail to admin@saftek.co.za or wdutoit@telkomsa.net Post to PO Box 1880, George, 6530 or contact me on 082 820 7619.

NAME: ____________________ PHONE: ____________________

ADDRESS: ____________________ FAX: ____________________

____________________ E-MAIL: ____________________

____________________ MOBILE: ____________________

Please fax to 044 873-6992
or e-mail to wdutoit@saftek.co.za or wdutoit@telkomsa.net
Post to PO Box 1880, George, 6530 or contact me on 082 820 7619.

QUESTIONNAIRE SURVEY ON:

PERCEPTION OF RISK

IN THE ELECTRICAL CONSTRUCTION AND MAINTENANCE INDUSTRY

The individual's perception of risk affects their risk-taking behaviour in either accepting or rejecting tasks with variable levels of risk involved.

2. On a scale of 1 (minor) to 5 (major), to what extent do you agree with the following statements?
(Please note the 'Unsure' option)

	Statement	**Unsure**	**Minor……………………..Major**				
			1	**2**	**3**	**4**	**5**
1.	The existence of H&S standards, (e.g. SANS 10142) influence electrical workers' risk-taking behaviour.						
2.	Unsafe behaviour in the electrical construction industry is the norm.						
3.	Current management practices of electrical construction projects does not promote healthy and safe human behaviour						
4.	The framework of legislation, electrical installation and other related legislation (e.g. the registration of electricians and the incorporation of H&S standards), prevents risk-taking behaviour.						
5.	If they can gain financially or be offered an incentive, then most electricians will perform unsafe tasks (e.g. take risks related to working on 'live' electrical equipment or other unsafe acts.						
6.	There is a clear difference between differing cultures of electrical construction workers in terms of perception of risk.						
7.	While exposed to the same dangers, different electrical workers will perceive hazards differently, and accordingly act differently.						

8.	Most electrical accidents are due to the incompetence of the management in managing H&S.						
9.	Because of their different perception of risk, electrical worker's H&S work procedures differ.						
10.	Management and management training is not the solution to risk-taking behaviour of workers.						
11.	Better H&S legislation will alter risk perception of unsafe acts.						
12.	Management competency is directly related to individuals' perception of risk and risk-taking behaviour.						
13.	Better policing by government inspectors will prevent risk-taking behaviour.						
14.	Better and more training of electrical construction workers will increase their perception of electrical risk and alter their risk-taking behaviour.						

Do you have any comments in general regarding electrical construction workers' perception of risk and their risk-taking behaviour?

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Please record your details below to facilitate contacting you, in the event of any further queries. Please note that all data provided will be treated in strict confidence. ***Should you however wish not to divulge your details please complete*** and either fax to 044 8732235 or 8746992 or e-mail to admin@saftek.co.za or wdutoit@telkomsa.net Post to PO Box 1880, George, 6530 or contact me on 082 820 7619.

NAME: _________________________ PHONE: ____________________

ADDRESS: _____________________ FAX: ______________________

_____________________ E-MAIL: ____________________

_____________________ MOBILE: ____________________

Specific Questionnaire			
Accident #:			
Date:			
Respondent's Name:			
Position:			
Q	**Questions**	**Yes or No**	**Other**
1.	Have you ever gambled?	Y / N	
2.	Have you gambled for financial gain this year?	Y / N	
3.	Have you ever been in trouble for gambling?	Y / N	
4.	Have you accidently hurt yourself in the past year (cuts / bruises)?	Y / N	
5.	Do you often injure yourself whilst performing a task at work?	Y / N	
6.	Have you ever been in a motor car accident where you were the driver?	Y / N	
7.	Have you been in more than one accident this year?	Y / N	
8.	Have you received more than one speeding fine in the past year?	Y / N	
9.	Do you believe to keep to the speed limit?	Y / N	
10.	What is your cultural background?		A / B / C / W
11.	What is your culture's attitude towards taking risks?		Hi / M / Lo
12.	Would you take a chance if you could complete a job task faster?	Y / N	
13.	Do you believe in all of Eskom's policies and procedures in terms of H&S?	Y / N	
14.	Who do you think is responsible for accidents 1. Workers and / or 2. Management and / or 3. Bad or incorrect H&S systems		1 / 2 / 3

15.	Do you believe in all the laws of South Africa.	Y / N	
16.	If not, why not? (Not fair to all).	Y / N	
17.	Do leaders (management and / or civil servants) set good examples to follow the rules?	Y / N	
18.	Are you influenced by their behaviour?	Y / N	
19.	Would you report unsafe / hazardous behaviour?	Y / N	
20.	Is there a difference in an unsafe act at home or at work?	Y / N	
21.	Would you be more inclined to take risks in an unsafe act at home, rather than at work	Y / N	
22.	What motivates you not to take part in an unsafe act? 1. Fear of penalty 2. Fear of injury 3. Both		1 / 2 / 3
23.	Should we take calculated risks in our lives?	Y / N	
24.	Can we take risks at work in terms of H&S?	Y / N	

ANNEXURE IV

RAW DATA

Results of questionnaire survey for incident case studies

Principle questionnaire survey - Eskom - Perception of risk

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q	Eskom Injured	3	0	3	2	5	5								12	6		3.00	4=
1	Eskom Supervisors	3	5	3	4	3	1	5	5	3	4	5	3	3	15	13		3.62	5
															27	19	Mean	3.31	5

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q	Eskom Injured	2	3	5	4	2	5								12	6		3.50	3=
2	Eskom Supervisors	3	2	4	2	3	2	5	3	4	3	2	4	4	15	13		3.15	6
															27	19	Mean	3.33	4

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q	Eskom Injured	3	1	3	1	3	0								12	6		1.83	9
3	Eskom Supervisors	1	1	3	1	1	1	1	1	3	3	1	3	3	15	13		1.77	12
															27	19	Mean	1.80	14

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q	Eskom Injured	3	1	3	5	5	5								12	6		3.67	2=
4	Eskom Supervisors	1	4	3	1	1	1	5	4	3	3	4	3	3	15	13		2.77	8
															27	19	Mean	3.22	6

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q	Eskom Injured	3	1	2	5	1	1								12	6		2.17	7
5	Eskom Supervisors	4	5	1	4	4	1	1	1	1	4	5	1	1	15	13		2.54	9
															27	19	Mean	2.35	11

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q 6	Eskom Injured	5	1	1	5	3	1								12	6		2.67	5
	Eskom Supervisors	5	1	5	4	5	5	1	1	5	5	1	5	5	15	13		3.69	4
															27	19	Mean	3.18	7

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q 7	Eskom Injured	5	1	3	5	3	5								12	6		3.67	2=
	Eskom Supervisors	5	5	2	5	5	5	5	1	2	5	5	2	2	15	13		3.77	3
															27	19	Mean	3.72	2

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q 8	Eskom Injured	2	2	1	1	1	5								12	6		2.00	8
	Eskom Supervisors	1	1	4	1	1	1	1	1	4	1	1	4	4	15	13		1.92	11=
															27	19	Mean	1.96	13

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q 9	Eskom Injured	3	1	3	1	1	1								12	6		1.67	10
	Eskom Supervisors	3	1	4	1	3	1	5	1	4	5	1	4	4	15	13		2.85	7
															27	19	Mean	2.26	12

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q 10	Eskom Injured	2	2	3	1	5	1								12	6		2.33	6
	Eskom Supervisors	5	1	5	5	5	5	5	5	5	5	1	5	5	15	13		4.38	2
															27	19	Mean	3.36	3

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q 11	Eskom Injured	2	0	1	5	5	5								12	6		3.00	4=
	Eskom Supervisors	1	1	1	1	1	5	5	5	1	1	1	1	1	15	13		1.92	11=
															27	19	Mean	2.46	10

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q	Eskom Injured	4	1	1	5	5	5								12	6		3.50	3=
12	Eskom Supervisors	1	5	1	1	1	5	1	5	1	3	5	1	1	15	13		2.38	10
															27	19	Mean	2.94	8

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q	Eskom Injured	5	1	1	5	5	5								12	6		3.67	2=
13	Eskom Supervisors	1	1	1	1	1	1	5	5	1	1	1	1	1	15	13		1.62	13
															27	19	Mean	2.64	9

		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	Stratum	Response	Mean	test	Rank
Q	Eskom Injured	3	4	5	5	5	5								12	6		4.50	1
14	Eskom Supervisors	4	5	5	1	4	5	5	5	5	5	5	5	5	15	13		4.54	1
															27	19	Mean	4.52	1

Specific questionnaire

Quest. #	**Questions posed**	**Supervisor Results**			**Injured Results**		
		No	**Yes**	**Tot**	**No**	**Yes**	**Tot**
Q01	Have you ever gambled?	4	9	13	1	5	6
Q02	Have you gambled for financial gain, this year?	13	0	13	5	1	6
Q03	Have you experienced trouble or difficulties due to gambling?	13	0	13	6		6
Q04	Do you injure yourself often at work?	10	3	13	3	3	6
Q05	History of more than one incident involvement at work?	13	0	13	6		6
Q06	Have a history of motor vehicle accidents as driver?	3	10	13	2	4	6

Q07	Have you been involved in more than one car accident?			2		11		13					6		6
Q08	Have you received speeding fines?			1		12		13			1		5		6
Q09	Do you believe in keeping the speed limit?			1		12		13			1		5		6
Q10	Cultural Background (European)	**BF**	**BM**	**CF**	**CM**	**WF**	**WM**		**BF**	**BM**	**CF**	**CM**	**WF**	**WM**	
		1	3				9	13		4		1		1	6
Q11	What is your cultural attitude to taking calculated risks?		**Lo**	**-**	**Med**	**-**	**Hi**			**Lo**	**-**	**Med**	**-**	**Hi**	
			5		6		2	13		5		1			6
Q12	Would you take a calculated risk?		**No**		**Calc**		**Yes**			**No**		**Calc**		**Yes**	
			9		3		1	13		5		1			6
Q13	Do you believe in all H&S policies and procedures?		**No**		**Most**		**All**			**No**		**Most**		**All**	
			2		0		11	13		1		1		4	6

		1	**1&2**	**2**	**2&3**	**3**	**All**		**1**	**1&2**	**2**	**2&3**	**3**	**All**	
Q14	Who is responsible for accidents? 1. Workers 2. Management 3. H&S system	9	2				2	13	5				1		6
			No		**Most**		**All**			**No**		**Most**		**All**	
Q15	Do you believe in all the laws of South Africa?		13		0		0	13		2		2		2	6
Q16	Do you believe the laws are fair to all?		13		0		0	13		2		2		2	6
		U	**-**	**No**	**-**	**Yes**		**Tot**	**U**	**-**	**No**	**-**	**Yes**		**Tot**
Q17	Do management & civil servants set a good example?			13		0		13	1		4		1		6
Q18	Are you influenced by management behaviour?			11		2		13			3		3		6
Q19	Would you report unsafe behaviour?			0		13		13			1		5		6
Q20	Do you believe there is a difference between an unsafe act at home and at work?			13		0		13					6		6

Q21	Would you be more inclined to take a risk at home rather than at work?	12	1		13	1	5		6
		P	**I**	**Both**		**P**	**I**	**Both**	
Q22	Does fear of penalty or fear of injury or both prevent you from taking part in an unsafe act?	0	12	1	13	0	4	2	6
		No	**Yes**			**No**	**Yes**		
Q23	Should we take calculated risks in our lives?	7	6		13	4	2		6
		No	**Yes**			**No**	**Yes**		
Q24	Can we take risks at work?	13	0		13	6	0		6

ANNEXURE V

ESKOM INCIDENT DESCRIPTIONS

Incident descriptions

Date	Incident Number	Incident Description
2009/08/07	1	Employee removed 380V fuses on380V busbars when a flash occurred and he obtained first degree burns to his face.
2009/09/14	2	The employee was injured while attempting to repair a burned off neutral on aerial bundle conductor that became alive through an 11kv line that touched the structure.
2009/10/19	3	Employee opened the pillar box, a flash occurred, injuries on both hands.
2009/11/13	4	During cable fault finding on a T4 switch an employee tried to remove insulation around the cable which was inside cable box when a flash occurred.
2009/12/02	5	During stormy conditions while responding to a fault where Tahiti substation was shut down, a Senior Technical Official was in the process of returning the substation to normal when the one breaker failed to close and on wrecking out a flash occurred.
2009/12/10	6	Employees trenched to open a cable to repair a fault. Two cables were found on top of each other with visible damage to both cables. The suspected cable was isolated to work on. While working a flash occurred
2010/02/07	7	While performing strap phasing in the substation between the Eskom and Municipality equipment, there was back feeding from the customer breaker that caused the equipment to be alive when a flash-over occurred.
2010/05/02	8	While replacing a 63 Amps LV circuit breaker the live conductor from one phase made contact with the stubby box then flash occurred.
2010/05/07	9	While an employee was attempting to apply portable earths to a live transformer, a flash occurred which burnt his shoes and trousers causing burns to his knee.
2010/06/01	10	While the authorised person was applying earths to the network another employee that was not authorised attempted to energise a feeder cable.

2010/07/13	11	While the TSC operator was busy isolating the mini-sub, the TSG team leader started disconnecting the cable ends from-the mini-sub and made contact with the live apparatus.
2010/11/16	12	While connecting a conductor for a new customer under live work conditions, the employee was testing if conditions, the employee was testing if the jumper was secured when a flash occurred that was caused by a puncture in the live work glove.
2010/11/16	13	While working on a mini-sub the Technical Official opened the high voltage side of the mini-sub to work in when he made contact with the live apparatus.
2011/01/01	14	The pole structure has two cable feeders and isolating points which were not labelled. During the isolating process in preparation to repair a cable fault, the correct cable was not isolated and earthed. While the team from TSG was busy with the cable repair, the operating was done from Control to normalise the network while they were under the impression that the correct cable was isolated and earthed. This resulted in the energising of the feeder that the TSG team was working on.
2011/01/01	15	The pole structure has two cable feeders and isolating points which were not labelled. During the isolating process in preparation to repair a cable fault, the correct cable was not isolated and earthed. While the team from TSG was busy with the cable repair, the operating was done from Control to normalise the network while they were under the impression that the correct cable was isolated and earthed. This resulted in the energising of the feeder that the TSG team was working on.

ANNEXURE VI

PHASE 5

QUESTIONAIRE SURVEY

Structured questionnaire to HR managers

Please fax to 044 873-6992
or e-mail to wdutoit@saftek.co.za or wdutoit@telkomsa.net
Post to PO Box 1880, George, 6530 or contact me on 082 820 7619.

QUESTIONNAIRE SURVEY ON:

Risk taking behaviour profiling in employee selection

Part of a Health and Safety survey study

This questionnaire survey is part of a research to improve Health and Safety (H&S) Management. Please spend your valuable time to complete this questionnaire. Your input is very important to improve Health and Safety.

3. On a scale of 1 (minor) to 5 (major), to what extent do you agree with the following statements?
(Please note the 'Unsure' option)

	Statement	**Unsure**	**Minor……………………..Major**				
			1	**2**	**3**	**4**	**5**
1.	Human behaviour risk analysis should form an important part of a job applicant's evaluations.						
2.	History of risk taking behaviour can be analysed to form part of job applicant's interview analysis.						
3.	Job task - employee profile matching should be standard for high risk engineering tasks.						
4.	It will be possible to match correct candidates to their risk profile for specific job task.						
5.	There is definitely a difference in each individual's risk taking behaviour profile.						
7.	Psychometric test during job interviews should incorporate values that can identify risk behaviour tendencies of individuals.						

8.	I would welcome a model that can be incorporated and used in job interviews for the correct selection of employees that will lower incidents due to risk taking behaviour.						
9.	Continuous employee evaluations need to be made according to incident profiles for adjustments in Job task allocations.						

Do you have any comments in general regarding individual risk behaviour profiling and job task matching?

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Please record your details below to facilitate contacting you, in the event of any further queries. Please note that all data provided will be treated in strict confidence. ***Should you however wish not to divulge your details please complete*** and either fax to 044 8732235 or 8746992 or e-mail to admin@saftek.co.za or wdutoit@telkomsa.net. Post to PO Box 1880, George, 6530 or contact me on 082 820 7619.

NAME: ________________________ PHONE: ________________________

ORGANISATION: __________________ FAX: ________________________

ADDRESS: ______________________ MOBILE: ________________________

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