AN INTEGRATED HEALTH, SAFETY AND ENVIRONMENTAL RISK ASSESSMENT MODEL FOR THE SOUTH AFRICAN GLOBAL SYSTEMS MOBILE TELECOMMUNICATIONS (GSM) INDUSTRY

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The past is a rich resource on which we can draw in order to make decisions for the future, but it does not dictate our choices. We should look back at the past and select what is good, and leave behind what is bad.

Nelson Mandela (1918 –)

To my son Jaco

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ABSTRACT

More than one billion people, almost one in six of the world's population, are now using GSM mobile phones.

The situation in South Africa is no different from that in the rest of the world. The rise of mobile telephone usage in South Africa has been driven by a combination of factors such as demand, sector reform, the licensing of new competition, and the emergence of major strategic investors, such as Vodacom and MTN.

It was estimated that by March 2005 there should be approximately 20 million cellular customers in South Africa. The growth in the South African cellular market is proportionate to the potential risks in an environment where organisations are continuously seeking ways of improving efficiency, cutting costs, and staying abreast of technological advances.

Elements of risk control such as Safety, Health, and Environmental Management can no longer be left out of the equation while organisations in the GSM industry are considering increasing their networks to meet the demands of growth. Although risk assessments are not specifically defined in the Occupational Health and Safety Act (85 of 1993); Section 8 does, however, stipulate under the general duties of the employer that the employer must establish, as far as is reasonably practicable, which hazards to the health or safety of persons are attached to any work which is performed.

This situation has changed with the promulgation of the Construction Regulations, GNR.1010 on 18 July 2003; which state that every contractor performing construction work shall, before the commencement of any construction work and during construction work, cause a risk assessment to

be performed by a competent person appointed in writing, and that the risk assessment shall form part of the health and safety plan to be applied on the site.

This requirement under the Construction Regulations will have a major impact on organisations in the GSM industry.

Integrated Health, Safety and Environmental risk assessments have now become a prerequisite before considering any further expansion of the GSM network in South Africa.

The relationship between the operational risk sub-disciplines of health, safety, and environmental management, as part of the risk-management function, has been established, and an operational risk-assessment model for the Global Systems Mobile Telecommunications industry in South Africa that measures occupational health, safety, and environmental management risks on an integrated basis has been developed.

The risk assessment model for the South African GSM industry is based on assessing the frequency of an activity in relation to the impact on the organisation's business processes, incident/accident potential, financial impact, legal status, and the nature of ecological impact.

KEY TERMS

Global Systems for Mobile Communications, Risk Assessments, Occupational Health, Safety and Environmental Management, Integrated Risk Management, Enterprise Risk Management.

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LIST OF ABBREVIATIONS AND ACRONYMS USED IN THE GSM INDUSTRY

A	
AC	Authentication Centre
AC	Alternating Current
ACD	Automatic Call Distributor
AI	Air Interface
AIS	Alarm Indication Signal
ANSI	American National Standards Institute
AOP	Acceptance of Proposal
APS	Application Program System
ASR	Answer Seizure Ratio
ATMN	Acceptance Test Manual
ATS	Acoustic Test System B&K 6712
AU	African Union
B	
BPMT	Business Process Modeling Tool
BS	Basic / Bearer Service
BSC	Base Station Controller
BSC	Balanced Score Cards
BSCID	Base Station Controller Identity
BSD	The Base Station in the area is down
BSIC	Base Station Identity Code
BSS	Base Station Sub-system
BTM	Bank Transaction Manager
BTS	Base Transceiver Station
C	
CAR	Corrective Action Request
CAS	Cause and solution
CCC	Customer Care Centre
CCS	Customer Care Systems
CDR	Call Data Record
CE	Computing Element
CellAD	Proprietary trailing equipment
CEPT	Conference of European Posts and Telegraphs

CERT	Computer Emergency Response Team
CFU	Call Forwarding Unconditional
CG	Charging Gateway
CIBER	Cellular Inter-carrier Billing Exchange
CIC	Client Information Centre
CM	Configuration Management
CMD	Command
CobiT	Control Objectives for Information Related Technologies
COFL	Cellular Operator Fixed Link
COID ACT	Compensation of Occupational Injuries and Diseases Act 103 of 1993
CONG	Base Station in the area is running into congestion
COO	Chief Operating Officer
CPU	Central Processing Unit
CR	Change Request
CR	Call Retention
CRDB	Central Reference Database
CRS	Change Requests
CS	Corporate Services
CSR	Call Success Rate
CTI	Computer Telephony Integration
CTR	Contract
D	
DA	Distribution Assistant
DAI	Digital Audio Interface
DAT	Data Sheet
DBE	Database
DC	Direct Current
DCAF	Distributed Console Access Facility
DDE	Dynamic Data Link
DEA	Department of Environmental Affairs
DEF(Business Model)	To Define - requirement, research and modeling
DEL(Business Model)	To Deliver - selling, caring, billing and invoicing
Delta p.p.m	Delta parts per million
DEPT	Department
DES(Business Model)	To Design - specification, plans, schedules and structures

DFD	Data Flow Diagram
DIR	Directory
DIV	Division
DMS	Document Management System
Dname	Destination name
DP	Digital Primary
DP	Distribution Point
DPC	Destination Point Code
DPK	Datapack
DQ	Directory Enquiries
DR	Disaster Recovery
DRC	Disaster Recovery Procedure
DRG (Document Type)	Drawing
DRP	Disaster Recovery Plan
DRT	Digital Radio Communication Tester
DTX	Discontinuous Transmission
DXX	Digital Cross Connect
E	
EA	Environmental Aspect
EAC	Environmental Action Committee
EDGE	Enhanced Data Rate For GSM Evolution
EDMS	Electronic Document Management System
EDSS-1	European Digital Signaling System – 1
EIA	Environmental Impact Assessment
EIR	Equipment Identity Register
EM	Emergency Maintenance
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EMR	Electromagnetic Radiation
EQU(Business Model)	To Equip - systems, infrastructure assets, tools and technology
ERD	Entity Relationship Diagram
ESP	Engineering Strategic Plan
EWDS	Siemens Electronic Digital Switching Systems
EX-SP	A Reversed Subscriber Problem

F	
FACCH	Fast Associated Control Channel
FCSD	Fixed Charge Supporting Documentation
FMEA	Fault Modes and Effects Analysis
FPLMN	Foreign Public Land Mobile Network
FRACAS	Failure Reporting, Analysis and Corrective Action System
FRM	Form
FS	Facilities Support
FSN	File Sequence Number
FTA	Fault Tree Analysis
FURS	Functional User Requirement Statement
G	
GCSC	Global Customer Support Centre
GGSN	Gateway GRPS Support Node
GoS	Grade of Service
GPP	Generation Partnership Project (3GPP).
GPROC	Generic Processor Board
GPRS	General Packet Radio Service
GSA	Globalstar Southern Africa
GSM	Global System for Mobile Communications
GUI	Graphical User Interface
H	
H&S	Health and Safety
HAZOP	Hazard
HF	High Frequency
HIRA	Hazards and Incidents Risk Assessment
HPS	High Performance System
HSN	Hopping Sequence Number
I	
IAT	Impact Analysis Team
ICASA	Independent Communications Authority of South Africa
ICN I RP	International Commission for Non Ionising Radiation Protection
ID	Identity/ Identification
IDMS	Integrated Data Management System

ILO	International Labour Organisation
IMEI	International Mobile Equipment Identifier
IMSI	International Mobile Subscriber Identity
IN	Intelligent Network
INC.INV.	Incident Investigation
INS	Intelligent Network Services
IO	Input / Output (read / write information on system)
IP(1)	Internet Protocol
IP(2)	Intelligent Peripheral
IPC	Illustrated parts catalogue
IPM	Interim Program Modification
IQMS	Integrated Quality Management System
IR	Investigation Report
IR	International Roaming
IR	Infrared
IS	Information Security
IS	Information Services / Systems
ISA	Information Service Access
ISAS	Integrated Services Administration System
ISD	Interconnect Service Desk
ISIG	Information Strategic Information Group
ISMP	Information Security Management Project
ISMP	Information Security Programme Manager
ISMS	Information Security Management System
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
ISTF	Information Security Task Force
ISTF	Information Security Task Force
IT	Information Technology
ITU	International Telecommunications Union
J	
K	
KPA	Key Performance Area

L	
LAN	Local Area Network
LCC	Life Cycle Cost
LMT	Local Maintenance Terminal
LU	Location Update
LURS	Logistical User Requirement Statement
M	
M&L	Microphone and Loudspeaker
MAIO	Mobile Allocation Index Offset
ME	Mobile Equipment
MED-DEV	Mediation Device
Merl	Milli-Erlang
MFC	Multi-Functional Controller
MHT	Mean Holding Time
MHz	Megahertz
MIB	Management Information Base
MIS	Management Information System
MOC	Mobile Originating Calls
MOSMS	Mobile Originating Short Message Service
MQR	Management Quality Representative
MS	Mobile Station
MSC	Mobile Switching Center
MSP	Multiple Services Platform
MSPP	Multiple Switch Pre-Processor
MSRN	Mobile Subscriber Roaming Number
MSS	Mobile Satellite Services
MTC	Mobile Terminating Calls
MTL	Message Transfer Link
MTSMS	Mobile Terminating Short Message Service
MTTC	Mobile Terminal Test Center
MW	Micro Wave
N	
NCTL	National Cellular Telecommunications Licence
NDC	National Destination Code
NEMA	National Environmental Management Act

NGO	Non Governmental Organisation
NIMBY	Not in my back yard syndrome
NM	Network Management
NMC	Network Management Centre
NP	Network Performance
NPD	New Product Development
NSS	Network Switching Subsystem
N-t-N	Node-to-Node
O	
OHSA	Occupational Health and Safety Act
OHSAS	Occupational Health and Safety Standard
OBF	Out of Box Failure
OCC	Occupational
OHS	Occupational Health & Safety
OHSACT	Occupational Health and Safety Act 85 of 1993
OMC-G	Operations and Maintenance Centre - General Packet Radio Switching
OMC-R	Operations and Maintenance Centre - Radio
OMC-S	Operations and Maintenance Centre - Switching
OMP	Operations and Maintenance Platform
OMS	Operation and Maintenance System
OMSC	OSH Management Steering Committee
OMT	Operations and Maintenance Terminal
OMT-WEB	Proprietary Web Interface
OS	Operating System
OSC	Operator Service Centre
OSS	Operational Sub-system
P	
PCI	Process Capability Index
PDN	Public Data Network
PSOS	Phantom Share Option Scheme
PABX	Private Automatic Branch Exchange
PC	Process Capability
PCH	Paging Channel
PDN	Private Data Network
PDP	Personal Development Plan

PFC	Packet Switching and Frame Relay Equipment
PHA	Preliminary Hazard Analysis
PI	Product Integration
PIN	Personal Identification Number
PL	Project Leader
PLMN	Public Land Mobile Network
PLN	Plan
PM	Project Manager
PM + R	Performance Measurement and Reporting
PMF	Project Management Framework
PMS	Product Management Services
PMS	Performance Management System
POIL	Point of Interconnect Link
POL(Document Type)	Policy
POT	Proof of Transmission
PPE	Personal Protective Equipment
PPFE	Pre-Paid Front End
PPL	Proposal
PRC	Performance Review Committee
PRC (Document Type)	Procedure
PSTN	Public Switched Telephone Network
PTP	Point-to-Point radio systems
PUK number	PIN Unblocking Key
Q	
QA	Quality Assurance
QCP	Quality Control Plan
QM	Quality Manager
QMS	Quality Management System
QMSC	Quality Management Steering Committee
QoS	Quality of Service
QPT	Quality Process Team
QSC	Quality Steering Committee
R	
RACH	Random Access Channel

RAM	Reliability, Availability and Maintainability
RAM	Routing and Addressing of Mailboxes
RAM	Random Access Memory
RAMS	Routing and Addressing of Mailboxes
RAS	Remote Access Server
RC	Review Committee
RCC	Recovery Co-ordinating Committee
REP	Report
RESP	Responsible
RF	Radio Frequency
RFC	Request for Change
RFO	Ready for Occupation
RFP	Request for Proposal
RFS	Ready for Service
RLC	Radio Link Control
ROD	Record of Decision
ROI	Return on Investment
RPC	Recovery Planning Co-ordinating
RTS	Requisition Tracking System
S	
SA	Service Administrator / Assistant
SABS	South African Bureau of Standards
SACCH	Slow Associated Control Channel
SANS	South African National Standards
SATRA	South African Telecommunications Regulatory Authority
SBH	System Busy Hour
SBIS	Supervisor Business Information Systems
SCP	Service Control Point
SDBA	Senior Database Administrator
SDCCH	Standalone Dedicated Control Channel
SDLC	Software Development Life Cycle
SDN	Switched Data Network
SGSN	Serving GPRS Support Node
SI	Switching Interface
SIM	Subscriber Identity Module
SIP	Strategic Information Plan

SIT	System Image Tape
SKC	Security Key Contacts
SLA	Service Level Agreement
SLP	Service Level Provided
SMBS	Short Message Billing System
SMP	Service Management Point
SMS	Short Message Service
SMS	Service Management Server
SMSC	Short Message Service Center
SN	Subscriber Number
SNA	Service Not Available
SNI	Siemens-Nixdorf Information System
SNMP	Simple Network Management Protocol
SOP	Standard Operating Procedure
SP	Service Provider
SPP	Subscriber Problem
SPCOV	Request for new coverage
SPHDSK	Service Provider Help Desk
SQL	Structural Query Language
SRM	Service Review Meeting
SSD	System Specification Document
SSD	Supplier Service Desk
SSS	Switching Subsystem
STD	Standard
SWP	Safe work procedures
T	
T&D	Training and Development
TCH	Traffic Channel
TE	Terminal Equipment
Telnet	Internet Protocol that Control Remote Server
TEMS	Test Mobile Systems
TID	Transaction Identifier
TMP	Temporary
TMSI	Temporary Mobile Subscriber Identity
TQM	Total Quality Management
TRX	Transcoder

TS	Timeslot
TSA	Test Switch
TT	Trouble Ticket
U	
UHF	Ultra High Frequency
UPS	Un-interruptible Power Supply
URL	Uniform Resource Locator
URS	User Requirement Specification
V	
VAMS	Value Added Services Maintenance System
VHF	Very High Frequency
VLR	Visitor Location Register
VLSI	Very Large Scale Integrated Silicon Technology
VMS	Voice Mail Systems
VP	Voice Platform
VPLMN	Visited Public Land Mobile Network
VRU	Voice Response Unit
W	
WAN	Wide Area Network
WAP	Wireless Access Protocol
WHO	World Health Organisation
WLL	Wireless Local Loop
WML	The language used for WAP features in mobile products. Similar to HTML on the internet, but faster and less complicated that HTML.
WWW	World Wide Web
X	
XCDR	Transcoder
Y	
Z	
1	
2	

3GPP	Third Generation Partnership Project
3GSM	Third Generation Global Systems Mobile
4	
5	

CHAPTER 1

INTRODUCTION TO THE GSM INDUSTRY IN SOUTH AFRICA

1. Background

More than one billion people – almost one in six of the world's population – are now using GSM (global systems for mobile communication) mobile phones. This historic milestone was reached a mere 12 years after the launch of the first networks (www.gsmworld.com/news/press_2004/press04: 22 February 2004).

The situation in Africa, and more especially in South Africa, is no different from that in the rest of the world. This is confirmed by the International Telecommunication Union press release of 26 April 2004, which stated:

> Mobile telephony has been critical in boosting access to telecommunications in Africa and has helped substantially lift numbers of telecommunications users. The rise of mobile usage has been driven by a combination of factors: demand, sector reform, the licensing of new competition and the emergence of major strategic investors, such as Vodacom and MTN. (www.itu.int/newsroom/press_releases: 19 August 2004).

South Africa has the largest telecommunications market in Africa, with three mobile cellular service providers: Vodacom, MTN and Cell C. It was estimated that by March 2004 there would be approximately 18 million cellular customers in South Africa. Of these, Vodacom estimated they would have a 54% market share in what they termed “a three-player market” (Vodacom Annual Report, 2004: 3).

The second largest mobile cellular service provider, MTN, reported record-breaking results for the quarter ending June 2004. The company experienced an increase of 5,7% in its South African subscriber base, representing a 28%

growth from 31 March 2003 to 6 495 million subscribers (*Sake Rapport,* 2004).

Cell C, the third mobile network, which introduced its service in South Africa during November 2001, has captured 12,5% of the subscriber base, representing over 2 million active subscribers.

Both Vodacom and MTN predict that the South African cellular market has the potential to grow to a saturation point between 25 and 30 million subscribers.

It is important to take note of the growth in the South African cellular market, as the anticipated growth in the GSM industry creates potential risks in an environment where organisations are always seeking ways of improving efficiency, cutting costs, and staying abreast of technological advances. Elements of risk control, such as safety, health, and environmental management, can therefore no longer be left out of the equation, particularly when organisations in the GSM industry are considering increasing their networks in southern Africa, and in the broader African market.

It is contended that integrated health, safety, and environmental risk assessments should be a prerequisite before any further expansion of the GSM network in South Africa is considered. Vodacom, MTN and, to a lesser extent, Cell C, have all indicated that they will look at viable opportunities to expand their business activities on the African continent.

2. Statutory requirements under the Occupational Health and Safety Act, No. 85 of 1993

Although risk assessments are not specifically defined in the Occupational Health and Safety Act, No. 85 of 1993, Section 8 stipulates, under the general duties of the employer, that the employer must, as far as is reasonably practicable, establish what hazards to the health or safety of employees are attached to any work which is performed. This situation changed with the promulgation of the Construction Regulations, GNR.1010 on 18 July 2003, which read:

> 7. Risk assessment. —
>
> (1) Every contractor performing construction work shall before the commencement of any construction work and during construction work, cause a risk assessment to be performed by a competent person appointed in writing and the risk assessment shall form part of the health and safety plan to be applied on the site and shall include at least: —
>
> (*a*) the identification of the risks and hazards to which persons may be exposed to;
>
> (*b*) the analysis and evaluation of the risks and hazards identified;
>
> (*c*) a documented plan of safe work procedures to mitigate, reduce or control the risks and hazards that have been identified;
>
> (*d*) a monitoring plan; and
>
> (*e*) a review plan.
>
> (2) A contractor shall ensure that a copy of the risk assessment is available on site for inspection by an inspector, client, client’s agent, contractor, employee, representative trade union, health and safety representative or any member of the health and safety committee.
>
> (3) Every contractor shall consult with the health and safety committee or, if no health and safety committee exists, with a representative group of employees, on the

development, monitoring and review of the risk assessment.

(4) A contractor shall ensure that all employees under his or her control are informed, instructed and trained by a competent person regarding any hazard and the related work procedures before any work commences, and thereafter at such times as may be determined in the risk assessment.

(5) A principal contractor shall ensure that all contractors are informed regarding any hazard as stipulated in the risk assessment before any work commences, and thereafter at such times as may be determined in the risk assessment.

(6) A contractor shall ensure that as far as is reasonably practicable, ergonomic related hazards are analyzed, evaluated and addressed in the risk assessment.

(7) Notwithstanding the requirements laid down in subregulation (4), no contractor shall allow or permit any employee or person to enter any site, unless such employee or person has undergone health and safety induction training pertaining to the hazards prevalent on the site at the time of entry.

(8) A contractor shall ensure that all visitors to a construction site undergo health and safety induction pertaining to the hazards prevalent on the site and shall be provided with the necessary personal protective equipment.

(9) Every employee on site shall —

(*a*) be in possession of proof of the health and safety induction training as determined in subregulation (7), issued by a competent person prior to the commencement of construction work; and (*b*) carry the proof contemplated in paragraph (*a*) for the duration of that project or for the period that the employee will be on the construction site.

The requirements under the Construction Regulations, particularly Regulation 7, will have a major impact on organisations in the GSM industry.

3. Statutory requirements under the National Environmental Management Act, No 107 of 1998, and the Environment Conservation Act, No 73 of 1989

Environmental Impact Assessments (EIA's) are mandatory under Section 24 of the National Environmental Management Act (NEMA), Section 22 of the Environment Conservation Act, Act 73 of 1989, and in terms of the requirements under Regulation 1183 under section 50(2) of the Environmental Conservation Act.

According to (Barnard 1999: 107) "The National Environmental Management Act (NEMA) in Section 23(2)(b) states that one of the general objectives of integrated environmental management is to… [I]dentify, predict and evaluate the actual and potential impact on the environment, socio-economic conditions and cultural heritage, the risks and consequences and alternatives and options for mitigation of activities, with a view to minimising negative impacts, maximising benefits, and promoting compliance with the principles of environmental management".

4. Goal of the study

The goal of this study is to develop an integrated health, safety and environmental operational risk assessment model for the South African GSM industry.

For the purpose of this study an integrated health, safety and environmental risk assessment model will refer to an **operational risk assessment model.**

5. Objectives of the study

The following specific objectives have been derived from the goal of the study:

- To study the literature on risk management, with particular emphasis on the risk assessment methods employed by organisations in the health, safety and environmental management disciplines
- To investigate the individual risk assessment techniques in the field of health, safety and environmental management
- To investigate the application of integrated health, safety and environmental risk assessment models in the South African GSM industry
- To identify and develop an integrated health, safety and environmental risk assessment model for the South African GSM industry.

6. Importance of the study

Although the literature study revealed that some studies have been conducted on the application of risk assessment models, most have concentrated on industry-specific models such as HAZOP, Fault Tree Analysis, and simulation models using Monte Carlo techniques.

In the American literature, several studies concentrate on financial risk assessment models, with models that address health and safety risks receiving less attention.

The author was unable to find any work specifically related to an integrated health, safety and environmental risk assessment model designed for the

South African context, and has come to the conclusion that this is a shortcoming in the South African GSM industry. The formulation of an integrated health, safety and environmental risk assessment model will, therefore, contribute to sound management within the South African GSM industry. Some of the specific benefits are mentioned below.

Such a model will, first and foremost, assist management to comply with the legal requirements under the Occupational Health and Safety, National Environmental Management and Environmental Conservation Acts, and will address the need for a comprehensive strategy to meet the health, safety and environmental operational risks of organisations operating in the industry.

A further contribution is that variations in the way in which the different assessment models for each of the health, safety and environmental disciplines is applied could be reduced if they were integrated into a single operational risk assessment model for organisations in the South African GSM industry. The cost implications of the different risk assessment models would therefore also be reduced, adding further value that would enhance the profitability of the organisations involved. Knowledge of the critical areas that would have an impact on an organisation’s health, safety and environmental risk profiles would also result in improved performance because these areas would then enjoy keener attention.

The monitoring of an operational risk profile for the GSM industry could be of particular interest to the regulating authorities, and organisations in the GSM industry could gain much from the knowledge they would gain of health, safety and environmental trends in the industry as a whole.

7. Research method

The research design developed for this study included a plan of action and method of research that would ultimately determine the credibility and trustworthiness of a research paper or project such as this. The overall research methodology included a number of components, described below.

The first component was a comprehensive literature study relating to the general field of operational risk control, with particular emphasis on health, safety and environmental management in the GSM industry.

The research essentially consisted of an exploratory analysis. In the planned investigation, a survey approach was used, in which the data were collected by means of self-administered questionnaires sent out by mail, followed by a personal visit to the three major GSM network service providers in South Africa to increase the validity of the research findings.

The research may also be classified as a census because all the elements of the sampling frame received questionnaires. The study itself is of a descriptive nature.

As is shown later, there is a clear distinction between the three major GSM network service providers and the contractors, or sub-contractors, contracted by them in terms of how they address their health, safety and environmental risks.

8. Limitations of the study

8.1 Theoretical limitations

No previous research aimed specifically at the integration of health, safety and environmental risk assessment models for the South African GSM insurance industry could be found in the literature. The study by Newbury

(2000: 1) addresses only the integration of health, safety and environmental management systems, emphasising the International Standards Organisation (ISO) standards, such as ISO 14000, for environmental management, and OHSAS 18000 for health and safety.

In this study an integrated health, safety and environmental operational risk assessment model is therefore developed using literature based on other industries. As there is very little to be found on this subject in previously published material, the variables in other industries such as the Petrochemical, Mining and Construction industries are, self-evidently, not the same as in the GSM industry.

8.2 Empirical limitations

It is inevitably the case that research, no matter how well planned and executed, can never deal with every potential issue — in short, it has limitations. The specific limitations of this investigation are briefly discussed below:

- While some methods and processes discussed may be useful for other related industries; this study is limited to South African organisations in the GSM industry.
- Establishing all the GSM organisations in the South African GSM industry was impractical; therefore, the empirical research is limited to the three major network service providers, the manufacturers and suppliers of GSM equipment to the three major network service providers, and the contractors and sub-contractors engaged by the network service providers to establish GSM networks on their behalf.
- Discovering the role of an integrated health, safety and environmental risk assessment model through interviews is inevitably a subjective process. To reduce this effect, a structured approach has been used.

- Organisations viewed the research as an intrusion into confidential areas. They were therefore reluctant to discuss their positions in relation to meeting the challenges of addressing health, safety and environmental risks within their organisations.
- The statistical analysis for this research is limited by the number of organisations in the South African GSM industry. The population consisted of 65 organisations.
- Formal data such as reports or other official publications on health, safety and environmental risk assessments were not available, particularly from contractors and sub-contractors. Most of the data from these groups were obtained from telephonic and personal interviews with the respondents.
- The results of this research are further restricted by the limited knowledge pertaining to the disciplines of health, safety and environmental management on the part of the contractor and sub-contractor respondent groups.

9. Outline of the study

Chapter 1 sketches the background of the study, particularly in relation to the role of risk assessment in the South African GSM industry. The general objectives and goals of the study, namely to examine the literature on risk management and risk assessment, and their integration into the disciplines of health, safety and environmental management, the development of an integrated health, safety and environmental management operational risk assessment model for the South African GSM industry are also discussed.

It concludes with a description of the importance of the research and the limitations of the study.

Repeated reference is made throughout this study to Global Systems for Mobile communications (GSM) and it is therefore appropriate that this technology should be discussed in detail to place it in perspective vis-à-vis the rest of the research. This discussion is given in Chapter 2; also included in the chapter is a historical background on the development of GSM, outlining how a cellular communication system functions, and the impact of GSM technology on occupational health, safety and environmental management.

In Chapter 3, where the focus is on the theoretical perspective of an integrated safety, health and environmental operational risk assessment model for the South African GSM industry, an account is given of the findings of the literature study. The literature relating to an integrated health, safety and environmental risk assessment model for the South African GSM industry was investigated, and the focus of the chapter falls on the establishment of an integrated operational risk assessment model for the three disciplines of health, safety and environmental management within the operational risk management function.

It is important that the literature study should identify synergies between GSM technology and health, safety and environmental management; and should establish what contribution an integrated health, safety and environmental operational risk assessment model could make to the GSM industry in South Africa.

In order to understand the health, safety and environmental operational risks associated with the GSM industry, it is also important to include the available risk management literature in the literature study to provide a perspective on risk management in the GSM industry.

In Chapter 4, the theoretical perspectives on safety, health and environmental operational risk assessment models for the South African GSM industry are addressed. An outline is presented of the individual approaches of the health, safety and environmental disciplines to assessing operational risks in order to establish any commonalities based on theoretical research on an integrated approach, or model, to assess operational risk within the South African GSM industry.

Chapter 5 is devoted to setting out all the important considerations relating to the research design, and provides details of the design, the unit of measurement, sampling design, form of measurement, and questionnaire design. The sampling frame used was the three major GSM network service providers in South Africa, namely Vodacom, MTN and Cell C. This included all manufacturers, suppliers, contractors and sub-contractors that manufacture or supply GSM equipment, or who are contracted by the three major GSM network service providers in South Africa. The population contained 65 elements.

The design of an integrated health, safety and environmental operational risk assessment tool for the South African GSM industry is dealt with in Chapter 6.

The findings of the research are summarised in Chapter 7, and recommendations are made on the basis of these findings. Finally, suggestions for future research arising from the findings of this study are made.

CHAPTER 2

GLOBAL SYSTEMS FOR MOBILE COMMUNICATIONS (GSM) INDUSTRY IN SOUTH AFRICA

1. A definition of the digital global services mobile (GSM) network

The discussion of the theoretical view on an integrated safety, health and environmental risk assessment model for the South African GSM industry in Chapter 3 makes extensive reference to GSM communications, and it is therefore appropriate to examine this technology in more detail to place it in perspective with the rest of the research.

The term "GSM" is internationally defined as "global system for mobile communications" (jscouria@www.shoshin.uwaterloo.ca). GSM is a globally accepted standard for digital cellular communication. It is also the name of a study group called the *Groupe Spécial Mobile*, established in 1982 at the Conference of European Posts and Telegraphs (CEPT) to create a common European mobile telephone standard to formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz.

With North America making a delayed entry into the GSM field, GSM systems soon existed on every continent and the acronym GSM was then appropriately changed to signify "global system for mobile communications. (Scourias J - jscouria@www.shoshin.uwaterloo.ca).

2. What is GSM?

GSM is an open, non-proprietary system that is constantly evolving. One of its great strengths is its international roaming capability. This gives consumers seamless, standardised, same number contact ability in more than 170 countries. GSM satellite roaming has extended service access to areas where terrestrial coverage is not available.

Today's second-generation GSM networks deliver quality, secure mobile voice and data service as SMS/text messaging, with full roaming capacity across the world.

The GSM platform is a very successful technology and an unprecedented story of global achievement. In the less than ten years since the first network was commercially launched, it has become the world's leading and fastest growing mobile standard, spanning over 179 countries. GSM technology is used by more than one in ten of the world's population, and growth continues with the number of subscribers worldwide expected to exceed one billion by the end of 2004. (http://www.gsmworld.com/news/press_2004/press04 - Cannes, France, 22 February 2004).

The progress has not stopped there. The GSM platform is living, growing and evolving, and already offers an expanded and feature-rich family of voice and enabling services.

According to Kester Mann, Senior Research Analyst at EMC:

> With subscriber numbers having passed the 1.5 billion mark in the first week of June 2004, EMC forecasts that global net additions of more than 240 million in both 2004 and 2005 will set the mobile industry up to break through the 2 billion subscriber mark as soon as July 2006, http://www.the3gportal.com/3gpnews/archives/007233.html - 23 June 2004).

GSM's unrivalled success can be attributed to many factors, including the unparalleled cooperation and support between all those supplying, running and exploiting the platform. It is based on a true end-to-end solution, from infrastructure and services to handsets and billing systems.

GSM is a standard that embraces all areas of technology, resulting in global, seamless wireless services for all its customers. It is all part of the "wireless" evolution, which includes technologies such as GSM, GPRS, EDGE and 3GSM, which make up the wireless evolution, as well as mobile services and applications such as SMS and WAP.

3GSM is the generic term used for the next generation of mobile communications services. These new systems will provide enhanced services such as voice, text and data services. They are expected soon to be able to offer video on demand and high-speed multimedia and Internet access. 3GSM represents third-generation services delivered on an evolved core GSM network. They are delivered at a technical level on third-generation standards developed by Third Generation Partnership Project (3GPP), which use air interfaces for W-CDMA and, in some specified markets, EDGE.

The new 3G wireless internet service provided by Vodacom and MTN in South Africa is evidence of the 3GSM technology which is currently being implemented across the industry by global groups such as 3GPP.

The main benefit of third-generation systems is that they will offer high-end service capabilities, which include substantially enhanced capacity, quality and data. 3GSM services also include concurrent usage of multiple services and will bridge the gap between wireless and internet/computing.

To return to GSM in general, it should be noted that it differs from first-generation wireless systems in that it uses digital technology and time division multiple access transmission methods. Voice is digitally encoded via a unique encoder, which emulates the characteristics of human speech. This method of transmission permits a very efficient data rate/information content ratio.

High bandwidth services are already becoming available through second-generation technologies. The development path to 3GSM is clearly mapped out, and brings with it the possibilities of sophisticated data and multimedia applications.

The GSM standard will continue to evolve, with wireless, satellite and cordless systems offering greatly expanded services. These will include high-speed, multimedia data services, inbuilt support for parallel use of such services, and seamless integration with the Internet and wire line networks.

3. Historical background

In the late 1980s, as cellular networks developed around the world, there was a need to establish compatible standards and frequencies between different networks. (http://www.gsmworld.com/about/history/index.shtml - June 2004).

The International Telecommunications Union (ITU) agreed to develop an international operating standard, which eventually (as already explained) became known as the global system for mobile communications (GSM).

GSM is now in use in over 200 countries around the world, allowing features such as international roaming. Thus, the main advantage of GSM is that anybody can make calls anywhere, at any time, provided there is coverage and capacity — the emphasis of GSM being on mobility of communication. (http://www.gsmworld.com/about/history/index.shtml - June 2004).

With business becoming increasingly international during the latter part of the 20th century, the cutting edge of the communications industry focused on exclusively local cellular solutions. None of these was remotely compatible with any of the others.

During the first wave of GSM technology, people were able to call the office if they were in their own homes, but not if they were with a client in another country. Nevertheless, it was clear there would be an escalating demand for a technology that facilitated flexible and reliable mobile communications. This in itself was a potentially lethal time bomb that threatened the durability of first-generation cellular networks. (http://www.gsmworld.com/about/history/index.shtml - June 2004).

The problem was capacity; or the lack of it. It was soon obvious that by the early 1990s the disparate analogue networks would collapse under the pressure of demand.

From the start, GSM pundits had it in mind that the new standard was likely to employ digital, rather than analogue technology, and operate in the 900MHz frequency band.(http://www.gsmworld.com/about/history/index.shtml - June 2004).

Digital technology offered an attractive combination of performance and spectral efficiency. In other words, it would provide high quality transmission, and enable more callers simultaneously to use the limited radio band available. In addition, such a system would allow the development of advanced features like speech security and data communications. (http://www.gsmworld.com/about/history/index.shtml - June 2004).

By making use of digital technology, it would also be possible to employ very large-scale integrated silicon technology (VLSI) that would have significant implications for both manufacturers and consumers.

Handsets could, for example, be made cheaper and smaller. It would also make it possible to introduce the first hand-held terminals, even though in the early days they would be practically indistinguishable from a brick in terms of size and weight.

A remarkable characteristic of the GSM revolution was that once started, it soon became unstoppable. After the ITU testing procedure had been agreed in April 1992, the increasing availability of terminals stimulated the emergence of the first genuine commercial network services.

In practice, then, the real launch of GSM took place in the latter part of 1992. Among the early runners were Denmark (two operators), Finland (two operators), France, Germany (two operators), Italy, Portugal (two operators) and Sweden (three operators). Then, on 17 June 1992, the first roaming agreement was signed between Telecom Finland and Vodafone in the UK. (http://www.gsmworld.com/about/history/index.shtml - June 2004).

Parallel to the arrival of the networks, industry professionals were seizing the opportunity of establishing their own networking at what was soon to become the major GSM global event, and by the end of 1993, GSM had broken through the 1 million-subscriber barrier.

One of the most attractive features of GSM is that it is a very secure network. All communications, both speech and data, are encrypted to prevent eavesdropping. In fact, in the early stages of its development it was found that the encryption algorithm was too powerful for certain technology export regulators. This could have had serious implications for the global spread of GSM by limiting the number of countries to which it could be sold. Alternative algorithms were subsequently developed that enabled the free dissemination of the technology worldwide. (http://www.gsmworld.com/technology/gsm.shtml - June 2004).

Their Subscriber Identity Module (SIM) card identifies GSM subscribers. It stores their identity number and authentication key and algorithm. The choice of algorithm is the responsibility of individual GSM operators who have to ensure security of authentication. (Siemens 2002: 27)

This kind of smartcard technology has proved itself to be a potent weapon in the battle for network security. This is, however, only the tip of the iceberg as far as SIM card potential is concerned. For example, it is no longer necessary for users to own a terminal; travellers can simply rent GSM phones at an airport and insert their SIM cards. Since it is the card, rather than the terminal, that enables network access, feature access and billing, the user is immediately on-line.

One of the defining characteristics of any revolution is that, however carefully it is planned; no one can really be sure where it will lead. An unexpected characteristic of the new mobile industry was that it carried the seeds of the liberalisation of the entire telecommunications market.

The GSM technology is the richest and most flexible on the market. The future will only be constrained by the limits of human imagination.

4. How a cellular network operates

4.1 The network structure

The international GSM service area covers all countries in which there is a GSM900, GSM1800 or GSM1900 network.

Networks provided by an operator on a national level for public mobile communication applications are referred to as Public Land Mobile Networks, or PLMNs. A PLMN is divided into fixed and mobile network components, and they are connected via air interfaces.

4.2 Fixed network components

The fixed network components of a GSM-PLMN consist of the following:

- **Base Station Subsystem (BSS)**: The BSS describes the radio access to the PLMN (Radio Sub-system). It is designed to receive and send digital voice and data information via the radio interface. Several fixed radio station (cells) are coordinated by one control unit.

- **Network Switching Subsystem (NSS)**: The NSS forms the interface between the radio subsystem and the public, offering trunk/customer networks (PSTN, ISDN, PDN). It executes all signalling functions for setting up connections from and to mobile subscribers. It is similar to the exchanges of fixed network communication systems, but it also fulfils important mobile communication specific functions.

The air or radio interface represents the connection between the mobile (MS) network components and the fixed network components (BSS, NSS). The organisation of the radio interface is decisive for advantages and disadvantages of different mobile systems.

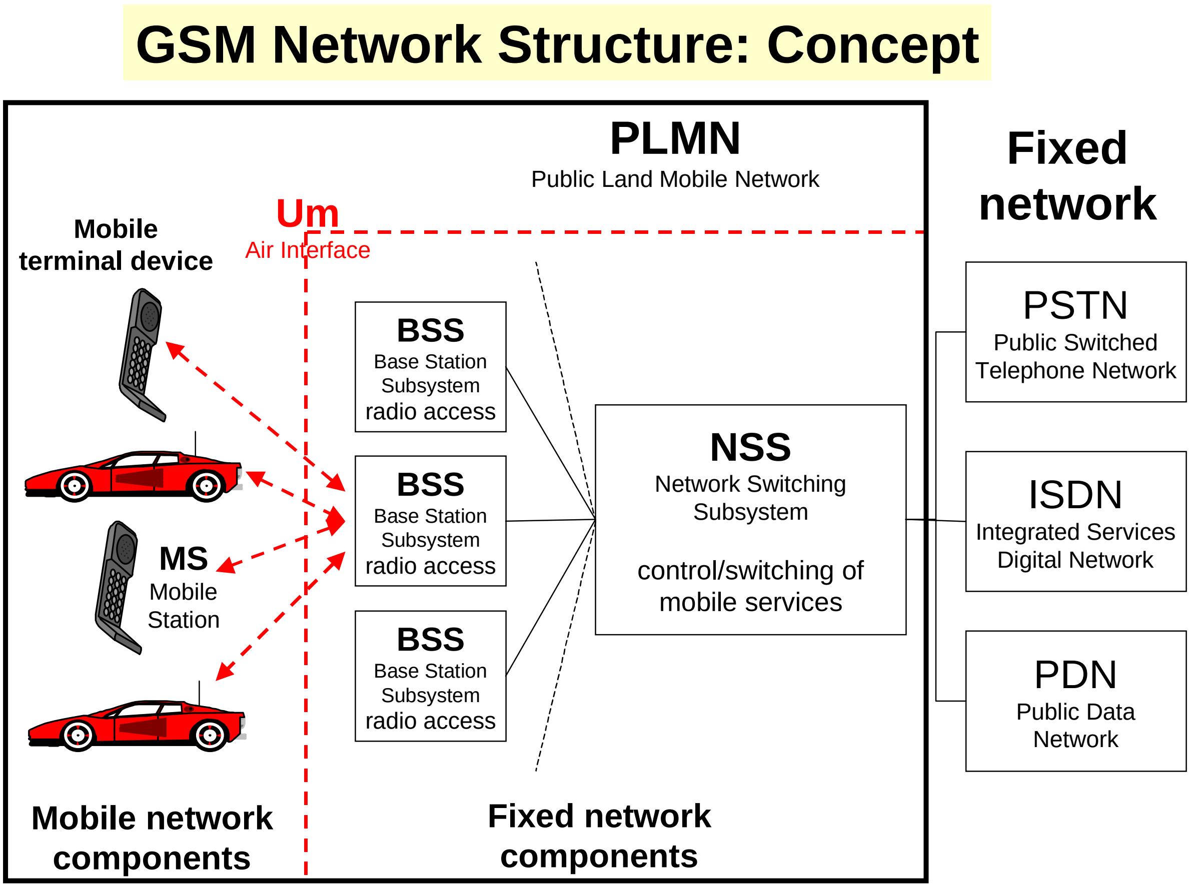

Figure 1 – Concept of a GSM network. (Siemens 2004: 5)

4.3 Mobile network components

Mobile network components are the user terminals that transmit speech and data from the mobile subscriber. The mobile network components are the following:

- **MS**: Mobile Station
- **ME**: Mobile Equipment
- **SIM**: Subscriber Identification Module
- **TE**: Terminal equipment – accessories connected to the MS via an adapter, e.g. laptop, fax machine

An important difference between fixed network communications and mobile communications is the separation of equipment and subscriber identity. It is possible for the mobile subscriber to use a variety of mobile terminal equipment with a personal identity by means of the SIM card, which includes his or her subscriber identity. The mobile station is defined as: **MS = ME + SIM**. (Siemens 2004: 16).

The SIM card is allocated and activated (cleared) by the provider upon completion of the contract. It is realised by means of a chip, which contains a variety of permanent and temporary information for the subscriber (e.g. a personal telephone register), and about her or him. Along with the personal (secret) ID numbers (IMSI - International Mobil Subscriber Identity, TMSI - Temporary Mobile Subscriber Identity, this stored information is, for example, algorithms and keys for ciphering the transmission. (Siemens 2004: 16).

The PIN (Personal Identity Number) is important for the subscriber; it must be entered before the start of the conversation in order to prevent fraud by unauthorised intruders. As a rule, calls cannot be made without a SIM card in the ME, and without the PIN being entered. Emergency calls are an exception. (Siemens 2004: 16).

4.4 Principle of the cellular communication system

PLMNs operating on a national level are divided by location into servicing areas (so-called cells) in which a transmitter and a receiver (BTS - Base Transceiver Station) cater for the mobile subscribers of the area concerned. The cells represent the smallest service area in the PLMN network.

A variety of cells ensures saturation of the service area. The cells are theoretically arranged in a honeycomb pattern. Adaptations to the population/traffic density, and the topography of the service area, lead to a more irregular pattern. The service areas of the individual cells partially overlap. (Siemens 2004: 6).

In order to avoid interference from different subscribers in surrounding cells, the cell structure is organised according to the principle of cellular systems, and frequency re-use. The narrow available frequency range is divided into individual frequencies, or channels.

Only some of these channels are used in a certain cell, the remaining being used in the adjacent cells. The same frequency is used again in cells that are sufficiently far apart from each other to avoid inter-channel interference. This means that any area can be covered, and thus a prodigious increase in network capacity can be achieved with a small supply of channel frequencies. (Siemens 2004: 4).

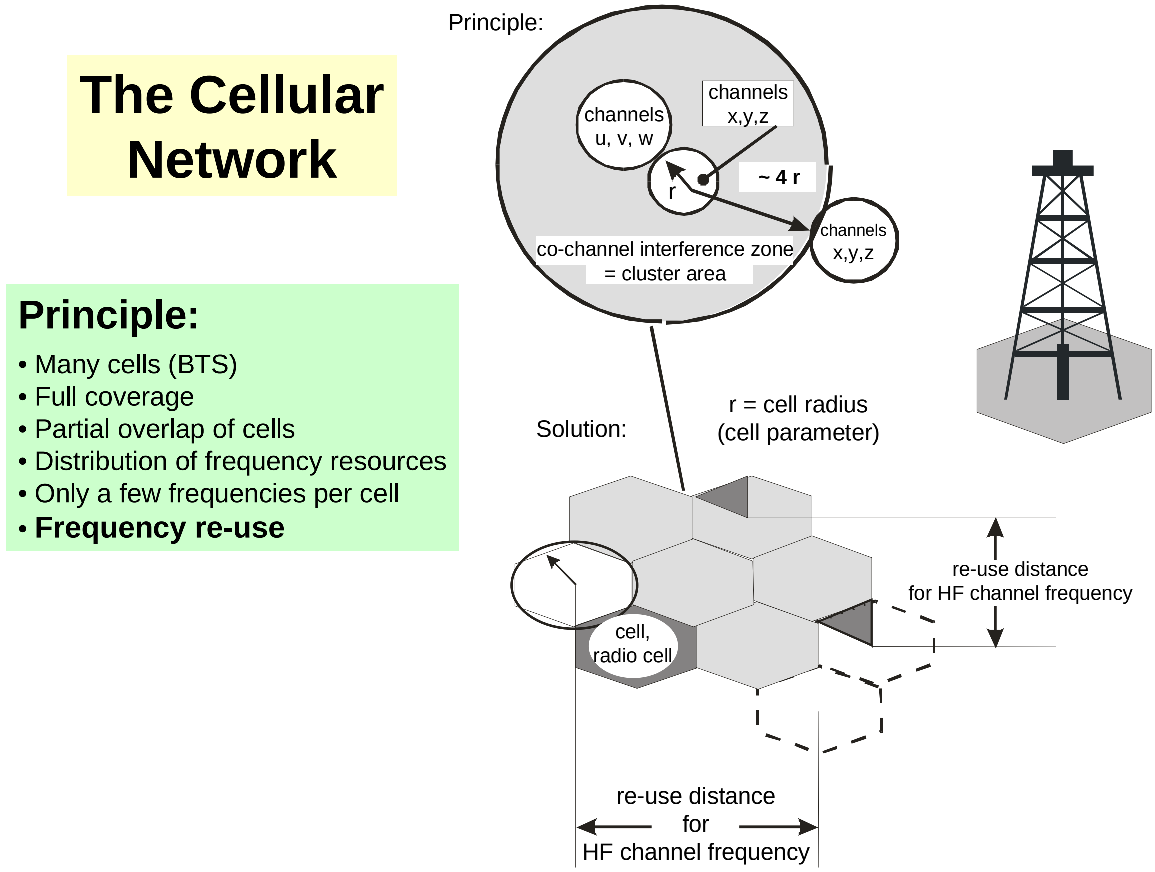

Figure 2 – Illustration of a cellular network (Siemens 2004:5)

4.4.1 Cluster

A certain minimum distance must be maintained between cells using the same frequencies in order to prevent interference, or at least to keep it to a bare minimum. This minimum distance (frequency re-use distance) depends on the concrete network planning, and corresponds to approximately four times the cell radius. On this principle, the available channels can be divided into, for example, seven parts and distributed over the PLMN area in such a way that each cell contains one of these seven sets of frequency channels.

The minimum area in which the whole range of HF channels is used is described as a cluster. Planning a concrete network implies that the population/traffic density, the topography of the area to be supplied, etc., must be taken into account. This network planning is complex process and special network planning software is used for this purpose.

4.4.2 The GSM cell

The higher the population or traffic density, the smaller the cell area because a limited number of HF channels can only cope with a limited traffic volume. This can be carried out via a reduction of the cell radius or by dividing the cells into sectors. (Siemens 2004: 7).

4.4.3 Cell size/Hierarchical cell concept

The size and shape of the cell depend on:

- The range of the MS radio contact (output peak power MS); topography (e.g. mountains, buildings or vegetation) and climate
- Traffic density: The maximum radius of a cell broadcast channel is 35 km in the GSM900 system, and 8 km in the GSM1800 system. The possibility of setting up "extended range cells" with a radius of up to 100 km has been integrated into GSM Phase 2+ for GSM900 systems. This should allow coverage of sparsely populated areas, especially coastal regions.
- Transmission power is limited for higher traffic densities in order to achieve a high degree of re-use of frequencies over smaller cells. The size of clusters is inversely proportional to the capacity of the radio system.
- For "normal" cells, also called macro cells, a cell size reduction for increasing the frequency re-use factor down to a minimum radius of approximately half a kilometre is achievable. Minimum field strength, and a maximum level of interference, which should not be exceeded, are required.
- A hierarchical cell concept is planned for business areas in city centres with an extremely high density of mobile communication subscribers. Micro cells with a 100 metres supply radius supplement macro cells. Subscribers can be delegated from the respective micro

cell to the hierarchically higher (overlay) macro cells (or the other way around), depending on their speed. (Siemens 2004: 7).

For this purpose, the antennae of the micro cells will only cover limited areas. Their height is considerably lower than the gable height of the surrounding buildings. Pico-cells are a further hierarchical level which are even smaller than micro-cells.

4.4.4 Cell coverage

- Omni Cells: The BTS is equipped with omni-directional antennae and serves the cell from the centre outwards. The cells are virtually circular.
- Sector Cells: The BTS supplies the cells from a corner with directional antennae. The cell shape is a circular segment, of which the apex angle depends on the installed antennae type.

  A sector of 180° or 120° is covered, in other words either a half or a third of the circle is covered.

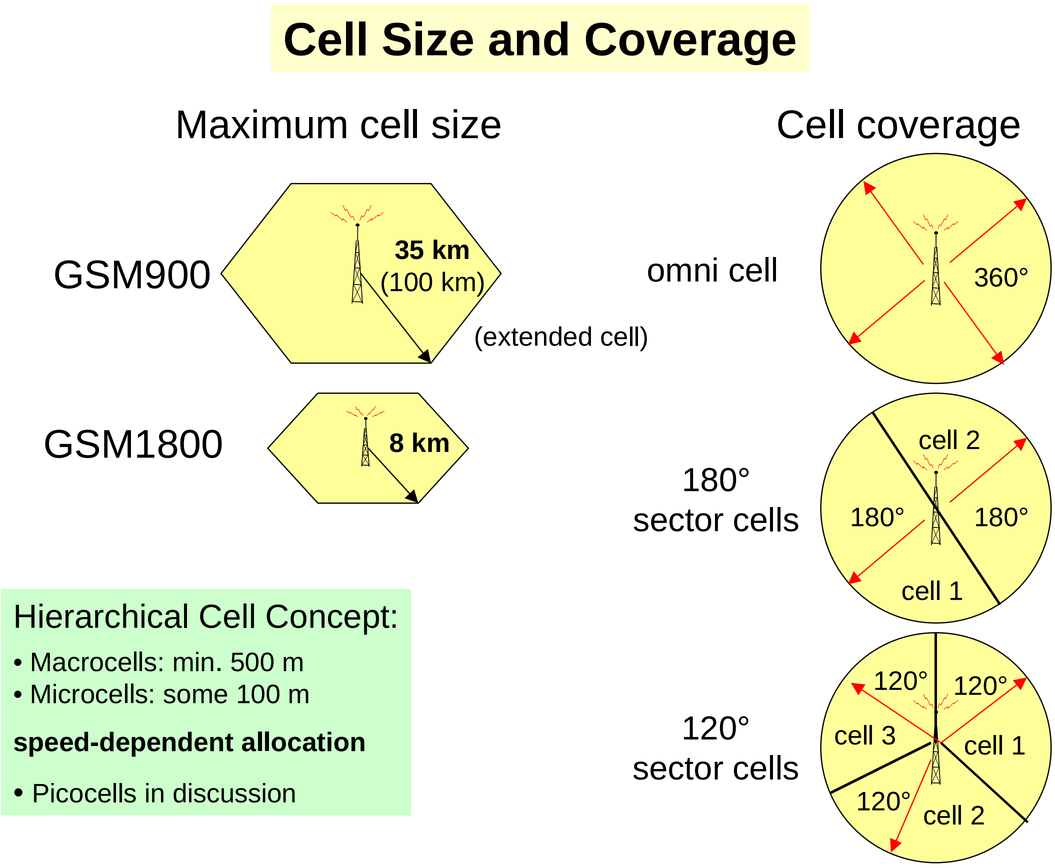

Figure 3 – Cell size and coverage (Siemens 2004: 8)

4.5 Roaming, location registration, and handover

4.5.1 Roaming

A further innovation of the cellular system is the roaming facility. This means that a subscriber can move freely within the mobile communication system, and remain accessible on a single personal telephone number anywhere in this area. With GSM, this concept of roaming can be expanded to the international area (international roaming). A subscriber whose home PLMN has a roaming agreement with other countries' GSM-PLMNs, can also be reached in these PLMNs (Visited PLMN - VPLMN) without dialling the corresponding VPLMNs code; calls can also be made from that VPLMN. (Siemens 2004: 6).

A prerequisite is, of course, that the subscriber should have authorisation for international roaming.

4.5.2 Location registration, location update and location area

The subscriber has to be located in the relevant cellular network. A procedure known as location registration, or Location Update (LU), carries out this function. It is important that the subscriber's temporary location area is recorded or registered with this procedure when the subscriber's mobile station is switched on and checked in, to make it possible to forward calls to him or her. The temporary location area is the area in which the MS can move freely without having to carry out a location update. As a rule, the location area consists of a multitude of cells, and is established by the operator according to the traffic or population density.

4.5.3 Handover

In cellular networks, it is not necessary for the subscriber to have her call interrupted when changing from one cell's service area to the area of a surrounding cell, as long as the cell areas overlap. This overlapping should be assured by means of good planning. If the MS can receive better supply from another cell than the one currently in use during a call, the MS connection will be diverted to the relevant cell. This procedure, which is designed for system quality maintenance, ideally takes place without the user being aware of it, and is known as handover. (Siemens 2004: 6).

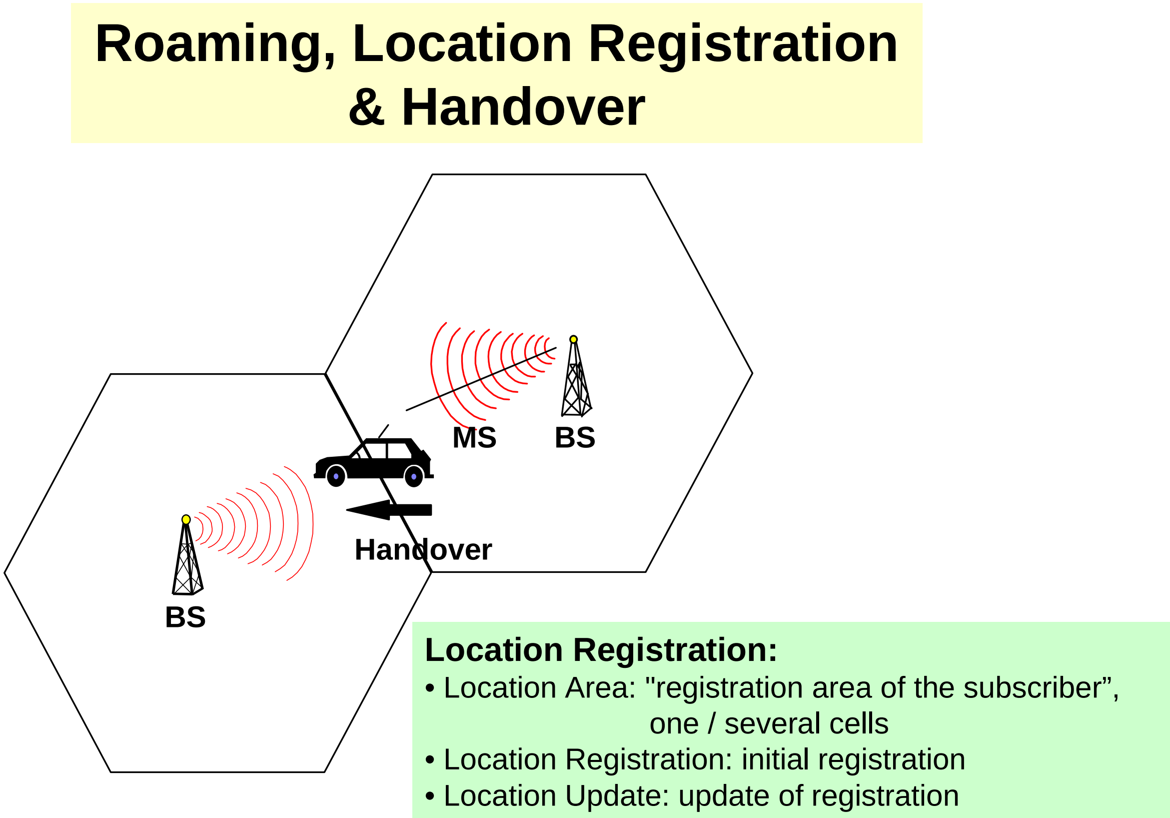

Figure 4 – Roaming, location registration and handover (Siemens 2004: 21)

4.6 South African cellular communications networks

The South African cellular communications networks are land-based mobile cellular radio telecommunications systems. Such systems operate by using part of the UHF radio spectrum allocated by the applicable governments under licences issued by the regulating telecommunications authorities within the country of operation. In the case of South Africa, the licences for Cell C, Vodacom and MTN were issued by ICASA (Independent Communications Authority of South Africa).

The frequency or position in the radio spectrum at which the three South African cellular operators operate, is generally expressed as 900 MHz (MTN and Vodacom) or 1800MHz (Megahertz), the latter used exclusively by Cell C.

The actual range of the spectrum is from 890 MHz to 1800 MHz, within which the operator is allocated 55 duplex channels, i.e. 55 transmit and 55 receive channels, to operate the GSM network.

The South African cellular system is designed to provide an uninterrupted call as a cell-phone user travels from one cell into another.

South Africa is only one of a number of countries globally that has seen a rapid proliferation in the deployment and use of cellular phone technology. Questions are often raised concerning the *modus operandi* of mobile telephone operators, as well as the safety, health, and environmental considerations associated with cell phones, and the supporting network of base stations.

4.7 Impact of GSM technology on occupational health and safety

The location of base stations and the appearance of antennae in South Africa are driven by both safety and aesthetic concerns, to such an extent that the concerns raised and proposals made by communities (interested and affected parties) are considered at the network development phase and all considerations are sympathetic to the local environment.

For the purpose of this research, it is important to quote a summary on the findings of the American National Standards Institute (ANSI) Committee published in an article by (Claycamp 1998: 101).

> The American National Standards Institute (ANSI) Committee concluded that there was no credible scientific evidence that exposures to RF in the 3 kHz to 300 GHz range were cumulative in any manner. For example, the energy of electromagnetic waves at 900 MHz is too weak to break atomic bonds, a process thought to be necessary in order to initiate cancerous changes in cells.

> Carcinogens have the apparent property that risk is best expressed as a function of cumulative exposure to the carcinogen. (Claycamp 1998: 107).

If there is no credible evidence for carcinogenic induction, then it is logical to assume that exposure rates (i.e. over the six-minute averaging period), and not necessarily cumulative exposures, can be used to manage risk.

A second issue regarding cancer causation that is often raised is the following: even if the energy of 900 MHz radio frequencies is too low to break bonds and initiate cancer, could the radio frequencies promote the development of cancer? While initiation of cancer by most carcinogens involves damage to tissue cell genes, the promotion of cancer is usually associated with the gene expression in initiated cells. Certainly, heat is an agent that can affect gene expression and induce heat shock and stress responses in cells. However, thermal effects in either tumour promotion (or tumour therapy) greatly exceed the normal metabolic range of thermal levels induced at the limiting MPE. (Claycamp 1998: 107).

Finally, the ANSI standard risk-assessment panel concluded that the literature revealed that the most sensitive measures of potential harmful biological effects were associated with an increase in body temperature in the presence of electromagnetic fields. While some critics of microwave research suggest that a new physics is yet to be discovered, the remarkable consistency of physical theory across biophysics and biology thus far suggests that discovery of a new science that explains speculative mechanisms of action is unlikely (Claycamp 1998: 108).

Rapidly advancing technology, and the sudden, ubiquitous presence of cellular phones and base station antennae, has rekindled public concern about exposure to high-frequency and microwave electromagnetic fields in South Africa. (Claycamp 1998: 108).

A different viewpoint on the impact of the GSM technology on occupational health and safety is expressed by Keddy (2000:7). “A further issue that I should mention is a concern that we have about the GSM system of cell-phone communication (Global System for Mobile Communication). The GSM mobile phone standard uses a digital, pulsed signal protocol to transmit all data. Briefly, the system puts out short bursts of data pulses at 217 Hz in what is known as TDMA (Time Division Multiple Access). This shares a broadcast channel between a number of users – in the case of GSM it is eight, each user having an equal time slot during the pulse. The point here is that pulsed microwaves have been shown to be biologically more active than continuous radiation of the same frequency and power level.” However, in conclusion (Keddy 2000: 7) points out that “At this time there is no absolute incontestable scientific evidence that cellphone radiation, at present cellphone frequencies and power densities cause malignancies.”

According to Keddy (2000: 39) the South African public, as well as the business community, are, to date, relatively uninformed regarding this issue. The picture is, however, rapidly changing, notwithstanding the fact that many individuals, companies, and heath and safety consultants, have expressed both concern, and conviction, that there is indeed a risk associated with the biological effects of the non-ionising radiation emitted by cell phones.

Szmigielski and Sobiczewska (2000: 365) state that “There still exist uncertainties in the knowledge about bioeffects of low-level MW fields. Admittedly, sufficient experimental and epidemiological evidence clearly indicates that, under certain conditions of exposure, weak and very weak MW fields can cause measurable effects in biological organisms (cells, animals, human beings), but mechanisms of these effects and their relevance for health status of the organisms are still difficult for interpretation.”

Based on the above literature, there is no conclusive scientific evidence that cellphone radiation, cellphone frequencies and power densities are the cause of measurable effects in biological organisms.

In a recent reaction to the impact of GSM technology on health and safety, a former scientist and teacher, in his private capacity submitted a complaint to the Advertising Standards Authority of South Africa against Nokia, a major cellphone manufacturer and supplier in South Africa because the latter was targeting children without giving consideration to the findings of the “Swart Commission”, which was based on research conducted in Sweden, in which it was found that the use of cellphones might be the cause of malignancies. (Beeld 2004: 7)

4.8 RF fields, human health and operating guidelines

It is important for the purpose of this study and research to understand the difference between the physical character of the radio frequency (RF) emissions emanating from a base station, and the ionising radiation associated with the X- ray machines routinely used in general dentistry.

RF waves are non-ionising in nature, being incapable of breaking chemical bonds in human tissue or cells. By contrast, X-rays are extremely potent in this regard. In fact, the only known physical effect attributable to RF fields is that of generating heat, which need not be harmful to biological tissue, provided appropriate safety and health guidelines are followed, and has been indicated in a preceding section.

The International Commission for Non-Ionising Radiation Protection (ICNIRP) has, in conjunction with the World Health Organization (WHO), developed scientifically derived safety guidelines for public and occupational exposure to RF fields. (www.who.int/pehmf/publications/facts_press/fact_english.htm - 28 June 2000)

4.9 RF guidelines

The South African Department of Health endorsed the RF safety guidelines laid down by the International Commission for Non-Ionising Radiation Protection (ICNIRP) in September 2002.

This statement has been confirmed by the South African Cellular Telecommunications Association (SACTA) "… the Department of Health has endorsed the use of the ICNIRP guidelines and with that in mind, and in accordance with international best practice, local suppliers and networks are striving towards adherence to the ICNIRP guidelines". (www.childrenfirst.org.za – 03 August 2005).

Figure 5 below shows the relative decrease in the field strength of the electromagnetic waves emanating from a typical base station when measured using ICNIRP as the datum.

In practice, the ICNIRP safety level would only be reached if one were directly in front of the antenna or microwave dish, and less than five metres way.

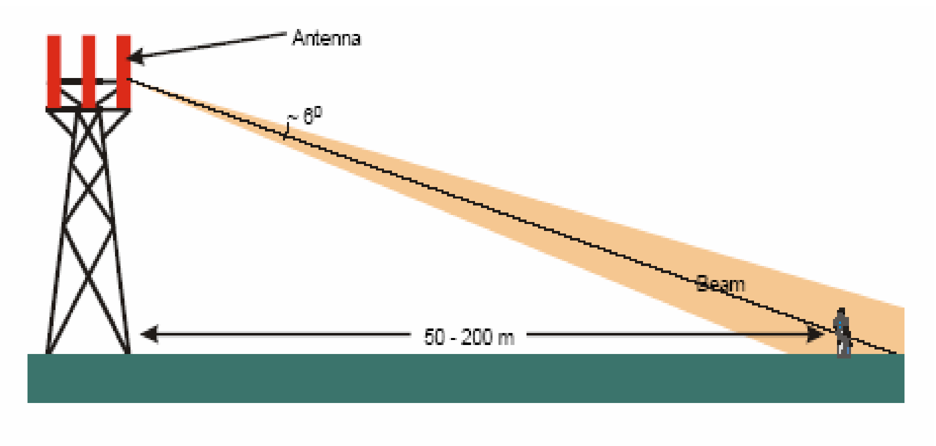

Figure 5 – Main beam from an antenna mounted on a tower. The beam is, in fact, less well defined than that shown here and there is a series of weak side lobes on either side of it. (Stewart 2000: 37)

The difference in these properties close to, and far from, an electric dipole antenna is illustrated in Figure 6, which shows the directions in which most of the energy flows. (The electric field directions are in the plane of the paper and perpendicular to the directions of energy flow, while the magnetic field directions are perpendicular to the paper.)

Far from the antenna, the energy flows outwards. However, near to the antenna most of the energy is stored around the antenna, flowing to and fro along its length, and only a small proportion is radiated outwards.

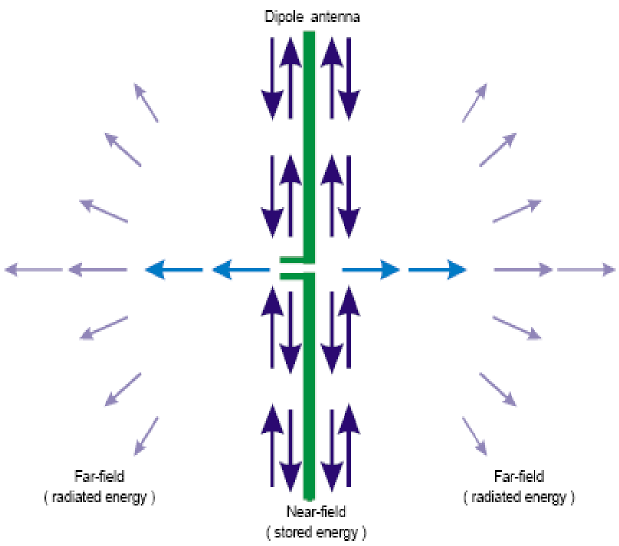

Figure 6 – Directions in which most of the energy flows (Stewart 2000: 35)

4.10 The World Health Organization

The WHO is of the opinion that because the radio frequency fields emanating from base stations are typically orders of magnitude below the ICNIRP derived RF safety guidelines, there is no potential health risk from exposure, provided the recommended ICNIRP compliance rules are followed. (www.who.int/pehmf/publications/facts_press/fact_english.htm - 28 June 2000)

4.10.1 Impact of GSM technology on environmental management

Several environmental management factors must be considered in the location of proposed base transceiver stations to counter their impact on the environment. The two most important factors would include bio-physical and socio-economic considerations (Vodacom 2000: 22).

4.10.2 Bio-physical factors

Bio-physical factors include the elevation of the site, relative to the surrounding topography, the surrounding land use, and the proximity to a site along, or near, a scenic route, or nature conservation area. According to (Vodacom 2000:22); other matters that require assessment are the following:

- Is there a backdrop of trees and other structures? From how many angles will the mast be camouflaged?
- Can the mast be painted in a way that will camouflage it?
- Will the BTS be screened from view? From how many angles will the mast be screened?
- Does the BTS break the skyline; and how high must the mast be?
- How close is the mast to similar structures?

4.10.3 Socio-economic factors

Socio-economic factors that have to be taken into account before the installation of a BTS would generally cover the following, as outlined in (Vodacom 2000: 22):

- Does the surrounding area have network coverage? (Generally people are more willing to accept new developments if they will benefit directly.)

- Will the site service the people in the immediate area (proximity of the site to a residential or office area)? What is the approximate affluence of the inhabitants?
- Affluent people appear to be more likely than other groups to belong to the NIMBY (Not In My Back Yard) contingent (i.e. they are not eager to have a BTS in their area, but do not mind if it is in someone else's, as long as they still have reception).
- Is the site close to on area of historical, conservation, or scenic value? And will any private views or panoramas be impaired?
- Are the inhabitants of the area known for their conservative attitudes towards new developments? In certain areas, the public are concerned with their "sense of place". This usually occurs where areas are perceived as being of outstanding natural beauty, as having historical importance, or as having a definite theme (e.g. a harbour, the Kruger National Park). In such cases, people may feel it is morally wrong to allow high-tech communication into places of tranquillity and "escape".

5. Summary

Mobile or cellular phones have become an integral part of modern society, and have helped revolutionise how we conduct our personal and business lives. Notwithstanding the potential threats to our safety, people are using cellular communications, and will continue to do so, because of the freedom of movement they bring.

Although health matters associated with the radio signals used by mobile (cellular) phone systems have been a much-debated issue, there is no convincing scientific evidence of a health risk associated with the proper use of mobile phones, or with living near a BTS. The debate on this issue is, however, likely to continue until such time as a massively convincing volume of scientific evidence has been accumulated.

A good deal of research has been undertaken into the subject of possible interference of electronic devices, and adverse health effects relating to the radio signals produced by mobile phones and base stations. Such studies have not demonstrated any substantive link between human health risks and GSM operations.

Chapter 3 is a survey of the literature on the theory of risk management, and the assessment of risks within the disciplines of occupational health, safety, and environmental management. Risk assessment theories and models are evaluated against published literature, and also against existing theory on this topic, to determine their applicability to the GSM industry in South Africa so as to establish a common risk-assessment model that can be used to address all levels of risk for heath, safety and environmental management within the GSM industry in South Africa.

CHAPTER 3

THEORETICAL PERSPECTIVE ON AN INTEGRATED HEALTH, SAFETY AND ENVIRONMENTAL RISK ASSESSMENT MODEL FOR THE GSM INDUSTRY IN SOUTH AFRICA

1. Introduction

In Chapter 2, a number of technical terms and definitions were explained to help the reader understand the Global System for Mobile Communications (GSM) industry. In the GSM industry, these definitions and technical terms are commonly used, and they form part of the telecommunications “language” in the industry.

Risk management is a separate discipline with its own "language". Definitions and terms used by risk management practitioners may have little or no meaning for people in the GSM industry. It is, however, important for practitioners in the GSM industry who are associated with the assessment of safety, health and environmental management, to have a clear understanding of the terminology and definitions common to operational risk management.

In this literature survey attention is paid to an integrated safety; health and environmental risk assessment model for the South African GSM industry. In addition, an attempt will be made to formulate an integrated risk assessment model for the three sub-disciplines of safety, health and environmental management within the risk management function.

In the literature survey it was found that it is important to identify synergies between GSM technology and the management functions of health, safety and environmental management.

One also has to determine whether an integrated health, safety and environmental management risk assessment model can enhance the GSM industry in South Africa, and if so, to what extent.

In order to understand the impact of health, safety and environmental management risks on the GSM industry, a comprehensive literature survey was undertaken of risk management issues relevant to the GSM industry.

This chapter comprises of an overview of risk management as a management function, as well as a review of the relationship between each of the following operational risk sub-disciplines, and the risk management function:

- safety
- health
- environmental management

The first section of Chapter 3 covers the basic theory and concepts required for understanding and interpreting literature on risk management theory which is discussed in the later sections of this chapter. The literature on specific safety, health and environmental management issues relevant to integrated risk management as a discipline are discussed in later sections.

2. The history of risk management

The first written statements on risk management can be traced back to Henry Fayol who, in an article dated 1916, listed six basic functions that should be included in management. At that stage he called it "security", but as time went by, a new concept would take root, which is more commonly referred to today as “the risk management discipline.”

According to (Snider 1991: 48), the first major international company to recognise and implement the concept of risk management was Massey-Ferguson. The first known policy statement on risk management was published by Massey-Ferguson early in 1966, and because of the fact that Massey-Ferguson operated internationally, managers and insurance brokers abroad became familiar with the concept. This was a significant factor in introducing risk management worldwide.

3. Definitions

The importance of risk management definitions cannot be overemphasised. As risk management terminology and definitions are relatively unknown in the field of GSM, individuals in this industry need a working knowledge of the terminology in order to place health, safety and environmental management within the GSM industry into perspective, and to avoid confusion between overlapping terms.

3.1 Risk

The word “risk” in insurance terminology is used to refer to the "thing" which is insured, the insured peril, the expected claims cost for a given policy, or as a general term for unwanted and uncertain future events (Carter, Crockford & Doherty 1994: 5).

From a management perspective, risk is generally considered to be the antithesis of benefit. It is viewed as diametrically opposed to profit or gain. It cancels out opportunity. It offsets the chance of succeeding. It is therefore a negative and undesirable factor which managers have to take into account.

A totally inclusive definition of risk includes hazards, dangers, and potential for loss, the degree or probability of a specific exposure to loss, as well as the liability to injury, damage, loss or pain. Examples of definitions of this concept are as follows:

"It encompasses jeopardy or the exposure to extreme danger for any situation. Loss potential due to risk also embraces rational behaviour, natural phenomena, and any other potential for realizing unwanted, negative consequences of any event. All of these defining elements of risk are wrapped together under the term risk". (Grose 1987: 24).

... risk is the potential realization of unwanted consequences of an event. Both a probability of occurrence of an event and the magnitude of its consequence are involved (Rowe 1982: 5).

... risk implies the presence of uncertainty ... This condition then becomes the foundation of any discussion of risk in a risk management context ... (Valsamakis, Vivian & Du Toit 2004: 25).

Valsamakis *et al.* (2004: 27) sum up the problem of defining risk as follows:

... interpretation depends to some extent on the particular orientation of the discussion of risk. Notwithstanding such qualifications however, there is still evidence of non-uniformity, rather than disagreement, concerning certain fundamental tenets when defining risk in the context of pure risk management and insurance.

Risk is unavoidable and present in virtually every daily situation. The concept common to all definitions of risk is uncertainty of outcomes. The one aspect which is sometimes viewed differently by authors is the way in which the outcomes of risks are characterised.

When formulating the definitions cited above, authors took the precaution of mentioning that the interpretation of the term depends, to some extent, on the particular orientation adopted in their discussion of risk.

3.2 Pure risk

Pure risks carry in themselves the possibility of loss or no loss (Dorfman 1994: 436; Rejda 1992: 14; Valsamakis, Vivian & Du Toit 1992: 28), in contrast to speculative risks, which offer the chance of loss or gain. Valsamakis *et al.* (2004: 34) offer the following definition:

"A classification often encountered is that of pure and speculative risks. Pure risks are those risks, which only have the possibility of a loss; for instance, the risk of destruction of a building due to fire. Speculative risks are those, which have the possibility of either a profit or a loss. Thus entering into a profit-making venture entails a speculative risk".

3.3 Objective and subjective risk

In situations where the outcome of an event is uncertain or not known in advance, such a situation is exposed to risk. According to Valsamakis *et al.* (2004: 27) "To the extent that the associated probabilities are assigned (objectively or subjectively) to possible outcomes, risk can be mathematically described. Where situations dictate that associated probabilities cannot be assigned (objectively or subjectively), risk cannot be quantified and thus it is immaterial from a risk management perspective whether one regards these situations as uncertain as opposed to risky".

3.4 Speculative risk

Both (Rejda 1992: 16) and (Dorfman 1994: 438) make it clear that in the case of speculative risk, the outcome can be either a loss or a profit (or even an unchanged situation).

"Speculative risk" attaches to actions that are planned to result in a benefit, an outcome that is of greater interest to management than loss. The fact that the law of large numbers can be applied more easily to pure risk than to speculative risk is important because it allows insurers to predict a loss in advance. The most important reason for not insuring speculative risk is that the process could be self-defeating. Take the following example quoted by (Greene 1983: 29): “A fire normally thought to represent only pure risk, may destroy a building which is uneconomical or was going to be destroyed anyway; thus, actually causing a profit being made for the owner.”

The assumption of risk by individuals is based primarily on the expectation of gain; to insure against the possibility of loss would substantially reduce, or eliminate, the extent of gain because the premium required would, in theory, amount to roughly the same as the expected return. "Thus, from an economic standpoint, insurance of speculative (business) risk is questionable" (Valsamakis *et al.* 2004: 261). Therefore, the insuring of speculative risk or business risk would represent a real transfer of risk from the business to the insurer.

3.5 Particular risk

“Particular risks are losses that have their origin in discreet events which are essentially personal in cause. Such risks would include fire damage to a building”. (Valsamakis *et al.* 2004: 35). Particular risks could be attributed to the mistakes and transgressions of human beings. A practical example would be that once a GSM installation has been completed, it is subject to little or no inherent risk at all. Because of the nature of the installation process, or the actions of maintenance staff members, the installation is, however, exposed to the risk of a systems failure (e.g. the malfunctioning of the electrical supply system, exposure to lightning and fire). Such hypothetical examples would include:

Maintenance staff members who perform “hot work” (welding task) at the top of an antenna when a spark could set the artificial tree ablaze that houses the antenna, resulting in the Base Transceiver Station (BTS) being totally destroyed.

A second hypothetical example would be the failure on the part of the installer of a standby generator set to earth the electrical installation, which may result in an electrical short in the circuit should a BTS be struck by lighting, causing the installation to be destroyed.

Both hypothetical events cited above may be attributed to the mistakes and misdeeds of human beings which, by definition, are termed “static risks”. .

3.6 Dynamic risk

Dynamic risk is associated with the uncertainties produced by an ever-changing society or economy.

A BTS may, for example, have been installed on school premises without any objection from the community. Should the situation change, for example if the debate on RF exposure and its potential risks intensifies, or new evidence of the adverse effect of RF exposure comes to light, public opinion on the risk for the children attending the school is bound to change.

Dynamic risks are closely associated with speculative risk, usually affect more individuals, and have a wider impact on society than static risks. In the GSM industry dynamic risks occur less frequently than static risks.

3.7 Fundamental risk

“Fundamental risk” is defined as a risk which has the potential to affect the entire economy, or large numbers of persons or groups within the economy. It is the opposite of a particular risk. (Valsamakis *et al.* 2004: 34).

3.8 Hidden risk

Losses attributable to hidden risks cannot be quantified, or directly related to an accident, and are consequently not included in the normal risk cover of an organisation.

These hidden risks may involve costs that are not accounted for. It is, for example, very difficult to determine the potential loss which could arise from an inferior communications installation during the course of a year of operation of the installation, because of the fact that losses of this nature have to be estimated on a somewhat arbitrary basis.

Costs related to dealing with public concerns about the location, and alleged health effects of emissions by radio base stations, cannot be quantified because it is difficult, if not impossible, to determine the monetary equivalent of the loss of goodwill, fame or reputation. This hidden risk will consequently not be included in a company's risk cover. Because hidden risks are difficult to quantify, a company cannot account for such risks in its budget (Berg *et al.* 1994: 34).

Hidden risks are rife in the GSM industry, especially in the South African context. The hidden risks and costs a service provider may face should it attempt to meet demands such as peak-time service provision, and compliance with standards and expectations, will result in the reduction of service excellence, and a decrease of recognition of achievements throughout the GSM industry.

3.9 Risk assessment

The concept of risk assessment has become a major theme in South African occupational health and safety legislation since the promulgation of the Construction Regulations. Across a wide range of activities which are defined under “construction”, employers are currently required to identify workplace hazards, and to assess the risks which might arise out of their business activities. For the reasons cited above, risk evaluation (assessment) could therefore be defined as the quantifying of a risk and determining its possible impact on the organisation (Valsamakis *et al* 2004: 15).

3.10 Risk rating

Risk rating, or characterisation, is defined as the process for estimating the incidence and severity of adverse health effects likely to occur because of actual or predicted exposure to workplace hazards. It is the final product of the risk assessment process that can be used by a risk manager to develop and prioritise control strategies, and to communicate risks (Guild, Ehrlich, Johnston & Ross: 2001: 74).

One of the most important steps is to determine whether the level of risk is acceptable is by assigning a risk rank level. Such estimations can be classified as:

3.10.1 Qualitative estimation

A simple ranking mechanism of low, moderate or high is used which is especially helpful when performing ‘baseline’ type risk assessments in which the objective is simply to identify the ‘significant’ risks which are subsequently more comprehensively measured (Guild *et al* 2001: 74).

3.10.2 Quantitative estimation

This method involves the use of a mathematical equation which is an extension of the low, medium and high scenarios, and which describes risk as a frequency. It may not be any more precise than the semi-quantitative as detailed under 3.10.3 below (Guild *et al* 2001: 74).

3.10.3 Semi - Quantitative estimation

The semi-quantitative method involves the use of a matrix, based on the rating of hazards, and the rating of likelihood of exposure where risks are rated as low, moderate or high. It provides a useful means for ranking risk on a comparative scale, and is more practical than the quantitative method (Guild *et al.* 2001: 74).

3.11 Peril

Rejda (1992: 14) and (Dorfman 1994: 435) define "peril" as the cause or source of a loss.

It is the view of Valsamakis *et al.* (1992: 30), that “[p]eril therefore is quite distinct from risk, which has been defined as the absence of certainty relative to both the occurrence of a loss-producing event and its outcome. Typical perils are fire, explosion, storm and earthquake".

A peril is an event that may cause a loss. The term “risk” sometimes replaces peril, but unless it is clear from the context exactly what type of risk is meant, it is suggested that risk be qualified by naming the peril concerned a fire risk, a storm risk, or whatever the case may be.

3.12 Hazard

According to (Dorfman 1994: 430) a hazard is “a circumstance increasing either the frequency or severity of losses”. (Rejda 1992: 8) adds the possibility of loss to his description, defining a hazard as a “condition that creates or increases the chance of loss”.

From the above definition it is clear that a hazard could be construed as the presence of a condition that affects the probability, frequency and size of a loss. For example, a suburban GSM installation is considered to be more hazardous in terms of potential radiation emissions than a similar installation in a city centre, which is deserted over weekends.

3.13 Incident

An incident is an unplanned, unexpected and undesired event which may, or may not; downgrade the efficiency of the business operation. Incidents may occur by chance or as a result of deliberate actions.

Occupational health and safety incidents are very common in the GSM industry. The three major cellular network operators in South Africa investigate all occupational health and safety incidents as a matter of course because such incidents are indicators of systems failures or potential systems failures, which may result in accidents.

Some authors on the subject also tend to refer to incidents as “near misses.”

3.14 Accident

Very little literature pertaining to accidents and definitions of the phenomenon is available in the context of risk management. It is, however, common to describe an accident as a "sudden, unforeseen and unintentional" event (Rejda 1992: 1), which may result in physical harm to a person and/or damage to property. “No accident has a singular cause. It is always composite“, adds (Grose 1987: 186).

Carter *et al.* (1994: 4.1-01) warn risk managers against the possibility of confusing the "underlying cause (e.g. faulty installation of electrical wiring) and operative peril (e.g. fire)" because of the danger of overlooking some of the sources of the loss, adding that “[t]his has led many writers on risk management to advocate the use of a ‘check list of perils’ to avoid such oversight.”

A better approach is first to look for risk sensitive areas and possible loss producing events, and then to identify the perils, which may trigger such events, and their likely impact on the enterprise. In this way it is possible to produce a comprehensive and logical pattern of risk identification. Risk assessments on GSM processes are used to address incidents and accidents proactively.

In order to conduct comprehensive and accurate risk assessments, it is very important for the GSM industry in South Africa to develop an integrated model for assessing health, safety and environmental risks in order to prevent or at least minimise incidents and accidents associated with processes within the GSM industry.

3.15 Risk management

Risk management is an integral component of good management and decision-making at all levels.

All organisations manage risk continuously whether they realise it or not – some more rigorously and systematically than others. More rigorous risk management occurs most visibly in organisations in which the core mandate is to protect the safety and health of their employees and contractors in an environmentally responsible manner.

According to the King ll Report on Corporate Governance for South Africa 2002 (Section 2, Risk Management/Chapter 1 Introduction and Definition' paragraph 5) "the risk management process entails the planning, arranging and controlling of activities and resources to minimise the impacts of all risks to levels that can be tolerated by shareowners and other stakeholders whom the board has identified as relevant to the business of the company".

In paragraph 6 the Report (2002), risk management as a process that uses internal controls as one of the measures to mitigate and control risks is further elaborated. Risks such as political, technological and legislative perils, which cannot be managed by means of traditional internal control systems, should be addressed adopting a flexible approach, and using forward planning and similar mechanisms.

As was the case with the concept of "risk", there are many accepted definitions of risk management in the literature.

Rejda (1992: 15) defines risk management as “executive decisions concerning the management of pure risks, made through systematic identification and analysis of loss exposures and search for the best methods of handling them”.

According to (Rowe 1982: 200), risk management is simply the “systematic assessment/approach to basic organisational type risks”, whereas Valsamakis *et al.* (1992: 56) describe risk management as “a managerial function aimed at protecting the organisation against the consequences (adverse) of pure risk, more particularly aimed at reducing the severity and variability of losses".

The King ll Report (2002) defines risk management as “the identification and evaluation of actual and potential risk areas as they pertain to the company as a total entity, followed by a process of either termination, transfer, acceptance (tolerance) or mitigation of each risk.” In view of the fact that many organisations today have an increased sensitivity to the impact of financial risks on their operations, Troy (1995: 72) is of the opinion that risk management should include the assessment of financial risk. The Society of Risk Managers (South Africa), however, believes that risk management is “a management function whose objective is the protection of people, assets and earnings by avoiding or minimising the potential for loss from pure risk, and the provision of funds to recover from losses that do occur”.

What is important is the fact that risk management is primarily a management function, which has to comply with the basic generic functions of planning, organising, leading and the controlling of resources within the organisation, in order to ensure that the organisation attains the goals and objectives it has set for itself within the parameters of cost-effectiveness.

According to (Englehart 1994: 65), risk management "is best understood through its history. In its search for a place of its own, risk management has had to fight turf battles with human resources, legal, operations and finance departments. In relation to these other departments, risk management is a relatively recent addition to the corporate structure".

The definition of risk management which, however, provides the foundation for this research is that of Rejda (1992: 47):

"… a systematic process for the identification and evaluation of pure loss exposures faced by an organisation or individual, and [for] the selection and administration of the most appropriate techniques for treating such exposures. It is a discipline that systematically identifies and analyses the various loss exposures faced by a firm or organisation, and the best methods of treating the loss exposure consistent with the organisation's goals and objectives…"

This definition was chosen because of its integrated approach to risk management according to a systematic process whereby risks are identified and evaluated in order to eliminate or minimise them through the selection of appropriate techniques which will enhance the attainment of the organisation's goals and objectives.

4. Enterprise risk management

According to Valsamakis *et al.* (2004: 72) the approach to risk management has changed in recent years:

“Traditional risk management practices tended to focus on the management of insurable risks such as losses resulting from fires, thefts and liability claims. It also included the responsibility for the buying of insurance and occasionally for occupational health and safety programmes. Over the past few years there has been a marked trend towards the expansion of risk management to include the management of other risks in the organisation”.

This new trend, referred to as "enterprise risk management" (ERM), may be attributed to the emergence of corporate governance, which refers to the relationships between the management of the organisation, its board, its shareholders, and other stakeholders.

Corporate governance is an organisation-wide issue that, as one of a number of co-ordinated initiatives within the organisation, will improve decision-making, enabling the shift to results-based management. Enterprise risk management requires an overview of all the aspects of an organisation with the aim of better managing the organisation’s risks.

Organisations that manage risk over the total spectrum of their business activities are more likely to achieve their objectives than organisations which focus on only one aspect of risk management.

Effective risk management minimises losses and negative outcomes, and identifies opportunities of improving service to stakeholders and the general public. The King ll Report (2002), of which the aim was to promote the highest standards of corporate governance in South Africa, has placed greater emphasis than ever before on an integrated risk management function which covers all the risks in an organisation – in other words, on enterprise risk management (Valsamakis *et al.* 2004: 76).

5. Integrated risk management

A systematic, integrated, but adaptable approach to addressing risk requires the organisation to build its capacity to address risk explicitly. This increases the organisation's and stakeholders' confidence in its ability to manage the identified risks.

If an organisation adopts such an approach, it contributes to better utilisation of resources, improved teamwork, and strengthened trust through sharing analyses and actions with its strategic partners. In addition, by emphasising the need for more active and frequent consultation and risk communication, an integrated approach to addressing risk within the organisation leads to a shared responsibility for managing its risk.

The current GSM-operating environment is demanding a more thoroughly integrated risk management approach to its sphere of operations. It is no longer sufficient for operators to manage risk at the individual activity level or in functional isolation.

Organisations in the GSM industry are faced with many different types of risks in the fields of project management, finances, human resources, technology, health, safety and the environment. These varied risks may be high-level, or high-impact, risks which demand an integrated and systematic corporate response.

In terms of the GSM industry in South Africa, integrated risk management requires an organisation to engage in the ongoing assessment of potential risks at every level, and to aggregate the results at corporate level. This approach facilitates priority-setting, in addition to improving decision-making.

It is essential that integrated risk management become embedded in the organisation's corporate strategy, and that it shape the organisation's risk management culture. This can be achieved by identifying, assessing and managing risks across an organisation's entire spectrum of activities, which reveals the importance of the whole — the sum of the risks and the interdependence of the parts — and will give direction to the organisation's risk assessment.

Integrated risk management does not only focus on the minimisation or mitigation of risk, but also supports activities which foster innovation, so that the greatest returns can be achieved within an environment of acceptable results, and low costs and risks. Integrated risk management strives for the optimal situation of addressing risks at all levels of the organisation.

Integrated risk assessment may, in the light of the preceding discussion, best be defined as: "… a continuous, proactive and systematic process to understand, manage and communicate risk from an organization-wide perspective. It is about making strategic decisions that contribute to the achievement of an organization's overall corporate objectives". (www.tbs-sct.gc.ca/pubs_pol/dcgpubs/RiskManagemnent/rmf-cgr01-1_e.html - 17 July 2002).

6. Environmental management

According to Fuggle & Rabie (2000: 5) the term 'environment' is widely used, but means various things to different people. They also claim that it is of particular importance for an environmental manager to recognize that different professions attach specific connotations to the term.

In terms of the Environment Conservation Act, Act 73 of 1989, 'environment' is defined as "the aggregate of surrounding objects, conditions and influences that influence the life and habits of man or any other organism or collection of organisms".

The term “environment” is a dynamic concept and may change over time — it may even differ from one country to another, depending on the context in which it is being used (e.g. socio-economic, cultural, or political).

In the South African legal context, the term “environment” has been viewed in both a wide and a narrow sense. The limited, or narrow, approach includes the natural environment, but excludes the social environment. Since the natural environment usually refers to natural resources, this approach is too narrow for the purposes of this investigation, because human beings have changed much of the purely natural environment.

The meaning and scope of “environment” will also be influenced by the interpretation which the courts might give to this concept in terms of the environmental rights enshrined in section 24 of the Bill of Rights.

The most recent definition of “environment” appears in Section 1 of the National Environmental Management Act of 1998. It reads as follows:

“Environment” means the surroundings within which humans exist and that are made up of —

(i) the land, water and atmosphere of the earth;

(ii) micro-organisms, plant and animal life;

(iii) any part or combination of (i) and (ii) and the interrelationships among and between them; and

(iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being

6.1 Environmental impact

An environmental impact is defined as any change to the environment, whether adverse or beneficial, wholly or partially resulting from an applicant’s activities, products or services (South African National Standards 2003: 6).

6.2 Environmental aspect

An environmental aspect is an element of a company's activities, products or services that can interact with the environment. These aspects, in turn, have an impact(s) on the environment by bringing about change to the environment — be it positive or negative. ISO 14001 calls for the organisation to identify those aspects which have significant impacts on the environment (Vodacom 200: 18).

6.3 Environmental impact assessment

An Environmental Impact Assessment (EIA) is a systematic gathering of all relevant quantitative and qualitative information by experts, in consultation with informed parties, in order to make it possible for informed decision-making to occur. The process includes a wide-ranging consultation process with statutory and non-statutory institutions (Hutchinson & Hutchinson 1997: 143)

7. An integrated risk management model for the GSM industry in South Africa

"The King II Report (2002) states that safety, health and environment (SHE) issues "should be dealt with in an integrated way where possible. However there may be specific strategic and best practice issues relevant to safety, health and the environment individually".

Based on personal experience as a safety, health and environmental management specialist in the GSM industry in South Africa, the researcher can testify to the fact that health, safety and environmental management does not function as an integrated whole in this industry. It has become clear that the application of an integrated risk assessment model, in conjunction with related risk management activities, would establish a risk-aware environment in which organisations in the South African GSM industry can function.

8. Summary

In this chapter an overview was presented of risk management as a management function as well as a review of the relationships between the operational risk sub-disciplines of health, safety and environmental management which all constitute parts of the risk management function.

The basic theory and concepts required for understanding and interpreting literature on risk management theory was dealt with in this chapter, as well as specific health, safety, and environmental management definitions relevant to research on integrated risk management as a discipline.

In the next chapter — Chapter 4 — an outline will be presented on individual approaches to assessing risk within the disciplines of occupational health, safety and environmental management. In addition an integrated approach to establish an integrated health, safety and environmental risk assessment model for the South African GSM industry will be put forward based on the grounds of theoretical research. .

CHAPTER 4

THEORETICAL PERSPECTIVE ON A HEALTH, SAFETY AND ENVIRONMENTAL RISK ASSESSMENT MODEL FOR THE SOUTH AFRICAN GSM INDUSTRY

1. Introduction

In this chapter each approach to assessing risk within the disciplines of occupational health, safety and environmental management is outlined and, on the grounds of theoretical research, an attempt will be made to combine the commonalties into an integrated approach to establish a model for assessing operational risk within the South African GSM industry.

As discussed in Chapter 2, low-level radio frequencies (RF) or microwave (MW) fields may, under certain conditions of exposure, have a measurable effect on biological organisms. The intensity of microwaves emitted by a GSM installation is, however, generally below the intensities that are considered to be harmful to humans.

Health impairment resulting from the long-term use of cellular phones has not been studied in detail; however, the available data indicate that the possibility of related non-specific health symptoms exists.

In Chapter 2, the researcher pointed out that transmitting antennas and base stations contribute minimally to environmental contamination by microwaves, and do not pose any health risks. While the risks posed by base stations are generally overestimated by the general public, it is crucial that organisations undertake risk assessments. The reasons relate not only to compliance with the statutory requirements contained in Section 8 of the Occupational Health and Safety Act (85 of 1993), and the National Environmental Management Act (107 of 1998), but also to demonstrate corporate social responsibility in terms of Section 24 of the Constitution.

With reference to health and safety, risks cannot be directly observed and it is necessary to perform an assessment to estimate the level of risk.

A number of techniques are available for assessing risks. With the help of the literature study, the researcher will concentrate on developing a model that will, first, identify risks; second, assess their potential seriousness; third, seek to influence the associated outcomes; and, finally, monitor the effectiveness of interventions.

Poor decisions about the handling of risks may have serious or even fatal consequences. Such decisions usually result from a lack of awareness of hazards, or from a flawed perception of the potential seriousness of those hazards.

Although risk assessments are not expressly addressed in the Occupational Health and Safety Act (85 of 1993), section 8 (General duties of employers to their employees) at 8(1) states:

> (1) Every employer shall provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of his employees.

At section 8(2) it is stipulated:

> Without derogating from the generality of an employer's duty under subsection (1), the matters to which those duties refers include in particular subsection (d) establishing, as far as is reasonably practicable, what hazards to the health or safety of persons are attached to any work which is performed, any article or substance which is produced, processed, used, handled, stored or transported and any plant or machinery which is used in his business, and he shall, as far as is

> reasonably practicable, further establish what precautionary measures should be taken with respect to such work, article, substance plant or machinery in order to protect the health and safety of persons, and he shall provide the necessary means to apply such precautionary measures.

Section 12 (General duties of employers regarding listed work) stipulates that:

> employees undertaking listed work or who are liable to be exposed to the hazards emanating from listed work, shall identify the hazards and evaluate the risks associated with such work constituting a hazard to their health. This section also sets out the steps that organisations should take in order to comply with the provisions of the 1993 Occupational Health and Safety Act.

In the 2003 Construction Regulations (GNR.1010 of 18 July 2003: Construction Regulations, 2003 Occupational Health and Safety Act, 1993), the Minister of Labour, in terms of section 43 of the Occupational Health and Safety Act, places the onus on the client to prepare a health and safety specification for construction work. The client is also obliged to provide any principal contractor who is making a bid, or is appointed to perform construction work for the client, with such a safety plan.

Most important for organisations in the GSM industry in South Africa is Regulation 7, which reads as follows:

> *7. Risk assessment —*
>
> (1) Every contractor performing construction work shall before the commencement of any construction work and during construction work, cause a risk assessment to be performed by a competent person appointed in writing

and the risk assessment shall form part of the health and safety plan to be applied on the site and shall include at least —

(a) the identification of the risks and hazards to which persons may be exposed to;

(b) the analysis and evaluation of the risks and hazards identified;

(c) a documented plan of safe work procedures to mitigate, reduce or control the risks and hazards that have been identified;

(d) a monitoring plan; and

(e) a review plan.

(2) A contractor shall ensure that a copy of the risk assessment is available on site for inspection by an inspector, client, client's agent, contractor, employee, representative trade union, health and safety representative or any member of the health and safety committee.

(3) Every contractor shall consult with the health and safety committee or, if no health and safety committee exists, with a representative group of employees, on the development, monitoring and review of the risk assessment.

(4) A contractor shall ensure that all employees under his or her control are informed, instructed and trained by a competent person regarding any hazard and the related work procedures before any work commences, and thereafter at such times as may be determined in the risk assessment.

(5) A principal contractor shall ensure that all contractors are informed regarding any hazard as stipulated in the risk

assessment before any work commences, and thereafter at such times as may be determined in the risk assessment.

(6) A contractor shall ensure that as far as is reasonably practicable, ergonomic related hazards are analysed, evaluated and addressed in the risk assessment.

(7) Notwithstanding the requirements laid down in sub regulation (4), no contractor shall allow or permit any employee or person to enter any site, unless such employee or person has undergone health and safety induction training pertaining to the hazards prevalent on the site at the time of entry.

(8) A contractor shall ensure that all visitors to a construction site undergo health and safety induction pertaining to the hazards prevalent on the site and shall be provided with the necessary personal protective equipment.

(9) Every employee on site shall —

be in possession of proof of the health and safety induction training as determined in sub regulation (7), issued by a competent person prior to the commencement of construction work; and carry the proof contemplated in paragraph (a) for the duration of that project or for the period that the employee will be on the construction site.

Before the promulgation of the Construction Regulations, no official requirements existed to bind organisations in the GSM industry to submit a risk assessment of work undertaken or proposed to be undertaken.

It is clear that Regulation 7 of the Construction Regulations only focuses on the occupational health and safety functions. Although regarded as a separate sub-discipline, environmental management was excluded from the Construction Regulations notwithstanding the fact that Sections 21, 22 and 26 of the Environment Conservation Act (73 of 1989), and Section 24(G) of the National Environmental Management Act, as amended, requires organisations to undertake environmental impact assessments (EIAs) regarding their proposed business activities. Because risk assessments are a legal requirement for many work activities, criminal or civil proceedings may ensue if organisations do not perform assessments, execute them poorly, or ignore their findings; hence the importance of a risk assessment model for the GSM industry.

Risk assessments are used to identify and prioritise the areas of the GSM industry that need to be addressed in order to ensure control of risks associated with GSM activities. These areas range from initial site identification to the final commissioning of a GSM installation.

A risk assessment allows an organisation to identify and assess risks and impacts according to set criteria, and to develop a written emergency plan or procedures covering all the identified safety risks.

Risk assessment is a structured process that identifies both the likelihood, and extent, of adverse consequences arising from a given activity, facility or system. Within the context of this standard, the adverse consequences of concern are physical harm to people, and damage to property or the environment.

In the execution of risk assessment to answer three fundamental questions are addressed:

- What can go wrong?
- How likely is this to happen?
- What will the likely consequences be?

These questions may be answered by undertaking a risk assessment, and a frequency and severity analysis respectively. Inconsistencies in terminology and concepts regarding risk assessments exist, and it is, therefore, important to standardise definitions of the major terms.

Regulation 5 of the Major Hazard Installation Regulations under the Occupational Health and Safety Act (85 of 1993), makes specific provision for risk assessments. It should be noted, however, that in terms of Regulation 2, GSM installations would fall beyond the scope of application of the regulations.

2. Health and safety risk assessments

Hunter (1992) is convinced that manufacturers should be aware of the potential safety risk of a product in its design stage:

> The concept of product safety, as applied to the design of mechanical products, implies that designers of products have some measure of control over the magnitude of the threat, which the products pose to people or property. The extent to which designers exert this control is a reflection of their concern for the public welfare. Another concern is the costs of litigation arising from injuries to persons or property caused by the use of the product. There are established methods for the recognition and evaluation of various types of hazards (Hunter 1992: 9).

These methods should clearly be applied as early as possible in the design effort. From a health and safety perspective, an assessment of the associated risks in the earliest stages of the design of a GSM network or installation is of paramount importance. Any threat to personal safety that can develop during the expected life span of a GSM installation should be seriously considered from the outset of a project. Such threats can arise from several sources.

2.1 Sources of risk

According to (Tchankova 2002: 291):

[T]he sources of risk can be categorised depending on the environment in which they arise, as follows:

- physical environment
- social environment
- political environment
- operational environment
- economic environment
- legal environment
- cognitive environment

In South Africa the above-mentioned sources of risk are considered highly relevant when assessing the establishment of a GSM network, and more specifically during the roll-out plan for constructing a BTS site. For the purposes of this research, each of the above sources of risk is discussed in relation to the GSM industry in South Africa.

2.1.1 Physical environment

The physical environment is an important source of risk. Choosing the wrong site for a BTS can lead to serious losses. The environmental influence of the BTS on the people, and people's influence on the environment, are important aspects of this source of risk. The physical location can be a source of profitable opportunities; for example, the monthly rental of a BTS site may make a significant contribution to the bottom-line results for property owners (including schools and churches).

2.1.2 Social environment

Changes in people's values, human behaviour, and the state of social structures are further sources of risk. Civil unrest, social riots, and strikes are events that exemplify the importance of the social environment as a source of risk.

The level of workers' skills, and their loyalty to the organisation in the GSM industry, has a considerable influence on the success of the organisation. Differences in social values and culture between various segments of society create opportunities. For example, the equal opportunities now enjoyed by groups who were denied opportunities in the past have led to faster development in the previously disadvantaged areas because of making the 1800-MHz spectrum available to both Vodacom and MTN. The Minister of Telecommunications in South Africa awarded both Vodacom and MTN a licence to operate on this frequency on the condition that 500 000 cellular telephones be made available to persons in the developing areas.

Effectively the additional 500 000 cellular telephones will create additional BTS sites in the rural areas, resulting in the obvious exposure to risks associated with the establishment of a local network.

2.1.3 Political environment

The political environment is an important source of risk in all countries. The ruling party can affect organisations in different ways, for example by regulating telecommunications — as is the case with the Independent Communications Authority of South Africa (ICASA) in South Africa. Such regulating includes implementing strict codes of practice about the environment. The political environment is an even more complex and important source of risk when an organisation operates internationally. The differences between governments give rise to different attitudes and policies toward businesses.

2.1.4 Operational environment

An organisation's operational activities invariably result in the creation of risk and uncertainty. For example, damage to an installation or production process might result in physical injuries to workers. Unfavourable working conditions can threaten the physical health of the workers. The procedure of hiring and firing contractors may generate a legal problem, and the installation of a BTS on a particular site may cause harm to the environment. In these cases, the organisation itself is a source of risk.

Because widening their operational environment provides opportunities, which improve the quality of life and work of the people, both Vodacom and MTN play a major role in the establishment of GSM networks in rural areas, as well as beyond the South African borders. But the international business (Vodacom in Tanzania and MTN in Nigeria) can suffer risks in the area because of the absence of logistical support systems, and their reliance on less advanced local systems.

It is imperative that, notwithstanding the fact that such hazards are known, effective mitigating control measures are implemented to minimise or eliminate these risks.

The following operational risks are common to the GSM industry, and should be identified by means of the risk assessment process.

1. *Electrical hazards:* The principal electrical hazard to humans is the potential of electrocution. The major electrical hazard to property is from electrical faults attributable to faulty installations which may cause short-circuits and arcing, in turn leading to large releases of energy and damage to equipment.

Examples of faulty installations are the following:

- Incorrect thickness of electrical wire (which cannot carry the electrical current fed through the electrical wire)
- Incorrectly rated circuit breakers, resulting in the circuit breaker not protecting the load carried by the electrical wiring, or the rating of the circuit breaker not allowing the air-conditioning units in the BTS to be activated after a power failure

The management of electrical risks can be attained through the application of the South African Bureau of Standards (SABS) code of practice (SABS 0149) which regulates electrical installations in South Africa. In addition to the above, the Electrical Installation Regulations (Government Notice R 2920 of 23 October 1992) regulate the responsibility for electrical installations; and the Electrical Machinery Regulations (Government Notice R 1593 of 12 August 1988) regulate the safety of electrical equipment. Both Regulations were promulgated under the Occupational Health and Safety Act, 85 of 1993.

2. *Fire hazards:* Fire hazards in GSM installations are generally associated with electrical faults. Fires may be caused by improperly installed electrical systems in the BTS, notwithstanding that cellular network operators have developed suitable designs and construction methods, and despite the installation of smoke and fire-detection systems linked directly to a control room, which monitors fire alarms on a 24-hour basis.

3. *Human factors:* According to (Hunter 1992: 19):

> "… the assumption is still made that the user of the product or the operator of the equipment will use or operate it in the manner intended by the designer. This assumption is often grossly erroneous. Human nature being what it is, the designer must also consider any other possible modes of use or operation and then evaluate which alternative modes are the most probable".

A classic example in the GSM industry would be a commissioning technician who ascends a mast 56 metres high to adjust the microwave antennas without the appropriate safety harness, or other personal protective equipment (PPE), for the mere sake of saving the BTS some down-time, and without any consideration for his own personal safety. It is a truism that as long as people are involved, errors and mistakes will be made. When human errors occur during use or operation of equipment, the chances of personal injury or damage to property are greatly increased. Some of these errors may be accidental, and their consequences are difficult for any designer to anticipate, although others may be more wilfully incurred by the user.

4. *Environmental risks:* According to (Hunter 1992: 20):

> These risks fall into two categories: internal and external. The internal risks are adverse things that can happen to damage the product internally as a result of changes in the surrounding environment. External risks are the adverse effects, which the product can have to cause damage to things external to the product.

At this point, it is important to illustrate the synergy between assessing risks to health, safety and the environment, and the close relationship between these disciplines. With reference to the GSM industry, the following are some of the environmental risk factors which ought to be considered:

- the presence of any vibrations where the product is to be located (Vibrations generated by electric standby generating plants can have an adverse effect on the environment.)
- any atmospheric contaminants (Electromagnetic emissions)
- the level of illumination available to the operator
- ambient noise levels
- the level of electromagnetic radiation (Electric switching devices can radiate electromagnetic disturbances, which cause static electricity.)

The disposal of the product at the end of its useful life must also be considered within the environmental framework. The project manager and his project team must consider the method of disposal, as well as the impact of this disposal method on the environment during all phases of the GSM network. The basic principle of “from the cradle to the grave“ in the GSM industry means that the network engineer must consider the hazards posed by the proposed product throughout its entire life cycle. This must include hazards which occur during the design process, manufacturing, expected use, foreseeable misuse and abuse, maintenance, and the hazards connected with the disposal of the product after it no longer has any use for the organisation.

2.1.5 Economic environment

The political environment usually influences the economic environment, but the globalisation of the GSM industry creates a market that is greater than a single national market, and needs to be considered as separate from the political environment.

With reference to South Africa’s position in the African Union (AU), a given activity of the South African government can affect the region’s capital market. Examples of sources of risk generated by the economic environment are, from a global perspective, economic recession and depression, and at a local level, interest rates and credit policy.

2.1.6 Legal environment

The legal environment is a further factor which creates risk and uncertainty in business. While this is valid for all countries, it has become increasingly important in South Africa over the past ten years. The legal system creates risk because of the disparity between existing and new laws pertaining to the environment.

According to (Fuggle & Rabie 2000: 96) "… it appears that the greater portion of environmental law falls squarely within the domain of administrative law, most of it being special administrative law. This characteristic is shared by a number of other fields of law, such as those relating to housing, public health, food and drugs, agriculture and aviation. It seems that in none of these have any distinctive principles yet evolved".

The complexity of practice increases because of the differences between legal standards in different provinces, a situation that can lead to conflict among the provincial legislatures.

The legal system can, however, also create opportunities by stabilising society, resulting in a situation in which organisations will understand the restrictions within they are expected to work. The legal system protects the individual's rights, such as the right not to have a BTS in one's back yard through the environmental impact assessment process which allows interested and affected parties to object to any development that may have an adverse effect on the environment.

The GSM industry in South Africa is well regulated. Specific examples include the Occupational Health and Safety Act, the National Environmental Management Act and the Telecommunications Act.

2.1.7 Cognitive environment

The risk manager's ability to reveal, understand and assess risk can, for psychological reasons, never be perfect. It is an established fact that the differences between the perceptions of different people, and the objective reality are an important source of risk in any organisation. The cognitive environment therefore constitutes a major challenge for every risk manager.

The researcher will consider two important questions in this regard: “How should one assess the impact of uncertainty on the organisation?” and ”How do we know whether the perception of risk is real or not?”

2.2 Resources exposed to risk

A particular risk can arise in more than one of several of these environments. For example, environmental pollution can result from human error (social environment), or from failures in control systems (operational environment).

In the practice of risk management only those sources of risk that threaten the organisation or its resources are investigated. That is why the analysis of resources exposed to risk is so important. In the following sections, the potential risks attached to specific categories of resources will be investigated.

2.2.1 Physical resource exposures

In the GSM industry physical resources refer to base stations, antennas, construction equipment and buildings. Because they can be damaged or destroyed, they are exposed to risk. Damage or failure to operate leads to losses. An important feature here is that a total GSM network can come to a halt if even a small part of it is out of order. This can lead to losses that greatly exceed the cost of this single piece of equipment.

2.2.2 Human resource exposures

Human resources are the wealth of each organisation. The success and competitiveness of an organisation depends, to a considerable extent, on the competence of its staff, and on their ability to be creative. Risks threatening human resources are, for example, injuries leading to partial working inability, including physical and psychological health, or the death of someone in the organisation. Within every organisational context, employing new workers or hiring casual labour poses a risk for the organisation.

It is general practice in the GSM industry to employ casual labour for short periods of time. Such casual labour is exposed to high-risk environments without being provided with the necessary competence training, and often without possessing the skills to perform the work for which they are employed.

Because the implementation of GSM technology requires highly skilled workers, it is the manager's task to integrate the elements which decrease the possibility of loss with the elements which maximise the probability of gain. Employee training is the best way of achieving this. A good training programme would increase workers' skills, and decrease the probability of failures and injuries. The loyalty of workers also has to be included in the human resource exposure.

2.2.3 Financial resources exposure

Money and other financial assets, such as the financing of a GSM network, are subject to financial risk. In this case the risk is associated with external factors, and not necessarily with a clear physical change in the assets.

In contrast to physical resources, the value of financial resources can increase or decrease without any direct physical change to the resources. As (Tchankova 2002: 297) explains, "Usually losses or gains are associated with the results of changing market conditions. A specific risk related to the financial resources is investment risk."

For example, investment procedures in new GSM projects include the requirement that the investment be profitable within a specified period of time. A possible risk is that an invested sum might not be redeemed at the expected rate, or even that it might be lost in full.

The cost of establishing a single BTS site in a rural area could be in excess of R1,5 million. It is therefore very important that a BTS installation generates revenue as soon as, and for as long as possible, without any interference such as “down-time”.

2.3 The risk assessment process

Glendon and McKenna (1995: 320) are of the opinion that “[t]he extent to which a person (or a system) is exposed to danger (or a hazard) represents the risk of a certain activity as a course of action”. Within the GSM industry risks cannot always be directly observed. In risk assessment, organisations will therefore have to rely on estimates and calculated sums.

The term used for people’s subjective appraisals is "risk perception". By contrast, a number of techniques such as Hazard and Operability Study (HAZOP) and Preliminary Risk Analysis (PRA) are available for assessing risks more objectively (Glendon & McKenna 1995: 320).

There is no generic risk assessment model for the GSM industry in South Africa that addresses the risks which could potentially threaten GSM activities. With the exception of a few changes, the following risk assessment process has been accepted as applicable to GSM industry activities in southern Africa.

The essence of a risk assessment is to be found in four basic activities, namely identifying (measuring) risks, evaluating their potential impact (their importance in the light of other factors), trying to influence the associated outcomes through appropriate control measures (e.g. doing something about them), and finally monitoring the effectiveness of interventions.

2.3.1 Risk identification

Risk identification is the basic stage in risk assessment. It lays the foundation for the development and implementation of new programmes for risk control in an organisation. When identifying risks, management should raise the following important questions:

- What are the risks?
- How many risks are there?

Identifying risk involves systematic assessment of all risks (physical, chemical, etc.) that could affect the system (equipment or employees). As stated before, section 8 of the Occupational Health and Safety Act (85 of 1993), makes it obligatory that hazards within a workplace be assessed.

In the first place these assessments involve determining the degree of risk associated with any given assignment to be performed by an employee. In addition to this, locations and processes associated with the risk have to be identified, as well as employees who are exposed, or people who might be exposed (e.g. visitors, employees or contractors) to them. The following conclusions about risk identification are important:

- Risk identification is a process that reveals and determines the possible risks facing the resources of the organisation.
- Risk identification is the investigation of organisational activities in all contexts directions, and at all levels of the organisation managerial levels. Internal and external environmental changes require risk identification to be undertaken on a continuous basis in order to reveal any new risks which might have arisen.
- Implementation of a structured approach to risk identification (sources of risk, risk factors, resources exposed to risk) is a modern, systematic way of conducting risk identification. It makes it possible to reveal the relationship that exists between the causes and consequences of an event (cause and effect).
- A proposed classification of sources of risk, for example, the physical, social, political, operational, economic, legal or cognitive environment, enhances the probability of covering all types of risk which might face an organisation.

- The grouping of the resources exposed to risk (physical, human and financial resources) is based on a practical consideration of the risk profile in the organisation.

2.3.2 Risk evaluation

Risk evaluation involves an analysis of information derived from the identification process so that priorities may be assigned in respect of high-risk activities. Instances where many employees or external people are exposed to relatively high risks would logically take precedence over situations or conditions in which small numbers of employees or external people are exposed to lower levels of risk. When evaluating risks, management should pose the following pertinent questions:

- How much danger does the activity constitute?
- How soon will the danger eventuate?
- At what frequency will it take place?
- Who is exposed?
- What are the consequences of the activity?

The initial process of preparing a GSM site (landscaping, the construction of the concrete base, provision of underground services for cabling and electrical infrastructure, and the installation of the security fencing) poses a low risk in terms of health and safety, but there will inevitably be a greater impact on the environment once the station is fully functional. Once the tower or mast has been constructed, the identification process will show that the installation poses a greater health and safety risk than the initial construction of the site.

The risk evaluation process can be used to identify and prioritise the risk that certain activities might expose individuals who work on the masts to radiation.

2.3.3 Risk control

Controlling risk takes the form of implementing managerial, procedural and/or engineering controls that will effectively reduce or eliminate the risk. The process does not end there because these controls have to be monitored to determine both their initial and continuing effectiveness. Controlling the risk is guided by the answers to the following questions:

- What are the most appropriate methods?
- What will be the benefit of these measures?

Legal compliance, as well as International Standard Organisation (ISO) systems audits — such as the ISO 14001 (Environmental), ISO 9001:2000 (Quality), and OHSAS 18001 (Health and Safety) third party audits — will ensure the effectiveness of managerial or procedural and engineering controls to a certain degree, depending on the extent to which the system has been entrenched.

2.3.4 Monitoring and measurement

This last stage of risk assessment provides a basis for ranking the risks in terms of their priorities, and for determining appropriate mitigating control measures, or deciding whether the complete process should be repeated.

Constant monitoring and evaluation of risks are the driving forces of a feedback system of control. This process must be repeated to ensure whether all the hazards that were identified initially are, in fact, still present or whether they have been successfully dealt with (checklists, audits and so on are used for this purpose). This can be done by checking each risk against historical data or outcomes, bearing in mind the number of people exposed, their vulnerability (e.g. young or inexperienced workers), and possible outcomes, including fatal injury, serious injury, health damage, plant damage, and environmental pollution. Monitoring includes judging the probability of harm occurring on a scale of "likely/frequent", through "probable", "possible" and "remote" to "improbable". These outcomes have to be plotted against probabilities in a matrix to arrive at a number of different risk categories.

Monitoring controls should make provision for benchmarking against other, or similar, controls within the industry, or in other, related industries, as well as for determining the changes required in order to measure up to those benchmarks.

Three types of risk assessment can be identified in the GSM industry:

- Assessments of large-scale, complex hazard sites, such as a GSM network built in a densely populated area (school, shopping centre or business complex), requiring quantitative risk assessment (e.g. involving fault trees, event trees, and hazard and operability studies).
- Risk assessments required under specific legislation such as the Hazardous Substances Act (15 of 1973) and the Occupational Health and Safety Act (85 of 1993)
- Assessments of risks related to a specific workplace, work process or customer requirements.

Regulations promulgated under the Occupational Health and Safety Act should be followed not merely to comply with existing legislation, but also in order to enhance both the effectiveness and objectivity of a risk assessment, and to facilitate comparison with other risk assessments.

3. Risk assessment models

Several risk assessment models are used in different industries. Some of these models as listed in Table 1 below are considered the most common methods used in risk analysis:

Table 1: Risk assessment methods (ISO/IEC 60300-3-9).

METHOD	DESCRIPTION
Event Tree Analysis	A risk identification and frequency analysis technique which employs inductive reasoning to translate different initiating events into possible outcomes
Fault Modes and Effects Analysis; Fault Modes, Effect and Criticality Analysis	A fundamental risk identification and frequency analysis technique which analyses all the fault modes of a given equipment item for their effects both on other components and the system
Fault Tree Analysis	A risk identification and frequency analysis technique, which starts with the undesired event and determines all the ways in which it could occur. These are displayed graphically
Hazard and Operability Study	A fundamental risk identification technique which systematically evaluates each part of the system to see how deviations from the design intent can occur and whether they can cause problems
Human Reliability Analysis	A frequency analysis technique which deals with the impact of people on system performance and evaluates the influence of human errors on reliability
Preliminary Hazard Analysis	A risk identification and frequency analysis technique that can be used early in the design stage to identify hazards and assess their criticality
Reliability Block Diagram	A frequency analysis technique that creates a model of the system and its redundancies to evaluate the overall system reliability

Other methods include the following:

Table 2: Alternative risk assessment methods. (ISO/IEC 60300-3-9)

METHOD	DESCRIPTION
Category Rating	A means of rating risks by the categories in which they fall in order to create prioritised groups of risks
Checklists	A risk identification technique, which provides a listing of typical hazardous substances and/or potential accident, sources of which need to be considered. Can evaluate conformance with codes and standards
Common Mode Failure Analysis	A method for assessing whether the coincidental failure of a number of different parts or components within a system is possible and to determine its likely overall effect
Consequence Models	The estimation of the impact of an event on people, property or the environment. Both simplified analytical approaches and complex computer models are available
Delphi Technique	A means of combining expert opinions that may support frequency analysis, consequence modelling and/or risk estimation
Hazard Indices	A risk assessment technique which can be used to rank different system options and identify the options with the least risk
Monte-Carlo Simulation	A frequency analysis technique which uses a model of the system and other simulation techniques to valuate variations in input conditions and assumptions
Review of Historical Data	A risk assessment identification technique that can be used to identify potential problem areas and also to provide an input into frequency analysis based on accident and reliability data

For the purpose of this research, a number of methods of analysis are discussed. These methods have been selected because of their applicability to the GSM industry in southern Africa. The sequence in which they are discussed does not imply that one method is less or more important than the other.

Information on these methods of analysis has been derived form the OHSAS 18000 International Standard on Occupational Health and Safety; volume 8 dated October 1999 (reference ISO/IEC 60300-3-9).

3.1 Hazard and operability (HAZOP) study

A HAZOP study is a form of fault modes and effects analysis (FMEA). HAZOP studies were originally developed for the chemical industry as a systematic technique for identifying hazards and operability problems throughout an entire facility.

This method is particularly useful in identifying unforeseen hazards designed into facilities due to a lack of information, or introduced into existing facilities due to changes in process conditions, or operating procedures. The basic objectives of the techniques are to:

- Produce a full description of the facility or process, including the intended design conditions
- Systematically review every part of the facility or process to discover how deviations from the intention of the design can occur
- Decide whether these deviations can lead to hazards or operability problems.

The principles of HAZOP studies can be applied to process plants in operation or in various stages of design. A HAZOP study carried out during the initial phase of design can frequently provide a guide to safer detailed design. The most common form of HAZOP study is carried out at the detailed design phase, and is referred to as a HAZOP II study.

A HAZOP study may highlight specific deviations for which mitigating measures need to be developed. For those cases where mitigating measures are not obvious or are potentially very costly, the results of the HAZOP study identify the initiating events necessary for further risk analysis (ISO/IEC 60300-3-9: Annex A – A1 [Informative]).

3.2 Fault modes and effects analysis (FMEA)

FMEA is primarily a qualitative technique, although it can be quantified, by which the effect or consequences of individual component fault modes are systematically identified. It is an inductive technique, which is based on the question “what happens if...?”.

The essential feature in any FMEA is the consideration of each major part or component of the system, how it becomes faulty (the fault mode), and what the effect of the fault mode on the system would be (the fault mode effect). Usually, the analysis is descriptive, and is organised by creating a table or worksheet for the information. As such, an FMEA clearly relates component fault modes to their causative factors and effects on the system, and presents them in an easily readable format.

FMEA is a “bottom-up” approach that considers consequences of component fault modes one at a time. As such, the method is tolerant of a slight amount of redundancy before becoming cumbersome to perform. In addition, another person familiar with the system can readily verify the results.

The major disadvantages of the technique are the difficulty of dealing with redundancy, and the incorporation of repair actions, as well as the focus on single component failures. An FMEA can be extended to perform what is called Fault Modes, Effects and Criticality Analysis (FMECA). In an FMECA, each fault mode identified is ranked according to the combined influence of its probability of occurrence, and the severity of its consequences (ISO/IEC 60300-3-9: Annex A – A2 [Informative]).

FMEAs and FMECAs provide input for analyses such as fault tree analyses. In addition to dealing with system components, they may be used to deal with human error. They can also be used for both hazard identification and probability estimation (if only a limited level of redundancy is present in the system).

3.3 Fault tree analysis (FTA)

FTA is a technique that may be either qualitative or quantitative. According to this method, conditions and factors that may contribute to a specified undesired event (called the top event) are deductively identified, organised in a logical manner, and represented pictorially. The faults identified in the tree may be events that are associated with component hardware failures, human errors, or any other pertinent events that may lead to the undesired event. Starting with the first event, the possible causes or fault modes of the next lower functional system level are identified. Following stepwise identification of undesirable system operation to successively lower system levels will lead to the desired system level, which is usually the component fault mode.

FTA affords a disciplined approach which is highly systematic, but at the same time sufficiently flexible to allow analysis of a variety of factors, including human interactions and physical phenomena. The application of the "top-down" approach, implicit in the technique, focuses attention on those effects of failure that are directly related to the top event. This is a distinct advantage, although it may also lead to not identifying effects which are important elsewhere.

FTA is especially useful for analysing systems with many interfaces and interactions. The pictorial representation leads to a ready understanding of the system behaviour and the factors included, but as the trees are often large, processing of fault trees may require specialised computer software packages.. This feature also makes the verification of the fault tree difficult.

FTA may be used for hazard identification, although it is primarily used in risk assessment as a tool to provide an estimate of failure probabilities or frequencies (ISO/IEC 60300-3-9: Annex A – A3 [Informative]).

3.4 Preliminary hazard analysis (PHA)

PHA is an inductive method of analysis in which the objective is to identify the hazards, arduous situations and events that can negatively impact on a given activity. It is most commonly carried out early in the development of a project when information is available on design details or operating procedures. It can also be useful when analysing existing systems or prioritising hazards where circumstances prevent the use of a more comprehensive technique.

PHA is used to formulate a list of hazards, and generic hazardous situations, by considering characteristics such as:

- Materials used or produced and their reactivity
- Equipment employed
- Operating environment
- Layout
- Interfaces among system components

The method is used to identify the possibilities that an accident could occur, a qualitative evaluation of the extent of possible injury or damage to health, and the designation of possible remedial measures. PHA should be updated during the phases of design, construction, and testing to detect any new hazards and to make modifications wherever necessary. The results obtained may be presented in formats such as tables and trees (ISO/IEC 60300-3-9: Annex A – A5 [Informative]).

3.5 Hazard identification and risk assessment process (HIRA)

The Hazard Identification and Risk Assessment Process (HIRA) is used in the South African mining industry to identify levels of risk. It is based on the identification of safety, health and environmental hazards, as well as on the associated safety, health and environmental risks, but with the emphasis on the frequency and severity of risks as primary parameters (OHSAS 18002, V8 dated October 1999).

This process framework incorporates risk assessment tools that provide for:

- Hazard identification
- Exposure assessment
- Risk characterisation

3.5.1 Steps of the HIRA process

Managers or employees carrying out the HIRA process have to proceed according to the following steps in accordance with OHSAS 18002, V8 (dated October 1999).

- Agree on the terminology to be used for safety, health and environmental hazards.
- Agree on the terminology to be used for safety, health and environmental risks.
- Draw up parameters for severity and frequency.
- Draw up a matrix, and agree on format and plotting.
- Observe of hazards by breaking up each process or activity into its component parts, and then enumerating and listing hazards.
- Plot these on the matrix.
- Draw up a profile of risks.
- Check for existing controls and affectivity risks
- Adjust risks accordingly.
- Draw up final risk profile.

3.5.2 Parameters used to determine the frequency rating of an incident

The following parameters are used to determine the frequency rating of an incident in accordance with the National Occupational Safety Association of South Africa (NOSA) HIRA process model.

The frequency is reflected as follows:

- 1/week: Daily to once per week
- 1/month: Weekly to once every two months
- 1/six months: From every two months to once every six months
- 1/year: From once every six months to once a year
- 1/10 years: From once every year to once every ten years

3.5.3 Parameters to determine severity

The following parameters are used to determine severity in accordance with the National Occupational Safety Association of South Africa (NOSA) HIRA process model:

- Estimated maximum loss (R mil)
- Effect on plant and personnel
- Effect on works
- Effect on business
- Effect on the public (Property damage, town residence and public reaction)

3.6 Risk rating

Risk rating is the process of estimating the frequency and severity of adverse effects likely to occur due to actual or predicted exposure to workplace hazards. It is the final product of the risk assessment process which is used to develop and prioritise control strategies, and to communicate risks.

One of the most important steps is to determine whether the level of risk is tolerable by assigning a risk rank-level to the situation under review. The estimations can be defined in qualitative, quantitative or semi-quantitative terms as:

Qualitative ranking: Analysts use their judgement while applying a simple ranking mechanism of "low", "moderate" or "high". This is especially useful when performing a "baseline” type of risk assessment where the object is simply to identify the "significant" risks which are then more comprehensively measured and/or analysed (Guild 2001: 74).

Quantitative ranking: This involves the use of a mathematical equation that is an extension of the low, medium and high ranks, and describes risk as a frequency of deaths. It may not be any more precise than the semi-quantitative option described below (Guild 2001: 74).

Semi-quantitative ranking. This method involves the use of a matrix based on the rating of hazards, and the rating of likelihood of exposure. Risks can be rated as low, medium or high. This provides a useful means for ranking risk on a comparative scale, and it is more practical than the quantitative method (Guild 2001: 74).

The method of risk rating is described below.

The frequency of a worker's exposure to a risk, and the severity of such an exposure, is assessed according to a risk-rating matrix. This estimation enables one to position the risk activity within the risk matrix, and in doing so to determine the acceptability of the risk according to one of three categories:

- High risk, where immediate action is required no matter what the cost.
- Medium risk, where further reduction of risk is necessary, but where it could be dealt with in the medium to long-term period.
- Tolerability, which takes into account the financial impact that should be reduced to as low as reasonably possible.

The purpose of corrective or preventive action is to reduce the frequency of the occurrence of the risk and/or reduce the severity of the outcome. It is important to ensure that corrective actions do not introduce any new risks. If the risk is regarded as tolerable, it is important to ensure that the existing system and risk do not change. Ongoing monitoring should also be implemented.

This straightforward approach is useful for preliminary (baseline risk) assessment, but it is likely that the actual level of risk cannot be determined. This will mean that more information will have to be obtained by means of a monitoring programme.

4. International Standard on Occupational Health and Safety (OHSAS 18001)

Although the International Standards Organisation (ISO) does not prescribe an international standard for occupational health and safety, the standard for occupational health and safety that is accepted worldwide (including in southern Africa) is the OHSAS 18001 standard. Because of a lack of occupational health and safety standards, the OHSAS 18001 standard will be used as a reference for risk assessment for the purpose of this research. According to OHSAS 18001, "the organisation should have a total appreciation of all significant occupational health and safety risks in its domain, after using the process of risk identification, risk assessment and risk control". Risk identification, risk assessment and risk control processes in the GSM industry should be appropriate and adequate, and should allow organisations to identify, evaluate and control their occupational health and safety risks on an ongoing basis.

The complexity of the risk identification, risk assessment and risk control processes depends to a major extent on factors such as the size of the organisation, the workplace situations within the organisation, and the nature, complexity, and significance of the risks to which the organisation is exposed.

With the exception of size of the respective organisations, all cellular network operators (Vodacom, MTN and Cell C) will share the same complexities of risk identification, risk assessment, and risk control processes for their respective installations in South Africa.

Each organisation should take into account the cost and time involved in carrying out risk identification, risk assessment and risk control processes, as well as the availability of reliable data with information already developed for regulatory or other purposes that can be used in the practical control they may have to exercise over the occupational health and safety risks being considered. The organisation should determine what its occupational health and safety risks are, and make an allowance for the inputs and outputs associated with its current and relevant past activities, processes, products and/or services.

According to the OHSAS 18001 standard:

> an organisation with no existing Occupational Health and Safety (OH&S) management system should establish its current position with regard to OH&S risks by means of an initial review. The aim should be to consider all OH&S risks faced by the organization, as a basis for establishing the OH&S management system.

This initial review should cover four key areas:

- Legislative and regulatory requirements.
- Identification of the health and safety risks faced by the organisation.
- An examination of all existing occupational health and safety management practices, processes and procedures.
- An evaluation of feedback from the investigation of previous incidents, accidents and emergencies.

5. Hazard identification, risk assessment and risk control according to the OHSAS 18001 standard

Hazard identification, risk assessment and risk control vary greatly across industries, ranging from simple assessments to complex quantitative analyses with extensive documentation which would, according to the OHSAS 18001 standard, provide for a documented system which includes the following elements:

- Identification of hazards.
- Evaluation of risks with existing (or proposed) control measures in place (taking into account exposure to specific hazards, the likelihood of failure of the control measures and the potential consequences of injury/damage).
- Evaluation of the tolerability of residual risk.
- Identification of any additional risk-control measures needed.

- Evaluation to determine whether the risk-control measures are sufficient to reduce the risk to a tolerable level.

5.1 Hazard identification and risk-assessment criteria

The following criteria apply to the hazard identification, risk assessment and risk-control processes:

- The nature, timing, scope and methodology of any form of hazard identification, risk assessment and risk control should be defined while taking into account any applicable legislative or other requirements.
- Competency requirements and training needs (refer to element 4.4.2 of the OHSAS 18001 standard) for performing hazard identification, risk assessment and risk control should be defined. For some organisations, depending on the type of process used, it may be necessary to use external advice or services.
- The roles of staff responsible for performing hazard identification, risk assessment and risk control, and what hey have been authorised to do, should be defined.
- Information from employee occupational health and safety reviews should be considered.
- Feedback on the results of hazard identification, risk assessment and risk control should be provided to management as input to establish occupational health and safety objectives, and for management review in terms of element 4.6 of the OHSAS 18001 standard.
- The mere existence of a written procedure to control a hazardous task does not remove the requirement for hazard identification, risk assessment and risk control of the operation.
- In addition to considering the hazards and risks posed by activities carried out by its own staff, the organisation should consider hazards and risks arising from the activities of contractors and visitors, and from the use of products or services supplied to it by others.

- The occupational health and safety hazards posed by materials, plant and equipment that degrade over time, particularly if these are in storage; should be known.
- Hazard identification, risk assessment and risk control should take into account the measures implemented for the control of risks that are in effect at the time of the assessment. If consideration of the resulting risk leads to amendments to these measures, further hazard identification and risk assessment should be conducted to reflect the amendments and to estimate the residual risk.
- There should be clear evidence that actions identified during hazard identification, risk assessment and risk-control processes are monitored for their timely completion.
- Hazard identification, risk assessment and risk control should be carried out proactively, rather than as a reactive measure. They should, for example, precede the introduction of new or revised activities or procedures, and risk reduction and control measures identified via the process should be in place before the change is implemented.
- There should be a feedback loop from subsequent operating experience to amend the hazard identification, risk assessment and risk-control processes, or the data on which they are based, in the light of the operating experience.
- Where appropriate, hazard identification, risk assessment and risk control should identify competency/training requirements for affected staff.
- Human error should be considered as an integral part of the hazard identification, risk assessment and risk control processes.
- Measures to manage risk should reflect the principle of elimination of the risk where practicable, followed, in turn, by risk reduction (either by reducing the probability of occurrence or potential severity of injury or damage), but with the adoption of personnel protective equipment (PPE) as a last resort (OHSAS 18002, V8 dated October 1999).
- Abnormal conditions.

- Emergency conditions and the consequences of such emergency conditions.

5.2 Hazard identification and risk-assessment document control

The OHSAS 18001 standard further stipulates under element 4.6 that it is important for the organisation to keep its documentation, data and records concerning the identification of hazards and the assessment and control of risks up to date in respect of ongoing activities. The organisation should also supplement these to cover new developments, and new or modified activities, before they are implemented. The results should show the level of risk associated with any particular risk that could have an effect on the organisation’s occupational health and safety objectives. If this occurs, the organisation would need to review its occupational health and safety objectives (OHSAS 18001 standard element 4.6).

5.3 Hazard identification and risk-assessment process review

Reviewing hazard identification, risk assessment and risk controls refers to element 4.6 under the OHSAS 18001 standard.

The hazard identification, risk assessment and risk-control processes should be reviewed at a predetermined time or period as set out in the organisation’s occupational health and safety policy document, or at a time predetermined by management. This period may vary depending on:

- The nature of the hazard
- The magnitude of the risk
- Changes in normal operation

Such a review should also be undertaken if changes within the organisation call into question the validity of the existing assessments. Such changes may include:

- Expansion, contraction, restructuring.
- Reapportioning of responsibilities.
- Changes made to working methods or patterns of behaviour.

5.4 Typical outputs

The OHSAS 18001 standard makes provision for documented procedure(s) for:

- Identification of hazards.
- Determination of the risks associated with the identified hazards.
- Indication of the level of the risks related to each hazard, and whether or not they are tolerable.
- Description of, or reference to, the measures to monitor and control risks (refer to elements 4.4.6 and 4.5.1), particularly risks that are not tolerable.
- Where appropriate, the objectives and actions to reduce identified risks (refer to element 4.3.3), and any follow-up activities to monitor progress in their reduction.
- Identification of competency and training requirements to implement the control measures (refer to element 4.4.2).
- The necessary control measures to be detailed as part of the operational control element of the system (refer to element 4.4.6).
- Records generated by each of the above-mentioned procedures.

Some reference documents, including the British Standard on Occupational Health and Safety (BS 8800), use the term “risk assessment" to include the entire process of hazard identification, determination of risk, and selection of appropriate risk-reduction or risk-control measures. OHSAS 18001 and OHSAS 18002 refer to the individual elements of this process separately, and use the term “risk assessment” to refer to the second of its steps, namely the determination of risk.

To summarise the risk assessment process: the researcher believes that this process is best illustrated by means of the schematic diagram adapted from (Glendon & McKenna 1995: 321) that appears in Figure 7.

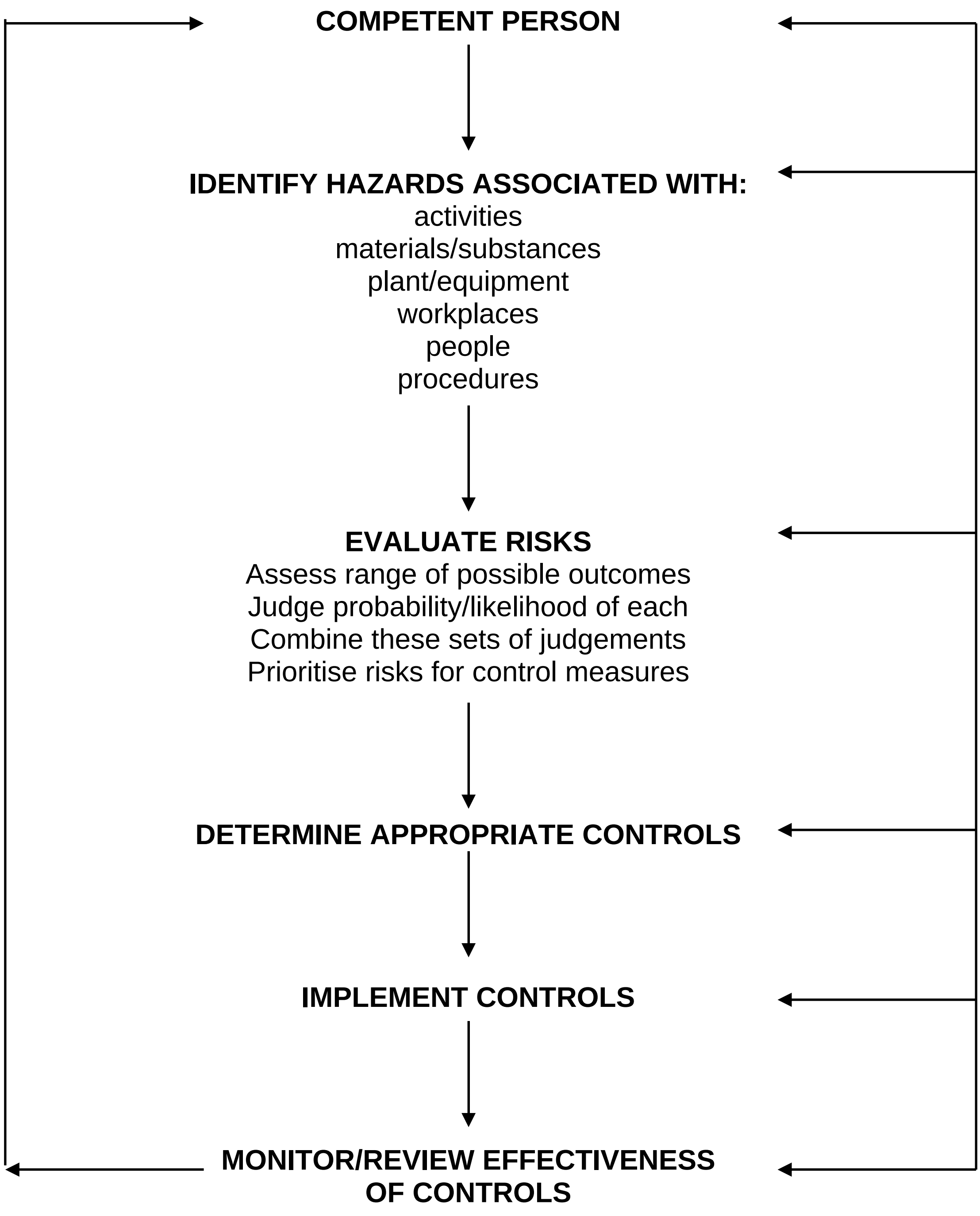

Figure 7 — Risk Assessment Process (Glendon & McKenna 1995: 321)

6. Introduction to Environmental Impact Assessments

An Environmental Impact Assessment (EIA) is simply a study undertaken to understand the effect of a new development on the environment. An EIA is normally undertaken when there is a perception of the possibility that the proposed development may harm the environment.

An EIA may therefore be defined as a process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of proposed projects and physical activities before major decisions and commitments are made (www.ea.gov.au/assessments 08 February 2002 p 3 of 23).

In the context of the GSM industry, the construction of a BTS is a development that may harm the environment.

The people conducting the EIA will inform interested and affected parties how all parts of the environment will be changed by the planned development. The EIA process starts by describing the environment which will be affected, for example, the plants, animals, water, air, archaeological legacies, and people's quality of life.

In the next phase of the EIA, the planned development will be examined in terms of its size, location and reason for the development. Based on this information, the interested and affected parties will be able to determine to what extent, and in which way, the development may affect or change their environment.

Both Vodacom and MTN were granted blanket EIA approval for the construction of their BTS sites during the early 1990s, and the impact of their BTS sites was never a concern. Since 1996 it has, however, become evident that the GSM network, with its vast number of BTS sites spread all over the country, has, in fact, had a very detrimental effect on the environment.

The third cellular operator in South Africa, Cell C, did not enjoy the same leniency as Vodacom and MTN, and had to submit an EIA for every BTS site it constructed. As a result, Cell C was unable to meet its projected roll-out of 1 000 BTS sites by the end of 2001.

To date, the lead-time for Cell C to obtain approval for a BTS site extends to beyond six months, which places Cell C at a competitive disadvantage in relation to Vodacom and MTN, who had already established themselves in the GSM industry before EIAs became a prerequisite for GSM site acquisition.

In terms of environmental management, the EIA is, in its simplest form, a planning tool that is now generally regarded as an integral component of sound decision-making within the GSM industry in South Africa. As a planning tool, it has both information-gathering and decision-making components, which provide the decision-maker with an objective basis for granting or denying approval for a proposed development.

Although many EIAs were carried out in South Africa before the EIA regulations came into being, particularly for large or controversial developments such as GSM installations, they were not legally required by the authorities, and standards varied greatly. The regulations, therefore, have had major implications for planners, developers and policy-makers in the GSM industry as well as for government.

In terms of the National Environmental Management Act (NEMA) (107 of 1998), planners, developers and organisations involved in the implementation and commissioning of GSM networks are now required to integrate environmental issues into their planning.

Although the regulations have provided a sound legal basis from which to evaluate the environmental impacts of a GSM network, a number of problems have been experienced with their implementation.

Some of these problems relate in part to the fact that the regulations are activity-based and do not focus on the environment in which an activity is occurring. Some seemingly minor activities, which are not listed, may still have a detrimental impact if undertaken in a highly sensitive environment. In addition, the regulations are not co-ordinated with other legislation, especially land-use planning legislation.

Despite a number of limitations, the regulations have assisted the role-players in the GSM industry to begin integrating environmental concerns into their decision-making. In conjunction with legislation such as NEMA, the regulations are assisting the GSM industry to achieve environmentally responsible development.

The legislative history of EIAs dates back to the National Environmental Policy Act of 1969 (NEPA) in the United States of America (US). This Federal Act provided for legally compulsory environmental impact assessment in certain circumstances, set a precedent to be followed in other States of the US, as well as in various foreign countries, including South Africa.

In the South African context, EIAs were embodied in the Environment Conservation Act of 1989 and later in the Constitution of the Republic of South Africa (1996). A landmark was the promulgation of the existing national environmental policy on 21 January 1994, with the primary focus on the promotion of sustainability and equity in resource allocation.

South Africa is subject to implied EIA requirements in terms of its obligations under international law. Numerous agreements between governments and Non-Governmental Organisations (NGO's) reached during the World Summit on Sustainable Development held in Johannesburg, have given practical substance to the transnational application of EIAs. The duty implied by the requirements of Customary International Law will, moreover, apply to South Africa.

> Given that there has been some significant development in other legislation than the Environment Conservation Act 1989, but also that the apparently imminent "activation" of ss 21-22 of the Environment Conservation Act by the publication of regulations could still take some time, the implied EIA requirement argued above gives some substance to the view that the situation in South Africa is rather better than it has ever been (Peckham 1997: 131).

6.1 Environmental evaluation requirements in South Africa

South Africa has historically lacked the integration of environmental concerns through an open system of government, which included a wide disclosure of information and an informed population. Other problems included the lack of scientific data, inadequate administrative structures, and the lack of trained staff (Fuggle & Rabie 2001: 748).

Fuggle and Rabie (2001: 748) add that:

> [I]n most less developed countries, including South Africa, scientific, educational or aesthetic requirements are regarded by many as a luxury, while the concern for the future is seldom as pressing as present needs for food, shelter and security. As a result, environmental concerns do not carry a strong electoral basis in many of these countries, leading to a lack of political will to introduce environmental assessments.

This situation has, however, changed drastically in South Africa since the latter part of 2001. Local government authorities now prohibit organisations in the GSM industry from constructing new BTS installations without approval. Such approvals now include a complete and detailed EIA of the proposed BTS, taking all interested and affected parties' concerns into consideration.

This has been particularly evident in the case of Cell C, the third cellular phone operator in South Africa, which has been unable to obtain a "blanket" site approval for new BTS installations without the appropriate EIAs being submitted prior to the construction of these sites.

These factors exist in a context in which economic growth and development are necessarily national goals. Clearly, an approach to environmental evaluations in South Africa is needed which reflects these conditions, taking account of both the limitations and requirements of this country.

6.2 Environmental considerations for planning and management of telecommunications structures – the South African National Standard (SANS 10397:2003)

Protecting the South African environment is currently considered to be of such great importance that a South African standard was approved by Standards South Africa (a division of the South African Bureau of Standards) in 2003 (SANS 10397:2003).

This standard was a direct result of the massive development of telecommunication technology over the past few years, and its rapid dissemination to meet the growing demand for better and more convenient communication. This standard will undoubtedly improve people's quality of life, and give them new choices in the decision-making process with regard to further GSM network expansion in South Africa.

New telecommunication structures have the potential to cause significant transformation of the environment, and result in a severe negative environmental impact. Telecommunication structures, by their nature, are frequently located on high-lying ground where they have a high visual impact, and they can also often have a deleterious effect on sensitive natural ecosystems such as mountains, hillsides, and other scenic areas.

Because of their potentially significant environmental impact, telecommunication structures were made subject to environmental impact assessment by the Environmental Impact Assessment (EIA) regulations of the Environment Conservation Act, 73 of 1989 in 1997.

In terms of these regulations, all telecommunication structures must go through a scoping study or environmental impact assessment (or both). The results of any such studies must be submitted to the relevant provincial environmental authority or the national Department of Environmental Affairs and Tourism for authorisation of the proposed activity.

According to Standards South Africa (2003:1)

> The Standard SANS 10397:2003 is intended to assist applicants of telecommunication structures to:
>
> - “Choose the most environmentally acceptable sites for telecommunication structures at the start of the planning process,
> - Identify mitigating measures that can be used to minimize the environmental impact of telecommunication structures as early as possible during the planning process,
> - Obtain exemption from some or all of the requirements of the EIA regulations for applications that will have a low level of environmental impact, and
> - Limit the environmental impact of telecommunication structures to the lowest possible level during their operational life” (SANS 10397:2003).

It is the intention of Standards South Africa that this standard should also assist provincial and national environmental authorities in reviewing the applications in terms of the EIA regulations by:

- Ensuring that the format of documents submitted for authorisation is relatively consistent, meaningful and understandable.

- Ensuring that EIA reports comply with certain minimum standards.
- Through reference, using the recommendations in this standard as conditions of approval.

According to Standards South Africa (2003:2), "[t]he ultimate aim of this standard is to make the assessment and decision-making process quicker and more efficient, to the benefit of both the applicant and the decision-making authority". (SANS 10397:2003). The environmental impact of communication masts (site selection and management of the mast), and the mast site, are two main considerations that should be taken into account when planning the location of a BTS.

The Environmental Considerations for the Planning and Management of Telecommunications Structures Standard (SANS 10397:2003) provides overall guidelines for the environmental site selection process for telecommunication structures. These guidelines consider the initial site selection process, placing emphasis on minimising the environmental impact by choosing the most environmentally acceptable site from the outset. The ultimate aim is to assist applicants who wish to put up telecommunication masts to speed up the environmental impact assessment authorisation process for these sites.

Clause 5 of the Standard provides guidelines for applicants regarding site maintenance and continued compliance with the requirements of the authority's Record of Decision (ROD). The recommendations of clause 5 are designed to be compatible with an ISO 14001-based environmental management system.

It is the intention of the Standards Authority that the application of the recommended management measures should help applicants to comply with authorisation conditions and, at the same time, to save the relevant authorities time by enabling them to refer to these standard requirements when authorising a telecommunication development, instead of compiling a new set of authorisation conditions for each application.

The inclusion of environmental considerations in the Planning and Management of Telecommunications Structures Standard (SANS 10397: 2003) has been a major breakthrough for cellular network operators in the GSM industry. Not only will this standard bring about savings in time and costs, it will also mean that the most important aspect in the planning of telecommunications structures, namely environmental considerations, is now regulated on a national basis through the application of this standard.

6.3 Environmental assessments

Extensive reference will be made to "impact assessment(s)" throughout the ensuing sections on environmental assessments and environmental impact assessments. Prior to that discussion, however, the concept, and the related terminology, is clearly defined, and placed into context to allow the discussion to proceed without interruption.

6.3.1 Environmental impact

According to (Fuggle & Rabie 2002: 754) "[I]f it is clear that significant impacts will result from a proposal, an impact assessment is conducted. There are three principal components of an impact assessment:

- *Scoping:* This determines the extent of and approach to the investigation. The proponent, in consultation with the relevant authorities and the interested and affected parties, determines which alternatives and issues should be investigated; the procedure that should be followed and particular report requirements. An opportunity is provided for objections to the scoping procedure undertaken. The Scoping guidelines of the Department of Environment Affairs (DEA) provide detailed information on scoping procedures.

- *Investigation:* The investigation is guided by the scoping decisions, and is intended to provide the authorities with enough information on the positive and negative aspects of the proposal, and feasible alternatives, with which to make a decision.
- *Report:* This should be based on the guidelines for report requirements of the Department of Environment Affairs (DEA). The parties may establish particular requirements for the report during the scoping stage".

The scope of the impact assessment investigation will vary from a relatively brief assessment by a competent party to a very detailed assessment by a team of professionals.

It should be reiterated that, if the proponent undertakes detailed environmental investigations during the development of the proposal stage, the organisation could then find during the scoping stage that the necessary investigations have already been conducted, and that the proposal includes the necessary findings. In such an instance, no further environmental investigations would be required.

In line with this, risks and impacts are more significant than ever before. We live in a greenhouse world of ozone holes and vanishing species. Many reputable scientists believe that the impact of human activities on the biosphere is reaching critical thresholds, with the consequent threat of ecological breakdown and social conflict.

Environmental assessments are, therefore, essential wherever development may impact on the environment. The approach of conducting EIA's provides a basis for designing policies and plans that take account of environmental potentials and constraints, and for managing the impacts and risks of GSM projects and activities.

The purpose of environmental assessments is twofold. First, the immediate aim is to facilitate sound decision-making processes in which environmental considerations are explicitly included. The environmental impact assessment process does so by providing clear, well-organised information on the environmental effects, risks, and consequences of development options and proposals.

Second, the process is usually directed toward achieving or supporting ultimate goals of environmental protection and sustainable development. These reference, or end, goals are variously phrased and framed in environmental assessment laws and policies, as are the specific objectives to be met by the process.

The Australian Department of Environment and Heritage comments as follows regarding environmental assessments:

> "Internationally, environmental assessments are becoming a multi-purpose process, with increasing emphasis given to promoting long term, societal goals that reflect and express the ideals of sustainable development. These include:
>
> - Safeguarding valued ecological processes and heritage areas;
> - Avoiding irreversible and unacceptable loss and deterioration of natural capital;
> - Ensuring development is adjusted to the potentials and capacities of the resource base;
> - Optimising natural resource use, conservation and management opportunities;
> - Protecting human health and community well being; and addressing distributional concerns related to the disruption of people and traditional lifestyles (retrieved on 8 February 2002 from www.ea.gov.au/assessments, p 3 of 23)".

As a widely used process for meeting these objectives, environmental assessments also meet a number of supporting and secondary aims. These include the following in the context of the GSM industry:

- *Improved co-ordination among participating agencies and actions*: The purpose here is to improve the relationship between the cellular network operator and the statutory authority responsible for issuing the appropriate permits to establish a BTS in a specific area. (The focus in this instance would be on the relationship between the cellular network operator and the local authority in whose area the BTS is proposed.)
- *Fostering better-designed and planned development projects (greener and more cost-effective).* This would be achieved by not constructing BTS sites (particularly towers) which may have a detrimental effect on the skyline or the surroundings such as in game parks. An interesting fact is that the Vodacom Tanzania project was not allowed to construct any BTS sites in the Serengeti because of the importance of protecting the environment in that area.
- *Empowering community development and building local capacity through public participation*. Historically the public, more commonly defined as interested and affected parties, did not have any say in the choice of a location for a BTS in their area. Today, all interested and affected parties have to be consulted prior to the establishment of a site in any area.
- Instilling environmental values and accountabilities across a range of institutions.
- *Internalising environmental costs and damages.* Within the industry, the "polluter pays" principle applies. BTS sites may no longer be left in a state of disarray after completion. Cellular network operators nowadays make an effort to restore the environment to its original state by replacing plants and trees. In areas where it is necessary to clear the surroundings to construct a BTS site, waste management programmes have been implemented to prevent the area from being polluted.

6.4 Stages of the Environmental Impact Assessment (EIA) Process

An environmental impact assessment usually consists of a preliminary analysis, a detailed assessment, and a follow-up phase.

6.4.1 Preliminary assessment

This involves a general description of the proposal, taking into account the level and type of assessment warranted. As far as the researcher has been able to determine, the three cellular network operators in South Africa use different types of screening and scoping procedures. However, the preliminary assessment should include the following:

- Screening to establish whether an EIA is required, and describing the likely extent of process application.
- Scoping to identify the key issues and impacts that need to be addressed.
- Preparing terms of reference for the EIA.

6.4.2 Detailed assessment

The key aspects of this stage of the process are the multidisciplinary scientific approach to gather and analyse information and views, and the preparation of an environmental impact statement or report. According to the Australian government website, this process is used decision-making, (www.ea.gov.au/assessments accessed 08 February 2002 p 6 of 23).

The detailed assessment should include:

- Impact analyses to identify, predict and evaluate the potential significance of risks, effects and consequences.

- Specifying measures to prevent, minimise and offset, or otherwise compensate for, environmental loss and damage.
- Developing a reporting system that would make it possible to document the results of the EIA, including recommended terms and conditions.
- Reviewing to ensure that the report meets predetermined terms of reference and standards of good practice.
- Decision-making for the approval or rejection of a proposal.
- Establishing terms and conditions.

6.4.3 Follow-up

Follow-up takes into account the potential environmental significance of the proposal, and the effect of the predicted impacts. This stage includes the following actions:

- Monitoring to verify whether actions comply with the terms and conditions, and that impacts are within the predicted ranges.
- Management to address unforeseen events or unanticipated impacts.
- Auditing or evaluation to document results, learn from experience, and improve the EIA and project planning.

6.5 Criteria for a successful EIA

An EIA should be done for all development projects or activities likely to have significant adverse impacts on the surroundings or which could add to potential predictable damage. This is a primary instrument for environmental management which is used to ensure that the detrimental impacts of developments are minimised, avoided or the site rehabilitated. The scope of such a review should correspond with the nature of the project or activity, and be commensurate with the likely issues and impacts. For this reason, the roles of key stakeholders, their responsibilities, and the rules governing their actions, should be well defined.

Throughout the project cycle, beginning as early as is feasible during the concept design phase, the EIA should be conducted with clear reference to the requirements for project authorisation and follow-up. This must clearly include impact management consistent with the application of “best available practicable” (BAP) science, and mitigation technology in accordance with established procedures and project-specific terms of reference. This process should take account of timelines by providing appropriate opportunities for public involvement of communities, groups and parties likely to be directly affected by, or who have an interest, in the project and/or its environmental impacts.

Wherever necessary or appropriate, the EIA should address other related and relevant factors, including cumulative and long-term social and health risks and impacts; large-scale effects; design, locational and technological alternatives to the proposal being assessed; sustainability considerations including resources, productivity, assimilative capacity, and biological diversity.

The EIA should result in accurate and appropriate information as to the nature, probable magnitude, and significance of the potential effects, risks, and consequences of a proposed undertaking and possible alternatives. It should lead to the preparation of an impact statement or report that presents this information in a clear, understandable and relevant form for decision-making. In addition, this analysis includes determining the reliability of the predictions, and clarifying areas of agreement and disagreement among the parties involved in the process.

To sum up, the EIA should provide the basis for environmentally sound decision-making. For this purpose, terms and conditions should be clearly specified so that they can be enforced. The EIA covers the design, planning and construction of acceptable development projects that meet environmental standards and management objectives. It includes an appropriate follow-up process, subject to requirements for monitoring, managing, auditing and evaluating actions, events, and impacts. These follow-up requirements are based on the significance of potential effects, and on the uncertainties associated with prediction and mitigation. Finally, EIAs ensure that organisations learn from experience so that they can improve the design of future projects, or even the application of the EIA process.

6.6 Principles of Environmental Impact Assessments

The basic principles, which underpin Environmental Impact Assessments (EIAs), are:

- A broad understanding of the term "environment".
- Informed decision-making.
- Accountability for decisions, and for the information on which they are based.
- An open, participatory approach to the planning of proposals.
- Proactive and positive planning.

According to Fuggle and Rabie (2002: 749):

> … the term "environment" is taken to include physical, biological, social, economic, cultural, historical and political components. Informed decision-making is achieved by integrating contributions from professionals involved in all disciplines relevant to the planning of a particular proposal. Due consideration is given to alternative options for the development, including, where appropriate, the no-go option.

Wider participation in the process is encouraged through an opportunity for public input in the decision-making process. This may involve consultation with interested and affected parties during scoping, or more active participation by affected groups during the planning stage (Fuggle & Rabie 2002: 749).

Finally, a positive and proactive approach is encouraged through the enhancement of positive impacts, as well as the mitigation of negative impacts. By using Integrated Environmental Management (IEM) attempts are made to ensure that the social costs of development (those borne by society) are outweighed by the social benefits (the benefits to the society as a result of the development) (Fuggle & Rabie 2002: 750).

6.7 Benefits of Environmental Impact Assessments

Possibly the main strength of environmental impact assessments is their flexibility. All GSM projects have a planning process with which an EIA can be integrated. Given its sensitivity to the social and economic, as well as environmental impacts of projects, the EIA process has been used extensively in all the GSM projects undertaken by Vodacom, MTN and Cell C in South Africa, but to a lesser extent in other southern Africa countries in which Vodacom and MTN operate.

Environmental impact assessments have been effectively employed by Siemens Telecommunications on the Cell C project, as a full turnkey project company.

For example, planners of a GSM project who have failed adequately to consult the community at the outset can take advantage of the EIA to involve the community in a necessary exchange of ideas and views. The EIA can be applied to assist in establishing and strengthening decision-making and communication mechanisms within a project. It can also pave the way for introducing innovations.

An EIA may reveal sound environmental, social, or economic reasons for shifting a project's direction. In view of the primacy accorded the opinions and aspirations of interested and affected parties, the EIA process may also function as a project control mechanism. While the EIA should not be expected to correct all the weaknesses of a flawed planning process, it can be a valuable tool for project implementation when it is properly designed and executed.

When the role of the EIA is more restricted, the situation can work in reverse. Other project planning activities can be used to gather necessary information for the EIA and to create support for the EIA process.

Each GSM project manager must decide how much importance to give to each planning activity.

In the GSM industry in South Africa, most organisations acknowledge the contribution of the EIA process to improved project design. The weakness of EIAs in the past has stemmed largely from the absence of environmental legislation enforcement, especially sections 21 to 23 of the 1989 Environmental Conservation Act, as well as from the failure to pay attention to findings at the implementation stage.

The benefits of environmental impact assessments are:

- Reduced cost and time of project implementation.
- Cost-saving modifications to project design.
- Increased project acceptance.
- Avoidance of negative effects and violations of laws and regulations.
- Improved project performance.
- Avoidance of treatment/clean-up costs (retrieved on 17 July 2002 from www.gdrc.org, page 2 of 13).

The benefits to interested and affected parties from taking part in environmental assessments include the following:

- A healthier local environment. Aesthetic values are taken into account during the construction of BTS sites, especially with regard to the masts. In this respect, all cellular network operators in South Africa have made a significant contributed by camouflaging cellular towers as indigenous trees.
- Improved human health. Vodacom, MTN and Cell C are all prohibited through the EIA process from installing a BTS where it has the potential of a threat to human health, especially in relation to microwave emissions from the antennas.
- Maintenance of biodiversity.
- Decreased resource use.
- A reduction of conflicts over natural resource use. In this regard, the South African government acted proactively by restricting the number of BTS sites. The three licensed cellular operators in South Africa (Vodacom, MTN and Cell C) are no longer allowed to establish individual BTS sites, but are now making use of "shared sites" (a single BTS site that accommodates multiple users).
- Increased community skills, knowledge, and pride.

6.8 Environmental Impact Assessment Procedure

The three stages of this procedure are now discussed in detail.

6.8.1 Stage 1: Developing and assessing the proposal

A key concept in environmental assessment is that its underlying principles should be incorporated into the planning of proposals, rather than being considerations to be addressed after the proposal has been developed.

The environmental assessment process suggests a number of steps when developing a proposal, which, if incorporated during planning, are likely to result in better planning, and a more streamlined decision-making process.

The recommended steps include:

- Establishing the policy, legal, and administrative requirements applicable to the proposal. A policy that will be published and communicated to all interested and affected parties must be formulated by the GSM organisation. The applicable legal requirements of both the national and local authorities must be obtained in order to determine with which legal requirements the GSM project will have to comply.
- Notifying interested and affected parties of the proposed development. The cellular operator notifies the interested and affected parties of its intention to construct a BTS site. This is done by means of notifications in the local press and notices posted at the BTS site itself
- Discussing the development with authorities and interested and affected parties. In the event that the interested and affected parties lodge an objection to the proposed location or appearance of the BTS site, environmental issues, and possible alternative sites, are discussed with the local authority and/or representatives of the interested and affected parties. Usually an amicable solution is found (e.g. the camouflaging of the tower or the relocation of the BTS site); and
- Considering appropriate mitigating options to minimise the risk.

It has been demonstrated by the three cellular network operators in South Africa (Vodacom, MTN and Cell C) that, by undertaking these steps at the inception of a proposal, and thereby integrating the planning and assessment stages of the proposal, the proponent is able to streamline the process and facilitate informed decision-making.

The classification of proposals determines whether a proposal follows the impact assessment, initial assessment, or no formal assessment route. This classification is done by the proponent (or a consultant) in consultation with the relevant authority. The procedure is structured to channel proposals down one of three routes:

- Towards an impact assessment, when it has become clear that the proposal will result in significant adverse impacts.
- Towards an initial assessment, where the proposal concerns a listed activity, or is in a listed environment, or where uncertainty exists as to whether the proposal may result in significant impacts.
- Towards no formal assessment, if the proposal meets planning requirements, and there are indications that the proposal will not result in significant adverse impacts (The Checklist of Environmental Characteristics, available from the Department of Environmental Affairs, itemises the environmental factors which need to be considered before concluding that a proposal will require no formal assessment.) Any proposal in which this route is followed is submitted directly for review by the authorities.

In the GSM industry, all new BTS developments follow the impact assessment route. According to the National Environmental Management Act (107 of 1998), all environmental impact assessments have to be undertaken by a third party (an independent environmental specialist). The completed environmental impact assessment is submitted to the local authority for consideration.

6.8.2 Stage 2: Decision by the authorities

During this stage, the responsible authority makes a decision about the acceptability of the proposal. The authority will only approve the development once it is satisfied that:

- Sufficient information has been provided in order to make a decision.
- Sufficient consultation with interested and affected parties has taken place.
- The proposal complies with the legal requirements.

The authority will usually find it necessary to set conditions of approval. This occurs when approval is given subject to certain mitigating measures, or other conditions, which should be clearly specified.

For example, the proponents may be required to prepare and submit an environmental management plan describing how the proposal will be implemented, and how implementation will be monitored. The conditions of approval might also specify how environmental restoration will be carried out, or may provide for final rehabilitation of the environment, such as camouflaging the BTS mast, or the construction of the BTS itself to blend in with the immediate environment. Examples include a stone finish on the exterior of the BTS, or housing the BTS inside a construction similar to constructions in its immediate environment.

Record of decision

Whether or not a proposal is approved, there is a record of decision, which is referred to as the ROD in the industry. This provides an explanation of how environmental considerations were taken into account and weighed against other considerations. The ROD is crucial for more open and accountable decision-making, and it is made available on request to any interested party. The ROD also reflects the conditions of approval.

Appeal

An administrative procedure allows for appeals against decisions taken. This process involves an appeal by the proponent against the conditions of approval of the development, or by an affected party (such as a neighbour, a church group, or a school governing body) against the approval of the development.

The environmental assessment process provides an opportunity to appeal to a higher authority (e.g. higher-tier authority, review panel, court of law). As an appeal can be a costly and delaying exercise, time limits are generally set for the filing of, and ruling on, an appeal.

6.8.3 Stage 3: Implementation

Once approval has been obtained, the proposal is likely to be implemented. In certain instances, there may be conditions of approval: a management plan and/or an environmental contract may be a prerequisite.

Environmental management plan

The purpose of a management plan is to describe how the proposal will be implemented, and what form of control will be exercised over its implementation. It will show in detail how negative environmental impacts will be managed and monitored (if there are any), how positive impacts will be maximised, and how the affected areas will be rehabilitated.

The various mitigating measures are organised and co-ordinated into a structured and well-formulated plan which guides the construction and operation of the BTS site.

A management plan might simply be required to detail the mitigation of one variable during the construction phase (such as the supply of a standby generation plant for the BTS site), or it might be required to provide a comprehensive overview of the management and monitoring requirements for the duration of the project.

It should therefore be viewed as a dynamic document, which requires updating or revision during the course of the project.

Environmental contract

An environmental contract may be required as a condition of approval. It constitutes contractual control over the development in which the penalties for not complying with the stated conditions are stipulated.

The contract lists certain mitigating requirements (such as re-vegetation) and associated penalties, which would have been negotiated with the proponent (such as financial compensation).

The establishment of a contract may also improve relations between conflicting parties as it provides a guarantee that the developer will make a sincere effort to minimise environmental damage.

6.9 Methods of evaluation

According to Fuggle & Rabie (2002: 768) the methods of environmental management evaluation discussed below are the most commonly used methods the world over. They can be used as single, stand-alone methods of application, or in combination with one another, depending on their application.

6.9.1 Checklist and matrix methods

According to (Fuggle and Rabie 2002: 768):

> “Checklists and matrices are the most frequently used tools of environmental evaluation. Both methods are designed to stimulate thought about possible consequences of specific actions and so ensuring comprehensiveness as well as precision in analysis. The methods are simple to use and do not require extensive material or manpower resources”.

6.9.2 Checklists

Checklists contain a set of environmental elements and actions. Since these are determined prior to a study of the area, these questions provide a static picture of possible relations between a development and its environmental setting.

The structure of most checklists suggests that a project or plan has only direct effects, though this drawback can be overcome by extending the questionnaire to cover secondary effects. A major drawback of checklists is that they do not highlight the structure of linkages between environmental parameters, and between specific actions and environmental elements (Fuggle & Rabie 2002: 768).

6.9.3 Leopold matrix

This approach to impact analysis was developed in 1971 by Dr Luna Leopold and others of the United States Geological Survey. Although derived from a checklist approach, the simple expedient of dividing the checklist into *two data sets* (one related to environmental elements, and the other to human actions), and arranging the two sets at right angles so as to form a matrix, greatly expanded the scope and usefulness of checklists.

The original Leopold system listed 100 project actions along the horizontal axis and 88 environmental elements on the vertical axis, thus identifying 8 800 possible interactions between actions and the environment on a single sheet of paper. The method is thus exceptionally comprehensive and precise, and incorporates fundamental information on first-order, cause-effect relationships.

The format is also useful for highlighting areas of particular concern, of high risk, or where further investigations are required. The method is also highly adaptable to various projects and environments.

The matrix is used by considering each action involved in the project against each environmental characteristic of the area. All cells that represent a possible impact are marked with a diagonal line and evaluated individually. Each marked cell is then scored twice, once from a technical perspective of the scale or magnitude of the impact, and once in terms of the social importance (significance) of the impact. A high score represents the greatest impact, and a low score the least. Plus signs are used to identify beneficial impacts, and minus signs negative impacts. Leopold's original scheme is not explicit on how the matrix should be used beyond this point. It is, nevertheless, evident that the matrix format lends itself to displaying, through numbers, symbols or shadings, cells with above-average impact, importance, risk, or uncertainty. One matrix with numerous entries or several matrices with single characteristics can be used. Similarly, the timing, duration, and probability of particular actions on specific environmental elements can be readily displayed.

6.9.4 Overlays and mapping

The use of maps in land-usage planning is a *sine qua non*, and the superimposition of maps showing different characteristics of an area in order to see spatial coincidence and variations is a very old technique. In 1968, Ian McHarg formalised the method when advocating its use for highway route selection.

This method consists, in essence, of identifying both social and natural processes as social values. Land and building values reflect a price value system, and for institutions that have no market value, as well as natural processes, a hierarchy of values is provided. The approach has been elaborated and modified by many users so that the basic technique may now find expression through computer simulation, multicoloured printed maps, or in map transparencies.

The basic tasks of parameter selection, internal ranking, and between parameter weighting nevertheless remain consistent. Computer manipulation merely permits greater data manipulation and flexibility, while cartographic techniques influence locational accuracy and subjective assessments of the final maps. The rapidly evolving technology associated with geographical information systems (GIS) has provided a sophisticated computer-based way of generating and superimposing mapped data for present-day users of the technique.

When viewed against the ideal criteria for environmental impact analyses, overlay methods are weak in many respects, but strong in others. Their two main strengths are the explicit prediction of spatial patterns, and the direct, familiar presentation of summarised data in a form that can be interpreted without difficulty. Other positive features are the ease with which project alternatives can be considered whenever spatial relationships are important, and the method’s effectiveness in communicating the number, types and location of affected parties. On the negative side, the method’s main drawbacks are its lack of comprehensiveness and precision, and its inability to consider non-spatial variables or second- or third-order interactions (Fuggle & Rabie 2002: 770).

6.9.5 Panel evaluation

The Delphi technique was pioneered by Olaf Helmer at the Rand Corporation, and is designed to encourage consensus from a panel of evaluators on issues or questions that cannot be evaluated in a classical quantitative sense. The opinions of these experts are usually subjective, albeit guided by some objective background; they can therefore best be described as informed judgements.

A number of approaches may be used to obtain expert opinion. One extreme is using a single expert, the other is the use of a committee: a method that is based on the premise that many opinions are better than one. Committees have many drawbacks, however, such as that vocal minorities or dominant individuals have undue influence, individuals are often unwilling to change their minds in public or to contradict persons in higher positions, and, where opinions differ strongly, polarisation of views rather than consensus is usual (Fuggle & Rabie 2002: 770).

The best-known system for impact analysis based on this approach is the Environmental Evaluation System designed by the Battelle, Columbus Laboratories in the United States. This is one of the most complex and detailed quantitative methods devised for EIA purposes. In principle, it is adaptable to a wide variety of projects and environments but, in practice, the fact that new weighting schemes have to be devised for different environments, and different applications, limits its use.

The method is based on two weighting systems obtained through Delphi procedures. First, all environmental parameters are weighted according to their relative importance, and a checklist of environmental parameters, together with associated importance units, results. Second, value functions are derived for each parameter in order to convert appropriate measured values into environmental quality units on a 0 to 1 scale, (e.g. a dissolved oxygen concentration of 6 Ingle transforms into an environmental quality score of 0,7).

Thus, starting from an objective measured value; environmental quality units are established and multiplied by the associated parameter importance units to yield Environmental Impact Units.

Since all parameters can be converted into these units, the values obtained can be summed to provide a total score for all impacts. Alternative projects can therefore be directly compared, while individual problem areas are highlighted. The latter is achieved by marking potential problem areas in a final summary table with red “flags". When a red flag is assigned, the problem area must be investigated in detail.

As the method starts from a checklist, all the difficulties of comprehensiveness and precision that relate to checklists apply. Also, as the method uses discrete parameters in isolation, interactions and chains of relations between parameters are not considered. The method also ignores uncertainty, risks and remedial measures, and no account is taken of affected parties or public opinion.

The method does not overcome problems of timing, duration and spatial location of impact. In addition it does not communicate well to those who are unfamiliar with its output tables.

The strengths of the procedure lie in its high degree of objectivity, as value-functions are standardised and are public knowledge, as are the weights assigned to particular environmental parameters. The numerical weighting system is explicit, permitting the calculation of a project impact for each alternative. Although any weighting system will be controversial, this one has been developed from systematic studies, and its rationale is documented. Furthermore, small changes in weightings do not cause wide fluctuations in final scores. The method has much to recommend it, but its lack of adaptability, and heavy demands on resources, limit widespread applications, particularly for preliminary studies (Fuggle & Rabie 2002: 771).

6.10 Methods of evaluation in South Africa

Although a number of environmental assessment methods are applied in South Africa, the cross-tabulation matrix approach, and the overlay and mapping techniques are the most popular (Fuggle & Rabie 2002: 768). In this research an attempt will be made to determine the methods, or a combination of the methods, organisations in the South African GSM industry apply to determine their environmental risks.

Before presenting this, however, the cross-tabulation matrix approach, and the overlay and mapping technique are described.

6.10.1 Cross-tabulation matrix approach

The cross-tabulation of specific environmental characteristics and specific human actions provides an easy way of focusing thinking on particular issues which may cause concern in a development project.

This format also provides a useful means of displaying and summarising a great deal of information that will be required by those assessing the project at a later stage. Using this method does not provide final solutions to environmental problems, but it does identify problem areas in a precise way, which makes it possible for efforts to be concentrated on overcoming specific, rather than nebulous, problems.

The essential feature of the physical format is two lists (one of environmental characteristics and one of human actions) arranged at right angles to one another along two edges of a simple ruled grid. The grid cells may be square if the lists are of approximately equal length or rectangular if one list is longer than the other, this being immaterial.

For any particular project, each list will probably contain between 30 and 50 items relevant to local environmental characteristics, and to actions associated with the project. In highly diverse environments with a variety of features, 50 environmental characteristics may be inadequate, but in a simple uniform landscape 20 elements may be sufficient. Similarly, a small-scale, single-phase project may be adequately described by 20 or so activities, while a large, complex, multistage project might best be handled by compiling activity lists separately for each phase — site preparation and infrastructure, construction, operation — with 20 or so elements in each list, rather than using a single list of 70 or 80 elements.

A completed matrix is simply a detailed record of an evaluation team's judgements on a wide range of issues relevant to the environmental implications of a project. Unfortunately, it is not possible to formulate an objective, quantitative index to indicate the degree of acceptability of the project. Review of the completed matrix will nevertheless reveal precise areas of concern.

This concern might be occasioned by a number of factors: identification of major impacts (scores of 4 or 5), inability to reach decisions or inadequate data (occurrence of question marks), areas of risk (!), or because no remedial measures are planned for certain impacts. Attention can therefore be focused on each specific problem area in turn to resolve difficulties.

Matters shown to be non-contentious or insignificant need no longer be of concern.

Apart from the consideration of individual cells, a matrix review must also look at the total effects of specific actions, and total effects on particular environmental characteristics. This is done by considering each row and column of the matrix as an entity.

Environmental elements subject to numerous small impacts that could cumulatively be of significance might consequently be seen, or, similarly, an action of no particular significance might be seen to have a widespread low-key effect. Actions or environmental characteristics subject to several elements of risk may also be identified (Fuggle & Rabie 2002: 775).

6.10.2 Overlay and mapping

This approach to environmental impact analysis is particularly useful for the selection of routes or sites for development.

The overlay or environmental mapping approach is, as the name suggests, based on maps, and the ultimate locational accuracy and impact of the technique are largely determined by technical cartographic skills and resources. The use of modern, computer-based geographical information systems may, however, make for easy manipulation of mapped data on different scales and in different formats, thus leading to a renewal of interest in the method.

Various environmental characteristics relevant to the selection of a physical location for a project are first classified according to suitability for the project, following which a value scale ranging from highly favourable to highly unfavourable is employed.

A map is then compiled for a particular characteristic, say soil type, and the areas falling into each category are identified and coloured or shaded. A separate map is drawn for each environmental characteristic evaluated. Finally, all maps are physically placed one on top of the other if transparent bases are used, or a composite map can be generated by a computer, and a project suitability map derived from a study of the suitability of the combined components (Fuggle & Rabie 2002: 776)

6.11 Practical example of an Environmental Impact Assessment in the GSM industry (Siemens Telecommunications)

Siemens Telecommunications (Pty) Ltd, a major telecommunications infrastructure provider, is a supplier to Vodacom in southern Africa as well as a full, turnkey project-management supplier to Cell C in South Africa.

The EIA process adopted by Siemens consisted of the following:

1. The selection of an Environmental Impact Assessment (EIA) Team.
2. An Aspect and Impact (A&I) environmental measurement tool to measure the environmental impacts of all the activities, products, and services that Siemens provides to its client base.

This tool, driven by the EIA Team, is based on the aspects and impacts of Siemens's activities, products, and services to determine their significant impacts on the environment. The significance rating is based on the severity of the environmental factors, plus the probability of the occurrence of the factors, from which is subtracted the effect of predefined mitigatory controls to minimise the impact of the significant environmental aspect, as illustrated below.

6.11.1 Selection of the EIA team

In order to retain objectivity, as well as to obtain inputs from all interested and affected parties within Siemens Telecommunications Pty) Ltd, the organisation established a representative EIA team that was appointed by management.

The selection of a representative EIA team ensured that:

- Each department had a representative who was involved, or was represented.
- The process involved anyone who might be able to contribute.
- At least the team leader had had a training session in the identification of aspects and impacts and understood this procedure.
- Technical experts were also involved.

6.11.2 Functions of the EIA team

The members of the EIA team were identified from all the departments' areas of activity (to cover activities, products and services). The EIA team then identified all departments whose actions had, or could have, environmental aspects and impacts. This was done by looking at all the organisational structures or departments, for example plant and site services (buildings and gardens), installation, commissioning, and warehouses, to mention only a few.

6.11.3 Identifying the environmental aspects of each of the above

This stage included documenting the following:

- The inputs and outputs associated with the organisation's current, past and planned activities, products and services.
- Normal, abnormal but reasonably foreseeable, and emergency situations.
- All elements of the environment (air, water, land, natural resources, flora and fauna, humans and their interrelations).
- The extent to which Siemens could control its own activities, products and services, and influence those up- and downstream.
- The environmental impacts, including actual and potential ones.
- Positive and negative impacts.

The following issues were also considered:

- Emissions into the air.
- Releases into water.
- Waste management.
- Contamination of land.
- Use of raw materials and natural resources.
- Other local environmental and community issues.

6.11.4 Appointing a legal specialist for the identification of legislative and regulatory requirements

Siemens appointed an environmental legal specialist to identify the legal requirements associated with the identified environmental aspects and impacts. These requirements included the following:

- National, provincial and local legislation.
- Legal requirements for individual site locations.
- Other countries' legal requirements in cases where the organisation carried out work outside of South Africa, such as Vodacom (Tanzania) and MTN (Nigeria).

6.11.5 Evaluation of the significance of impacts

As mentioned above, the EIA team included representatives from all departments. Their task was to determine the significance of the respective aspects and impacts by employing a standard rating method termed a "Determination of Significance Table" which is shown in Table 3.

After establishing the significance of these, the EIA team reviewed the values, and determined the actions that were required. Most often the environmental factors with high ratings were dealt with by setting objectives and targets, and establishing action plans in order to reduce the rating.

This was followed by documenting the control measures. The actions implemented and any associated procedures, work instructions, wall charts, and other relevant features were recorded under mitigating controls and actions in the aspects and impacts register.

6.12 Communication of the aspects and impacts

Within the organisation, heads of department and all line managers ensured the communication of their departments' aspects and impacts by

- Ensuring that the aspects and impacts register was accessible to all departmental staff members via their heads of department.
- Ensuring that all staff members were made aware of, and understood, the aspects and impacts in their areas.

- Conducting training sessions for staff members who did not understand the aspects and impacts.

6.13 Review of aspects and impacts

The aspects and impacts register is reviewed and updated when there are any changes in Siemens' products, services and/or business activities. Departmental heads record such significant changes whenever:

- There are material changes to the activities, products, services or controls within the department.
- There are material legal or company-specific changes (such as policies and procedures).
- Objectives and targets have been achieved which may reduce the significance of the aspect and impacts.

The register is reviewed at least once a year if no other reviews are prompted. When any changes are identified, such changes are processed through the review process described above.

An example of the Aspect and Impact (A&I) register used by Siemens Telecommunications for a turnkey project to establish a BTS site is given below.

Table 3: Determination of Significance Table

A. SEVERITY OF IMPACT (Made up the following components)		
SCALE OF ASSOCIATED IMPACT E.g. • Local extending only as far as the activity site and immediate surrounding • Regional/Provincial/ • National/Global	***DURATION*** E.g. • Short term 0-3 months • Medium term Less than 3 years. • Long term More than 3 years • Permanent	***NATURE AND VOLUMES*** E.g. • More toxic and higher volumes will contribute to a higher rating than less hazardous and lower volume materials.
Minimal	Medium	High
1	2	3

B. LIKELIHOOD/PROBABILITY OF OCCURRENCE				
Unlikely (Never in history of the business unit)	Possible (Once in history of the business unit)	Seldom (Up to once per year)	Regular (Weekly to monthly	Continuous (Daily)
1	2	3	4	5

C. MITIGATING CONTROLS IN PLACE				
None	Very little	Some	Good control	Complete control
1	2	3	4	5

Significance before control = [A + B]

Significance after control calculation = [A + B] / [C]

SIGNIFICANCE VALUE	**Minor** **< 3**	**Medium** **4 – 6**	**Major** **>6**	**Rating** **=**

ACTIVITY/ASPECT	IMPACT	SIGNIFICANCE													
		SEVERITY			OCCURENCE POSSIBILITY					MITIGATING CONTROLS					VALUE
		1	2	3	1	2	3	4	5	1	2	3	4	5	
AREA SURVEY: VEHICLES															
Use of Fuel	Consumes natural resource			3		2				1					**5**
Oil Leaks	Groundwater & soil contamination	1						4			2				**3**
Exhaust Fumes	Air contamination		2		4							3			**1**
Movement on Terrain	Fauna & flora disruption			3				4					4		**2**
EVALUATE AREA SURVEY															
Make decision to continue or not to maximise business needs while minimising environmental implications	All aspects associated with the activities following the decision	1						4				3			**2**
CONDUCT EIA															
Meet environmental legal requirements	Positive impact	1			1						2				**1**

ACTIVITY/ASPECT	**IMPACT**	**SIGNIFICANCE**													
		SEVERITY			**OCCURENCE POSSIBILITY**					**MITIGATING CONTROLS**					**VALUE**
		1	2	3	1	2	3	4	5	1	2	3	4	5	
Travel-related aspects as above for site surveys	Positive impact		2			2						3			**1**
EIA APPROVAL															
Submit EIA approval documentation				3	1								4		**2**
Implement EIA condition fulfilment				3		2						3			**2**
Refer to Phase 4 implementation			2			2							4		**2**
COMPILE & SUBMIT DOCUMENTS															
Use of paper	Consumption of natural resource	1			1					1					**1**
SITE VISIT															
As for site visit above	As for site visit above		2				3					3			**2**

ACTIVITY/ASPECT	IMPACT	SIGNIFICANCE													
		SEVERITY			OCCURENCE POSSIBILITY					MITIGATING CONTROLS					VALUE
		1	2	3	1	2	3	4	5	1	2	3	4	5	
FINAL INSPECTION & HANDOVER															
Ensure all environmental requirements have been satisfied	Positive control to reduce environmental impacts associated with the civil sub-contractor	1			1					1					**1**
TRAINING & COMPETENCE															
EMS inclusion in the induction and competence training, communication of EMS to all contractor and sub-contractors	Positive. Increased awareness and competence and subsequent improvement in all impacts		2				3			1					2

7. Conclusion

In this chapter the focus has been on the theoretical perspective on safety, health and environmental risk assessment models for the South African GSM industry.

By means of the literature study, it was found that a number of techniques are available for assessing risks. It was also pointed out that that the aim of this study will be on establishing a model that may be used, first, to identify risks, second, to assess potential seriousness, third, seek to influence associated outcomes and, finally, to monitor the effectiveness of interventions.

It was pointed out that the Construction Regulations (GNR.1010 of 18 July 2003) specifically address risk assessments. Section 7 of these Regulations will have a major impact on organisations in the South African GSM industry in that every contractor performing construction work will have to conduct a risk assessment to be performed by a competent, properly appointed person before starting any construction work and during the course of the construction work, The risk assessment will have to form part of the health and safety plan which will be applied on the site, and the assessment will have to include at least the identification of the risks and hazards to which persons may be exposed, an analysis and evaluation of the risks and hazards identified, as well as a documented plan of safe work procedures to mitigate, reduce or control the risks and hazards identified.

It was evident from the literature study that the Hazard Identification and Risk Assessment Process (HIRA) is a popular risk assessment tool that has a definite application for GSM organisations in South Africa.

In the latter part of the literature study, attention was focused on Environmental Impact Assessment (EIA). It was pointed out that an EIA is normally undertaken when a proposed development may harm the environment.

EIA was defined as a process of identifying, predicting, evaluating, and mitigating the biophysical, social and other relevant effects of proposed projects and physical activities before any major decisions and commitments are made.

It was found that EIAs are more important than ever before. This statement is based on the statutory requirements, which provide a basis for designing policies and plans that take account of environmental potentials and constraints, and for managing the impacts and risks of GSM projects and activities.

An important conclusion of this study is that the purpose of EIAs is twofold. First, the immediate aim is to facilitate sound, integrated decision-making in which environmental considerations are explicitly included. This is achieved in the EIA process by providing clear, well-organised information on the environmental effects, risks, and consequences of development options and proposals.

Second, the process is usually directed towards attaining, or supporting, the ultimate goals of environmental protection and sustainable development. These end goals are variously phrased and framed in environmental assessment laws and policies, as are the specific objectives to be met by the process.

Chapter 4 concluded with a practical example of an EIA approach applied by Siemens Telecommunications, a major role-player in the South African GSM industry and elsewhere in Africa.

The focal point of Chapter 5 is the development of an integrated health, safety and environmental management risk assessment model for the GSM industry in South Africa. This is achieved by concentrating on a mechanism for assessing risks associated with the functions of health, safety and environmental management on an integrated basis in the local GSM industry.

CHAPTER 5

RESEARCH METHODOLOGY AND DESIGN

This chapter is devoted to setting out all the important considerations relating to the research design, and will provide details of the research design, unit of measurement, sampling design, form of measurement, and the design of the questionnaire.

The population and unit of measurement are discussed to give a broad outline of the procedure followed in this study.

1. Theoretical introduction to the design strategy

According to Emory and Cooper (1995: 9), when deciding on the broader research design strategy one has to consider the following factors:

- How well the research problem is crystallised.
- How data will be collected.
- The researcher’s influence on the variables under study.
- The purpose of the study.
- The time frame.
- The topical scope — breadth and width of the study.
- The research environment.
- The research participant’s perception of the research.

The first seven items on this list have great significance for this research project, and are therefore discussed below.

1.1 Degree of problem crystallisation

Risk assessments for the GSM industry in southern Africa have not been as widely implemented as in other industries or parts of the world, nor are there many tools that can be applied to measure the risks associated with health, safety, and environmental management. Many organisations undertake what they refer to as risk assessments. In fact, however, they are actually measuring their health, safety, and environmental risks as separate entities, without considering integrating them into one measuring tool that will address all three sub-disciplines at the same time.

These factors have contributed to this study, which has many of the characteristics of an exploratory investigation. Exploratory studies normally have a much looser structure than formal studies, or experiments, and are to a certain degree designed in an attempt to pose research questions for further study. In exploratory studies attempts are therefore made to formulate hypotheses and research questions which can be the subject of future formal studies (Emory *& Cooper* 1995:15).

This research is, therefore, classified as an exploratory study.

1.2 Method of data collection

Data were collected by means of self-administered questionnaires (refer to Annexure A). This method was used to overcome the logistic difficulties associated with reaching all the selected respondents within the GSM industry.

1.3 Control over research variables

A distinction is drawn between experimental and *ex post facto* designs in terms of the extent to which it is possible to exercise control over variables, or the ability to influence the measured variables. In an *ex post facto* design, the researcher has no control over the variables being measured, and can measure and report only what has happened or what is happening (Emory & Cooper 1995: 115-116).

This research deals with after-the-fact results, and it is consequently logical to regard it as an *ex post facto* study.

1.4 Purpose of the study

This section refers to the quantification of aspects of the research, such as who, why, where, when and what. Such a study is regarded as a descriptive study (Emory *& Cooper* 1995:116).

As an exploratory study, an attempt is made to determine whether organisations in the GSM industry apply an integrated risk assessment model for assessing their health, safety, and environmental management.

It will therefore be possible to determine at the conclusion of the research whether or not organisations in the South African GSM industry apply an integrated approach to assessing their safety, health and environmental management risks.

1.5 Time dimension

No time limit was set for the completion of this research. It may also be regarded as a cross-sectional study since "[c]ross-sectional studies are carried out once and the findings represent a snapshot in time" (Emory *& Cooper* 1995: 116).

1.6 Topical scope

This research covers the entire GSM industry in South Africa.

2. Population and unit of measurement

The relevant population for this study was all organisations in the GSM industry in South Africa. This population was selected to determine whether organisations in the GSM industry in South Africa apply an integrated risk assessment model for assessing their safety, health and environmental management risks.

It is an accepted norm in the risk-management industry that the functions of safety, health and environmental management are dealt with under the risk management or financial portfolio within an organisational setting. Accordingly, questionnaires were sent to the Chief Financial Officers, Financial Directors, Group Risk Managers, Risk Managers, Safety, Health and Environmental specialists, or the Safety, Health and Environmental managers of Vodacom, MTN and Cell C.

3. Sampling frame

Defining a target population for this research was relatively easy. Since the research was aimed at determining general practice regarding safety, health and environmental management in all organisations in the GSM industry in South Africa, the sampling frame (the list from which the sample was selected) consisted of these organisations.

4. Sample size

As discussed in the previous section, a census type of sample was used in this research.

Although the size of the sample is very important in many sampling designs, its calculation is not important in a census sample. The entire population was sampled.

The major GSM network service-providers in South Africa comprise the following organisations, which were inlcuded in the population:

- Vodacom
- MTN
- Cell C

The researcher decided also to include, as part of the population, all manufacturers, suppliers, contractors, and sub-contractors working on GSM equipment in South Africa for the country's three major GSM network service providers. This was done in an attempt to increase the comprehensiveness of the project, and to ensure that the scope of the study was wider, and therefore more inclusive, than would have been the case had it been limited to the three service providers.

5. Measurement and questionnaire design

In this section of the chapter the method of measurement, and hence also the design of the questionnaire is discussed.

5.1 Questionnaire design process

Dillon, Madden & Fritle (1990: 377) describe the following four activities, or phases, as requirements for the design of a questionnaire:

- Preliminary considerations.
- Asking questions.
- Constructing the questionnaire.
- Pre-testing the questionnaire.

5.1.1 Preliminary considerations

The following are issues to be considered before formulating the questions:

- What information is required?
- Who are the target respondents?
- What data collection method will be used to survey these respondents?

5.1.2 Asking questions

The following guidelines were borne in mind in the formulation of the questions:

- Why are these questions being asked?
- Be clear and concise.
- Response choices should not overlap.
- Use natural and familiar language.
- Do not use words or phrases that show bias.
- Avoid double-barrelled, or ambiguous, questions.
- Provide explicit alternatives.
- Questions should be reliable and valid.

5.1.3 Constructing the questionnaire

The following factors were taken into account while constructing the questionnaire:

- Decide whether a question should be couched as open-ended or closed.
- If closed, decide on the appropriate number of response categories and category descriptions.

- The questionnaire should flow from evaluative questions to diagnostic questions, and finally to classification-type questions.
- The questionnaire should be designed in such a way that confusion is avoided, and recording errors are minimised.

5.1.4 Pre-testing the questionnaire

All aspects of the questionnaire were pre-tested. The pre-test was conducted with the three major GSM network service providers, namely Vodacom, MTN and Cell C, in an environment identical to the one that was used in the final survey.

No significant changes had to be made to the questionnaire that was used during the pre-test.

5.1.5 Administration of the questionnaire

Four primary steps were followed in the preparation and construction of the questionnaire for this research. During the preliminary considerations, the target respondents had already been identified, and the researcher, in collaboration with his supervisor, decided that questionnaires would be distributed to the respondents by surface mail.

The information required, and the way in which the questions were designed will be discussed in a subsequent section.

All questions were carefully formulated, and only commonly known terms and phrases were used. Care was taken to make sure that none of the questions contained phrases or words which could suggest any bias by the researcher.

In line with standard ethical considerations for research of this nature, the respondents were informed of the purpose of the questionnaire, namely to determine whether organisations in the South African GSM industry apply a formal, integrated risk-assessment model to assess their safety, health and environmental risks.

Great care was taken to ensure that each question referred to only one issue, or that it contained a single statement.

Most of the questions had explicit alternatives. The respondents were required to select one of these alternatives. Where it was impractical to list all possible alternatives, the most prominent alternatives were listed, and a final alternative provided. A final open alternative was provided for the respondents to comment on any aspect not contained in the list of categories. Each question was coded with a unique integer number. This was done to simplify the analysis of the data during the analysis phase.

A covering letter was attached to the questionnaire, (refer to Annexure B) urging respondents to be as honest as possible, assuring them that all the information provided would be treated confidentially, and that no information would be made available to any other person or institution. This was regarded as necessary because the questionnaires were not an answered anonymously. The purpose of the covering letter was also to persuade the respondents to complete the questionnaire.

All aspects of the questionnaire, such as the layout, the individual questions, the question sequence, and word meanings, were pre-tested.

As far as possible, the questionnaire was administered in an environment similar to that of the target audience. After pre-testing, all questionnaires were sent by surface mail to the respondents. A stamped, self-addressed envelope was included with the questionnaire. The researcher anticipated that this would increase the response rate but, in fact, it did not. A number of respondents had to be contacted telephonically for their submissions, and questionnaires had to be re-sent using electronic mail (e-mail).

Each returned envelope was marked with a unique number that was assigned to each organisation in the South African GSM industry that formed part of the sampling frame. When a returned questionnaire was received, the researcher was able to determine exactly which respondent had completed the questionnaire.

The respondents were all informed in the covering letter that they would receive a summary of the results of the questionnaire. This was done as an incentive for respondents to return their completed questionnaires.

A target return of 80% was set due to the size of the population as well as the relevance of the topic to the population.

5.1.6 Validity and reliability

The questionnaire can be set to have met the criteria of validity and reliability in the sense that it could be used to measure those issues and variables that were intended to be measured. Furthermore, reliability and validity tend to pose a far greater challenge that was the case in this investigation when the area of focus is more emotionally laden, or when the issues involve topics such as religion and politics.

6. Discussion of the questionnaire questions

The questionnaire was divided into three sections, the first covering general and geographical information, the second dealing with organisational structure and the third dealing specifically with risk assessment.

Each of these groups of questions is discussed in the following sub-sections.

6.1 Discussion of general and geographical information questions

In Question 1.1 the respondent was required to indicate the type of organisation within the GSM industry by whom he or she was employed. This question was important in the research, as it was used to demarcate the sectors within the GSM industry, such as GSM network service providers, manufacturers, suppliers, and contractors.

In Questions 1.2 the predominant feature of the organisation within the GSM industry was established. The possible answers included respondents who were service providers, suppliers of GSM equipment to GSM service providers, and contractors and sub-contractors who rendered a service to a GSM service provider.

This question was asked specifically to eliminate those respondents in question 1.1 who might have been part of the fixed-line network.

Question 1.3 was aimed at determining the geographical areas of operation in which the organisation functioned. Not all organisations in the GSM industry have operations beyond the borders of South Africa. The purpose of these questions was to determine whether organisations operating outside of South Africa might have had a different approach to risk assessment than those that operate exclusively within the South African borders.

6.2 Discussion of structure questions

In Questions 2.1 to questions 2.4 structure competencies were investigated. The questions dealt with whether the organisation had a risk management department, which functions it undertook, whether these functions were integrated, and whether safety, health and environmental management were treated as stand-alone units.

Question 2.5 dealt specifically with the responsibility of the safety, health and environmental management functions at executive level, while question 2.6 dealt with the functional responsibility of safety, health and environmental management.

Question 2.7 was aimed at determining whether the organisation had a risk management strategy, and whether this took the form of a documented plan for the updating of risk control measures.

Formal planners are classified as those who have written strategic plans, while informal planners are those who do not. Thune and House (1994: 81-87) have shown that formal planners have far more business success than do informal planners. They also found that there were improvements in the business successes of companies who went from informal planning to formal planning, hence the importance of a written strategic plan.

Although an occupational health and safety policy statement is not a legal requirement in terms of section 7 of the Occupational Health and Safety Act (85 of 1993), and an environmental management policy is not prescribed by the National Environmental Management Act (107 of 1998), the OHSAS 18000 Health and Safety and ISO 14000, both international standards of environmental management, prescribe that an organisation should have a policy statement to give these functions direction, and to ensure executive management’s commitment to health, safety, and environmental management principles.

Questions 2.9 and questions 2.10 dealt specifically with international standards certification.

These questions were asked specifically to establish whether the respondents were committed to achieving international standards, and whether such standards were a requirement in their area of operation. It is important to note that a number of organisations in the GSM industry are global players. In order to be globally competitive, it is critical that these organisations comply with international standards such as OHSAS 18000 and ISO 14000. Question 2.11 gave the researcher a good indication of the extent to which the organisation considered safety, health and environmental management important factors in determining the organisation's overall strategic plan.

6.3 Discussion of risk assessment questions

Question 3.1 was aimed at determining whether the organisation had implemented a formal procedure for assessing its health and safety risks. Many organisations employ informal measures for assessing their risks, and do not use the formal measuring tools that are available in the industry.

In the event of the response to question 3.1 being affirmative, question 3.2 was designed to establish which formal tools were employed as primary measurement tools by the respondent to measure the organisation's risks. Questions 3.3 established which measuring instrument were used as secondary tool.

As for question 3.4, the aim was to determine whether the organisation had implemented a formal procedure for assessing its environmental risks. Where the response to question 3.4 was positive, question 3.5 was designed to establish which formal tools were employed as primary measuring tools by the respondent to measure the organisation's environmental risks.

In Question 3.6 it was attempted to establish whether the organisation's products, services and/or processes required an Environmental Impact Assessment (EIA).

Questions relating to integrated safety, health and environmental management functions were covered in questions 3.7 to questions 3.9.

Question 3.7 dealt specifically with the question of whether the organisation applied a risk assessment tool to measure risks confronting the integrated functions of health, safety and environmental management, which would imply that the organisation has an integrated safety, health and environmental management function.

Question 3.9 was aimed at determining whether an organisation which has not integrated the functions of health, safety and environmental management, plans to do so in the foreseeable future.

The purpose of this question was to encourage those respondents whose organisations do not have an integrated health, safety and environmental management programme to consider implementing such a programme.

The last question, questions 3.11, was designed to measure what benefits the respondent believed the organisation perceived itself as deriving, or expecting to derive in future, through the integration of the safety, health and environmental management functions.

6.4 Statistical analysis of data

The responses to the questionnaire were dealt with on two levels, namely the categorisation of all the responses, and the application of statistical techniques to determine the significance of differences between the groups of respondents.

Due to the exploratory nature of this research, it was not possible to perform complex multivariate statistical analyses on the data.

7. Summary of research design

This chapter has described the procedure that was followed in the research design, and in the design of the questionnaire. It was pointed out that this research is exploratory in nature.

Data were collected by means of self-administered questionnaires sent by mail to the respondents. The research may be described as a descriptive, cross-sectional, *ex post facto* study. It may, further, be classified as a census because all the elements of the sampling frame received questionnaires.

The sampling frame represented the three major GSM network service providers in South Africa (Vodacom, MTN, and Cell C), and included all GSM equipment manufacturers, suppliers, contractors, and sub-contractors who were suppliers of goods and services to the three major GSM network service providers in South Africa.

The population contained 65 elements (refer to Annexure C).

In Chapter 6 the research findings will be evaluated in relation to the goals and objectives of the study. Recommendations will be based on the conclusions arrived at in Chapter 6. These recommendations will contribute generally to risk management as a science, but in particular to establishing an instrument for measuring the risks associated with occupational health, safety, and environmental management in the South African GSM industry.

Finally, suggestions will be made for possible future research in which some initiatives for the improvement of the management of occupational health, safety and environmental management in South Africa could be developed.

CHAPTER 6

FINDINGS, ANALYSIS AND DISCUSSION

1. Introduction

In this chapter the results obtained from the analysis of the data in the returned questionnaires are presented. A total of 63 questionnaires were sent out, of which 53 were returned, representing an **84,13%** response rate.

The research findings will be evaluated in relation to the goals and objectives of the study. Recommendations (see Chapter 8) will be based on the conclusions arrived at by means of this evaluation.

2. Grouping of respondents

The respondents (refer to Annexure D) were classified into five groups, which are described below. (See also Table 7.)

2.1 Group 1: Network providers

The GSM industry in South Africa comprises three network service providers, namely Vodacom, MTN and Cell C. For the purposes of this research, these three major network providers will be referred to as **Group 1.**

2.2 Group 2: Manufacturers of GSM equipment

Group 2 includes those organisations in the GSM industry that listed "manufacturing" as their predominant activity. It should be noted that it was found during the research that a manufacturer of GSM equipment could also be a supplier of GSM equipment. Accordingly, those manufacturers of GSM equipment who listed manufacturing as their predominant activity were regarded as manufacturers only, notwithstanding the fact that they may also have been suppliers of GSM equipment. **Group 2** thus consists of the seven respondents who indicated that manufacturing was their main (although not necessarily their only) activity.

2.3 Group 3: Suppliers of GSM equipment

Group 3 comprised organisations in the GSM industry that listed the supply of GSM equipment to the industry as their predominant activity. As explained above in relation to Group 2, these organisations might also have engaged in other activities, such as certain manufacturing or contracting. They are included in this group because of the emphasis on supplying GSM equipment as their main activity.

2.4 Group 4: GSM equipment contractors

Group 4 comprised the majority of the respondents. These respondents, listed as GSM equipment contractors, comprised organisations which perform functions such as site acquisition, conducting environmental impact assessments, site clearing, construction of sites, erecting security fencing, construction of containers, building of masts, erection of towers, installation of base station radio transmitters, commissioning of base station radio transmitters, and installation of feeder cables and antennas.

Other contractors included in this group were those engaged in site maintenance and general equipment maintenance.

2.5 Group 5: GSM equipment sub-contractors

Group 5 comprised organisations sub-contracted by those classified as Group 4. It is possible that the sub-contractors may perform similar functions to those undertaken by the contractors.

Table 7: Definition of groups

GROUP	DEFINITION
Group 1	Network provider
Group 2	Manufacturers
Group 3	Suppliers
Group 4	Contractors
Group 5	Sub-contractors

3. THE QUESTIONNAIRE

The questionnaire (refer to Annexure A) is divided into three sections. The first section covers general and geographical information, the second deals with organisational structure, and the third deals specifically with risk assessment. The findings on each of these sections of the questionnaire are discussed below.

3.1 Section 1: General and geographical information

In this section an analysis of the individual questions in this section of the questionnaire is provided. In the main, it deals with the frequency distributions of respondents who selected the various options to each question. This is followed by a more detailed analysis of some of the questions where it was necessary to test for independence between the identified organisations, namely the independence between network providers, manufacturers, suppliers and contractors.

3.1.1 Question 1.1: Please indicate your type of organisation

Instruction: Please mark ALL applicable squares with an x

Table 8: Type of organisation

TYPE OF ORGANISATION	
Network provider	4
Manufacturer	5
Supplier	6
Contractor	7
Sub-contractor	8
Other (specify)	9

The purpose of this question was to determine the sector of the GSM industry in which the organisation functioned. The information was used to classify organisations as belonging to the state sector, as private GSM service providers, or as functioning in support of the service providers, such as manufacturing, supplying and contracting. Furthermore, responses to this question provided an indication of whether a respondent was a member of the GSM industry.

This question was designed for the specific purpose of eliminating those organisations which might have been part of the fixed line network, such as Telkom and the SNO. The respondents were also requested to indicate their type of GSM organisation. This was required in order to group the organisations to facilitate statistical analysis of the differences which might have existed between the types of organisations.

Table 9: Results: — Type of organisation

Q1.1	TYPE OF ORGANISATION	GP1	GP2	GP3	GP4	GP5	%
Q1.1.1	Network provider	3					6
Q1.1.2	Manufacturer		7				13
Q1.1.3	Supplier			7			13
Q1.1.4	Contractor				30		57
Q1.1.5	Sub-contractor					6	11
TOTAL		3	7	7	30	6	53

Network provider organisations represent 6 percent of the total number of respondents, while manufacturers represent 13 percent, suppliers 13 percent, contractors 57 percent, and sub-contractors 6 percent (see Figure 9 below). There were enough respondents in each group to allow for a statistical analysis of the results.

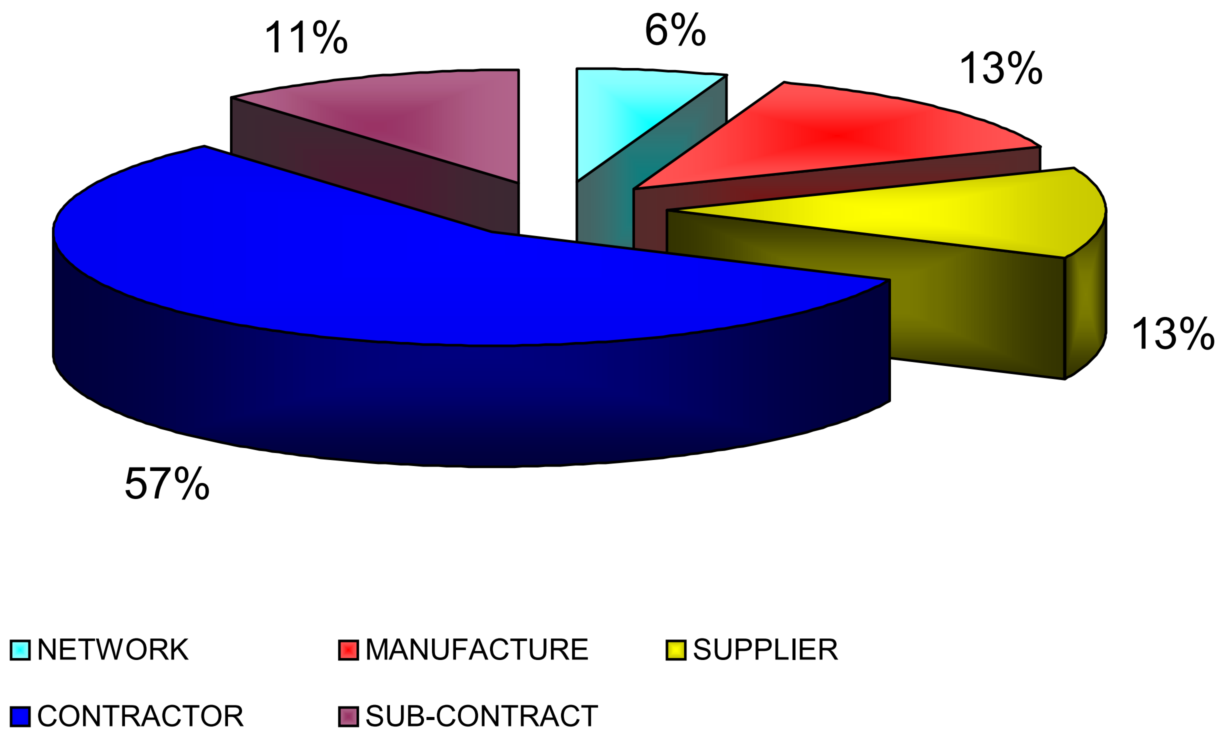

Figure 8: Type of organisation in the GSM industry

3.1.2 Question 1.3: In which of the following countries does your organisation provide a service?

Not all organisations in the GSM industry have operations outside South Africa. The purpose of these questions was to determine whether organisations operating in other parts of Africa have a different approach to risk assessment compared with organisations that confine their operations to South Africa, and to determine the extent of the spread of risk of GSM organisations operating outside of South Africa.

Because of the inconsistent manner in which the respondents reacted to this question, it was clear that it was either not well formulated, or that the respondents did not understand the question, and could therefore not respond in a way which could produce useful results. It is, however, difficult to understand why the respondents experienced difficulties with this question as the wording is perfectly straightforward, and the issue that is addressed is concrete in the extreme. A further possibility is that the respondents did not have the knowledge that is implied in the question at their immediate disposal, or that they might have been reluctant to provide information which could, in some way, have been perceived as being of strategic value. Whatever the case might have been, it was impossible to use the information associated with this item, and as a result no results are reported.

4. SECTION 2: RISK MANAGEMENT STRUCTURE QUESTIONS

This section of the questionnaire was used to investigate structure competencies in order to determine whether the organisation had a risk management department and, if so, what functions it was responsible for, whether these functions were integrated, or whether health, safety and environmental management functioned independently.

In this set of questions the responsibility of the health, safety and environmental management functions at executive level were also explored.

An important consideration in this research was to determine whether the organisations involved had clearly-defined risk management strategies and, if so, whether they were cast in the form of a documented plan for the upgrading of health, safety, and environmental management control measures.

4.1 Question 2.1: Does your organisation have a division, department or section of risk management?

Instruction: Please mark ONLY ONE square with an x

Yes	1

No	2

One of the objectives of the research was to find out whether each of the organisations in the GSM industry had a division, department or a section with the specific responsibility for risk management.

Table 10: Results: — Organisational structure

Q2.1	ORGANISATIONAL STRUCTURE	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q2.1.1	Yes	3	11	5	19	3	11	12	44	4	15	51
Q2.1.2	No	0	0	2	7	4	15	18	71	2	7	49
% TOTAL THAT HAVE A RISK MANAGEMENT FUNCTION		100		71		40		43		67		100

CONCLUSION 1

There is a noteworthy difference between network service providers, suppliers and contractor and sub-contractors in terms of including risk management as a distinct function within their organisational structure.

According to the findings, all GSM network providers had a division, department or a section of risk management, while 71 percent of GSM equipment manufacturers confirmed the existence of such a division, department or section. Only 40 percent of suppliers of GSM equipment indicated that they had a risk management unit, whereas 43 percent of contractors, and 67 percent of sub-contractors indicated that such a unit existed within their organisations.

Forty-nine percent (49,05%) of the respondents indicated that their organisations did not have a risk management division, department or section.

4.2 Question 2.2: Which of the following functions form part of the organisation's risk management division, department or section?

Instruction: Please mark ALL applicable squares with an x

RISK MANAGEMENT FUNCTIONS	
Risk finance	3
Occupational health	4
Occupational hygiene	5
Occupational safety	6
Environmental management	7
Quality assurance	8
Loss control	9
Security	10
Other (specify)	11

This question was devised to investigate structure competencies, and the aim was to determine whether the organisation has a risk management department and, if so, what functions it assumed, whether these functions were integrated, or whether safety, health and environmental management functioned as independent units.

Table 11: Results: — Risk management functions

Q2.2	RISK MANAGEMENT FUNCTIONS	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q2.2.1	Risk finance	2	13	4	25	1	6	8	50	1	6	30
Q2.2.2	Occupational health	3	8	5	14	5	14	19	53	4	11	68
Q2.2.3	Occupational hygiene	2	18	3	27	0	0	5	46	1	9	21
Q2.2.4	Occupational safety	3	7	4	10	6	14	23	55	6	14	79
Q2.2.5	Environmental management	3	14	3	14	2	8	11	50	3	14	42
Q2.2.6	Quality assurance	2	5	4	11	4	11	24	65	3	8	70
Q2.2.7	Loss control	2	18	4	37	0	0	5	45	0	0	21
Q2.2.8	Security	2	18	4	37	2	18	3	27	0	0	21

Thirty percent of the respondents indicated that the risk finance function was carried out by the risk management division, department or section, while 68 percent stated that occupational health is included as part of the risk management unit; 21 percent of respondents said that occupational hygiene was a function within their organisation’s risk management units; and 79 percent of respondents indicated that occupational safety formed part of these units.

Forty-two percent of the respondents indicated that the environmental management function formed part of the risk management unit, while 70 percent reported that quality assurance was a function within the division, department or section of risk management.

With regard to the security function, 21 percent of respondents stated that this function fell under the division, department or section of risk management.

CONCLUSION 2

The organisations surveyed clearly regarded the occupational safety function as an important function within the organisation's risk management structure. This may be attributed largely to the fact that the Occupational Health and Safety Act (85 of 1993), has a significant impact on activities in the GSM industry.

CONCLUSION 3

The organisations surveyed regarded the quality assurance function as an important function within the organisation's risk management structure. This is probably attributable to the fact that customer requirements necessitate a formal system to measure the quality of manufacturers' or suppliers' quality processes, products, or services.

4.3 Question 2.4: Which of the following functions are fully integrated as a department or division in your organisation?

Instruction: Please mark ONLY ONE square with an x

INTEGRATED FUNCTIONS	
Occupational health & safety **(Only)**	18
Occupational health, safety and environmental management	19
Other (specify)	20

This part of the questionnaire dealt with the level of integration of the risk management function. Risk management broadly aims to prevent losses from occurring, to reduce the impact of the loss in the event that a hazardous situation continues, and to attempt to recover from the loss with the least possible economic consequence.

This question was intended to establish the scope of the risk management function of organisations in the GSM industry for benchmarking purposes.

Table 12: Results: — Integrated functions

Q2.4	**INTEGRATED FUNCTIONS**	**GP 1**	**GP 2**	**GP 3**	**GP 4**	**GP 5**	**TOTAL %**
Q2.4.1	Occupational health & safety	1	3	4	11	3	41
Q2.4.2	Health, Safety & Environ-mental management	2	3		17	2	45
Q2.4.3	Other (specify)		1	1	2		6

Only 45 percent of the respondents indicated that the functions of occupational health, safety, and environmental management are fully integrated in their organisations.

CONCLUSION 4

The provisions of the Occupational Health and Safety Act (85 of 1993) determine that health and safety have to be integrated. This finding indicates quite clearly that this is not the case in the industries surveyed.

There is a real danger that organisations in the GSM industry will find it difficult to maintain a competitive advantage in the marketplace if they continue to treat occupational health, safety, and environmental management functions as separate entities.

Du Toit (IRCA 1996: 12) endorses the opinion that an organisation's vision and mission statements should include health and safety, environmental protection, and quality control programmes that are translated into long-range and short-range performance objectives: "This cultural model emphasises an integrated approach ... and that synergy can be obtained by developing the same culture and attitudes towards all three disciplines".

4.4 Question 2.7: Does your organisation have a safety, health and environmental management strategy approved by management?

Instruction: Please mark ONLY ONE square with an x

Yes	44	No	45

According to Thune and House (1994: 81), "[f]ormal planners have much more business success than informal planners. It was also established that there were improvements in the business successes of organisations that went from informal planning to formal planning". It is self-evident that it is difficult for employees to make risk management decisions within the organisation's overall strategic framework if they are not aware of the organisation's strategies; hence the importance of a written strategic plan that formulates the organisation's mission in terms of risk management goals or, alternatively, occupational health, safety, and environmental management goals individually.

The literature on risk management, as discussed in Chapter 2, stresses the importance of a risk management strategy for organisations in the GSM industry. It was therefore important to ascertain whether the organisations surveyed had a risk management strategy. Respondents who indicated that their organisations had a written risk management strategy were requested to return a copy of the document with the questionnaire so that the researcher could find out whether a strategy included the integration of occupational health, safety and environmental management.

Table 13: Results: — Strategy

Q2.7	STRATEGY	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q2.7.1	Yes	3	100	5	71	4	57	10	34		0	41
Q2.7.2	No			2	29	3	43	20	66	6	100	47
% TOTAL HAVING A RISK MANAGEMENT STRATEGY		100		71		57		34		0		

The findings show that all GSM network providers have an occupational health, safety, and environmental management strategy; 71 percent of manufacturers of GSM equipment confirmed the existence of such a strategy within their organisations; 57 percent of suppliers of GSM equipment indicated that such a strategy was in place in their organisations; although only 34 percent of contractors said that their organisations had an occupational health, safety, and environmental management strategy.

It is significant to note that **none** of the organisations in Group 5 (sub-contractors) had an occupational health, safety, and environmental management strategy.

CONCLUSION 5

As was expected, the three network providers indicated that their organisations had an occupational health, safety, and environmental management strategy.

One of the factors taken into account when awarding network licences and the financing thereof, is that network operators or network providers should comply with international standards on occupational health, safety, and environmental management, hence the requirement of an occupational health, safety, and environmental management strategy.

This requirement will obviously be cascaded down the supply chain in the GSM industry, and manufacturers, suppliers and, to a lesser extent, contractors and sub-contractors, may have to meet similar requirements to secure business with the network providers.

Table 14: Difference between network providers; manufacturers, suppliers, contractors and sub-contractors based on an occupational health, safety and environmental management strategy

The χ^2-test was used to calculate the significance of differences between network providers, manufacturers, suppliers, contractors and sub-contractors regarding an occupational health, safety and environmental management strategy.

Group \ Question Options	Yes	No
Network provider	3	0
Manufacturers	5	2
Suppliers	4	3
Contractors	10	20
Sub-contractors	0	6
Summary information	χ^2-statistic: 12.596 Degrees of freedom: 4 Significance (*p*-value): 0.0131	

From the significance (referred to as the *p*-value) in Table 14 it can be seen that there is a significant difference between network providers, manufacturers, suppliers, contractors, and sub-contractors regarding an occupational health, safety, and environmental management strategy. (For the detailed statistical analysis refer to Annexure E.)

The percentage of organisations in the GSM industry that have an occupational health, safety, and environmental management strategy is clearly significantly different from group to group, and it can therefore be stated that network providers, manufacturers, suppliers, contractors and sub-contractors place different emphases on the importance of an occupational health, safety, and environmental management strategy in their organisations. The findings suggest that contractors and sub-contractors in the GSM industry are not formal planners insofar as occupational health, safety and environmental management is concerned.

However, if organisations in the GSM industry are to manage occupational health, safety, and environmental management successfully in the long term, it is imperative that they formulate strategies based on their strengths and core competencies in the industry in which they operate. The strategic weakness shown to exist among contractors and sub-contractors in the GSM industry in relation to occupational health, safety, and environmental management points to the possibility that they may have limited business success in managing this function. In terms of the importance of these functions with regard to long-term strategic advantages, this finding might be indicative of potentially dire consequences for these organisations in the long run.

4.5 Question 2.8: Does your organisation have a safety, health and environmental management policy statement that has been approved by the executive management?

Instruction: Please mark ONLY ONE square with an x

Yes	46	No	47

Although an occupational health and safety policy statement is not a legal requirement in terms of section 7 of the Occupational Health and Safety Act (85 of 1993), and an environmental management policy is not prescribed by the National Environmental Management Act (107 of 1998), the OHSAS 18000 Health and Safety and ISO 14001 Environmental Management international standards both stipulate that an organisation should have a policy statement to give these functions direction, and to ensure executive management's commitment to health, safety, and environmental management principles.

In order to make occupational health, safety, and environmental management a reality within an organisation, and to manage these concerns in a proactive manner, it is imperative that organisations devise an occupational health, safety, and environmental management policy statement, which should be ratified and supported by the executive of the organisation.

An organisation that lacks such a policy statement is most likely to lose focus. A policy statement will give direction to all levels of management, and will specify the goals of the organisation in relation to occupational health, safety, and environmental management. To make risk management a viable, ongoing part of the organisaition, it is important not to isolate the occupational health, safety, and environmental management function from the level where strategic decisions are taken.

Table 15: Results: — Health, safety and environmental management policy statement approved by the executive management

Q2.8	POLICY	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q2.8.1	Yes	3	100	6	86	5	71	14	47	1	17	55
Q2.8.2	No	0	0	1	14	2	29	16	53	5	83	45
% TOTAL WITH A HEALTH, SAFETY AND ENVIRONMENTAL MANAGEMENT POLICY		100		86		71		47		17		100

The results of the study show that all GSM network providers had an occupational health, safety, and environmental management policy. Eighty-six percent of manufacturers of GSM equipment also confirmed that their organisations had an occupational health, safety, and environmental management policy statement. Seventy-one percent of suppliers of GSM equipment said their organisations had such a policy statement, while only 47 percent of contractors indicated that their organisations had one.

It is important to note that only 17 percent of the organisations in Group 5 (sub-contractors) had an occupational health, safety, and environmental management policy statement.

Given the type of activities undertaken by contractors and sub-contractors in the GSM industry, it had been expected that these two groups would have had an occupational health, safety, and environmental management policy statement.

CONCLUSION 6

Although an occupational health and safety policy statement is not a legal requirement in terms of section 7 of the Occupational Health and Safety Act (85 of 1993), it is important to note that the majority of respondents did, in fact, regard a risk management policy as important in their organisation.

Table 16: Difference between network providers, manufacturers, suppliers, contractors and sub-contractors based on an occupational health, safety and environmental management policy statement

The χ^2-test of the significance of differences was used to establish the magnitude of the observed differences between network providers, manufacturers, suppliers, contractors, and sub-contractors based on an occupational health, safety, and environmental management policy statement.

Group \ Question Options	Yes	No
Network provider	3	0
Manufacturers	6	1
Suppliers	5	2
Contractors	14	16
Sub-contractors	1	5
Summary information	χ^2-statistic: 10.277 Degrees of freedom: 4 Significance (p-value): 0.0353	

From the p-value shown in Table 16, it can be seen that there is a significant difference between network providers, manufacturers, suppliers, contractors, and sub-contractors in terms of an occupational health, safety and environmental management policy statement. (For the detailed statistical analysis refer to Annexure F.)

4.6 Question 2.9: Does your organisation have recognised certification or registration for the following international standards?

Instruction: Please mark ONLY ONE square with an x

ISO 9000	Yes	48	No	49
ISO 14001	Yes	50	No	51
OHSAS 18000	Yes	52	No	53

This question deals specifically with international standards certification, and it was asked with the purpose of establishing whether the organisations surveyed were committed to achieving international standards, and whether such standards were a requirement in their area of operation. It is important to note that a number of organisations in the GSM industry are global players, and that compliance with international standards, such as OHSAS 18000 and ISO 14000, is critical to their success in competing in the global market.

Adoption of the ISO 14001 and OHSAS 18000 management systems establishes an overall sense of direction, and provides the principles of action for an organisation. These systems set objectives for occupational health and safety responsibility and performance required throughout the organisation. They demonstrate the formal commitment of an organisation, particularly of its top management, to sound occupational health, safety, and environmental management principles.

The ISO standards were designed as a management system to provide organisations with a set of documented procedures to manage their occupational health, safety, and environmental management, and to be audited (benchmarked) against a standard that is internationally recognised. Both the ISO 14001 and OHSAS 18001 management systems promote overall health, safety, and environmental objectives, and a commitment to improving health and safety performance, as well as environmental sustainability.

Such systems should be congruent with the nature and scale of the organisation's health, safety, and environmental risks, and should include a commitment to ongoing improvement. In addition, the organisation should be sufficiently committed to comply with (at least) current legislation, and with other requirements, such as those of their customers.

Table 17: Results: — Recognised ISO certification

Q2.9	RECOGNISED ISO CERTIFICATION	GP 1		GP 2		GP 3		GP 4		GP 5		TOTAL %
Q2.9.1	ISO 9000	2	66	6	86	3	43	6	20	1	17	34
Q2.9.2	ISO 14001	2	66	2	29							8
Q2.9.3	OHSAS 18000	1	33	1	14					1	17	6

An important finding is that 86 percent of manufacturing organisations in the GSM industry met the ISO 9000 certification standard for quality assurance. The assumption at the outset of the research had been that the majority of respondents would meet the ISO requirements for occupational health, safety, and environmental management.

The findings pertaining to recognised ISO certification indicate that only 8 percent of the respondents had an ISO 14001 (Environmental management) certification, and that a mere 6 percent had an OHSAS 18000 (Health and Safety) certification.

CONCLUSION 7

Organisations in the GSM industry in South Africa do not regard the international standards pertaining to occupational health, safety, and environmental management as important in conducting their business.

CONCLUSION 8

Greater emphasis is placed on quality assurance by organisations in the GSM industry in South Africa, than on international occupational health, safety, and environmental management standards.

4.7 Question 2.11: What role does health, safety and environmental management have in your organisation's strategic plan?

Instruction: Please mark ONLY ONE square with an x

60	61	62	63	64
Unimportant	Fairly unimportant	Neither important or unimportant	Important	Extremely important

This question provided a good indication of the importance of health, safety and environmental management in determining an organisation's overall strategic plans.

Table 18: Results: — Role in organisation's strategic plan

Q2.11	ROLE IN ORGANISATION'S STRATEGIC PLAN	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q2.11.1	Unimportant	1	33					2	7			6
Q2.11.2	Fairly unimportant			1	14							2
Q2.11.3	Neither important or unimportant							1	3			2
Q2.11.4	Important	2	66	5	71	6	86	15	50	5	83	62
Q2.11.5	Extremely important			1	14	1	14	12	40	1	17	28

CONCLUSION 9

Health, safety, and environmental management are overwhelmingly considered an important factor in determining the organisations' overall strategic plans.

5. PART 3: DISCUSSION OF RISK ASSESSMENT QUESTIONS

The questions in this part of the questionnaire were designed to ascertain whether the organisation had implemented a formal procedure for assessing its health and safety hazards and risks, and to establish the organisation's exposure to environmental management impacts and aspects.

It was necessary to establish what formal tool is employed as a primary measurement instrument to measure health and safety hazards and risks, as well as environmental impacts and aspects.

Matters related to integrated health, safety, and environmental management functions were also covered. Specific questions dealt with risk assessment tools to measure risks for the integrated functions of health, safety, and environmental management.

5.1 Question 3.1: Does your organisation have a formal system to measure its health and safety risks?

Instruction: Please mark ONLY ONE square with an x

Yes	1	No	2

The purpose of this question was to find out whether the organisation employed a formal procedure for assessing its health and safety risks. Many organisations employed informal measures for assessing their risks, and did not use the formal measuring tools available in the industry.

IMPORTANT NOTE

The motivation for this research was based on the hypothesis that organisations in the GSM industry in South Africa do not have a formal system of measuring their health and safety risks.

Table 19: Results: — Formal system to measure risks

Q3.1	FORMAL SYSTEM TO MEASURE RISKS	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	Total %
Q3.1.1	Yes	2	66	2	29		0	12	40	1	17	32
Q3.1.2	No	1	34	5	71	7	100	18	60	5	83	68
% HAVING A SYSTEM TO MEASURE RISKS		66		29		0		40		17		100

The results show that only 32 percent of the organisations surveyed had a formal system for measuring their health and safety risks.

In the areas where the frequency of health and safety risks is considered to be high, contractors and sub-contractors in the GSM industry have relatively low or no formal systems for measuring their health and safety risks. Forty percent of contractors, and as few as 17 percent of sub-contractors indicated that they applied a formal system for measuring their health and safety risks.

CONCLUSION 10

The majority of organisations in the GSM industry in South Africa do not have a formal system for measuring their health and safety risks.

5.2 Question 3.2: Which of the following risk assessment tools does your organisation apply as a primary tool to measure its health and safety risks?

Instruction: Please mark ALL the applicable squares with an x

PRIMARY RISK ASSESSMENT TOOL	
Event tree analysis (ETA)	3
Fault modes and effects analysis & fault modes, effect and criticality analysis (FMEA)	4
Fault tree analysis (FTA)	5
Hazard & operability study (HAZOP)	6
Human reliability analysis (HRA)	7
Preliminary hazard analysis	8
Reliability block diagram	9
Hazard and incident risk assessment (HIRA)	10
Other (specify)	11

This question was designed to establish which formal tools are employed by the organisations surveyed as primary measurement tools to assess their risks.

Table 20: Results: — Primary risk assessment tool

Q3.2	PRIMARY RISK ASSESSMENT TOOL	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.2.1	Event tree analysis (ETA)	1	33									2
Q3.2.2	Fault modes and effects analysis (FMEA)							1	3			2
Q3.2.3	Fault tree analysis (FTA)	1	33									2
Q3.2.4	Hazard & operability study (HAZOP)	2	66					3	10	1	17	11
Q3.2.5	Human reliability analysis (HRA)							3	10	1	17	8
Q3.2.6	Preliminary hazard analysis	2	66					2	7			8
Q3.2.7	Reliability block diagram											0
Q3.2.8	Hazard and incident risk assessment (HIRA)	1	33	1	14			12	40			26

The results show that hazard and incident risk assessment (HIRA) was applied by 8 percent of the respondents as a primary tool to measure the organisation's risks; 11% applied hazard and operability studies (HAZOP), and a further 8% employed preliminary hazard analysis (PHA).

CONCLUSION 11

Hazard and operability studies (HAZOP) are the most commonly used primary measuring instrument to determine organisations' health, safety, and environmental risks in the GSM industry in South Africa.

5.3 Which of the following risk assessment tools does your organisation apply as a secondary tool to measure its health and safety risks?

Instruction: Please mark ALL the applicable square with an x

SECONDARY RISK ASSESMENT TOOLS	
Category rating	12
Checklists	13
Common mode failure analysis	14
Consequence models	15
Delphi technique	16
Hazard indices	17
Monte-Carlo simulation	18
Review of historical data	19

The purpose of this question was to establish which tool is used as a secondary measurement tool to measure an organisation's risks.

Table 21: Results: — Secondary risk assessment tools

Q3.3	SECONDARY RISK ASSESMENT TOOLS	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.3.1	Category rating	1	33									2
Q3.3.2	Checklists	2	66	2	29			12	40	1	17	32
Q3.3.3	Common mode failure analysis											
Q3.3.4	Consequence models	1	33									2
Q3.3.5	Delphi technique											
Q3.3.6	Hazard indices	1	33					1	3	1	17	6
Q3.3.7	Monte-Carlo simulation	2	66	1	14			3	10			11
Q3.3.8	Review of historical data											

The only noteworthy result on the question of secondary risk assessment tools applied by organisations in the GSM industry is that 32 percent of them use checklists as their secondary risk assessment instrument.

CONCLUSION 12

Checklists are applied as a secondary tool to measure health and safety risks of organisations in the GSM industry in South Africa.

5.4 Does your organisation have a formal system for measuring its environmental management risks?

Instruction: Please mark ONLY ONE square with an x

Yes	21	No	22

The objective of this question was to establish whether the organisation's products, services, and processes require environmental impact assessments (EIAs).

Table 22: Results: — Formal environmental measurement

Q3.4	FORMAL ENVIRONMENTAL MEASUREMENT	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.4.1	Yes	2	66	3	43	2	29	7	24			26
Q3.4.2	No	1	34	4	57	5	71	23	76	6	100	74
% FORMAL ENVIRONMENTAL MEASUREMENT		66		43		29		24		0		100

Seventy-four percent of the respondents indicated that their organisations did not use a formal system to measure the environmental impacts of their products, services or processes.

CONCLUSION 13

Seventy-four percent of organisations in the South African GSM industry do not meet the legal requirement in terms of the National Environmental Management Act (NEMA) that the establishment of a cellular network and/or auxiliary services shall be subject to a formal measurement (environmental impact assessment) conducted by an independent body.

5.5 Which of the following risk assessment tools does your organisation apply to measure its environmental management risks?

Instruction: Please mark ALL the applicable squares with an x

ENVIRONMENTAL RISK ASSESSMENT	
Checklists	23
Leopold matrix	24
Overlays and mapping	25
Panel evaluation	26
Cross-tabulation matrix approach	27
Other (specify)	28

The results show that checklists were used by 30 percent of the respondents to measure their organisations' environmental risks.

Table 23: Results: — Environmental risk assessment

Q3.5	ENVIRONMENTAL RISK ASSESSMENT	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.5.1	Checklists	2	66	2	29	2	29	9	30	1	17	30
Q3.5.2	Leopold matrix							1	3			2
Q3.5.3	Overlays and mapping											
Q3.5.4	Panel evaluation	2	66			1	14					6
Q3.5.5	Cross-tabulation matrix											
Q3.5.6	Other (specify)	1	33	1	14			1	3			6

CONCLUSION 14

Checklists are applied in the majority of cases by the organisations in the GSM industry in South Africa that measure their environmental risks.

5.6 Does your organisation's products; services or processes require environmental impact assessments?

Instruction: Please mark ONLY ONE square with an x

Yes	29	No	30

Table 24: Results: — Environmental impact assessments

Q3.6	ENVIRONMENTAL IMPACT ASESSMENTS	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.6.1	Yes	3	100	3	43	3	43	18	60	2	34	55
Q3.6.2	No			4	57	4	57	12	40	4	66	45
% PRODUCTS, SERVICES & PROCESSES REQUIRE AN EIA		100		43		43		60		34		100

Fifty-five percent of the respondents indicated that their organisation's products, services or processes required an environmental impact assessment (EIA), while 45 percent of respondents said their organisations did not require any EIAs.

In both areas where EIAs are of critical importance, namely network service providers (100%) and those organisations responsible for the installation of networks and their auxiliary services (contractors – 60%), the majority of respondents indicated that they required EIAs for their products, services or processes.

CONCLUSION 15

Environmental impact assessments are of critical importance to organisations in the GSM industry in South Africa in order to establish their products, services or processes.

5.7 Does your organisation make use of a risk assessment tool to measure risks for the integrated functions of health, safety and environmental management?

Instruction: Please mark ONLY ONE square with an x

Yes	31	No	32

This question related specifically to integrated safety, health and environmental management functions. It probed whether the organisation employed a risk assessment tool to measure risks for the integrated functions of health, safety, and environmental management, which would imply that the organisation had an integrated safety, health and environmental management function.

Table 25: Results: — Integrated risk assessment tool

Q3.7	INTEGRATED RISK ASSESSMENT TOOL	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.7.1	Yes	1	33	2	29	1	14	7	24		0	21
Q3.7.2	No	2	64	5	71	6	86	23	76	6	100	79
% USE INTEGRATED RISK ASSESSMENT TOOL		33		29		14		24		0		100

The responses to this question indicate that 79 percent of the respondents do not use a risk assessment tool to measure risks for the integrated functions of health, safety, and environmental management.

A relatively high percentage of the organisations that do not apply integrated risk assessments, are found in Group 3 (86%) and Group 5 (100%).

CONCLUSION 16

The functions of health and safety are not integrated with the environmental management function, and these three functions are treated as separate entities when evaluating the risks or impacts in these areas.

IMPORTANT IMPLICATION

The fact that **fewer than 21%** of the respondents' organisations have an integrated risk assessment tool to formally measure their health, safety, and environmental risks, highlights the need to develop an integrated health, safety, and environmental risk assessment model for the GSM industry.

5.8 If your organisation has not integrated the functions of health, safety and environmental management, does it plan to do so in the near future?

Instruction: Please mark ONLY ONE square with an x

Yes	33	No	34	N/A	35

Table 26: Results: — Future integrated risk management functions

Q3.9	INTEGRATED RISK MANAGEMENT FUTURE	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.9.1	Yes			3	43	6	86	18	60	6	100	63
Q3.9.2	No	1	33	1	14			3	10			9
Q3.9.3	N/A	2	66	3	43	1	14	9	30			28

These findings show that 63 percent of the respondents' organisations plan to integrate the functions of health, safety, and environmental management in the future.

5.9 Is your organisation considering including (integrating) the following functions in addition to the safety, health and environmental management functions?

Instruction: Please mark ALL the applicable squares with an x

Quality assurance	Yes	36	No	37
Security/loss control	Yes	38	No	39
Information security	Yes	40	No	41

The purpose of this question was to determine whether the organisations that have already integrated the functions of health, safety, and environmental management plan to include any other function in the near future. This question applied only to those respondents whose organisations had implemented an integrated health, safety, and environmental management system.

Table 27: Results: — Future to include other RM functions

Q3.10	FUTURE TO INCLUDE RM FUNCTIONS	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.10.1	Quality assurance	3	100	6	86	6	86	21	70	5	83	77
Q3.10.2	Security/loss control	1	33	1	14	4	57	9	30	4	67	36
Q3.10.3	Information security	1	33	1	14	2	29	7	23	1	17	23

Based on the results set out in Table 27, 77 percent of the respondents indicated that they would prefer to include quality assurance as part of the health, safety, and environmental management function.

CONCLUSION 17

Quality assurance is the function that is most likely to be considered for integration with the health and safety function.

IMPORTANT NOTE

This finding is in line with the most recent trend in business, which is to integrate the functions of safety, health, environmental management, and quality within an umbrella function referred to as **SHEQ.**

5.10 How does your organisation benefit from integrating the functions of safety, health and environmental management?

Instruction: Please mark ALL squares with an x

BENEFITS FORM AN INTEGRATED APPROACH	
Financial (cost saving)	42
Organisational (saving on human resources)	43
Functional (saving on duplication of functions)	44
Operational (saving on production)	45
Efficiency (saving on processes)	46
Other (specify)	47

The intention with this question was to measure what benefits the respondent believed the organisation perceives itself as deriving, or expecting to derive in the future, through the integration of the health, safety, and environmental management functions.

Table 28: Results: — Integrating risk management

Q3.11	BENEFITS FROM INTEGRATING RM	GP 1	%	GP 2	%	GP 3	%	GP 4	%	GP 5	%	TOTAL %
Q3.11.1	Financial (cost saving)	2	66	5	71	7	100	22	73	4	66	79
Q3.10.2	Organisational (saving on human resources)	2	66	3	43	1	14	17	57	3	50	49
Q3.10.3	Functional (saving on duplication of functions)	3	100	6	86	4	57	13	43	5	83	58
Q3.10.4	Operational (saving on production)	3	100	2	29	4	57	14	47	4	66	51
Q3.10.5	Efficiency (saving on processes)	2	100	4	57	4	57	14	47	4	66	53

The majority of respondents (79 percent) cited financial (cost saving) benefits as the most important advantage of integrating safety, health and environmental management functions.

A breakdown of the results shows that 66 percent of the GSM network providers believed financial (cost saving) benefits to be an important advantage of integrating safety, health, and environmental management, compared with 71 percent of manufacturers of GSM equipment, 100% of suppliers of GSM equipment, 73 percent of contractors, and 66 percent of sub-contractors who named financial (cost saving) as an important benefit of integrating safety, health and environmental management.

CONCLUSION 18:

Financial (Cost saving) benefits through the integration of safety, health, and environmental management functions are considered the most important factor when integrating the Health, Safety, and Environmental management functions

6. ANALYSIS OF RELATIONSHIPS BETWEEN ORGANISATIONS WITH A HEALTH, SAFETY AND ENVIRON MENTAL MANAGEMENT STRATEGY, AND A POLICY STATEMENT IN RELATION TO THE APPLICATION OF AN INTEGRATED RISK ASSESSMENT TOOL TO MEASURE HEALTH, SAFETY AND ENVIRONMENTAL RISKS

Because of the exploratory nature of this research, and the limited available data to perform an in-depth statistical analysis, it was decided to apply a Pivot Table report for the purpose of analysing the data presented by the different groups of respondents.

The decision to use a Pivot Table report was based on the fact that the Pivot Table is an interactive table which the researcher can use to summarise large quantities of data. Through manipulation rows and columns can be rotated to determine different summaries of the source data, filter the data by displaying different pages, or display the details for areas of interest.

A further reason for using the PivotTable report was to compare related totals or to compare several facts surrounding each figure, such as the number of respondents who had indicated that their organisations had implemented a health, safety, and environmental management strategy, and the number of respondents who had indicated that their organisations use a formal system to measure their health, safety, and environmental management risks. Because a Pivot Table report is interactive, it was possible to change the view of the data to determine more details, or to calculate different summaries.

6.1 Organisations with a risk management division, department or section that also have a health, safety and environmental management strategy

During the analysis of the data it became evident that it would be important for this, as well as future research, to determine if those organisations in the GSM industry that have a division, department or section of risk management have elected to implement a health, safety and environmental management strategy. Such a strategy would be a reasonable indicator of how these three disciplines would be addressed within the organisation in relation to their organisational position, importance in terms of consultation for decision-making and inclusion in the organisation's overall strategy and policy.

Table 29: Results: — Organisations with a risk management division, department or section, and a health, safety and environmental management strategy

Sum of teller	Q2_1			Percentage of total
Q2_17	1	2	Grand total	
1	13	9	22	42
2	14	17	31	
Grand total	27	26	53	
Percentage of total	51			

The results of the analysis show that of the 51 percent of the organisations that indicated that they had a division, department, or section of risk management, only 42 percent in fact had a health, safety and environmental management strategy.

CONCLUSION 19

The importance of a health, safety, and environmental management strategy is underestimated by organisations in the GSM industry.

6.2 Organisations with a risk management division, department or section that also have a health, safety and environmental management policy

Table 30: Results: — Organisations with a risk management division, department or section that also have a health, safety and environmental management policy approved by their executive management

Sum of teller	Q2_1			Percentage of total
Q2_18	1	2	Grand total	
1	16	13	29	55
2	11	13	24	
Grand total	27	26	53	
Percentage of total	51			

The results of this analysis show that, of the organisations that had a risk management division, department or section, only 55 percent had a health, safety, and environmental management policy approved by their executive management.

This marginal increase of 13 percent, compared to the percentage of respondents who indicated that their organisations have a health, safety, and environmental management strategy, and the percentage of respondents whose organisations had a health, safety, and environmental management policy approved by their executive management, may be attributed to the fact that the three major GSM network services providers, prior to awarding contracts to manufacturers, suppliers and contractors for GSM-related products and services, require submission of a health, safety, and environmental management policy from the manufacturers, suppliers, and contractors involved.

CONCLUSION 20

The majority of respondents consider a risk management policy, as envisaged in section 7 of the Occupational Health and Safety Act (85 of 1993), as important in their organisation.

6.3 Organisations with a risk management division, department or section that also apply a formal system to measure their risks

Table 31: Results: — Organisations with a risk management division, department or section that also apply a formal system to measure their risks

Sum of teller	Q2_1			Percentage of total
Q3_1	1	2	Grand total	
1	10	7	17	32
2	17	19	36	
Grand total	27	26	53	
Percentage of total	51			

Of the organisations that indicated that they had a risk management division, department or section, only 32 percent in fact employed a formal system to measure their risks.

It is important to note that the activities undertaken by organisations in the GSM industry in South Africa are all broadly classified as activities that fall under the definition of "construction" in terms of the Construction Regulations, GNR.1010 of 18 July 2003, promulgated under the Occupational Health and Safety Act (85 of 1993).

CONCLUSION 21:

This result is rather disconcerting as the requirements under the Construction Regulations (Regulation 7) specifically state that an organisation must be able to demonstrate a formal system to measure its risks.

6.4 Organisations that apply a formal system to measure their risks and that also apply a formal system to measure their environmental risks

Table 32: Results: — Organisations that apply a formal system to measure their risks and that also apply a formal system to measure their environmental risks

Sum of teller	Q3_1			Percentage of total
Q3_20	1	2	Grand total	
1	10	4	14	26
2	7	32	39	
Grand total	17	36	53	
Percentage of total	32			

The results of the analysis show that 32 percent of the organisations that indicated that they had a formal system for measuring their risks, only 26 percent had a formal system for measuring their environmental risks.

CONCLUSION 22

This result is quite alarming: The National Environmental Management Act requires that an organisation must be able to demonstrate a formal system for measuring its risks. Based on the research results, it appears that 74% of the organisations in the GSM industry do not meet this legal requirement.

6.5 Organisations that apply a formal system to measure their risks and that also have a formal system for conducting environmental impact assessments.

Table 33: Results: — Organisations that apply a formal system to measure their risks and that also have a formal system for conducting environmental impact assessments

Sum of teller	Q3_1			Percentage of total
Q3_27	1	2	Grand total	
1	12	17	29	55
2	5	19	24	
Grand total	17	36	53	
Percentage of total	32			

The results of the analysis show that of the 32 percent of organisations that had a formal system for measuring their risks, only 55 percent had a formal system for conducting environmental impact assessments.

6.6 Organisations that apply a formal system to measure their risks and that also use an integrated risk assessment tool

Table 34: Results: — Organisations that apply a formal system to measure their risks and that also use an integrated risk assessment tool

Sum of teller	Q3_1			Percentage of total
Q3_28	1	2	Grand total	
1	8	3	11	21
2	9	33	42	
Grand total	17	36	53	
Percentage of total	32			

The analysis of these results shows that of the 32 percent of organisations that claimed to apply a formal system to measure their risks, only 21 percent had an integrated risk assessment tool.

CONCLUSION 23

It is evident from the results that most organisations in the GSM industry that have a formal system for measuring their risks, have not adopted an integrated risk assessment model to assess their health, safety and environmental risks.

7. SUMMARY OF THE FINDINGS AND ANALYSIS

In this chapter the results of the analysis of the data contained in the returned questionnaires that were sent out to the target groups (network providers, manufacturers, suppliers, contractors and sub-contractors) has been presented. A summary of the information was provided for the majority of the questions included in the questionnaire.

Furthermore, analyses were performed specifically to determine interdependence between Group 1 (network providers), Group 2 (manufacturers), Group 3 (suppliers), Group 4 (contractors) and Group 5 (sub-contractors). This has led to a number of recommendations for GSM organisations that are considering the implementation of an integrated health, safety, and environmental management risk assessment tool to measure their occupational health, safety, and environmental management risks.

The focal point of chapter 7 will be the development of an integrated health, safety, and environmental management risk assessment model for the GSM industry in South Africa. The central point of the chapter will therefore be on the development of a mechanism for assessing health, safety, and environmental risks on an integrated basis in the GSM industry in South Africa.

CHAPTER 7

THE DEVELOPMENT OF AN INTEGRATED HEALTH, SAFETY, AND ENVIRONMENTAL MANAGEMENT RISK-ASSESSMENT MODEL FOR THE GSM INDUSTRY IN SOUTH AFRICA

1. Introduction

The advantages of integrating health, safety, and environmental management are well documented, and have been the central topic of discussion in the field of risk management for a number of years. The mechanism for integrating these functions is, however, less evident.

There is no clear evidence in the GSM industry in South Africa of the integration of the separate management standards for health and safety, and environment management into a single standard.

According to Newbury (2000: 1),

> [T]he developed integrated standard sets out the “skeleton” of the management system, it does not necessarily provide the day-to-day tools for the implementation of an integrated system. In practise the mechanisms of significance assessment; risk assessment and audit contained in both a health and safety or environmental management standard cause the most difficulty when attempting to integrate into one combined system.

The question that should necessarily be raised is whether it is possible to integrate the hazard identification and risk assessment (HIRA) process with the environmental impact assessment process (EIA) to form one system for the GSM industry which will provide a practical instrument for the effective evaluation and control of safety, health, and environmental risks.

2. Integrated management systems

Because of the existence of separate management systems such as the ISO 14000 series for Environmental Management (1996) and OHSAS 18000 for Occupational Health and Safety, which must be read with the British

Standard BS 8800 for Occupational Health and Safety Management Systems (1996), the necessity of integrating these management standards for the GSM industry in South Africa has been raised a number of times throughout the industry. Proponents of integration argue that there is no fundamental difference between health, safety, and environment management systems. Health, safety, and environmental standards are based on legal requirements, and can usually be assessed with reference to detailed, often legal, standards.

From a legal perspective, the integration of health, safety, and environment management systems may be seen as a logical first stage in the process of integration.

2.1 Advantages of integrating health, safety, and environmental management systems

Occupational health and safety systems are very similar to environmental management systems in respect of their conception of control, using similar methods such as policy statements, risk assessments, and written systems of work. According to (Newbury 1999: 2), “[t]his common approach is not unsurprising as most health and safety potential risks are also environmental risks".

Workers employed to construct a BTS site will be exposed to potential risks during the construction of a 56-metre tower if they ascend or descend from the tower without proper fall-arrest equipment. The tower itself may have an effect on the environment, while the microwave emissions from the antennas may have a detrimental effect on the surrounding habitat. This example shows that health and safety perils are interwoven with environmental hazards.

2.2 Commonalties between health, safety, and environmental management systems

In South Africa, health, safety, and environmental management issues are controlled by detailed statutory legislation, namely (the Occupational Health and Safety Act (85 of 1993) and the National Environmental Management Act (107 of 1998). These Acts are enforced both nationally and at local authority level.

Because of their commonalties and shared origins, there are clear advantages to be reaped from managing both issues in a single common system. The means of assessment and control of health, safety, and environmental management issues are the same, and technical means of control have often been considered together. Management responsibilities and planning could be integrated to avoid duplication, and working instructions relating to the processes involved could be formulated to include health, safety, and environmental management issues. Training and awareness programmes could also incorporate health, safety, and environmental management issues, where auditing and monitoring should, once again, be integrated to avoid duplication.

Vodacom and Siemens Telecommunications have successfully developed a comprehensive occupational health, safety, and environmental management audit system that has been implemented successfully in South Africa.

2.3 Disadvantages of integrating health, safety and environmental management systems

Health and safety processes, and environmental management processes, have to be managed through separate pieces of legislation. For example, the requirement for a risk assessment is dealt with in the 1993 Occupational Health and Safety Act, Construction, regulation 7, whereas the National Environmental Conservation Act (107 of 1998), regulates environmental impact assessments.

2.4 The integrated approach

Newbury (2000: 5) claimed that "the advantages would appear to outweigh the disadvantages. To develop safety, health and environmental integrated management systems some organisations have developed different approaches."

Many companies would prefer initially to introduce each separate system sequentially, and then possibly to merge them at a later stage, as has been the case with Siemens Telecommunications. Other organisations have informally linked health and safety to their existing environmental management system, such as in the case of the ISO 14001 system.

There is no "quick-fix recipe" for achieving success in this field. A survey undertaken by Newbury (1997) indicated that the greatest difficulty arises from the integration of the key mechanisms of the significance review, the risk assessment, and the audit.

Newbury (2000: 7) pointed out that the "tools of significance review, risk assessment and audit are the primary means to 'drive forward' an integrated system. Without workable integrated mechanisms it is unlikely that the benefits of integration will be achieved".

2.4.1 Significance rating

The purpose of significance rating in the initial status review is broadly to compare the current levels of occupational safety, health, and environmental management performance of the company with the minimum standards, and to compare the relative potential of one risk topic with another. This makes it possible for the planning and introduction of this management standard to be focused on reducing potential loss, and maximising the organisation's effectiveness. The purpose of the initial review is not to undertake risk assessments, but rather to prioritise the risk-assessment process and rapidly to examine those significant items which could lead to harm or loss (Newbury 2000: 7).

This is an essential process because, when an organisation undertakes the risk assessment itself, the programme often takes some time to complete. There is consequently a danger that, if this programme is not given priority, health, safety, or environmental areas of significant non-performance might not be assessed quickly enough, leading to significant harm or loss.

2.4.2 Risk assessment

Newbury (2000: 9) explained the complexities of an integrated risk assessment system as follows:

> Initial research centred on developing a fully integrated mechanism for risk assessment for Safety, Health and Environment. However, when tested, with trials of this fully integrated mechanism in a large manufacturing plant, the completely integrated risk assessment model failed, because health and safety is a task-based function whereas the environment often examines the global situation.

Looking mainly at health and safety risk assessments, one finds, however, that each task and process needs to be examined and assessed individually as the risk levels may vary considerably. Take, for example, the construction of a BTS mast as opposed to the adjustment of antennas on the mast. Although both processes involve the mast as a common denominator, each involves a different discipline with its own inherent risks.

This fundamental dichotomy between task and global risk-assessment tools prevents a complete integration of risk assessment (Newbury 2000: 9).

This does not, however, entirely rule out some form of integration. Newbury (2000: 9) has therefore developed a method for the partial integration of the risk-assessment mechanism for safety, health, and environmental management. This partial integration has a similar "look and feel" to both the common and separate elements of the risk-assessment model proposed in this dissertation (Newbury 2000: 9).

If one were to succeed in integrating health, safety, and environmental management into a single management standard, these functions are far more likely to be perceived as having the same importance, and relevance, as any other business function. Issue; based on one style of management standard, one-way of thinking. Risk issues will be managed according to a unitary style, based on one and the same way of thinking**.** An integrated approach will promote the management of inevitable, and positive, change in the GSM industry.

- *Time frame:* It is estimated that it would take approximately three years effectively to introduce such an integrated system from scratch. There would need to be a clear and visible commitment from the top, and a "champion" would have to be appointed to drive the system during the early stages.
- *Objectives:* Both short- and long-term achievable objectives will need to be set, so that visible progress can be made. If long-term objectives appear to be too daunting, or take too long to be met, they may act as demotivators.
- *Training:* All employees will need appropriate training and adequate information at each stage of the implementation process to explain current progress and the milestones of the project.

The stages of establishing an integrated risk assessment model for safety, health, and environmental factors (as proposed by Newbury 1997: 9) are shown in Figure 9.

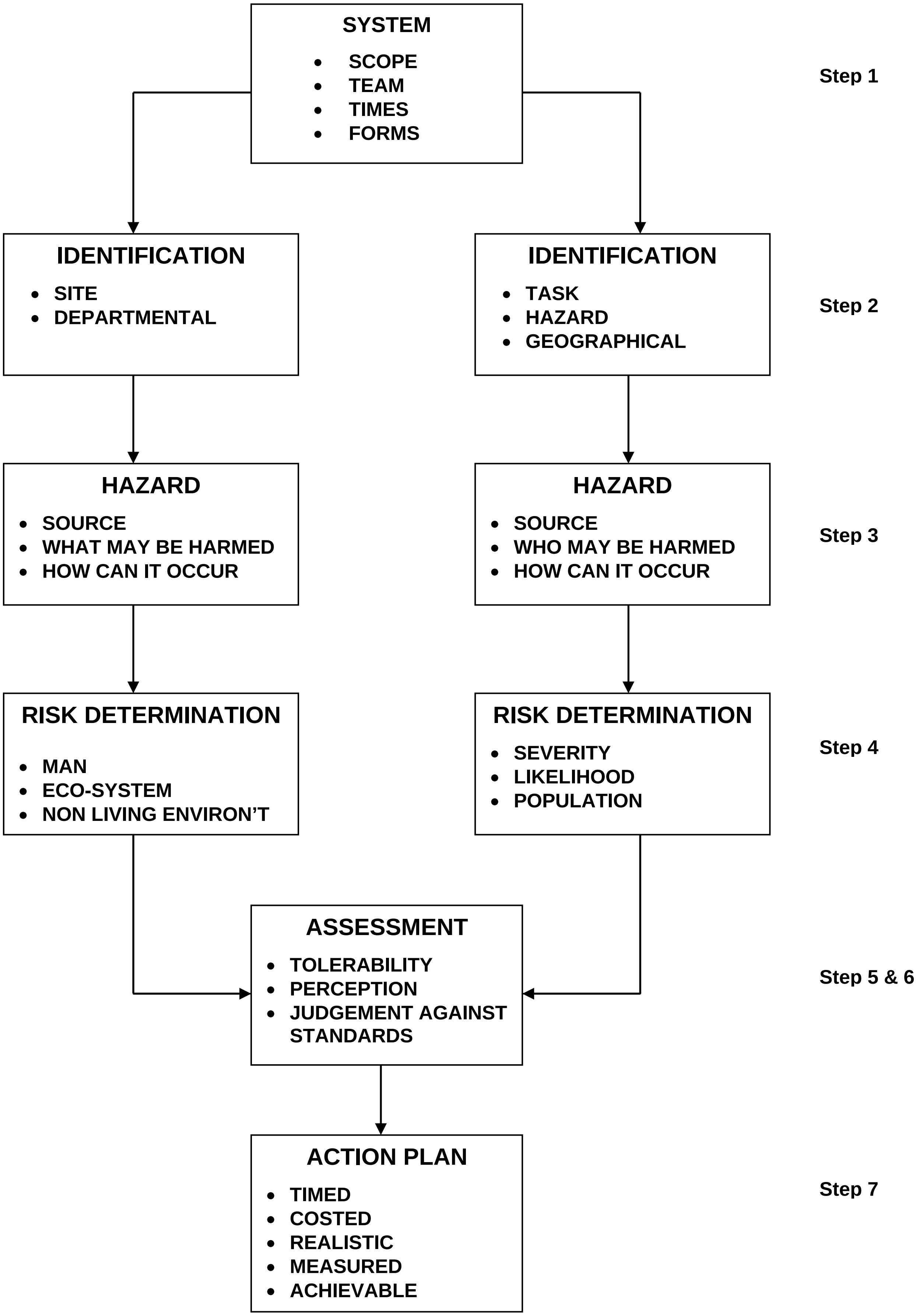

Figure 9: Stages of an integrated Risk Assessment (Newbury 2000:10)

While the practical implications of the model illustrated in Figure 9 may seem daunting, there are considerable benefits attached to having demonstrable control, independent of personalities, of safety, health, and environmental standards within the GSM. After the initial set-up costs, implementation of this model will result in increased efficiencies and cost savings, along with continuous improvement.

Implementation of an integrated management system will give organisations in the GSM industry effective control of health, safety, and environmental issues. This will, in turn, allow them to effect ongoing improvements in these areas. Additionally, such an integrated approach will increase market share, and it will promote the perception of a "green", well-managed, responsible company, not only with interested and affected parties, but with the wider public as well.

According to Newbury (2000: 20)

> [a]n Integrated Health Safety and Environmental Management System can be developed, but resource intensive initially, but with the long term benefits of competitive advantage. For this to be successful, practical mechanisms for integrated Significance Review and Risk Assessment need to be developed.
>
> Risk assessments for both health and safety and environment can be integrated into one methodology, which whilst is not wholly integrated, has a similar ‘look and feel’ for both the separate and common elements.

Clearly, therefore, it is of great importance to determine factors, such as levels of risk, impact of risks, and methods of handling risk, in an integrated model for occupational health, safety, and environmental management, applicable to the GSM industry.

3. Proposed risk-assessment model to address health, safety, and environmental risks for the GSM industry

It is evident from the literature, particularly as regards integrated risk assessment in support of an integrated occupational safety, health, and environmental management system proposed by Newbury, that it is possible to develop a model that would address risk assessments for the sub-disciplines of occupational health and safety, as well as environmental management.

It is argued here that by combining the Siemens Telecommunications Aspect and Impact (A&I) environmental risk assessment tool with the HIRA risk assessment tool, it will be possible to develop an integrated risk-assessment model for occupational health, safety, and environmental management in the GSM industry in South Africa.

3.1 Detailed description of the model is given in the sections that follow.

According to Glendon & McKenna (1995: 61) the fundamental equation in any risk evaluation exercise is:

Risk = frequency x severity

Risk profile = risk/mitigating control measures

For the purpose of this research, this model is based on the following relationships:

Risk = Probability of occurrence of an event. An event not always directly observable, but which has the potential to cause harm to the system elements being realised as a consequence of exposure to hazards/danger over a given period. (Glendon & McKenna 1995: 318)

Frequency = The rate at which an activity will happen or is to be repeated measured over a period of time. (Crowther 1995: 472).

Severity: = The state or extent to which the activity has a negative impact.

Risk profile = The determined risk mitigated through control measures that have a detrimental change or effect on the original risk status.

3.1.1 The matrix

The frequency and severity calculations are based on multiples of 5, representing a total of 25 squares, each square representing a risk value of the activity being assessed. Refer to figure 10 for details. These 25 squares are further grouped as follows:

High risk – Values between 17 and 25

Medium risk – Values between 16 and 8

Low risk – Values between 5 and 7

3.1.2 Frequency

The frequency table applied in the HIRA model is retained, in view of the fact that it is applicable to all the elements of health, safety, and environmental management. The frequency rating table is based on values from 1 to 5, where 1 has the lowest and 5 the highest rating.

Frequency table

Frequency rating 5	=	Incidents occur on a regular basis, and the probability that the incident may happen is estimated to be at least once a day.
Frequency rating 4	=	An incident will probably occur once a week.
Frequency rating 3	=	It is estimated that the incident may occur once a month.
Frequency rating 2	=	This rating implies that the incident has a small likelihood of happening once a year.
Frequency rating 1	=	This rating indicates that the possibility of an incident taking place is rare, and that it could happen only once in five years.

Probability table

PROBABILITY	Could happen once in 5 years	Could happen once a year	Could happen once a month	Could happen once a week	Could happen once a day
FREQUENCY	1/5 years	1/year	1/month	1/week	1/day
RATING	**1**	**2**	**3**	**4**	**5**

3.2 Severity

The severity is calculated on the average of the following five business activities, deemed to have the greatest impact on the health, safety, and environmental management activities in the GSM industry in South Africa.

It should be pointed out that although Tchankova (2002: 294) identified seven sources of risk (refer to pages 63-64 in chapter 4). The following business activities as outlined below are considered to be the most pertinent on which any activity within the GSM industry will have an effect. This statement is based on the practical experience the researcher has had as an occupational health, safety, and environmental practitioner in the South African GSM industry.

- Business environment
- Health and safety environment
- Financial environment
- Legal and political environment
- Environmental management

Severity is rated on an ascending scale from 1 to 5, where the most severe incident is rated as 5, and an incident with a minimal or no effect is rated as 1. The categories of severity are set out below.

3.2.1 Impact on business activities

The rating of the impact on business activities is as follows:

Severity rating 5	=	Catastrophic down-time in business processes, delay in business processes in excess of one month
Severity rating 4	=	Critical down-time in business processes, delay in business processes of less than one month
Severity rating 3	=	Serious down-time in business processes, delay in business processes of more than one week
Severity rating 2	=	Medium down-time in business processes, delay in business processes of more than one day delay
Severity rating 1	=	Minimal or zero down-time in business processes, delay in business processes of less than one day

3.2.2 Nature of incident (past and future potential)

The rating of the nature of an incident (past and future potential) is as follows:

Severity rating 5	=	The incident has in the past resulted in, or may in the future result in, one or more human fatalities or several injuries.
Severity rating 4	=	The incident will result in not more than one fatality, or disabling injury with an injury potential of the injured person being absent for in excess of three working days.
Severity rating 3	=	A serious incident will result in a disabling injury to one or more persons, causing the injured person to be absent for fewer than three working days.
Severity rating 2	=	The incident will result in minor injuries, the injured person being absent for less than one working day.
Severity rating 1	=	Any incident where no injury is recorded.

3.2.3 Financial impact of the nature of loss / damage

The rating of the financial impact of the nature of the loss or damage is as follows:

Severity rating 5	=	The financial impact of the loss will be considered Devastating, and the loss will be in excess of R10 million.
Severity rating 4	=	The financial impact of the loss will be considered Widespread, and the estimated value attached to the loss will be between R1 and R10 million.
Severity rating 3	=	The financial impact of the loss will be considered significant, but will be less than R1 million in monetary value.
Severity rating 2	=	Minor damage or financial impact, with a loss estimated to be less then R50 000.
Severity rating 1	=	Insignificant loss, financial impact or damage will be incurred.

3.2.4 Impact of legislative requirements

The rating of the impact of legislative requirements is as follows:

Severity rating 5	=	The incident/activity will create pressure from international stakeholders, as well as national government and/or public to cease such business activities.
Severity rating 4	=	The incident/activity will result in national government pressure either to cease, or to change, such business activities.
Severity rating 3	=	The incident/activity will result in regional (provincial) government pressure either to cease, or to change such business activities
Severity rating 2	=	The incident/activity will result in local government pressure (metropolitan area) either to cease, or to change, such business activities.
Severity rating 1	=	The incident/activity will result in local public reaction, perhaps organised by a few individuals as an organised interest/affected group.

3.2.5 Nature of environmental management impact

The rating of the environmental management impact is as follows:

Severity rating 5	=	The incident will be considered an environmental disaster resulting in irreversible ecological and/or and cause social damage.
Severity rating 4	=	The incident will be considered a major environmental incident, causing visible damage to land, sources. The incident will cause potentially reversible, long-term ecological damage, which will be widespread, and will have a permanent impact on the community.
Severity rating 3	=	The incident will have the potential to be reversed, but will result in long-term ecological damage and may have a significant impact on the community.
Severity rating 2	=	The incident will result in a short-term ecological disturbance, and will have a restricted impact on the community.
Severity rating 1	=	The incident will only cause expected ecological stresses, and may have a nuisance potential for the community or public with minimal or zero environmental consequences.

3.3 Severity table

Table 35: Severity table

RATING	Impact on business activities	Nature of incident (past and future potential)	Nature of loss / damage (financial)	Legal impact (legal)	Nature of impact (environmental)
5	Catastrophic down-time process delay >month	Fatal injury/ several injuries	Devastating damage/loss >R10 mil	International pressure	Irreversible ecological and/or social damage
4	Critical down-time process delay < month	Disabling injury > 3 days	Widespread damage/loss between R1 - R10 mil	National government pressure	Major incident, potentially reversible with long-term ecological damage and permanent impact on community
3	Serious down-time process delay (> 1 week)	Disabling injury < 3 days	Widespread damage/loss < R1 mil	Provincial government pressure	Potentially reversible with long-term ecological damage and significant impact on community
2	Medium down-time process delay (> 1 day)	Minor injury	Minor damage/loss < R50 000	Local authorities reaction (organised)	Short-term ecological disturbance and/or restricted impact on community
1	Minimal or zero down-time process delay (< 1 day)	No injury	Insignificant damage or zero loss	Individual complaints (little or no reaction)	Minimal or zero environmental consequences, ecological stress and/or nuisance to the community

4. Application of the model

The risk assessment model has been developed on the basis of simplicity, and is not restricted to the health, safety, and environmental practitioner. It should, in practice, be possible for any person exposed to, or associated with, operational risk-management activities in the GSM industry in South Africa to apply it. The risk assessment matrix forms the basis from which all risks are calculated.

The purpose of using a risk-assessment matrix is twofold:

Avoiding ambiguity: The possibility that if two persons assess the same risk they will attribute different values to it is eliminated. By applying the risk matrix, practitioners avoid ambiguity, and risks should be quantified on the same basis even if two or more persons assess the risk at different times, or under different circumstances. This is commonly referred to as "using the same scorecard".

Avoiding the influence of external factors: Because of the "fixed variables" applied, it is not possible for the person(s) conducting the risk assessment to be influenced by personal circumstances, or to assess the risk beyond the scope of the risk assessment. The areas to be assessed are all predetermined. Should the assessment cover an area beyond the scope of the variables, the least applicable variable can be replaced with a variable that will address the specific dimensions that have to be assessed.

In order to illustrate the model practically, the following GSM-related scenario will be used:

> Five employees are busy with the monthly antenna maintenance on a 56-metre BTS lattice mast. All five employees are at the top of the mast when it collapses, severing the mast at the 12-metre section. As a result

of the collapse of the lattice mast, three employees are killed, and the other two suffer serious multiple injuries.

The operation is stopped by the Chief Inspector from the Department of Labour, and the site is switched off to enable the incident investigators to conduct their investigation. The immediate result is that this particular BTS site, which has been classified as a "platinum site", will lose an income in excess of R500 000 per day.

Based on the proposed model, the future risks of monthly antenna maintenance on a 56-metre BTS lattice mast will be calculated as follows.

4.1 List main and sub-activities

Under "Main activities" on the risk analysis matrix (see below), list all the most important actions associated with the monthly maintenance of antennas on a 56-metre mast.

List all sub-activities in the next column of the risk analysis calculation sheet, alongside the main activities. Main activities – Maintenance of antenna.

Sub-activities – Climb mast, loosen antenna, clean antenna, redirect antenna, tighten antenna, and climb down mast.

TASKS / GENERAL ACTIVITIES	
Maintenance of antenna	
	Climb mast
	Loosen antenna
	Clean antenna
	Redirect antenna
	Tighten antenna
	Climb down mast

4.2 Calculate the frequency/probability

By applying the frequency table, the practitioner can calculate the probability of such an event taking place, and the probable frequency of future risks related to monthly antenna maintenance on a 56-metre BTS lattice mast. Each sub-activity will be calculated as follows:

Probability of event happening – Could happen once a month = **3**

Frequency of event happening – 1/Month = **3**

PROBABILITY	Could happen once in 5 years	Could happen once a year	Could happen once a month	Could happen once a week	Could happen once a day
FREQUENCY	1/5 years	1/year	1/month	1/week	1/day
RATING	**1**	**2**	**3**	**4**	**5**

Therefore the frequency/probability rating is calculated as **3** and entered accordingly on the risk analysis calculation sheet (3)

IMPORTANT NOTE: The average of the probability and frequency will be calculated as the average rating for frequency and entered on the risk analysis calculation sheet as a frequency.

The above calculation of the probability may be made more, or less, sophisticated depending upon the quality of data available, and the accuracy with which probabilities and frequencies can be specified. In some instances, probability and consequences judgements will be made on the basis of experience of the process or risk under consideration, which may be subjective, but, at least, based upon expert knowledge.

4.3 Calculate severity

The calculation of the severity is based on the selection of an applicable value from each of the five variables listed under the severity table. Each selection is transferred to the applicable variable column, and entered accordingly on the risk analysis calculation sheet as an individual severity rating.

The Risk Assessment Model is then used to calculate the severity by adding all the severity ratings, and then calculating an average severity rating for that particular activity or sub-activity.

With the help of the severity table, the severity of each sub-activity, and the impact of these activities, measured against each of the five different variables are calculated as follows for the scenario described:

SUB-ACTIVITY	BUSINESS IMPACT	INCIDENT IMPACT	FINANCIAL IMPACT	LEGAL IMPACT	ENVIRO IMPACT	RATING
Climb mast	4	5	4	3	1	3.4
Loosen antenna	4	5	4	3	1	3.4
Clean antenna	3	5	4	3	1	3.2
Redirect antenna	5	5	4	3	3	4.0
Tighten antenna	4	5	1	3	1	2.8
Climb down mast	2	5	1	3	1	2.4

IMPORTANT NOTE: The average for each sub-activity calculated against the five variables is listed as the risk rating for that specific sub-activity. The risk rating of the main activity is based on the average of all the sub-activities, which is entered on the risk analysis calculation sheet as a severity rating.

Example: Based on historical data relating to the monthly antenna maintenance of a 56-metre BTS lattice mast (main activity), which involves climbing a mast (sub-activity):

- **Impact on business activities.** Critical down-time for business operations should a BTS site be shut down (Rating 4).
- **Nature of incident based on past and future potential.** As a result of the three fatalities and two serious injuries (historical data), a repeat of such an incident is possible (future prediction) (Rating 5).
- **Nature of loss/damage, the financial impact.** Should the BTS site be closed down for a period of, say, five days by the Department of Labour to conduct an investigation, the financial impact will be a loss of R 2,5 million (Rating 4).
- **Legal impact.** Because of the nature of the incident (a reportable incident in terms of Section 24 of the Occupational Health and Safety Act), the Chief Inspector of the Department of Labour must be informed, and the Provincial Director of this Department will conduct the investigation (Rating 3).
- **Nature of environmental impact.** The incident did not have any environmental impact, and therefore received a rating of one (Rating 1).

The average for each sub-activity calculated against the five variables is listed as the risk rating for that specific sub-activity. In applying this method it will be possible for the person responsible for assessing the risk to determine which variable has the highest risk impact on the activity, which will enable him to apply mitigating control measures to minimise the identified risk. The specific risk factor or variable is now managed as a direct result of its high value, which is considered to be the major contributing factor to the risk rating of the activity. This method will preclude the possibility of managing a risk profile based on an average, and not addressing a major risk-contributing factor.

Table 36: Example of the calculation of the severity of a sub-activity (climbing a mast)

RATING	IMPACT ON BUSINESS ACTIVITIES	NATURE OF INCIDENT (PAST AND FUTURE POTENTIAL)	NATURE OF LOSS / DAMAGE (FINANCIAL)	LEGAL IMPACT (LEGAL)	NATURE OF IMPACT (ENVIRONMENTAL)
5	Catastrophic down-time process delay >month	Fatal injury/ several injuries	Devastating damage/loss >R10 mil	International pressure	Irreversible ecological and/or social damage
4	Critical downtime process delay < month	Disabling injury > 3 days	Widespread damage/loss between R1 - R10 mil	National government pressure	Major incident potentially reversible with long-term ecological damage and permanent impact on community
3	Serious down-time process delay (> 1 week)	Disabling injury <3 days	Widespread damage/loss <R1 mil	Provincial government pressure	Potentially reversible with long-term ecological damage and significant impact on community
2	Medium down-time process delay (>day)	Minor injury	Minor damage/loss <R50 000	Local authorities reaction (organised)	Short-term ecological disturbance and/or restricted impact on community
1	Minimal or zero down-time process delay (<day)	No injury	Insignificant damage or zero loss	Individual complaints (little or no reaction)	Minimal or zero environmental consequences, ecological stress and/or nuisance to the community

4.4 Calculate risk profile

To arrive at the risk profile, the two components (frequency and severity) are multiplied to yield a figure between 1 and 25. This figure represents a priority risk-rating for the activity, and is a measure of the urgency with which it should be controlled. For example, if the frequency is considered "probable", in other words, a person may be exposed to it once a month, a rating of 4 might be given for frequency. The severity (consequence) is potentially quite serious. Thus, risk rating for this incident = likelihood (probability) x (most severe possible) consequences (average of the five severity variables) = 4 x 3,4 = 13,6. By itself, a risk rating of 13,6 has little meaning. However, when the risk ratings of all risks in that specific workplace are compared, the priorities will be at the top of the list.

Alternatively, various thresholds may be identified for dealing with risks. For example, any risk that receives a risk rating of more than 17 may be considered so dangerous that it merits immediate control measures. A rating of less than 8 may be judged to require attention within a week.

It is of importance that the organisation predetermines its levels of risk (High, medium, and low), and assign a rank order which will be a guide to the priority in which the risks should be addressed.

For the “Integrated Safety, Health, and Environmental Risk Assessment Model” refer to:

- Integrated Safety, Health, and Environmental Risk Assessment Matrix;
- Integrated Safety, Health, and Environmental Risk Assessment Calculation Sheet; and
- Practical application of the Integrated Safety, Health, and Environmental Risk Assessment model.

RISK RATING MATRIX

(red)	HIGH	17 - 25
(blue)	MEDIUM	8 - 16
(yellow)	LOW	1 - 7

FREQUENCY

	5	10	15	20	25
	4	8	12	16	20
	3	6	9	12	15
	2	4	6	8	10
	1	2	3	4	5
DESCRIPTION	RARE	LOW LIKELIHOOD	CAN HAPPEN	PROBABLE	REGULAR
PROBABILITY	COULD HAPPEN ONCE IN 5 YEARS	COULD HAPPEN ONCE A YEAR	COULD HAPPEN ONCE A MONTH	COULD HAPPEN ONCE A WEEK	COULD HAPPEN ONCE A DAY
FREQUENCY	1/5 YEARS	1/YEAR	1/MONTH	1/WEEK	1/DAY
RATING	1	2	3	4	5

SEVERITY

RATING	**IMPACT** ON BUSINESS ACTIVITIES	NATURE OF INCIDENT **(PAST AND FUTURE POTENTIAL)**	NATURE OF LOSS / DAMAGE **(FINANCIAL)**	LEGAL IMPACT **(LEGAL)**	NATURE OF ECOLOGICAL IMPACT **(ENVIRONMENTAL)**
5	CATASTROPHIC DOWN TIME PROCESS DELAY >MONTH	FATAL INJURY/ SEVERAL INJURIES	DEVASTATING DAMAGE/LOSS >R10 MIL	INTER-NATIONAL PRESSURE	IRREVERSIBLE ECOLOGICAL AND/OR SOCIAL DAMAGE
4	CRITICAL DOWN TIME PROCESS DELAY < MONTH	DISABLING INJURY >3 DAYS	WIDESPREAD DAMAGE/LOSS BETWEEN R1 - R10 MIL	NATIONAL GOVERNMENT PRESSURE	MAJOR INCIDENT, POTENTIAL REVERSIBLE WITH LONG TERM ECOLOGICAL DAMAGE AND PERMANENT IMPACT ON COMMUNITY
3	SERIOUS DOWN TIME PROCESS DELAY (>WEEK)	DISABLING INJURY <3 DAYS	WIDESPREAD DAMAGE/LOSS <R1 MIL	PROVINCIAL GOVERNMENT PRESSURE	POTENTIAL REVERSIBLE WITH LONG TERM ECOLOGICAL DAMAGE AND SIGNIFICANT IMPACT ON COMMUNITY
2	MEDIUM DOWN TIME PROCESS DELAY (>DAY)	MINOR INJURY	MINOR DAMAGE/LOSS <R50 000	LOCAL AUTHORITIES REACTION (ORGANISED)	SHORT-TERM ECOLOGICAL DISTURBANCE AND/OR RESTRICTED IMPACT ON COMMUNITY
1	MINIMAL OR ZERO DOWN TIME PROCESS DELAY (<DAY)	NO INJURY	INSIGNIFICANT DAMAGE OR ZERO LOSS	INDIVIDUAL COMPLAINTS (LITTLE OR NO REACTION)	MINIMAL OR ZERO ENVIRONMENTAL CONSEQUENCES, ECOLOGICAL STRESS AND/OR NUISANCE TO THE COMMUNITY

Figure 10: Risk rating matrix

BU/DEPARTMENT:	
COMPILED BY:	
DATE:	
SCOPE:	

HAZARD/RISK ASSESSMENT

TASKS / GENERAL ACTIVITIES		FREQUENCY 1 - 5	SEVERITY 1 - 5	RATING	Mitigating 1 - 5	RISK	Frequency	Business Impact	Incident Impact	Financial Impact	Legal Impact	Enviro Impact	Mitigatory Controls & Actions	Legal Reference
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								
		0	0	0	1	0.00								

HAZARD/RISK ASSESSMENT

BU/DEPARTMENT:	VODACOM 5
COMPILED BY:	FJ BARNARD
DATE:	02/01/2004
SCOPE:	MICRO CELL
	BASE STATION STRUCTURE

TASKS / GENERAL ACTIVITIES		FREQUENCY 1 - 5	SEVERITY 1 - 5	RATING	Mitigating 1 - 5	RISK	Frequency	Business Impact	Incident Impact	Financial Impact	Legal Impact	Enviro Impact	Mitigatory Controls & Actions	Legal Reference
ADMINISTRATION		0	0	0	1	0.00								
	APPOINTMENTS	5	4.2	21	3	7.00	5	5	4	4	4	4	QA-QP/PP040	
	COMPETENT PERSON TRAINING	3	4.2	12.6	2	6.30	3	5	4	4	4	4	TRAINING PROGRAMME	
	NOTIFICATION OF DEPT. LABOUR	3	2.4	7.2	2	3.60	3	5	1	1	4	1	AS PER REQUIREMENT	
		0	0	0	1	0.00								
EQUIPMENT		0	0	0	1	0.00								
	OFF LOAD EQUIPMENT (BTS, RACKS , RECTIFIERS)	5	2	10	1	10.00	5	1	2	3	3	1		
	USING LIFT/STAIRS TO MOVE EQUIPMENT	5	2	10	1	10.00	5	1	2	3	3	1		
	INSTALL EQUIPMENT	5	2	10	1	10.00	5	1	2	3	3	1		
	CONNECT TO AC POWER	5	2.8	14	3	4.67	5	2	5	3	3	1	QA-QP/PP071	
	ISSUE COC BEFORE USE OF INSTALLATION	4	1.6	6.4	3	2.13	4	2	1	1	3	1	QA-QP/PP071	
CONSTRUCTION		0	0	0	1	0.00								
	FIT CABLING	5	2.6	13	2	6.50	5	2	4	3	3	1	QA-QP/PP072	
	FIT MICRO CELL STRUCTURE TO WALL/IN CEILING	5	2.6	13	2	6.50	5	2	4	3	3	1	QA-QP/PP072	
	ELECTRIFICATION OF SITE	5	2.6	13	2	6.50	5	2	4	3	3	1	QA-QP/PP072	
	ITEMS FALLING	5	2.6	13	2	6.50	5	2	4	3	3	1	QA-QP/PP072	
	FALL PROTECTION PLAN	5	4.2	21	3	7.00	5	5	4	4	4	4	QA-QP/PP076	
		0	0	0	1	0.00								
SITE ESTABLISHMENT		0	0	0	1	0.00								
	TRAVEL TO AND FROM SITE	5	3	15	1	15.00	5	2	5	3	4	1		
	SITE HEALTH AND SAFETY FILE	5	2	10	3	3.33	5	2	1	3	3	1	SITE FILES	
	EMPLOY CASUAL LABOUR	3	3	9	5	1.80	3	3	4	3	4	1	SIEMENS POLICY	
	ISSUE OF PPE	2	3	6	3	2.00	2	2	5	3	4	1	QA-QP/PP062	
	SITE DEMARCATION	4	2.4	9.6	3	3.20	4	2	1	2	4	3		
	FIRE EXTINGHUISER	3	1.4	4.2	2	2.10	3	1	1	1	3	1	QA-QP/PP064	
	FIRST AID BOX	4	2	8	2	4.00	4	2	3	1	3	1	QA-QP/PP063	
	ABLUTIONS	3	1.4	4.2	2	2.10	3	1	1	1	3	1	QA-QP/PP061	
	DRINKING WATER	3	1.4	4.2	2	2.10	3	1	1	1	3	1	QA-QP/PP061	
	TEMPORARY ELECTRICAL SUPPLY	3	1.4	4.2	2	2.10	3	1	1	1	3	1	QA-QP/PP071	
		0	0	0	1	0.00								
FALL HAZARDS		0	0	0	1	0.00								
	EVALUATE ACTIVITIES AGAINST FALL PROTECTION	4	3.2	12.8	3	4.27	4	3	5	3	4	1	QA-QP/PP076	
	IDENTIFY ANCHOR POINTS	4	3.2	12.8	3	4.27	4	3	5	3	4	1	QA-QP/PP076	
	INSTALL LADDERS/CAGES	4	3.2	12.8	3	4.27	4	3	5	3	4	1	QA-QP/PP076	
	INSTALL ANCHOR POINTS	4	3.2	12.8	3	4.27	4	3	5	3	4	1	QA-QP/PP076	
	EVALUATE ROOFING MATERIAL/WALKWAYS	4	3.2	12.8	3	4.27	4	3	5	3	4	1	QA-QP/PP076	
		0	0	0	1	0.00								

5. Application of the model in other industries

The proposed risk-assessment model has been based on the Frank Bird practical risk-assessment model. (Bird & Germain 1992: 417). Although more complex than the proposed integrated occupational health, safety, and environmental risk-assessment model for the South African GSM industry, the latter provides for simplicity and easy application by users in the South African GSM industry.

An important advantage of the integrated occupational health, safety, and environmental risk-assessment model for the GSM industry is that it can be relatively easily adapted for application in any other industry. In order for the model to meet industry-specific requirements, the following factors should be taken into account at all times:

- *The risk matrix:* The risk matrix is based on the multiplication of the frequency/probability with the severity, resulting in multiples of 5 with a maximum rating of 25. The categories are as follows:
    - High risk is rated between 17 and 25.
    - Medium risk is rated between 8 and 16.
    - Low risk is rated between 1 and 7.
- *Fixed variables:* The frequency and probability should always remain as fixed variables with a multiplier of 5 and the maximum rating as 5.
- *Severity variables:* The severity is based on five variables which make provision for the:
    - Business impact
    - Incident impact
    - Financial impact
    - Legal impact
    - Environmental impact

One or more of the severity variables may be interchanged with any other industry-specific severity variable. For example, in a petrochemical industry, the legal impact may be replaced with a variable that addresses specific hazards related to the petrochemical industry.

6. Conclusion

The application of the proposed model to assess health, safety, and environmental risks in the GSM industry has been measured against the responses received from the population, as outlined in Chapter 5.

The proposed model for assessing health, safety, and environmental risks in the GSM industry may be highly refined and accurate under certain circumstances, depending upon the quality of the available data, and the accuracy with which frequencies/probabilities and severities can be specified. In some cases, frequencies/probabilities and severity judgements will be made on the basis of experience of the process or hazard under consideration; e.g. they will be subjective, but based upon expert knowledge.

The next chapter (chapter 8) will be devoted to dealing with the specific findings of the research in relation to the application of an integrated risk assessment model to measure health, safety, and environmental risks for the GSM industry in South Africa.

At the conclusion of Chapter 8, specific recommendations will be made relating to the implementation of the proposed integrated health, safety, and environmental risk-assessment model in the GSM industry.

CHAPTER 8

FINDINGS AND RECOMMENDATIONS

1. Introduction

In this chapter the research conclusions of the study will be evaluated in relation to the objectives set out in Chapter 1. The recommendations based on these conclusions will result in improved measures for assessing the health, safety, and environmental management risks of organisations in the GSM industry in South Africa. They will also contribute to management science generally, and in particular to risk management as applied in the GSM industry.

Finally, suggestions will be made for future research which may develop further initiatives for the improvement of the management of health, safety, and environmental factors in the South African GSM industry.

2. Evaluation of the research conclusions

The goal and objectives of this study were stated in Chapter 1, and are repeated here.

2.1 Goal of the study

> To develop an integrated occupational health, safety, and environmental operational risk-assessment model for the South African GSM industry.

2.2 Objectives of the study

The following objectives have been derived from the goal of the study:

- To study the literature on risk management, with particular emphasis on the risk-assessment methods employed by organisations in the health, safety, and environmental management disciplines;
- To investigate the individual risk-assessment techniques in the field of health, safety, and environmental management;
- To investigate the application of integrated health, safety, and environmental risk-assessment models in the South African GSM industry; and
- To develop a viable and integrated health, safety, and environmental risk assessment model for the South African GSM industry;

The perspective adopted throughout the study was to design a risk-assessment model that could be used to assess the health, safety, and environmental risks of the GSM industry in South Africa. This model would be aligned with other risk-assessment models and based on the theoretical aspects of risk management as revealed during the literature study.

As extensive reference was made to the terminology used in the Global Systems for Mobile communications (GSM), it was appropriate to discuss this technology in more detail, at the start of the research (in Chapter 2).

In Chapter 3, the focus was on an overview of risk management as a management function, as well as on a review of the relationship between the operational risk sub-disciplines of health, safety, and environmental management as part of the risk-management function. It covered the basic theory and concepts required for understanding and interpreting literature on risk management theory, as well as specific health, safety, and environmental management definitions relevant to the research on integrated risk management as a discipline.

In Chapter 4 the individual approach to assessing health, safety, and environmental risks was outlined, and attention was drawn to commonalties based on the theoretical research of an integrated approach or model to assess risk in the South African GSM industry. The research design, details of the design, unit of measurement, sampling design, form of measurement, and the design of the questionnaire were dealt with in Chapter 5, giving a broad outline of the procedure followed in the study.

The results obtained from the analysis of the returned questionnaires were presented in Chapter 6, and it included an evaluation of the research findings in relation to the goals and objectives of the study.

The emphasis in Chapter 7 was on the development of an integrated health, safety, and environmental management risk-assessment model for the GSM industry in South Africa. Consideration was also given to a mechanism for the integrated assessment of risks associated with the functions of health, safety, and environmental management in the industry.

In the current chapter, recommendations will be made based on the findings reported in Chapter 6. These recommendations will contribute generally to risk management as a science, but, in particular, to the compilation of an instrument for measuring the risks associated with occupational health, safety, and environmental management in the South African GSM industry.

Finally, suggestions will be made for possible future research projects that may develop initiatives for the improvement of the management of occupational health, safety, and environmental risks in South Africa.

The specific conclusions of this study will now be summarised and compared to the objectives of the items included in the questionnaire.

3. Specific conclusions of the study

Although all the findings are considered to be of importance to the study, the following conclusions are highlighted since they address specific risk-assessment techniques, as well as the application of an integrated health, safety, and environmental risk-assessment model for the GSM industry in South Africa.

3.1 Question 2.1: Does the organisation have a division, department or section of risk management?

One of the objectives of the research was to determine whether organisations in the GSM industry have a division, department or section dealing with risk management.

According to the findings of the research, fifty-one percent (51%) of the respondents indicated that they had a division, department or section of risk management.

There was a significant difference between network service providers, suppliers and contractor/sub-contractors regarding the inclusion of risk management as a separate function. While all network service providers had a separate structure within the organisation that administered risk management, this was not the case with suppliers and contractor/sub-contractors.

3.2 Question 2.2: Which function of the organisation's risk management division, department or section is the most representative?

Eighty percent (80%) of respondents reported the occupational safety function as the most representative within their division, department, or section of risk management.

It is apparent, therefore, that the occupational safety function is considered to be an important function in the organisation's risk-management structure. This can probably be attributed largely to the fact that the Occupational Health and Safety Act (85 of 1993), has an important impact on activities in the GSM industry.

3.3 Question 2.4: The level of health, safety and environmental management integration

Only forty-five percent (45%) of the respondents indicated that the functions of occupational health, safety, and environmental management were fully integrated in their organisations.

3.4 Question 2.7: Does your organisation have a safety, health and environmental management strategy approved by management?

The literature on risk management emphasises the importance of a risk-management strategy for organisations. It was, therefore, important to determine whether the organisations surveyed had developed a risk management strategy.

The results show that forty-two percent (42%) of organisations in the GSM industry had an occupational health, safety, and environmental management strategy.

It is important to note that not one of the organisations listed under Group 5 (sub-contractors) had developed an occupational health, safety, and environmental management strategy. From the research results it can be concluded that contractors and sub-contractors in the GSM industry are not, in fact, formal planners in terms of occupational health, safety, and environmental management, and may have limited business success in terms of managing these concerns.

3.5 Question 2.8: Does the organisation have a safety, health and environmental management policy?

In order to make occupational health, safety, and environmental management a reality within an organisation, and to manage these concerns in a proactive way, it is imperative that organisations develop a policy statement for this function, which should be adopted by the executive of the organisation.

Without an occupational health, safety, and environmental management policy statement, any organisation would tend to lose focus in this area. A policy statement affords direction to all levels of management, and it will specify the goals of the organisation in relation to occupational health, safety, and environmental management. To turn risk management into an effective reality, it is important not to isolate the occupational health, safety, and environmental management function from the level where strategic decisions are taken.

The results of this survey showed that fifty-four percent (54%) of the respondents had an occupational health, safety, and environmental management policy.

3.6 Question 2.9: Level of recognised International Standards Organisation (ISO) certification or registration

The standards of the International Standards Organisation (ISO) are designed to provide organisations with a documented system for managing their quality (ISO 9000:2000) and environmental (ISO 14000) concerns, and to audit (benchmark) their systems against a standard that is internationally recognised. The OHSAS 18000 management systems promote overall health and safety objectives, and a commitment to improving health and safety performance within organisations.

A notable finding of this research is that eighty-six percent (86%) of the manufacturing organisations in the GSM industry meet the ISO 9000 certification standard for quality assurance. It is apparent that there is a far greater emphasis on quality management within the manufacturing and supplier sectors than in the network service provider, contractor, and sub-contractor sectors within the GSM industry in South Africa.

The findings pertaining to recognised ISO certification indicate that only seven percent (7%) of the respondents had ISO 14001 (environmental management) certification, and as few as six percent (6%) of the respondents had OHSAS 18000 (health and safety) certification.

It may therefore be concluded that organisations in the GSM industry in South Africa do not consider the international standards pertaining to occupational health, safety, and environmental management important in conducting their business. It is evident that greater emphasis is placed on quality assurance.

3.7 Question 2.11: The role of safety, health and environmental management in the organisation’s strategic plan

The results of the question on the role of safety, health, and environmental management in the organisation’s strategic plan reflect that sixty-two percent (62%) of the respondents considered safety; health, and environmental management an important factor in determining the organisation’s overall strategic plan.

3.8 The level within the organisation to measure its health and safety risks

The results show that only thirty-two percent (32%) of the respondents had a formal system of measuring health and safety risks in the organisation. In the areas where the frequency of health and safety risks is considered to be high, contractors and sub-contractors reported relatively low-level or no formal systems to measure health and safety risks. Forty percent (40%) of the contractors, and only seventeen percent (17%) of the sub-contractors indicated that they used a formal system of measuring health and safety risks. It was found that the majority of organisations in the South African GSM industry do not have a formal system for measuring their health and safety risks.

3.9 The risk assessment tools applied as primary tools to measure health and safety risks

The results reflect that eleven percent (11%) of the organisations surveyed applied Hazard and Operability Studies (HAZOP), eight percent (8%) use Incident Risk Assessment (HIRA), and a further eight percent (8%) employ Preliminary Hazard Analysis (PHA) as primary measurement tools to measure the organisation's risks.

3.10 The level of a formal system to measure environmental management risks

Seventy-three percent (73%) of the respondents indicated that they used a formal system to measure the environmental impacts of their products, services, or processes.

3.11 Which environmental risk assessment tool is predominantly used by organisations to measure environmental management risks?

The results show that thirty percent (30%) of the respondents use checklists as the predominant tool for measuring the organisation's environmental risks.

3.12 Does the organisation's products/services/processes require environmental impact assessments?

Environmental Impact Assessments (EIAs) are of critical importance to organisations in the GSM industry in South Africa in order to establish the impact of their products, services, or processes on the environment. The purpose of this question was to establish whether the organisation's products, services, and processes require an Environmental Impact Assessment (EIA).

Fifty-eight percent (58%) of the respondents indicated that their organisation did not require an Environmental Impact Assessment (EIA) for its products, services, or processes.

In terms of the National Environmental Management Act (NEMA), any organisation involved in the establishment of a cellular network and/or auxiliary services is required to have a formal measurement (EIA) conducted by an independent body. Seventy-four percent (74%) of the organisations in the GSM industry therefore do not meet this legal requirement.

3.13 Does the organisation make use of a risk assessment tool to measure risks for the integrated functions of health, safety and environmental management?

The primary goal in conducting the research was to develop an integrated health, safety, and environmental risk-assessment model for the South African GSM industry. This goal was based on the presumption that no formal model existed for the integrated assessment of health, safety, and environmental risks in the South African GSM industry. A second goal was to investigate the application of an integrated health, safety, and environmental risk-assessment model.

The results indicate that seventy-nine percent (79%) of the respondents do not make use of a risk-assessment tool to measure risks for the integrated functions of health, safety, and environmental management.

This result is an obvious justification for the research, and for the subsequent development of such a risk assessment tool.

3.14 Benefits from integrating the functions of safety, health and environmental management

Based on the results, seventy-five percent (75%) of the respondents cited financial benefits (cost saving) as the most important advantage of integrating safety, health, and environmental management functions.

4. Significant findings of the research

One of the concerns raised throughout the research was, "Would this research be of any value, given the fact that the GSM industry in South Africa, in terms of the Occupational Health and Safety, as well as the National Environmental Management Acts, should be well regulated?"

At the conclusion of the research, it was found that this research was well justified. This assertion is based on the significant findings listed below:

4.1 Health, safety and environmental management strategy

Only forty-two percent (42%) of the respondents indicated that they did, in fact, have a health, safety, and environmental management strategy. The conclusion that can be drawn here is that health, safety, and environmental management did not play a significant role in the determination of the overall strategies of the organisations surveyed.

4.2 Health, safety and environmental management policy

Of the total number of respondents, only fifty-five percent (55%) indicated that they had a health, safety, and environmental management policy approved by their executive management. Although it is not a legal requirement under Section 7 of the Occupational Health and Safety Act, one would have assumed that to give direction to their overall health, safety, and environmental management systems, such a policy would have been regarded as a prerequisite for any of the organisations surveyed.

4.3 Formal system to measure its risks

Only thirty-two (32%) of the respondents indicated that they had a formal system for measuring their organisation's risks. The question to be asked is, "How do organisations in the GSM industry in South Africa measure their risks?"

4.4 Integrated risk-assessment tool

Of the thirty-two (32%) of organisations that applied a formal system for measuring their risks, only twenty-one percent (21%) had an integrated risk assessment tool. The fact that such a parlously low percentage of respondents had a formal risk-measuring system provides more than sufficient grounds for further research.

4.5 Quality assurance

Seventy-seven percent (77%) of the respondents indicated that the quality assurance function would be included as part of the integrated functions of health, safety, and environmental management; and therefore quality assurance is the function that was most likely to be considered for integration with the health and safety function.

This finding is in line with the most recent trends in business, namely to integrate the functions of safety, health, environmental issues, and quality assurance as a single function referred to as **SHEQ.**

5. Conclusion

The findings, especially the significant findings, indicate that this research project was well justified.

The fact that **less than 25%** of the sample population had an integrated risk-assessment tool for formally measuring their organisation's health, safety, and environmental risks, **fully justifies the establishment of an integrated health, safety and environmental risk-assessment model for the GSM industry.**

6. Contribution of the research

The motivation for this research stemmed from the hypothesis that organisations in the GSM industry in South Africa do not have a formal system of measuring their health, safety, and environmental risks

This question relates specifically to integrated safety, health, and environmental management functions, and was designed to ascertain whether organisations had a risk-assessment tool for use by the integrated functions of health, safety, and environmental management.

The answers to this question indicate that 79% of the respondents did not make use of a risk assessment tool to measure risks relating to the integrated functions of health, safety, and environmental management.

The requirements under section 8 of the Occupational Health and Safety Act, and specifically those in 8(d) referring to the responsibility of the employer to conduct risk assessments are as follows:

> 8. General duties of employers to their employees
>
> (d) establishing, as far as is reasonably practicable, what hazards to the health or safety of persons are attached to any work which is performed, any article or substance which is produced, processed, used, handled, stored or transported and any plant or machinery which is used in his business, and he shall, as far as is reasonably practicable, further establish what precautionary measures should be taken with respect to such work, article, substance, plant or machinery in order to protect the health and safety of persons, and he shall provide the necessary means to apply such precautionary measures.

Specific provision has now been made in the Construction Regulations, promulgated under the Occupational Health and Safety Act, that a principal contractor, who intends to carry out any construction work as specified in

Regulation 3 (and specifically regulation 3(1)(b)(iii), which includes working at a height greater than 3 meters above ground or on a landing), has the following obligation in terms of Regulation 7:

> 7. Risk assessment. —
>
> (1) Every contractor performing construction work shall before the commencement of any construction work and during construction work, cause a risk assessment to be performed by a competent person appointed in writing and the risk assessment shall form part of the health and safety plan to be applied on the site and shall include at least —
>
> (*a*) the identification of the risks and hazards to which persons may be exposed to;
>
> (*b*) the analysis and evaluation of the risks and hazards identified;

The researcher was convinced by the results of the investigation that the majority of organisations in the GSM industry in South Africa do not make use of a risk-assessment tool to measure perils faced by the integrated functions of health, safety, and environmental management. It is clear, therefore, that these organisations cannot conceivably comply with Section 8 and Regulation 7 of the Occupational Health and Safety Act, and the Construction Regulations respectively, and it can be unequivocally stated that the integrated health, safety, and environmental risk-assessment model designed for organisations in the GSM industry in South Africa as part of this research project has contributed significantly to the science of risk management.

A further contribution to this science is that this risk-assessment model can relatively easily be adapted for application in other industries.

It can therefore be unequivocally stated that this research has made an important contribution to the science of Risk Management

7. Suggestions for future study

At the time of this research, the Construction Regulations under the Occupational Health and Safety Act, 85 of 1993, had been implemented for such a limited period that it was not possible to measure their impact on the industry.

The requirements set out in these Regulations, particularly Regulation 7, which deals with risk assessments, may have a major impact on GSM organisations in South Africa. It is therefore suggested that further research be conducted to determine the impact of these Regulations, as well as the application of the proposed risk-assessment tool which was developed as part of this research.

ANNEXURE A

1	2	3

QUESTIONNAIRE

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SECTION 1. GENERAL AND GEOGRAPHICAL INFORMATION

Q1.1 Please indicate your type of organisation.
Instruction: Please mark ALL applicable squares with an x

TYPE OF ORGANISATION	
Network provider	4
Manufacturer	5
Supplier	6
Contractor	7
Sub-contractor	8
Other (Specify)	9

☐	4
☐	5
☐	6
☐	7
☐	8

Other: ………………………………………………………..

………………………………………………………………..

Q1.2 Please indicate the predominant feature of the service that your organisation provide.
Instruction: Please mark ALL applicable squares with an x

PREDOMINANT FEATURE	
GSM network provider	10
Supplier of GSM equipment	11
Contractor on GSM equipment	12

☐	9
☐	10
☐	11

Sub-contractor on GSM equipment	13	12
Other (Specify)	14	

Other: ……………………………………………………………..

……………………………………………………………………..

Q1.3 In which of the following countries does your organisation provide a service?
Instruction: Please mark ALL applicable squares with an x

COUNTRIES OF OPERATION		
Angola	15	13
Botswana	16	14
Congo	17	15
Democratic Republic of the Congo	18	16
Gabon	19	17
Kenya	20	18
Lesotho	21	19
Madagascar	22	20
Malawi	23	21
Mauritius	24	22
Mozambique	25	23
Namibia	26	24
South Africa	27	25
Swaziland	28	26

Tanzania	29
Uganda	30
Zambia	31
Zimbabwe	32
Other (In Africa only) (Specify)	33

27 28 29 30 31

Other (In Africa only): ……………………………………..

……………………………………………………………………..

……………………………………………………………………..

……………………………………………………………………..

……………………………………………………………………..

PLEASE SEE NEXT PAGE FOR SECTION 2

FOR OFFICIAL USE

SECTION 2. ORGANISATIONAL STRUCTURE.

Q2.1 Does your organisation have a division/department/section of risk management?
Instruction: Please mark ONLY ONE square with an x

Yes	1
No	2

32

Q2.2 Which of the following functions forms part of your organisation's risk management division/department/section?
Instruction: Please mark ALL applicable squares with an x

RISK MANAGEMENT FUNCTIONS		
Risk finance	3	33
Occupational Health	4	34
Occupational Hygiene	5	35
Occupational Safety	6	36
Environmental management	7	37
Quality assurance	8	38
Loss control	9	39
Security	10	40
Other (Specify)	11	41

Other: …………………………………………………………..

…………………………………………………………………..

Q2.3 Are the following functions managed as an independent department/division/section in your organisation?
Instruction: Please mark ONLY ONE square with an x

Occupational Health	Yes	12	No	13

☐ 42

Occupational Safety	Yes	14	No	15

☐ 43

Environmental management	Yes	16	No	17

☐ 44

Q2.4 Which of the following functions are fully integrated as a department/division in your organisation?
Instruction: Please mark ONLY ONE square with an x

INTEGRATED FUNCTIONS	
Occupational Health & Safety **(Only)**	18
Occupational Health, Safety and Environmental management	19
Other (Specify)	20

☐ 45

Other: ………………………………………………………..

………………………………………………………………..

Q2.5 Who at management level reports to the executive management committee (EXCO) or to the Board of Directors (BOD) on Occupational Health, Safety and Environmental management?
Instruction: Please mark <u>ONLY ONE</u> square with an x

EXECUTIVE RESPONSIBILTY	
Chief executive officer	21
Chief financial officer	22
Financial director	23
Operations director	24
Human Resources director	25
Director Facilities	26
Director Safety, Health and Environmental	27
General manager	28
Manager Safety, Health and Environmental	29
Internal Auditor	30
Other (Specify)	31

☐ 46

Other: ………………………………………………………..

…………………………………………………………….

Q2.6 Please indicate who is responsible at functional level for health, safety and environmental management
Instruction: Please mark <u>ONLY ONE</u> square with an x

FUNCTIONAL RESPONSIBILTY	
Director Human Resources	32
Director Facilities	33
Director Operations	34

Director Safety, Health and Environmental	35
Safety, Health and Environmental manager	36
Safety, Health and Environmental specialist	37
Safety, Health and Environmental contractor	38
Risk Manager	39
Loss Control Manager	40
Internal Auditor	41
Quality Assurance Manager	42
Other (Specify)	43

☐ 47

Other: …………………………………………………………..

……………………………………………………………….

Q2.7 Does your organisation have a Safety, Health and Environmental management strategy approved by management?

Instruction: Please mark ONLY ONE square with an x

Yes	44	No	45

☐ 48

If the answer is yes to Q2.7 above, please include a copy of the strategy document with the return of this questionnaire.

Q2.8 Does your organisation have a Safety, Health and environmental management policy statement that is approved by the executive management?
Instruction: Please mark <u>ONLY ONE</u> square with an x

Yes	46	No	47

☐ 49

If the answer is yes to Q2.8 above, please include a copy of the policy statement with the return of this questionnaire.

Q2.9 Does your organisation have recognised certification or registration for the following international standards?
Instruction: Please mark <u>ONLY ONE</u> square with an x

ISO 9000	Yes	48	No	49

☐ 50

ISO 14001	Yes	50	No	51

☐ 51

OHSAS 18000	Yes	52	No	53

☐ 52

Q2.10 Does your organisation use any of the following standards as a marketing tool for your products, services and facilities or for strategic purposes to obtain licensing agreements or financing?
Instruction: Please mark <u>ONLY ONE</u> square with an x

ISO 9000	Yes	54	No	55

ISO 14001	Yes	56	No	57

OHSAS 18000	Yes	58	No	59

☐ 53

☐ 54

☐ 55

Q2.11 What role does Safety, Health and Environmental management have in your organisation's Strategic plan?
Instruction: Please mark <u>ONLY ONE</u> square with an x

60	61	62	63	64
Unimportant	Fairly unimportant	Neither important or unimportant	Important	Extremely important

☐ 56

PLEASE SEE NEXT PAGE FOR SECTION 3

FOR OFFICIAL USE

SECTION 3. RISK ASSESSMENTS

Q3.1 Does your organisation have a formal system to measure its Health and Safety risks?
Instruction: Please mark <u>ONLY ONE</u> square with an x

Yes	1	No	2

57

If no, please skip questions Q3.2 & Q3.3 and answer from question Q3.4 onwards

Q3.2 Which of the following risk assessment tools does your organisation apply as **<u>primary</u>** tools to measure its Health and Safety risks?
Instruction: Please mark <u>ALL</u> the applicable squares with an x

PRIMARY RISK ASSESSMENT TOOL		
Event Tree Analysis (ETA)	3	58
Fault Modes and Effects Analysis & Fault Modes, Effect and criticality Analysis (FMEA)	4	59
Fault Tree Analysis (FTA)	5	60
Hazard & Operability study (HAZOP)	6	61
Human Reliability Analysis (HRA)	7	62
Preliminary Hazard Analysis	8	63
Reliability Block Diagram	9	64
Hazard and Incident Risk Assessment (HIRA)	10	65
Other (Specify)	11	

Other: ……………………………………………………………..

……………………………………………………………………..

Q3.3 Which of the following risk assessment tools does your organisation apply as **secondary** tools to measure its Health and Safety risks?
Instruction: Please mark ALL the applicable square with an x

SECONDARY RISK ASSESMENT TOOLS		
Category Rating	12	66
Checklists	13	67
Common Mode Failure Analysis	14	68
Consequence Models	15	69
Delphi Technique	16	70
Hazard Indices	17	71
Monte-Carlo Simulation	18	72
Review of Historical Data	19	73
Other (Specify)	20	

Other: ………………………………………………………..

………………………………………………………………..

Q3.4 Does your organisation have a formal system to measure its Environmental management risks?
Instruction: Please mark ONLY ONE square with an x

Yes	21	No	22

74

If no, please skip question Q3.5 and continue with question Q3.6 onwards

Q3.5 Which of the following risk assessment tools does your organisation apply as tools to measure its Environmental management risks?
Instruction: Please mark ALL the applicable squares with an x

ENVIRONMENTAL RISK ASSESSMENT	
Checklists	23
Leopold Matrix	24
Overlays and mapping	25
Panel evaluation	26
Cross-tabulation matrix approach	27
Other (Specify)	28

75
76
77
78
79

Other: ……………………………………………………..

……………………………………………………………..

Q3.6 Does your organisation's products/services/processes require Environmental Impact Assessments (EIA's)?
Instruction: Please mark ONLY ONE square with an x

Yes	29	No	30

80

Q3.7 Does your organisation make use of a risk assessment tool to measure risks for the **integrated** functions of Health, Safety and Environmental management?
Instruction: Please mark ONLY ONE square with an x

Yes	31	No	32

81

If the answer is yes to question Q3.7 above, please answer Question Q3.8 below

Q3.8 Please specify the risk assessment tools employed by your organisation to measure risks for the **integrated** functions of Health, Safety and Environmental management?

Specify …………………………………………………………..

……………………………………………………………………

Q3.9 If your organisation has not integrated the functions of Health, Safety and Environmental management, does your organisation plan to do so in the near future?
Instruction: Please mark ONLY ONE square with an x

Yes	33	No	34	N/A	35

☐ 82

If the answer is yes to question Q3.9 above, please answer question Q3.10 below

Q3.10 Does your organisation consider to include **(integrate)** the following functions in addition to the Safety, Health and Environmental management functions?
Instruction: Please mark ALL the applicable squares with an x

Quality assurance	Yes	36	No	37

☐ 83

Security/Loss control	Yes	38	No	39

☐ 84

Information security	Yes	40	No	41

☐ 85

Other ……………………………………………………………

……………………………………………………………………..

Q3.11 How does your organisation benefit from integrating the functions of Safety, Health and Environmental management?
Instruction: Please mark ALL squares with an x

BENEFITS FORM AN INTEGRATED APPROACH		
Financial (Cost saving)	42	86
Organisational (Saving on manpower)	43	87
Functional (Saving on duplication of functions)	44	88
Operational (Saving on production)	45	89
Efficiency (Saving on processes)	46	90
Other (Specify)	47	

Other: ……………………………………………………..

……………………………………………………………..

SECTION 4. GENERAL COMMENTS.

Please add any comment(s) you wish to bring across to the researcher pertaining to the questions raised in the questionnaire and/or any other matter related to the research topic.

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ANNEXURE B

20 October 2003

To Whom it may Concern

MR FJ BARNARD : STUDENT # 740 603 7

Mr Barnard is registered for a DCom (Business Management) degree at the University of South Africa (Unisa). The topic for his research is:

> *AN INTEGRATED SAFETY, HEALTH AND ENVIRONMENTAL RISK ASSESSMENT MODEL FOR THE SOUTH AFRICAN GLOBAL SYSTEMS MOBILE TELECOMMUNICATIONS INDUSTRY.*

A requirement, which forms part of this research, is that all organisations within the GSM industry in South Africa complete the attached questionnaire in order to determine the present status of, or, the applicability of a risk assessment model for safety, health and environmental management in the South African GSM industry.

The following important aspects regarding the completion of the questionnaire should be pointed out:

- Completion of the questionnaire should not take up much of your time. Questions have structured answers and you have only to cross **(x)** the appropriate number(s).
- Your answers will be treated as ***strictly confidential*** and will not be made available as raw data or in any other format to any other person or organisation.
- Information required:
  - **SECTION 1**
    Covers the general and geographical information of your organisation such as the predominant feature of the service that it provides as well as the countries in which service is provided.
  - **SECTION 2**
    Contains a number of questions related to the organisational design such as the structure of the risk management division/department/section responsible for health, safety and environmental management as well as aspects related to health, safety and environmental strategy and policy.
  - **SECTION 3**
    The emphasis in this section is on risk assessments and related to systems used in measuring health, safety and environmental risks as well as the benefits from integrating the functions of health, safety and environmental management.

  On completion of this research, the findings (in the format of an article) will be made available to all those organisations that participated in this survey and submitted completed questionnaires.

Kindly return the completed questionnaire in the enclosed self-addressed enveloped by ***14 November 2003.*** Should you require any further details or wish to discuss any matter related to this research, please do not hesitate to contact Mr Barnard directly (082 370 6000).

Your cooperation in this matter will be highly appreciated.

Yours faithfully

Prof GS du Toit
School of Business Management

Contact us Faculty of Economic and Management Sciences
PO Box 392, Pretoria, South Africa,0003
(+27) (0)12 429-4460/4419 (+27) (0)12 429-4798
www.unisa.ac.za

POPULATION: GSM ORGANISATIONS IN SOUTH AFRICA

1 VODACOM

2 CELL C

3 MTN

4 SIEMENS

5 ESKOM ENTERPRISES

6 TRANSTEL

7 NOKIA

8 MOTOROLA

9 ERICKSON

10 ALCATEL

11 AST NETWORKS

12 SAMSUNG

13 PANASONIC

14 SPESCOM

15 SECTIONAL POLES

16 PLESSEY

17 BROLAZ

18 BRORON

19 ELECTROWAVE

20 MERGENT

21 ROAL

22 SELMEC

23 TAPPANS

24 CENTRAL INFORMATION SERVICES

25 CONSTRUCTION EQUIPMENT

26 CONTACT 4 PROCUREMENT

27 ETLEIMU

28 FUTURISTIC BUSINESS SOLUTIONS

29 GRINTEK

30 INGOMA

31 IXIA TRADING

32 MAST PROJECTS

33 MEDTEL

34 MOVERE WIRELESS

35 NEW AFRICA TECHNICAL SUPPLIES

36 PROLANTIC

37 SCHULLER COMMUNICATIONS

38 SECTORAL

39 SKYWAVE

40 THAMELEA TECHNOLOGIES

41 CELLROY

42 WAVELINX WIRELESS

43 AFRISED

44 APHALELE TELECOM

45 BCKN CONSULTING

46 BOKGONI PROJECTS

47 BUA AFRICA

48 SIRIUS

49 REALTEL

50 WEBB INDUSTRIES

51 TELTON

52 FANRA

53 DELPHIUS

54 VRG TELECOMMUNICATIONS

55 TELSAF DATA

56 EDC INSTALLATIONS

57 TUV RHEILAND INSPECTION SERVICES

58 PEO TECH

59 INFRASTRUCTURE PLANNING

60 TILCA

61 GFC CONSTRUCTION

62 DANIEL DE JAGER

63 DOWN TO EARTH TECHNOLOGIES

64 LATCHWAY SYSTEMS

65 MERLIN PROJECT SERVICES

66 INNOVATIVE INSPECTION SERVICE

RESPONDENTS: GSM ORGANISATIONS IN SOUTH AFRICA

1 VODACOM

2 CELL C

3 MTN

4 SIEMENS

5 MOTOROLA

6 ERICKSON

7 ALCATEL

8 SPESCOM

9 SECTIONAL POLES

10 PLESSEY

11 BROLAZ

12 BRORON

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26 MEDTEL

27 NEW AFRICA TECHNICAL SUPPLIES

28 PROLANTIC

29 SCHULLER COMMUNICATIONS

30 SKYWAVE

31 THAMELEA TECHNOLOGIES

32 CELLROY

33 WAVELINX WIRELESS

34 AFRISED

35 APHALELE TELECOM

36 BOKGONI PROJECTS

37 BUA AFRICA

38 SIRIUS

39 TELTON

40 FANRA

41 DELPHIUS

42 VRG TELECOMMUNICATIONS

43 TELSAF DATA

44 EDC INSTALLATIONS

45 PEO TECH

46 INFRASTRUCTURE PLANNING

47 TILCA

48 GFC CONSTRUCTION

49 DANIEL DE JAGER

50 DOWN TO EARTH TECHNOLOGIES

51 LATCHWAY SYSTEMS

52 MERLIN PROJECT SERVICES

53 INNOVATIVE INSPECTION SERVICE

CBS-Chi-Square Analysis I-STRAT

Information Entered - Observations

Number of Columns:	2
Number of Rows:	5
Alpha Error:	.05
Degrees of Freedom:	4
Critical chi-square:	9.48773

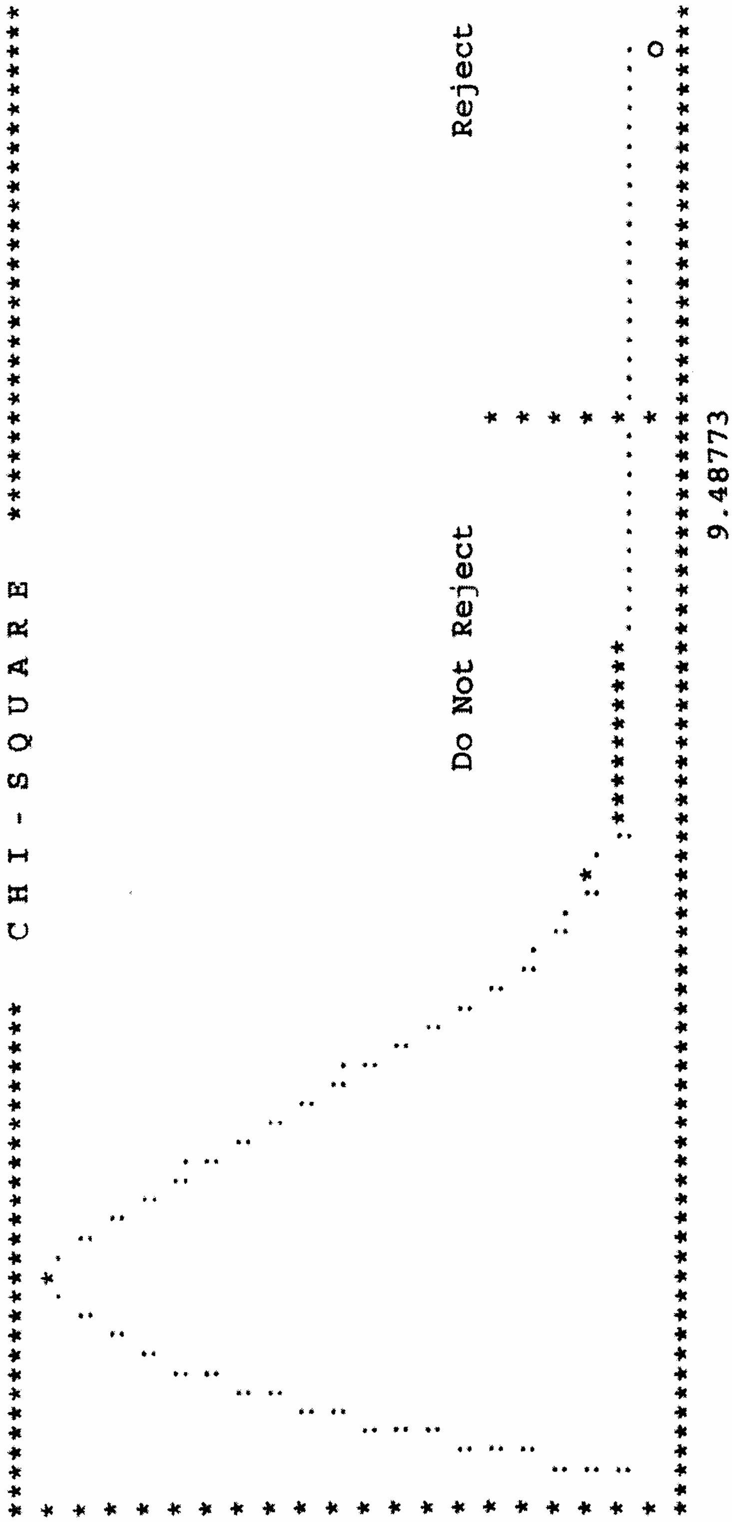
	YES	NO	Total
1 =	3	0	3
2 =	5	2	7
3 =	4	3	7
4 =	10	20	30
5 =	0	6	6
Total	22	31	53

Results - Expectations

	YES	NO	Total
1 =	1.245	1.755	3
2 =	2.906	4.094	7
3 =	2.906	4.094	7
4 =	12.453	17.547	30
5 =	2.491	3.509	6
Total	22	31	53

Critical chi-square:	9.4877
Computed chi-square:	12.5968
p value:	0.0131

Conclusion: Reject Hypothesis


C H I - S Q U A R E
Do Not Reject
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CBS-Chi-Square Analysis I-POLICY

Information Entered - Observations

Number of Columns:	2
Number of Rows:	5
Alpha Error:	.05
Degrees of Freedom:	4
Critical chi-square:	9.48773

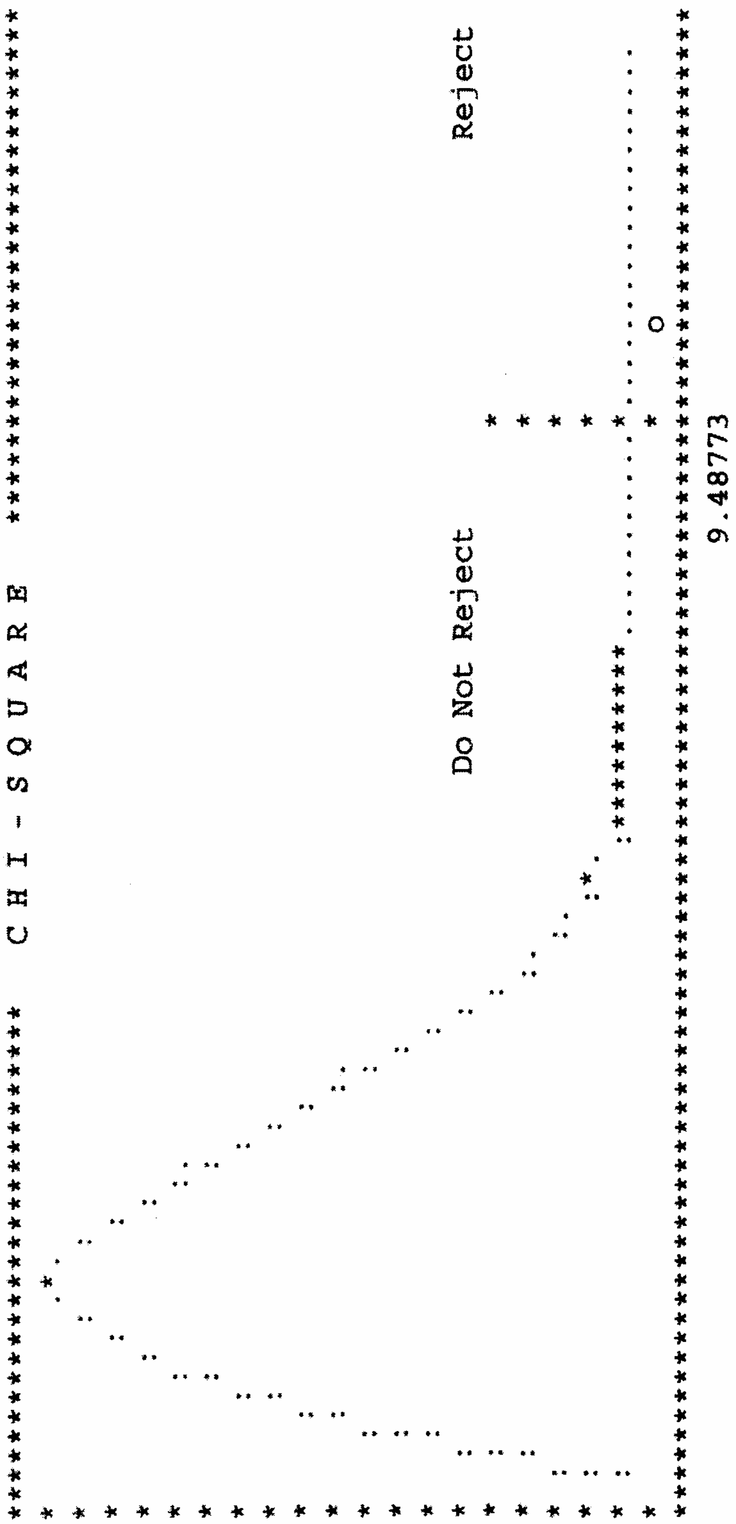
	YES	NO	Total
1 =	3	0	3
2 =	6	1	7
3 =	5	2	7
4 =	14	16	30
5 =	1	5	6
Total	29	24	53

Results - Expectations

	YES	NO	Total
1 =	1.642	1.358	3
2 =	3.830	3.170	7
3 =	3.830	3.170	7
4 =	16.415	13.585	30
5 =	3.283	2.717	6
Total	29	24	53

Critical chi-square:	9.4877
Computed chi-square:	10.2769
p value:	0.0353

Conclusion: Reject Hypothesis


C H I - S Q U A R E
Do Not Reject
Reject
9.48773

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