

# The identification and evaluation of the causes of fatigue in the ferrochrome smelting environment

**D. Dall**  
**20085087**  
**B.Eng (Chemical)**

Mini-Dissertation submitted in *partial* fulfilment for the degree  
Masters of Business Administration at the Potchefstroom Campus  
of the North-West University

Supervisor: Me. Retha Scholtz

November 2015

## ABSTRACT

Fatigue is a concept that has been researched extensively and is a complex phenomenon that leads to numerous problems for both the individual as well as the organisation. According to the philosopher Johnson (1825:327) “*The highest pleasure which nature has indulged to sensitive perception is that of rest after fatigue*”. Fatigue is the body’s response to sleep loss or prolonged physical or mental exertion. Fatigue is an unsafe condition in the workplace and can lead to sick leave, impaired memory, poor judgement, slow problem solving, reduced visual perception and reduced capacity for interpersonal communication.

There has been an increased drive worldwide to manage fatigue through Fatigue Risk Management Systems (FRMS). FRMS became internationally accepted between 2008 and 2010 after gaining sufficient critical mass of industry, government and academic influencers. Lately the need to manage fatigue has also been recognised in South Africa. In December 2014 the South African Government published a Guideline for the implementation of a Mandatory code of practice for risk based fatigue management at mines. Reducing the levels of fatigue can have huge advantages for both organisations and their employees.

Since many causes of fatigue are in control of the individual, fatigue management should be a shared responsibility between the organisation and its employees. Literature recommends that a FRMS should be data driven, which necessitates the need for research. Although there is an abundance of research on fatigue, there is little research available within the South African mining industry.

The purpose of this study was to identify from literature the relevant variables that the company should be concerned about when managing fatigue as well as the defences that are available to manage fatigue.

Participants in the research included 289 employees who worked at the three Furnace Production departments at Glencore’s Wonderkop Smelter as well as Almar, an internal transportation contractor. Data was gathered by means of a self-report questionnaire and an instrument that measured the level of fatigue. It was empirically identified which variables contributed the most to fatigue at Glencore’s Wonderkop Smelter.

The only variable that showed a statistical relationship with fatigue was sleep. The effect of sleep on fatigue is significant but not of practical significance.

**Key terms:**

Fatigue; sleep, overtime, shift cycle, commuting time, annual leave

# TABLE OF CONTENTS

<b>ABSTRACT .....</b>	<b>1</b>
<b>CHAPTER 1 .....</b>	<b>1</b>
<b>NATURE AND SCOPE OF THE STUDY .....</b>	<b>1</b>
<b>1.1 INTRODUCTION .....</b>	<b>1</b>
<b>1.2 PROBLEM STATEMENT .....</b>	<b>2</b>
<b>1.3 OBJECTIVES OF THE STUDY .....</b>	<b>3</b>
1.3.1 General objective.....	3
1.3.2 Specific objectives .....	3
<b>1.4 EXPECTED CONTRIBUTION OF THE STUDY .....</b>	<b>4</b>
1.4.1 Contribution of the study for the individual .....	4
1.4.2 Contribution of the study for the organization.....	4
1.4.3 Contribution of the study for literature .....	4
<b>1.5 RESEARCH METHOD .....</b>	<b>4</b>
1.5.1 Literature review .....	4
1.5.2 Empirical study .....	5
1.5.2.1 Research approach .....	5
1.5.2.2 Population .....	5
1.5.2.3 Sampling frame .....	5
1.5.2.4 Sampling procedure.....	6
1.5.2.5 Measuring instruments .....	6
1.5.2.6 Statistical analysis .....	8

1.5.2.7	Ethical considerations.....	8
1.5.2.8	Limitations of the study .....	8
<b>1.6</b>	<b>CHAPTER DIVISION.....</b>	<b>9</b>
<b>CHAPTER 2.....</b>		<b>10</b>
<b>LITERATURE REVIEW.....</b>		<b>10</b>
<b>2.1</b>	<b>INTRODUCTION .....</b>	<b>10</b>
<b>2.2</b>	<b>FATIGUE.....</b>	<b>10</b>
2.2.1	History of fatigue.....	10
2.2.2	Fatigue and concepts related to fatigue .....	11
2.2.3	Fatigue in the workplace.....	12
2.2.4	Conditions associated with fatigue.....	13
2.2.4.1	Chronic Fatigue Syndrome .....	13
2.2.4.2	Burnout.....	14
2.2.4.3	A brief history of chronic fatigue and Burnout .....	15
<b>2.3</b>	<b>INTERNATIONAL PERSPECTIVE ON CONDITIONS OF WORK AND EMPLOYEMENT .....</b>	<b>17</b>
<b>2.4</b>	<b>DIFFERENT SHIFT RULE OPTIONS.....</b>	<b>17</b>
<b>2.5</b>	<b>SOUTH AFRICAN PERSPECTIVE ON CONDITIONS OF WORK AND EMPLOYEMENT .....</b>	<b>19</b>
2.5.1	Mandatory code of practice for risk based fatigue management .....	19
2.5.2	Basic Conditions of Employment Act .....	20
<b>2.6</b>	<b>FATIGUE MANAGEMENT .....</b>	<b>21</b>
<b>2.7</b>	<b>SUMMARY .....</b>	<b>22</b>

<b>CHAPTER 3.....</b>	<b>23</b>
<b>EMPIRICAL STUDY .....</b>	<b>23</b>
<b>3.1 INTRODUCTION .....</b>	<b>23</b>
<b>3.2 THE QUESTIONNAIRE.....</b>	<b>23</b>
3.2.1 Structure of the questionnaire .....	23
3.2.2 Basis of the design .....	23
3.2.3 Translation of the questionnaire.....	23
<b>3.3 DATA COLLECTION .....</b>	<b>24</b>
3.3.1 Research process.....	24
3.3.2 Statistical data analysis .....	24
3.3.2.1 Validity and reliability .....	24
3.3.2.1.1 Content and construct validity .....	24
3.3.2.1.2 Reliability .....	24
3.3.2.2 Correlation coefficient .....	25
3.3.2.3 Hypothesis testing .....	25
3.3.2.4 Practicality .....	26
3.3.2.5 Causation and correlation .....	27
<b>3.4 RESULTS AND DISCUSSION .....</b>	<b>28</b>
3.4.1 Reliability of the results.....	28
3.4.2 Descriptive statistics .....	28
3.4.3 Comparison between the variables.....	38
3.4.4 Relationships between the variables.....	39
<b>3.5 SUMMARY .....</b>	<b>40</b>

<b>CHAPTER 4.....</b>	<b>41</b>
<b>CONCLUSIONS AND RECOMMENDATIONS .....</b>	<b>41</b>
<b>4.1 INTRODUCTION .....</b>	<b>41</b>
<b>4.2 CONCLUSIONS .....</b>	<b>41</b>
<b>4.3 LIMITATIONS.....</b>	<b>41</b>
<b>4.4 RECOMMENDATIONS .....</b>	<b>42</b>
4.4.1 Recommendations from the study .....	42
4.4.2 Recommendations for further research.....	42
<b>4.5 SUMMARY .....</b>	<b>43</b>
<b>BIBLIOGRAPHY .....</b>	<b>44</b>
<b>APPENDIX A: THE QUESTIONNAIRE.....</b>	<b>48</b>

## LIST OF TABLES

Table 1-1: Contingency table of the population.....	6
Table 1-2: Population according to Patterson salary band.....	6
Table 2-1: Comparison between CFS and Burnout adapted from Leone <i>et al.</i> (2011:452). ....	16
Table 2-2: Shift rule schedule used in Europe (ILO:2015c).....	18
Table 2-3: Shift rule system.....	19
Table 2-4: Maximum ordinary worker hours according to the Basic conditions of the employment act.....	21
Table 3-1: Five point Likert scale.....	23
Table 3-2: Interpretation of effect sizes (Steyn, 2000:1).....	26
Table 3-3: Statistics for hypothesis testing the difference between means. ....	38
Table 3-4: Statistics for hypothesis testing the relationship between variables with fatigue. ....	39

## LIST OF FIGURES

Figure 2-1: Relationship between fatigue, CFS and burnout.....	17
Figure 3-1: Cronbach`s alpha for the different questionnaires and subscales.....	28
Figure 3-2: Sample division between the three groups. ....	29
Figure 3-3: Histograms of age for the three groups. ....	30
Figure 3-4: Histograms of race. ....	31
Figure 3-5: Histograms of employment duration. ....	31
Figure 3-6: Bar chart of Patterson salary bands.....	32
Figure 3-7: Histograms of commuting time. ....	33
Figure 3-8: Histograms of overtime worked per month. ....	34
Figure 3-9: Histograms of sleep for the three groups of employees. ....	35
Figure 3-10: Histograms of sleep for employees on dayshift and shift. ....	36
Figure 3-11: Histograms of sleep for employees on shift at Almar and employees on shift at Furnaces production.....	37

# CHAPTER 1

## NATURE AND SCOPE OF THE STUDY

### 1.1 INTRODUCTION

Several high profile accidents in the South African Mining industry have been reported in which fatigue was either causal or contributory (Schutte, 2011:26). According to Lerman *et al.* (2012:231) and Dembe *et al.* (2005:588) fatigue is an unsafe condition in the workplace. Fatigue can lead to sick leave, impaired memory, poor judgement, slow problem solving, reduced visual perception and reduced capacity for interpersonal communication (Beurskens *et al.*, 2000:253; Schutte, 2011:27).

Fatigue is currently a very relevant topic in the South African mining industry. The Chief Inspector of Mines, Mr David Msiza, issued a guideline on 19 December 2014 for a Mandatory code of practice for risk based fatigue management at mines (South Africa, 2014). This code of practice needs to address the causes of fatigue and it should include a management plan.

Although fatigue is a widely researched topic there is very little research specific to the mining industry. The causes of fatigue include working long hours, shift work, overexertion and disruption of sleep (Lerman *et al.*, 2012:231; Schutte, 2011:26). These are all present in the mining industry. The consequences of fatigue are expensive to treat. There is currently a lack of procedures or plans to manage fatigue in the mining industry. Since many causes of fatigue are in control of the individual, fatigue management should be a shared responsibility between the organisation and its employees.

Fatigue can be divided into two types, acute fatigue and chronic fatigue (Beurskens *et al.*, 2000:353). Acute fatigue is characterised by its reversibility, it is a normal phenomenon and disappears after a period of rest (Beurskens *et al.*, 2000:353; Bultman *et al.*, 2000:412). Chronic fatigue is irreversible and mechanisms that are useful to reduce acute fatigue are not effective on chronic fatigue. Chronic Fatigue Syndrome (CFS) was recently renamed to Systemic Exertion Intolerance Disease (SEID) and some of the criteria also changed (Jason, *et al.*, 2015:1).

Acute fatigue can be divided into mental and physical fatigue. Mental fatigue is associated with over or under load and physical fatigue is associated with high thermal stress and over exertion (Schutte, 2011:26). Schutte (2011:26) gives the following operational definition for acute fatigue "fatigue is a state of declining alertness which eventually ends in sleep". According to Lerman *et*

*al.* (2012:231) there is however a difference between fatigue and sleepiness. Sleepiness is the body's tendency to fall asleep and it is one of the consequences of fatigue. Fatigue is the body's response to sleep loss or prolonged physical or mental exertion. There can be numerous causes of sleep deprivation. These include working long hours, shift work, disruption of circadian rhythms, repetitive tasks, medical condition and poorly designed shift systems (Dembe *et al.*, 2004:589; Lerman *et al.*, 2012:231; Schutte, 2011:27). While acute fatigue can be reduced by switching tasks or by a period of rest chronic fatigue is not easily reversible in the short term and is not task specific (Bultman *et al.*, 2000:412).

A Fatigue Risk Management System (FRMS) is made out of a set of safety management systems that aim to reduce fatigue in the workforce (Moore-Ede, 2010). The system should be based on research data. The purpose of this study is to identify from literature the relevant variables that the company should be concerned about in managing fatigue. It will identify which variables contribute the most to fatigue at Glencore's Wonderkop Smelter.

## **1.2 PROBLEM STATEMENT**

In the fast paced life of the 21<sup>st</sup> century it is sometimes difficult to get enough rest. As a result of increased connectivity people tend to spend more time awake, on mobile devices, smart phones, surfing the internet, watching television and so forth. People sleep less and their sleep is also interrupted more. The result is that people generally do not rest out well. Poor rest as well as long hours leads to a range of problems like fatigue, CFS and burnout. Fatigue is a growing problem in modern society (Schutte, 2011:26). According to Herbert Freuberger (1980) one of the first burnout researchers, burnout was "a demon, born of society and times we live in and our on-going struggle to invest our lives with meaning".

Studies have associated overtime and increased working hours with diseases like hypertension, diabetes, depression and cardiovascular diseases (Dembe *et al.*, 2004:588). These diseases are all very expensive to treat and chronic. Drake *et al.* (2004:1459) found that shift workers suffer much more from insomnia and that insomnia, excessive sleepiness, and circadian rhythm disorders are associated with accidents and absenteeism. Chronic fatigue can lead to sick leave, impaired memory, poor judgement, slow problem solving, reduced visual perception and reduced capacity for interpersonal communication (Beurskens *et al.*, 2000:253; Schutte, 2011:27).

According to Lerman *et al.* (2012:231) fatigue is an unsafe condition in the workplace that can be managed. Jobs with schedules that routinely involve overtime work or extended hours increase the risk of suffering an occupational injury or illness (Dembe *et al.*, 2005:595).

According to Dembe *et al.* (2007:595) special precautions need to be taken when employees work more than 12 hours per shift, 60 hours per week and with long commutes.

In the mining industry employees work on numerous different shift schedules and many employees work overtime as a result of the 24/7 operations. Coordinators and managers are on standby and are called at night for reporting and advice. It is important that employees in the mining industry are always well rested and alert, since the mining industry is a high risk environment. Well rested employees are also better motivated and more productive.

The cost of managing wellness at Glencore's operations is high. There are programmes to increase aids awareness, and numerous campaigns are held annually to increase awareness of diabetes, hypertension, stress and so forth. Based on the literature of fatigue it is important that Glencore should investigate the level of fatigue amongst employees and ensure that it is adequately managed.

Although fatigue is a reality, there is very little research specific to South Africa. No research could be found specific to the South African mining industry and little research specific to the mining industry worldwide.

In summary, the result of a fast paced world where there is often a lack of rest and sleep, combined with long working hours, overtime, overexertion at work and mentally or physically demanding work creates an environment where fatigue can flourish. As described this is the environment at the mines, smelters and other 24/7 operations.

### **1.3 OBJECTIVES OF THE STUDY**

#### **1.3.1 General objective**

The general objective of this research was to measure the level of fatigue at Glencore's Wonderkop Smelter. The level of fatigue was determined and compared amongst employees who work on different shifts.

#### **1.3.2 Specific objectives**

The specific objectives of this research were to identify the variables with the strongest relationship to fatigue. These variables could then be used to actively manage fatigue at the company.

## **1.4 EXPECTED CONTRIBUTION OF THE STUDY**

### **1.4.1 Contribution of the study for the individual**

The study will form the basis for the fatigue risk management system. If certain measures are implemented it will lead to a less fatigued workforce, which is beneficial to the health and wellness of the individual. Relevant information will also be shared with employees. This will give the individual the required knowledge to manage his or her own fatigue.

### **1.4.2 Contribution of the study for the organization**

The study determined the main causes of fatigue at Glencore's Wonderkop Smelter. This information will form the basis for the Fatigue Risk Management System (FRMS).

The study gathered relevant information from literature that can be used to make informed decisions and identify indicators the company can use to actively monitor and manage fatigue of employees. The study gathered plant specific data that enhanced understanding of the problem. The most direct consequence of lower levels of fatigue will be increased production and safety.

### **1.4.3 Contribution of the study for literature**

The study measured fatigue in the mining industry at Glencore's Wonderkop Smelter. There is currently very little literature available on fatigue in South Africa. No literature could be found on fatigue in the mining industry of South Africa.

## **1.5 RESEARCH METHOD**

### **1.5.1 Literature review**

The literature survey identified all relevant literature in South Africa. Databases like SAE Publications were explored to find literature specific to the South African context. A broader literature survey was done on other databases like EbscoHost and Google Scholar. The purpose was to ensure a holistic understanding of fatigue. The literature study focused on identifying the causes, symptoms and consequences of fatigue and related conditions. It also focused on ways to manage it.

The sources that were consulted include:

- Journals
- The services at the library (specifically that of Christine Bronkhorst)
- The Internet

*Keywords include:*

- Fatigue
- Overtime
- Incidents and accidents
- Shift cycle
- Commuting time
- Questionnaire
- Subjective feeling of fatigue
- Concentration
- Motivation
- Physical activity
- Annual leave

## **1.5.2 Empirical study**

### **1.5.2.1 Research approach**

The quantitative research approach was used for the study. The most applicable approach to gather data is survey research. Quantitative data was gathered by means of a questionnaire as research instrument. A cross sectional design was followed, since a measurement at a single time is adequate to answer all the research questions.

Primary data was used. Employees completed a questionnaire. The questionnaire gathered biographical data and included an instrument to measure fatigue.

### **1.5.2.2 Population**

The target population was employees employed at Glencore`s Wonderkop Smelter at the three production departments as well as Almar, an internal transportation contractor. The population included employees on a Patterson salary band B1 to C5. The target population consisted of 425 employees.

### **1.5.2.3 Sampling frame**

The following table indicates the gender and ethnic origins of the population.

**Table 1-1: Contingency table of the population.**

	<b>Female</b>	<b>Male</b>	<b>Total</b>
<b>African</b>	8.5%	86.4%	94.9%
<b>Coloured</b>	0.0%	1.4%	1.4%
<b>White</b>	0.3%	3.4%	3.7%
<b>Total</b>	8.8%	91.2%	100.0%

The population consisted of employees on three different shift cycles, 57% were on a four shift cycle, 34% were on engineering dayshift and 9% on normal dayshift. Shift cycles and working hours are discussed in chapter 2. The following table contains the population according to their Patterson bands.

**Table 1-2: Population according to Patterson salary band.**

<b>Patterson salary band</b>	<b>Percentage of population</b>
<b>B1</b>	20.0%
<b>B2</b>	37.6%
<b>B3</b>	27.8%
<b>C1 to C3</b>	8.8%
<b>C4</b>	0.3%
<b>C5</b>	5.4%

As a result of the normal hierarchical reporting structure the majority of employees were on the lower bands.

The sample was a convenience sample. All employees in the population were requested to complete a questionnaire with the exception of employees who were either on leave or on training. The aim was to keep the sample proportional to the number of employees in the different departments.

#### **1.5.2.4 Sampling procedure**

Meetings were held with the different shifts. During these meetings relevant information was shared and employees were ensured of their anonymity. Each employee was provided a questionnaire to complete which was collected after completion.

#### **1.5.2.5 Measuring instruments**

There are numerous instruments to measure fatigue in different situations. Hewlett *et al.* (2011) compared 11 different measuring instruments for fatigue. Hewlett *et al.*'s (2011) analysis included the following instruments:

- Multi-dimensional Assessment of Fatigue (MAF)
- Multi-dimensional Fatigue Inventory (MFI)
- Multi-dimensional Fatigue Scale
- Checklist Individual Strength (CIS20R)

Based on the analysis the best instrument to measure fatigue in the healthy working population is the CIS20R. The other instruments were all developed to measure fatigue in patients with specific medical conditions like cancer, multiple sclerosis and arthritis.

The CIS uses 20 statements to determine chronic fatigue. Each statement should be evaluated on a 7 point Likert scale, where 1 means the participant agrees “yes, that is true” and 7 the participant disagrees “no, that is not true”. The Likert scale is ideal to measure constructs in the social sciences. Nine of the twenty items are reverse scored, namely items 2, 5, 6, 7, 8, 11, 12, 15 and 20. The CIS has four subscales which measure the following:

- Subjective feeling of fatigue (items 1, 4, 6, 9, 12, 14, 16, 20)
- Concentration (items 3, 8, 11, 13, 19)
- Motivation (items 2, 5, 15, 18)
- Physical activity (items 7, 10, 17)

The total score is the average of the values indicated by the participant and can be expressed as a percentage. Motivation is measured by four different items, the level of motivation of a particular employee will be the sum of his responses divided by 28 (7X4=28).

The typical items for each of the subscales are:

- Subjective feeling of fatigue
  - I feel tired
- Concentration
  - Thinking requires effort
- Motivation
  - I feel very active
- Physical activity
  - I do quite a lot during a day

Beurskens *et al.* (2000:357) evaluated the validity of the Checklist Individual Strength (CIS) in the working population to determine the level of chronic fatigue. It was determined that the CIS is an appropriate instrument for measuring chronic fatigue in the working population. The internal consistency was good, Cronbach's  $\alpha$  ranged from 0.83 to 0.92 (Beurskens *et al.*, 2000:354).

The CIS was translated into Tswana, since 49% of the employees in the population were Tswana speaking. The translation was done by the translation services at the North West University.

The CIS measures fatigue. A person is diagnosed with Chronic Fatigue Syndrome (CFS) if the person's score is high over a 6 month period. It was not possible to determine whether certain employees had CFS since only a single measurement was done. There are also other criteria that are required before a person can be diagnosed with CFS.

The questionnaire was completed anonymously, no information was required that could identify an individual. The questionnaire had three parts:

- a. Biographical information
- b. Questions to measure the variables that are of interest
- c. CIS.

#### **1.5.2.6 Statistical analysis**

The validity and reliability of the instrument was first determined with an exploratory factor analysis. The internal consistency (or reliability) of the data was calculated using Cronbach's alpha.

Data was analysed by using histograms and bar charts. The data was compared through means, averages and standard deviations and then grouped, based on different criteria to do a statistical analysis. The statistical approach depended on the research question. Different approaches were used to analyse the data.

Pearson's sample correlation coefficient was used to determine whether linear correlations existed. Hypothesis testing was used to determine whether correlations were statistically significant and the effect size was used to determine whether there was practical significance.

#### **1.5.2.7 Ethical considerations**

The confidentiality of the respondents was upheld. Confidentiality was ensured by not including questions that could lead to the identification of an individual.

#### **1.5.2.8 Limitations of the study**

The questionnaire was translated from English to Tswana. Translation problems might reduce the validity of the Tswana questionnaire.

Interpretation problems might contribute to the misunderstanding of some of the questions due to the questionnaires only distributed in English and Tswana, while there were numerous employees who did not speak English or Tswana as a first language.

The level of fatigue was based on a self-report questionnaire and there were no means to externally validate the responses. The variables in question were also not possible to validate externally, for example actual hours of sleep, previous annual leave and overtime.

## **1.6 CHAPTER DIVISION**

### **Chapter 1: Nature and scope of the study**

This chapter contains the introduction of the study and the problem statement. A discussion follows regarding research objectives and the research methods. The limitations of the study are discussed along with the layout of the chapters.

### **Chapter 2: Literature review**

A thorough literature review was done on the topic of fatigue and related conditions as well as ways to manage the risk of fatigue.

### **Chapter 3: Empirical study**

This chapter contains discussions of the method that was used to gather data, the statistical tools that were used as well as an analysis and discussion of the results.

### **Chapter 4: Conclusion and recommendations**

This chapter contains the conclusions and recommendations that were made, based on the results and the literature review.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 INTRODUCTION

Fatigue is common in all human beings and is as old as humanity itself. According to the philosopher Johnson (1825:327) “*The highest pleasure which nature has indulged to sensitive perception is that of rest after fatigue*”.

Over the past century the definition of fatigue has changed in accordance with work. In the early 20<sup>th</sup> century people worked physically hard and fatigue was also described in physical terms (Fletcher *et al.*, 2015:7). After industrialisation work became more repetitive and fatigue was described more in psychological terms (Fletcher *et al.*, 2015:7). When electricity became widely available sleep and circadian rhythms became more apparent. Today information overload is studied as well as concepts such as social media fatigue (Bright *et al.*, 2015).

Chronic fatigue syndrome and burnout are conditions that are at the far end of a continuum of severity and duration of fatigue symptoms (Leone *et al.*, 2011:452). A central theme for both burnout and CFS is that there is a lack of energy that needs to be restored in some way (Leone *et al.*, 2011:453). In 2015 the IOM renamed Chronic Fatigue Syndrome (CFS) to Systematic Exertion Intolerance Disease (SEID).

A turning point was reached between 2008 and 2010 when Fatigue Risk Management Systems became widely accepted after gaining sufficient critical mass of industry, government, and academic influencers to be accepted internationally (Moore-Ede, 2010). In December 2014 the South African Government published a Guideline for the implementation for a Mandatory code of practice for risk based fatigue management at mines (South Africa, 2014).

#### 2.2 FATIGUE

##### 2.2.1 History of fatigue

Fletcher *et al.* (2015) analysed the history of fatigue and found that worker fatigue has been researched and documented since the 19<sup>th</sup> century and that the nature of work related fatigue has also changed over time.

A brief summary of the findings of Fletcher *et al.* (2015) regarding the above mentioned research follows:

- Initial accounts of fatigue focussed on physical aspects. In the agricultural times work tended to be more physical in nature and fatigue therefore was also more physical in nature.
- After industrialization work became more repetitive and fatigue increasingly included psychological or cognitive components.
- When electricity became widely available sleep and circadian factors underlying fatigue became more apparent.
- There was an increase in focus on workforce fatigue from 1927 with the opening of the Harvard University Fatigue Laboratory.
- The laboratory's mission statement was "to work with industry to explain the physiology of fatigue" During the last stages of World War II the distinct elements that were considered to make up fatigue began to increase significantly.

Today fatigue is a multidimensional concept that can be described and measured in numerous different ways (Phillips, 2015; Hewlett *et al.*, 2011).

Lately a concept such as social media fatigue, which is caused when people are overwhelmed by information on the social media, is also researched (Bright *et al.*, 2015). According to Jabr (2013) our brains need more downtime to replenish their mental reserves.

Over the past 20 years fatigue risk management systems (FRMS) have been developed and implemented (Moore-Ede, 2010:2). According to Moore-Ede (2010) the FRMS reached a tipping point between 2008 to 2010, by gaining sufficient critical mass of industry, government and academic influencers to be accepted internationally. In December 2014 the South African Government published a Guideline for the implementation for a Mandatory code of practice for risk based fatigue management at mines (South Africa, 2015).

### **2.2.2 Fatigue and concepts related to fatigue**

Fatigue can be described in numerous different ways. It can be considered an experience, a psychological condition or a multidimensional concept (Phillips, 2015). According the Oxford dictionary (2013) fatigue is "*extreme tiredness resulting from mental or physical exertion or illness.*"

Acute fatigue is characterised by its reversibility, task specificity and the functional use of compensation mechanisms (Beurskens *et al.*, 2000:353). Acute fatigue is a normal phenomenon that disappears after a period of rest, when tasks are switched or when particular compensation strategies are used, for example to work at a slower pace (Beurskens *et al.*, 2000:353; Bultmann *et al.*, 2000:412).

Sleepiness and fatigue are concepts that are sometimes used interchangeably. It is however important to note that sleepiness is not the same as fatigue. Sleepiness is the tendency to fall asleep whereas fatigue is the body's response to sleep loss of prolonged mental or physical exertion (Lerman *et al.* 2015:231). Fatigue can be reduced by rest without sleep but sleepiness often increases when a person is inactive (Lerman *et al.* 2015:231).

Phillips (2015) studied numerous definitions of fatigue. Based on the research fatigue can be defined as an experience, a psychological condition, a performance decrement and lately fatigue has also been defined as a multifaceted concept.

Phillips (2015:49) is of the opinion that definitions of fatigue do not meet the criteria of a robust definition, in other words it should describe the origins, state and consequences of fatigue. Phillips (2015:53) recommends the following definition:

*"Fatigue is a suboptimal psychophysiological condition caused by exertion. The degree and dimensional character of the condition depends on the form, dynamics and context of exertion. The context of exertion is described by the value and meaning of performance to the individual; rest and sleep history; circadian effects; psychosocial factors spanning work and home life; individual traits; health, fitness and other individual states; and environmental conditions. The fatigue condition results in changes in strategies or resource use such that original levels of mental processing or physical activity are maintained or reduced."*

For the purpose of this specific study the following can be added to the definition *"Reduced levels of mental processing or physical activity can lead to lower productivity and accidents and incidents in high risk environments"*. With this addition the definition captures the origins, state and consequences of fatigue adequately. It is questionable whether literature will ever agree on a unified definition of fatigue since fatigue is so multifaceted.

### **2.2.3 Fatigue in the workplace**

According to numerous authors there is ample evidence that fatigue can have a negative impact on safety and performance (Lerman *et al.* 2012:232; Schutte, 2011:26; Dembe *et al.*, 2005; Dembe, 2008:203). According to Lerman *et al.* (2012), Dembe *et al.* (2005:588) and Moore-edde (2010) fatigue is an unsafe condition in the workplace that can be managed. Fatigue can also lead to sick leave, impaired memory, poor judgement, slow problem solving, reduced visual perception and reduced capacity for interpersonal communication (Beurskens *et al.*, 2000:253; Schutte, 2011:27).

According to Dembe *et al.* (2005:595) working in jobs that routinely involve overtime or extended hours increases the risk of suffering an occupational injury or illness. This risk was found to increase, even after controlling for the entire working time spent “at risk” (Dembe *et al.*, 2005:595). According to Lerman *et al.* (2012:253) there are associations between long working hours and health. Numerous studies found relationships between overtime and unhealthy weight gain, increased alcohol use, increased smoking and poor general health (Lerman *et al.*, 2012:253).

Dembe *et al.* (2005:595) further found that long working hours indirectly lead to workplace accidents by inducing fatigue in workers. Lerman *et al.* (2008:1191) analysed several factors related to injury rates and found that overtime carried the greatest overall risk.

Dembe *et al.* (2008:1192) found those women working high amounts of overtime were more prone to injury risk than men. This suggests that women are particularly susceptible to the effects of a long fatiguing workweek. It is expected from women to have numerous personal activities and responsibilities such as child care and other family responsibilities which reduce the sleep they obtain to recover from fatigue.

Fatigue is related to both duration of sleep and circadian rhythm (Lerman *et al.* 2012:231). According to Lerman *et al.* (2012) inadequate duration of sleep is also correlated with injury rate. In an attempt to quantify the risk associated with sleep deprivation Dawson and Reid (1997) correlated the hours someone was awake with blood alcohol concentration. Twenty four hours of sleep deprivation showed impairment to neurobehavioral performance comparable to a 0.10% blood alcohol level. A 0.10% blood alcohol level is comparable to drinking three to four drinks for a person weighing about 80kg (Dawson & Reid, 1997).

According to Lerman *et al.* (2012:240) the average person requires 8 hours of sleep daily to prevent fatigue associated with sleep loss. When calculating shift schedules and rules it is important to take into consideration that the true sleep opportunity is less than the non-work time because of commuting time and other personal activities (Lerman *et al.*, 2012:240).

According to Fletcher *et al.* (2015:7) reductions in excessive working hours improved outcomes, including levels of productivity and absenteeism.

## **2.2.4 Conditions associated with fatigue**

### **2.2.4.1 Chronic Fatigue Syndrome**

Chronic fatigue is irreversible, not task-specific and the compensation mechanisms that were useful in reducing acute fatigue are not effective anymore (Beurskens *et al.*, 2000:353). Chronic

fatigue manifests itself in inefficient action patterns, declining interest, involvement, commitment, reduced concentration and motivation as well as negative emotions (Bultman *et al.*, 2000:412).

Operational definitions of Chronic Fatigue Syndrome include (Beurskens *et al.* 2000:353):

*“The change in the psychological control mechanisms that regulate task behaviour, resulting from preliminary mental and/or physical efforts which have become bothersome to such an extent that the individual is no longer able to adequately meet the demands that the job requires on his or her mental functioning, or that the individual is able to meet these demands only at the cost of increasing mental effort and surmounting of psychic resistance.”*

According to Meijman and Schaufeli (1996) *“prolonged fatigue manifests itself in inefficient action patterns; declining interest, involvement, and commitment; reduced concentration and motivation; and negative emotions”*.

Houdenrove and Luyten (2009:153) reviewed literature about the treatment of CFS. According to a group of academics and clinicians CFS patients can be cured and full recovery is possible, while others think that enhancing coping with the illness is a more realistic and feasible goal.

On 10 February 2015 the US Institute of Medicine (IOM, 2015) released a report with a new definition and name for CFS. CFS was renamed to systemic exertion intolerance disease (SEID). According to the IOM the new name better reflects the key symptoms of the disease which is extreme exhaustion after any exertion (Reardon, 2015).

#### **2.2.4.2 Burnout**

According to Maslach and Jackson (1981:99) burnout is a syndrome of emotional exhaustion and cynicism. Maslach describes burnout as a chronic problem and a reflection of an uneasy relationship between people and their work or work overload. Ethical dilemmas also contribute to burnout (Maslach, 1976:44).

Burned-out people often feel exhausted, overwhelmed, bitter and cynical (Maslach, 1976:44). According to Maslach (1976:44) reversing burnout requires focussing on both the individuals as well as their organizations to bring these two back into sync with each other.

Burnout is not a state or condition but rather a process, namely burning out, and the end state of burnout is “clinical” burnout (Schaufeli *et al.*, 2001). The opposite of burnout is engagement (Maslach, 1976:44).

### 2.2.4.3 A brief history of chronic fatigue and Burnout

Burnout is closely related to chronic fatigue syndrome (CFS). Leone *et al.* (2011) explored CFS and burnout in a historical context to determine what the links and relationships were between the two fatigue based syndromes and came to the following conclusions:

- Burnout and Chronic Fatigue Syndrome are two fatigue based syndromes which have evolved largely independently from each (Leone *et al.*, 2011:449).
- Both are associated with sickness, absence and work disability and there seems to be an overlap in the symptoms (Leone *et al.*, 2011:449).
- The development of the term CFS followed a medical path (Leone *et al.*, 2011:542) while burnout followed a psychological path where stress from strenuous interpersonal relationships at work depleted emotional and empathetic reserves leaving one to feel drained and weak or burned out (Leone *et al.*, 2011:453).
- Burnout is considered to be a work related fatigue condition whereas CFS is a more general fatigue condition (Leone *et al.*, 2011:452).

According to Leone *et al.* (2011:452) both burnout and CFS are conditions that are at the far end of a continuum of severity and duration of fatigue symptoms. A central theme for both burnout and CFS is that there is a lack of energy that needs to be restored in some way (Leone *et al.*, 2011:453).

Leone *et al.* (2011:453) also indicated that as CFS and Burnout developed further, the line between burnout being a psychological condition and CFS being a medical condition became more vague.

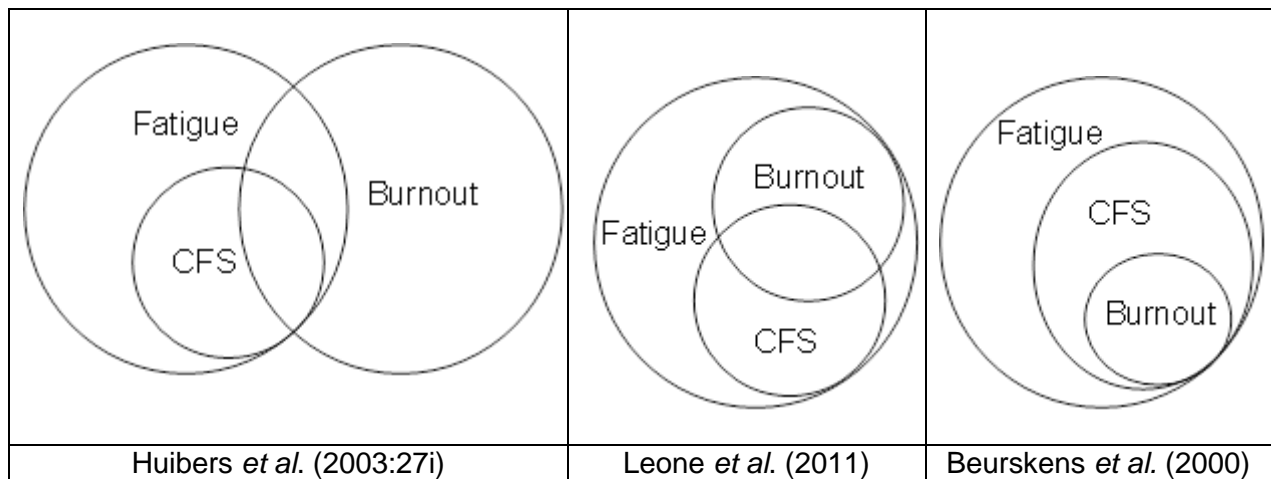
Both CFS and burnout have symptoms such as depressed mood, muscle pain, nausea, headaches and flu like symptoms and both are associated with sickness, absence and work disability (Leone *et al.*, 2011). These similarities in symptoms often lead to confusion. The origin of CFS lies within medicine and the origins of burnout in psychology, although both have fatigue as a core component (Leone *et al.*, 2011:449). This explains all the similarities between the two syndromes. The following table was adopted from Leone *et al.* (2011:452). It indicates the differences between Chronic Fatigue Syndrome (CFS) and burnout.

**Table 2-1: Comparison between CFS and Burnout adapted from Leone *et al.* (2011:452).**

Definition for CFS	Definition for Burnout
Severe and persisting fatigue lasting at least 6 months and which is not explained by an identifiable cause or condition	Symptoms consisting of enhance feelings of exhaustion, cynicism and reduced feelings of professional efficacy.
<p>Four of the following symptoms are present for at least 6 months:</p> <ul style="list-style-type: none"> <li>➤ Impaired memory or concentration</li> <li>➤ Sore throat</li> <li>➤ Tender cervical or axillary lymph nodes</li> <li>➤ Muscle pain</li> <li>➤ Multi joint pain</li> <li>➤ New headaches</li> <li>➤ Unrefreshing sleep</li> <li>➤ Post exertion malaise</li> </ul>	<ul style="list-style-type: none"> <li>➤ Exhaustion: Feelings of fatigue and/or exhaustion</li> <li>➤ Cynicism: Indifferent or distant attitude towards one`s work</li> <li>➤ Reduced Professional efficacy: Negative attitude towards one`s own performance in relation to the job.</li> </ul>

Based on these definitions CFS and burnout are similar but not the same.

Based on the descriptions of fatigue, Chronic Fatigue Syndrome and burnout by Beurskens *et al.* (2000) and Leone *et al.* (2011), a model was developed to display their different views. According to Beurskens *et al.* (2000:354) burnout is a mental state which can be regarded as an extreme expression of long-term fatigue. Huibers *et al.* (2003:27i) also proposed a model. Figure 2-1 displays the different views of researchers on the relationship between fatigue, CFS and burnout.



**Figure 2-1: Relationship between fatigue, CFS and burnout.**

Based on literature, the description of Leone *et al.* (2011) for fatigue, chronic fatigue syndrome and burnout is the most accurate.

## 2.3 INTERNATIONAL PERSPECTIVE ON CONDITIONS OF WORK AND EMPLOYEMENT

The International Labour Organisation (ILO, 2015a) is devoted to promote social justice and internationally recognised human and labour rights. Its main aims are to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialogue on work-related issues (ILO: 2015a).

During the Hours of Work (Industry) Convention of 1919, it was decided to introduce a maximum standard working time of 48 hours per week and eight hours per day as an international norm (ILO, 2015b). During the convention it was also decided that these limits could be exceeded as long as daily working time is not more than 10 hours and weekly working time not more than 56 hours (ILO, 2015b). Daily working time is also limited by the requirement of 11 hours rest during a 24 hour period.

## 2.4 DIFFERENT SHIFT RULE OPTIONS

The shift schedule itself is also a potential source of fatigue and there is no single remedy to this schedule-induced risk (Lerman *et al.*, 2012:240). There are other considerations organisations should consider when designing shift-schedules, such as work-life-balance. The Basic Conditions Employment Act sets a framework which should also be adhered to. There are numerous shift schedules, each with its own advantages and disadvantages.

The following table contains the shift schedule that is used in Europe (ILO, 2015c). This schedule is also widely used in South Africa.

**Table 2-2: Shift rule schedule used in Europe (ILO:2015c).**

<b>DAY</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Mon	M	A	N	O
Tue	M	A	N	O
Wed	A	N	O	M
Thu	A	N	O	M
Fri	N	O	M	A
<b>Sat</b>	N	O	M	A
<b>Sun</b>	N	O	M	A
Mon	O	M	A	N
Tue	O	M	A	N
Wed	M	A	N	O
Thu	M	A	N	O
Fri	A	N	O	M
<b>Sat</b>	A	N	O	M
Sun	<b>A</b>	<b>N</b>	<b>O</b>	<b>M</b>

On this schedule employees rotate clockwise (morning, afternoon then night). They work seven, eight hour shifts followed by off days. A disadvantage of this shift schedule is that employees only have one weekend per month that coincides with a Saturday and Sunday.

The following table indicates a different shift system that is also followed in South Africa.

**Table 2-3: Shift rule system.**

DAY	A	B	C	D
Mon	O	A	N	M
Tue	O	A	N	M
Wed	T	A	N	M
Thu	M	A	N	O
Fri	M	N	A	O
Sat	M12	N12	O	O
Sun	M12	N12	O	O
Mon	M	N	O	A
Tue	M	N	O	A
Wed	M	N	T	A
Thu	O	N	M	A
Fri	O	A	M	N
Sat	O	O	M12	N12
Sun	O	O	M12	N12
Mon	A	O	M	N
Tue	A	O	M	N
Wed	A	T	M	N
Thu	A	M	O	N
Fri	N	M	O	A
Sat	N12	M12	O	O
Sun	N12	M12	O	O

This shift schedule allows employees two weekends per month that coincides with a Saturday or Sunday. This will definitely allow employees to spend more time with their families. This is also an advantage for employees who have to travel far. The disadvantage is that on certain days there is a shift that rotates anticlockwise. This is also known as a quick change. During a quick change an employee is off for only 8 hours before he or she has to work again. During each shift cycle there are also two consecutive days where employees have to work 12 hours.

## **2.5 SOUTH AFRICAN PERSPECTIVE ON CONDITIONS OF WORK AND EMPLOYEMENT**

### **2.5.1 Mandatory code of practice for risk based fatigue management**

On 19 December 2014 a Guideline was published for a mandatory code of practice for risk based fatigue management at mines (South Africa, 2014).

The objectives of the guideline are to:

1. Develop strategies for controlling risks of fatigue effectively
2. Develop site specific fatigue management plans

### 3. Look at factors considered when managing fatigue

The guideline indicates numerous work related and non-work related causes of fatigue. The guideline lists the following work related causes of fatigue:

- Work time arrangements
- High physical workloads
- Temperature extremes
- Excessive noise
- Work stress
- Poor ergonomic design of work

The guideline lists the following non work related causes of fatigue:

- Undiagnosed medical conditions
- Living conditions
- Alcohol and substance abuse
- Lack of exercise
- Certain medications

In the guideline the following equation is used to determine total worker fatigue:

$$F_t = F_{ss} + F_{ew} + F_{pf}$$

Where:

- $F_t$  = total worker fatigue
- $F_{ss}$  = fatigue caused by shift work time arrangements
- $F_{ew}$  = fatigue caused by poor ergonomics and environmental and work factors
- $F_{pf}$  = fatigue caused by personal factors

The guideline recommends a five step process for fatigue risk management, which are:

1. Hazard identification
2. Risk assessment
3. Risk control
4. Monitoring and evaluation
5. Documenting

## 2.5.2 Basic Conditions of Employment Act

The following table contains the maximum ordinary worker hours. It was adapted from the Basic Conditions of Employment Act section 9.

**Table 2-4: Maximum ordinary worker hours according to the Basic conditions of the employment act.**

Number of days worked per week	Maximum	
	Ordinary hours per day	Ordinary hours per week
1 to 5	9	45
More than 5	8	45

The Basic Conditions of the Employment Act states that workers may only work overtime by agreement and that they may not work more than 10 hours overtime per week and more than 12 hours continuously in a specific day.

The Act also states that whenever a worker works more than 6 hours a day, they must have a 60 minute break after 5 hours, which can be reduced to intervals of 30 minutes by agreement.

## **2.6 FATIGUE MANAGEMENT**

A Fatigue Risk Management System (FRMS) should be science based, data driven and subject to continuous improvement. It is a system to manage the risks associated with fatigue (Lerman *et al.* 2012:231).

According to Lerman *et al.* (2012) the following characteristics are essential for the successful implementation of a FRMS:

1. Science based: supported by established peer reviewed science
2. Data Driven: decisions based on collection and objective analysis of data
3. Cooperative: designed together by all stakeholders
4. Fully implemented: system-wide use of tools, systems, policies, procedures
5. Integrated: built into corporate safety and health management systems
6. Continuously improved: progressively reduces risk using feedback, evaluation, and modification
7. Budgeted: Justified by an accurate return on investment business case
8. Owned: responsibility accepted by senior corporate leadership

Furthermore, a FRMS can include the following components (Lerman *et al.* 2012:234):

1. Fatigue management policy.
2. Fatigue risk management, including collecting information on fatigue as a hazard, analysing its risk and initiating controls to mitigate the risk.
3. Fatigue reporting systems for employees.
4. Fatigue incident investigation.
5. Fatigue management training and education for employees, management (and families).
6. Sleep disorder management.
7. A process for the auditing of the FRMS.

Lerman *et al.* (2012) explains that fatigue risk management is a shared responsibility between employees and the company. The only remedy for sleep deprivation, which will lead to fatigue, is sleep, and the employee should use opportunities available to obtain enough rest and sleep (Lerman *et al.* 2012:234).

Key defences of an FRMS (Lerman *et al.* 2012:236):

1. balance between workload and staffing
2. shift scheduling
3. employee fatigue training and sleep disorder management
4. workplace environment design
5. fatigue monitoring and alertness for duty

The company is responsible for systems to support and manage fatigue. The ultimate responsibility however still lies with the employee to manage his or her own fatigue.

## **2.7 SUMMARY**

Fatigue is a complex phenomenon that leads to numerous problems for both the individual as well as the organisation. Reducing the levels of fatigue can have huge advantages for both organisations and their employees.

Fatigue Risk Management Systems (FRMS) are made up of different systems to manage fatigue. Internationally a FRMS has already been accepted. In South Africa the requirement for a risk based fatigue management system only recently became a requirement. Numerous systems that are applied to manage fatigue are however already in place and it should be ensured that there is synergy between these systems and the mandatory code of practice.

Fatigue management should be a shared responsibility between individuals and the company. The responsibility of implementing, monitoring and support systems lies with the company while the responsibility of ensuring that a specific individual gets enough rest lies with that person. When considering ways to manage and reduce fatigue it is important to take a holistic approach.

## CHAPTER 3

### EMPIRICAL STUDY

#### 3.1 INTRODUCTION

The objectives of this research were to identify the variables with the most significant relationship to fatigue at Glencore`s Wonderkop Smelter and to use these to actively manage fatigue at the company.

The measuring instrument, relevant statistics of analysis and results thereof are discussed in this chapter.

#### 3.2 THE QUESTIONNAIRE

##### 3.2.1 Structure of the questionnaire

The questionnaire was divided into two sections. The first section was compiled to gather biographical data and data relating to different variables which are possibly correlated with fatigue according to literature. The second section contains the questionnaire: Checklist Individual Strength (CIS20), a 20 point instrument that was developed by Beurskens *et al.* (2000) that measured four different aspects of fatigue. Refer to Appendix A for the questionnaire.

##### 3.2.2 Basis of the design

The original design of the CIS by Beurskens *et al.* (2000) had a 7 point Likert scale. The 7 point Likert scale was changed to a 5 point Likert scale for easier interpretation by the participants. The following table contains the choices of the 5 point Likert scale.

**Table 3-1: Five point Likert scale.**

Almost always	Sometimes	Every once in a while	Rarely	Never
---------------	-----------	-----------------------	--------	-------

The scale ranged from “Almost always” to “Never”. The original scale on the CIS20 ranged from “yes, that is true” to “no, that is not true”.

##### 3.2.3 Translation of the questionnaire

The first language of 49% of the employees of the population is Tswana and for this reason the questionnaire was translated into Tswana, to accommodate these employees. The translation was done by the translation services of the North West University. After translating the

questionnaire, two Tswana speaking employees completed the questionnaire. Minor changes were then made due to dialectic differences in Tswana from different regions. Refer to Appendix B for the translated questionnaire.

### **3.3 DATA COLLECTION**

#### **3.3.1 Research process**

One meeting was scheduled with each shifts at the three production departments. The purpose of the research, and the questionnaire were explained and discussed. Participants were also ensured of their anonymity. Tswana-speaking participants were requested to complete the Tswana questionnaire and employees who spoke other languages could complete the English questionnaire.

The population consisted of 425 employees and a total of 289 questionnaires were completed. A total of 136 employees did not complete a questionnaire due to other obligations. All employees that attended the meetings completed the questionnaire. The response rate was 68%.

#### **3.3.2 Statistical data analysis**

##### **3.3.2.1 Validity and reliability**

###### **3.3.2.1.1 Content and construct validity**

Generally validity is defined as how well an instrument measures what it claims to measure (Brown, 2000:8). Content validity is an indication of how well the test items match the test objectives (Brown, 2000:8). Construct validity is an indication of whether a test measures the construct that it claims to be measuring (Brown, 2000:9).

Hewlett *et al.* (2011) analysed literature on the Checklist Individual Strength and found no information available on how the items were generated which means that there is not proof that during the development of the CIS20 a process was followed to ensure content validity. Hewlett *et al.* (2011) further found that the CIS20 was able to discriminate amongst healthy workers and workers that had a health reason for being fatigued which means that the test has construct validity.

###### **3.3.2.1.2 Reliability**

Reliability is concerned with ability of an instrument to measure consistently (Tavakol & Dennick, 2011:53). Validity and reliability is closely associated. An instrument cannot be valid if

it is not reliable (Tavakol & Dennick, 2011:53). According to Tavakol and Dennick (2011:53) Cronbach's alpha is the most widely used objective measure of reliability.

Cronbach's alpha provides a measure of the internal consistency of an instrument. It describes the extent to which all the items measure the same construct. It is thus an indication of the interrelatedness of different items in an instrument (Tavakol & Dennick, 2011:53). Cronbach's alpha should thus be calculated for each construct. A low alpha is an indication that there is poor interrelatedness between the items (Tavakol & Dennick, 2011:53).

A low value of alpha can be as a result of (Tavakol & Dennick, 2011:55):

- Few questions in the construct
- Poor interrelatedness between the items
- Heterogeneous constructs.

A high value of alpha is an indication that there is good interrelatedness between the items in the construct. Very high values of alpha may however suggest redundancies and indicate that the test should be shortened (Tavakol & Dennick, 2011:55).

### **3.3.2.2 Correlation coefficient**

The correlation coefficient is an indication of the strength of a linear relationship between two variables (Davore & Farnum, 2008:108). The correlation coefficient should be interpreted as follows (Davore & Farnum, 2008:109):

- The value of  $r$  varies between +1 and -1
- Between 0.8 and 1 indicates a substantial positive relationship
- Between 0.5 and 0.8 indicates a moderate positive relationship
- Between 0.5 and -0.5 indicates a weak relationship
- Between -0.5 and -0.8 indicates a moderate negative relationship
- Between -0.8 and -1 indicates a substantial negative relationship

### **3.3.2.3 Hypothesis testing**

Hypothesis testing was used to compare the mean level of fatigue for different groups as well as to determine if correlations between different variables were statistically significant.

Davore and Farnum (2008:346) explain hypothesis testing as follows: "The null hypothesis is the statement that is initially assumed to be true, denoted  $H_0$ . The alternative hypothesis is the claim that is contradictory to the null hypothesis, denoted  $H_a$ . The null hypothesis will be rejected for the alternative hypothesis only if there is sufficient evidence. If the sample evidence does not strongly contradict the null hypothesis then the null hypothesis will be considered the

truth. The two possible conclusions from hypothesis testing are to reject the null hypothesis or fail to reject the null hypothesis.”

The p-value is also known as the observed significance level. The p-value is the probability, calculated assuming that  $H_0$  is true, of obtaining a test value at least as contradictory to  $H_0$  as the value that actually resulted (Davore & Farnum, 2008:349). The smaller the p-value the more contradictory the data is to  $H_0$ . The null hypothesis should be rejected if the p-value is sufficiently small.

In hypothesis testing there are two types of errors that can be made. These are (Davore & Farnum, 2008:348):

- Type I errors
- Type II errors

The probability of making a type I error is denoted  $\alpha$  and is called the significance level of the test (Davore & Farnum, 2008:348). This means that if  $H_0$  is actually true and the test is repeated on different samples in the population then  $H_0$  will be incorrectly rejected only 1% of the time (Davore & Farnum, 2008:348). A type II error consists of not rejecting null hypothesis when it is false.

The following decision rule specifies a test with a desired significance level of  $\alpha$ :

- Reject  $H_0$  if the p-value  $\leq \alpha$
- Do not reject  $H_0$  if p-value  $> \alpha$

This form of hypothesis testing was used to determine whether there was statistically a difference between the means of the different groups.

### 3.3.2.4 Practicality

A low p-value indicates statistical significance but not necessarily practical significance (Ellis & Steyn, 2003:51). The effect size is an indication of whether there is practical significance (Ellis & Steyn, 2003:51). The effect size is ideal for arbitrary scales where it is difficult to get a “feeling” for the scale like with a Likert scale (Steyn, 2000:1). The following table was adapted from Ellis and Steyn (2003:54).

**Table 3-2: Interpretation of effect sizes (Steyn, 2000:1).**

Difference between means		Regression fit	
Effect size	Effect	Values of $R^2$	Effect
<0.15	Small	< 0.13	Non-significant
0.15-0.35	Medium	0.13-0.25	Significant

0.35>	Large	> 0.25	Practically important
-------	-------	--------	-----------------------

The effect size can be calculated for the difference between means and the regression fit. Based on table 3-2, if the effect size is  $<0.15$ , then the effect is small. If it is between 0.15 and 0.35 there is a medium effect and once the effect size is more than 0.35 there is a large effect. As discussed the correlation coefficient, denoted  $R^2$  is an indication of whether a linear relationship exists between two variables. If the correlation coefficient is  $< 0.13$ , then the effect is considered non-significant. If it is between 0.13 and 0.25, then the correlation is considered significant, only if the value of  $R^2$  is  $> 0.25$ , then the correlation is of practical importance.

### 3.3.2.5 Causation and correlation

It is important to note that association does not imply causation. The correlation between variables can be calculated. The correlation coefficient is an indication of the strength of the correlation as discussed. The correlation coefficient only indicates association and it does not necessarily indicate causation as well. Causation can only be determined if there is a cause effect relationship between the variables. According to Holland (2015:945) a well-designed randomized experiment can be a powerful aid in investigating causal relationships.

In this research there are causal relationships between the following variables:

- fatigue and overtime
- fatigue and sleep

Working too long hours will directly lead to an increase in fatigue. This follows from the numerous definitions of fatigue. Sleep is the process where fatigue is reduced and energy is once again replenished. However, too little sleep will lead to employees not resting out properly and then fatigue will increase. There is thus a direct cause effect relationship between sleep and fatigue.

There are numerous variables that indirectly lead to fatigue like:

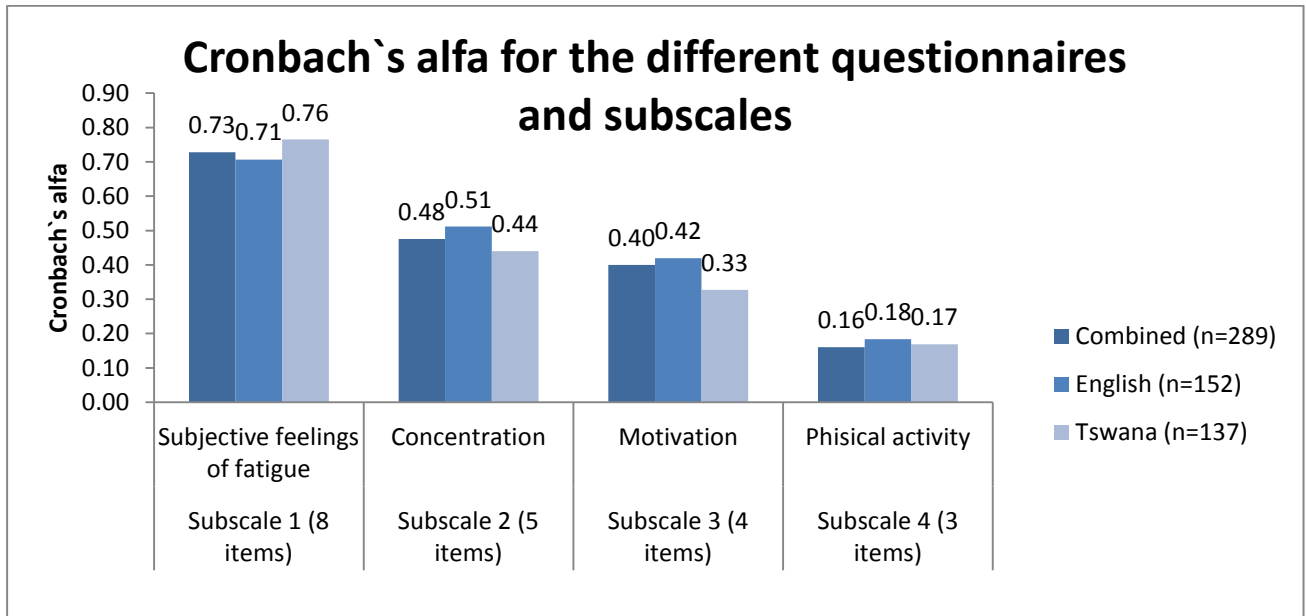
- Shift work
- Long commutes

Shift work disrupts the circadian rhythm which will lead to poorer quality sleep and thus employees will not be thoroughly revitalised. Long commutes will reduce sleep since employees have to get up earlier to be at work on time and thus cannot sleep enough. Both these variables are expected to indirectly increase the levels of fatigue.

### 3.4 RESULTS AND DISCUSSION

#### 3.4.1 Reliability of the results

Cronbach's alpha was calculated for the four different subscales that the CIS measures. Figure 3-1 contains the results of Cronbach's alpha for data gathered from the English questionnaires, the questionnaires translated into Tswana as well as the combined data from the English and Tswana questionnaires.



**Figure 3-1: Cronbach's alfa for the different questionnaires and subscales.**

Cronbach alpha for the subjective feelings of fatigue is above 0.70 in all the cases which means that the data is generally acceptable as reliable. Cronbach alpha for the other three subscales is however substantially lower. Cronbach alpha for Concentration ranged from 0.44 to 0.51. It was expected that Cronbach alpha for concentration should be lower since the construct only contains five items. The Cronbach alpha of 0.44 to 0.51 is however too low to consider this data as reliable. Cronbach alpha for Motivation and Physical activity is also too low and the data cannot be considered reliable.

Since only subscale 1, Subjective feelings of fatigue, is considered reliable, only this subscale is used in further discussions of fatigue.

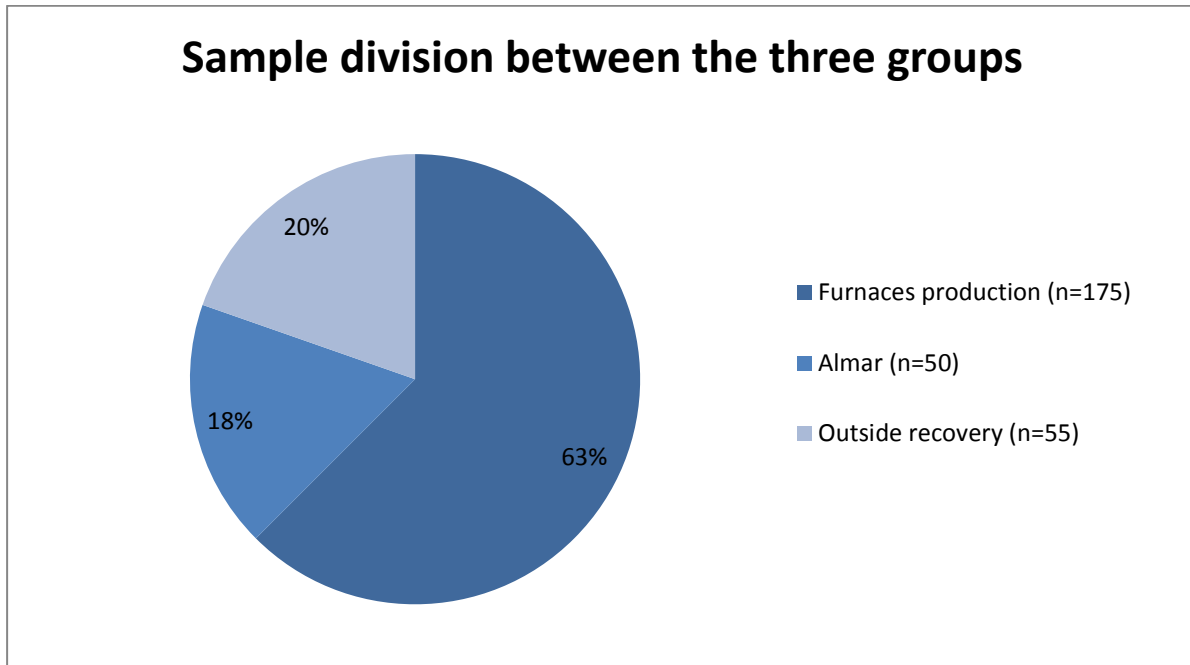
#### 3.4.2 Descriptive statistics

The sample can be divided into three different groups which are:

- Furnaces production
- Almar, a subcontractor operating heavy earth moving machinery

- Outside recovery, the team who is responsible for the recovery of metal on day shift

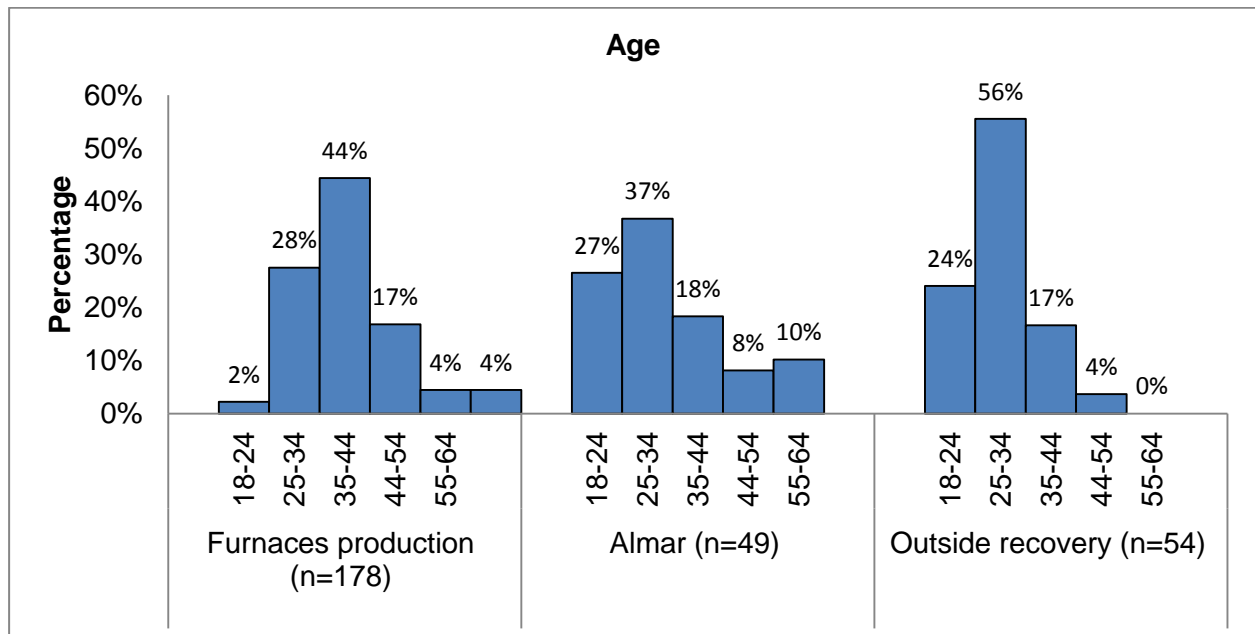
The following pie chart indicates the percentage that each of these three groups contributed to the total sample size.



**Figure 3-2: Sample division between the three groups.**

These three groups were analysed separately for a better understanding of the data and to enable the identification of specific controls in each of the groups.

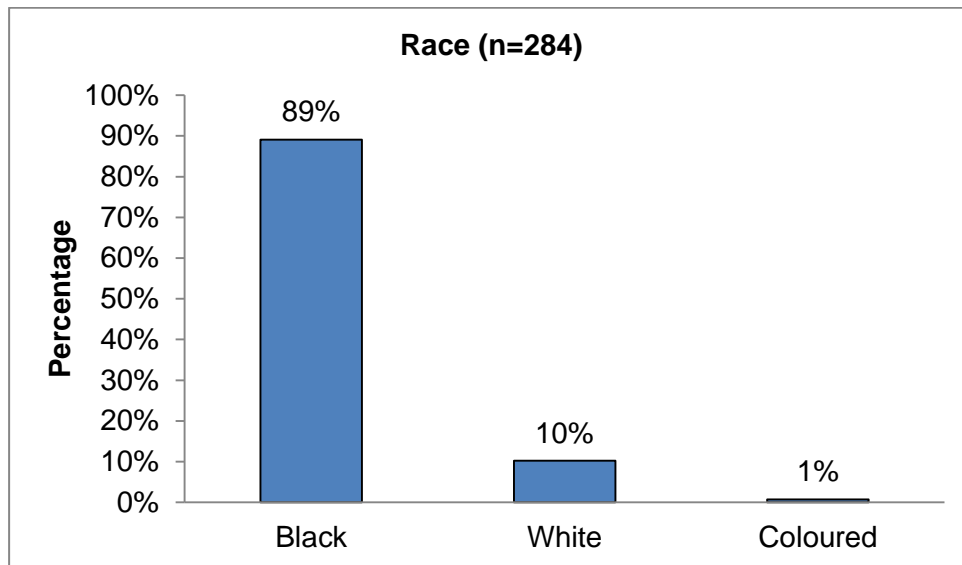
The following histogram indicates the age of the respondents.



**Figure 3-3: Histograms of age for the three groups.**

The majority of employees working at Furnaces production are aged between 35 and 44, at both Almar and Outside recovery the employees are much younger and the majority are aged between 25 and 34. To work on the Outside recovery team requires the most basic of skills and therefore employees with only matric are employed on this team. These employees are also used to promote into the lower levels of the Furnaces production positions. It was thus expected that the Outside recovery team should be on average younger than the Furnaces production group.

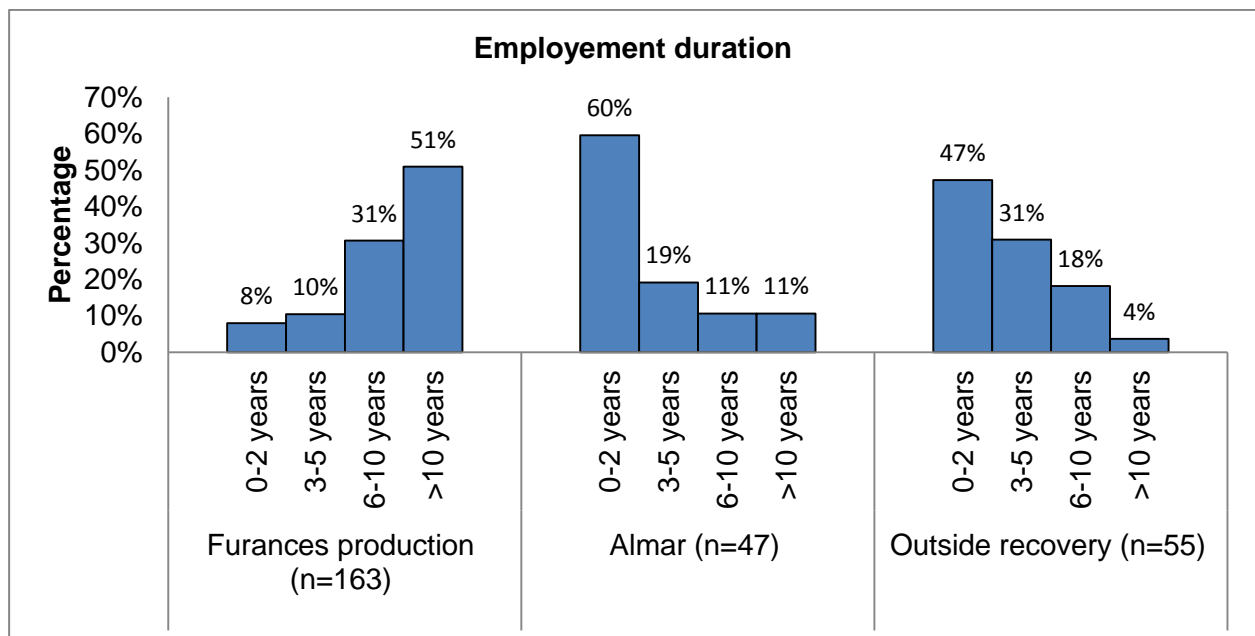
The following bar chart indicates the race of the sample.



**Figure 3-4: Histograms of race.**

The majority of the employees in the sample were black. Since there was only two coloured employees whom completed the questionnaire their data was not used during the statistical analysis.

The following histogram indicates the employment duration.

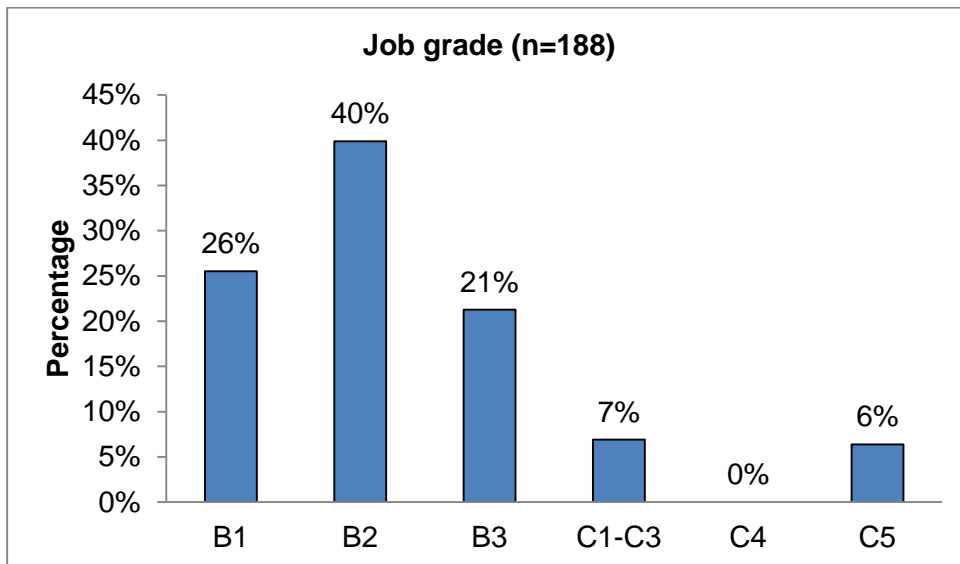


**Figure 3-5: Histograms of employment duration.**

Based on these graphs, 51% of the employees working at Furnaces production have been employed for more than 10 years and 82% have been employed for more than 6 years. At Almar and Outside recovery the majority of employees have been employed for less than 2 years. At Almar 60% of employees have been with the company for less than 2 years and at

Outside recovery 47% of the employees have less than 2 years of working experience. It is clear that there is a high employee turnover at both Almar and Outside recovery.

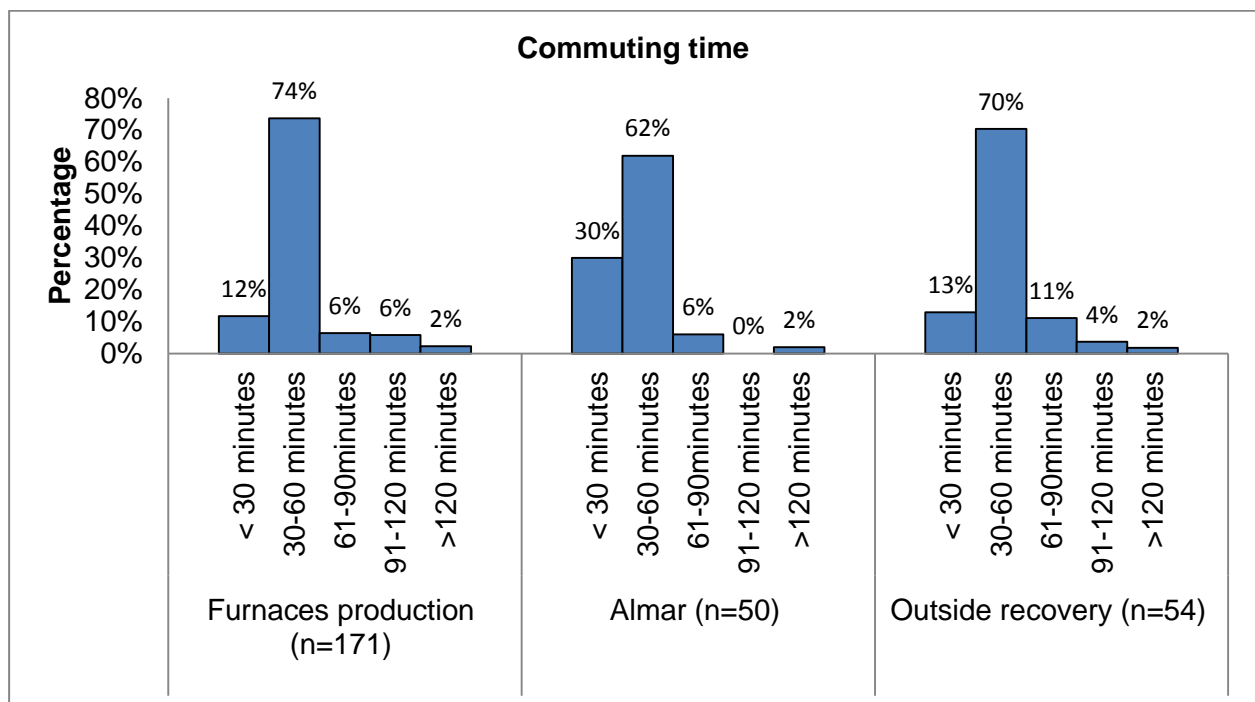
The following bar chart indicates the job grades of the employees working at Furnaces production according to their Patterson salary bands.



**Figure 3-6: Bar chart of Patterson salary bands.**

This data clearly indicates the normal hierarchical reporting structure of the company where there are fewer employees appointed on the higher levels.

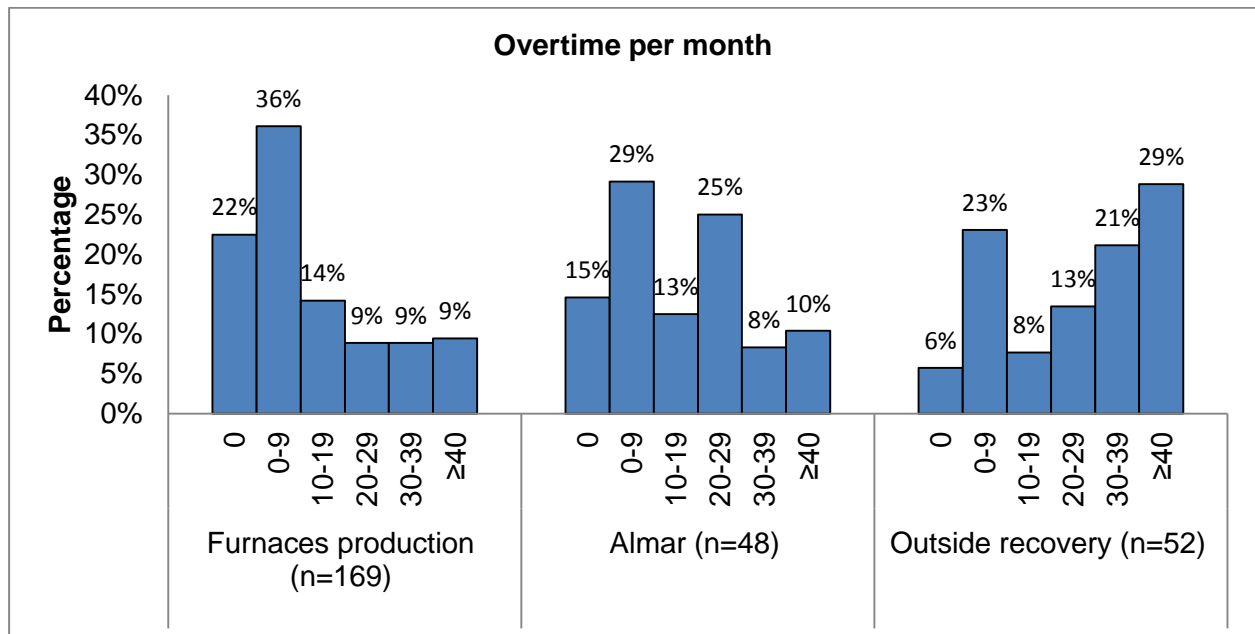
The following histogram indicates the commuting time of the respondents.



**Figure 3-7: Histograms of commuting time.**

A commuting time of more than 60 minutes can be considered long. The commuting time for 82% of Furnaces production employees was less than 60 minutes. In the case of Almar, 94% of employees indicated that they commuted less than 60 minutes and 84% in the case of Outside recovery.

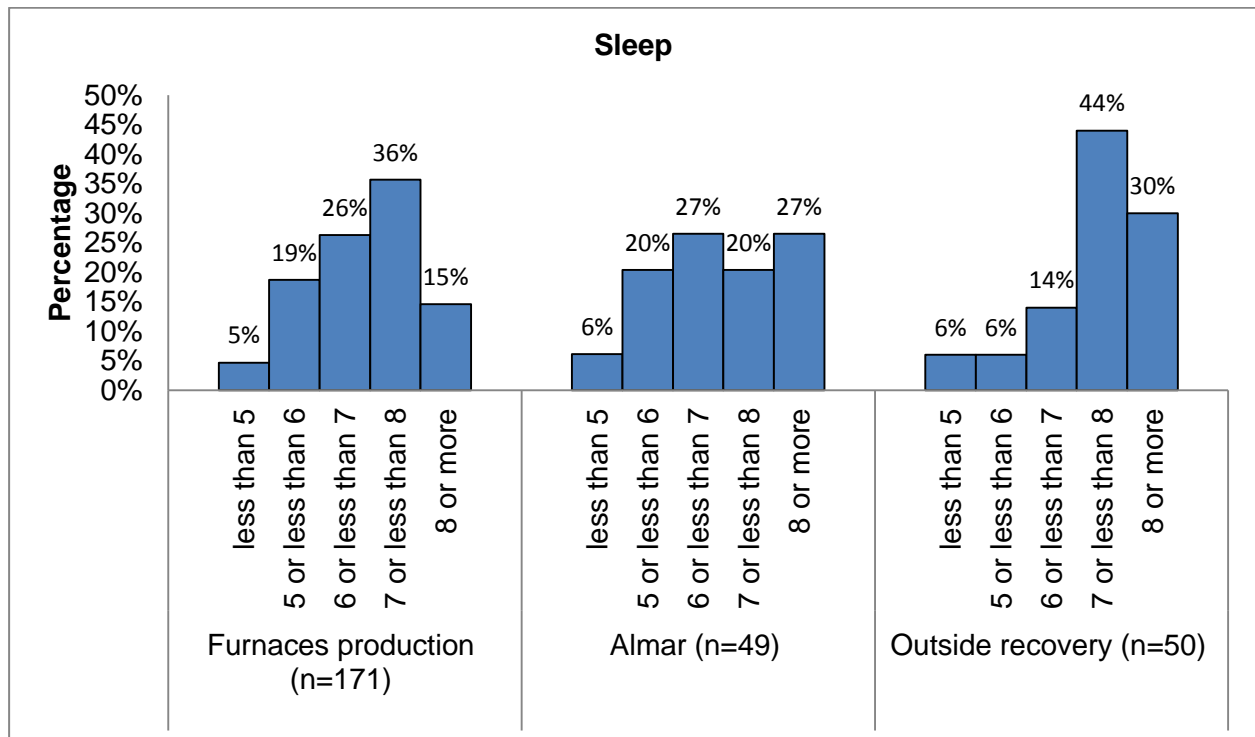
The following graph indicates the overtime that employees reported working.



**Figure 3-8: Histograms of overtime worked per month.**

It is clear that at Furnaces production employees worked the fewest hours overtime. This is possibly because the question required employees to report their “average overtime over the past four months” and all the furnaces were on shutdowns. A shutdown usually lasts for about a month and employees in production are very seldom required to work overtime during a shutdown. It might also not have been reasonable to expect that employees would know the exact hours of overtime which they have worked over the past four months. The law specifies that employees may not work more than 40 hours overtime per month. The large number of employees who report that they work more than 40 hours overtime cannot be correct. It must be their perception, since based on the actual overtime there were no employee in the population that have worked more than 40 hours overtime for each of the previous four months.

The following histogram indicates the reported sleeping hours of the respondents.

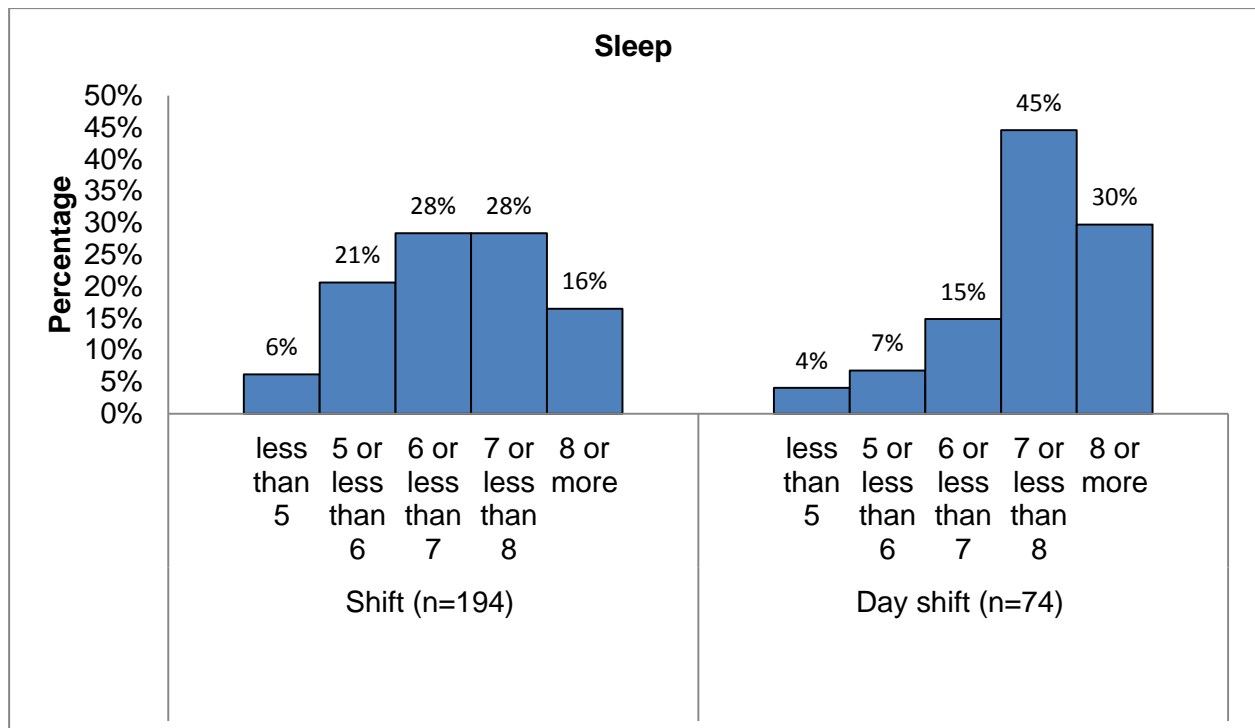


**Figure 3-9: Histograms of sleep for the three groups of employees.**

It is widely considered that 8 hours of sleep is healthy. Sleep is the essential to recover strength and reduce the levels of fatigue. It is also an employee's responsibility to make use of the time available to gain enough sleep. The sleep patterns between the shifts differed substantially. The Furnaces production and Almar groups contained employees that are on both day shift and shift whereas all the employees at Outside recovery are on dayshift.

The following histogram indicates the reported sleeping hours of the respondents where they have been divided into the following two groups:

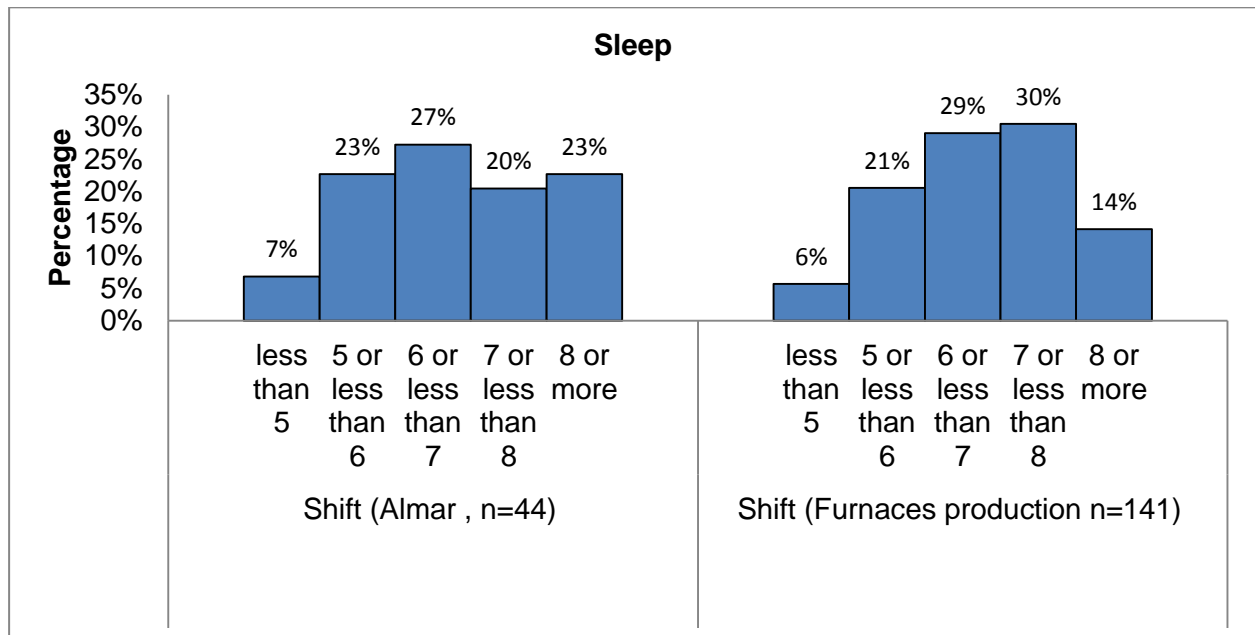
- Employees working on the four shift cycle and
- Employees working only day shift.



**Figure 3-10: Histograms of sleep for employees on dayshift and shift.**

According to these two histograms it is clear that the employees on day shift sleep more than the employees on shift. A total of 75% of the employees on day shift sleep more than 7 hours whereas only 45% of employees working shift reported that they sleep more than 7 hours.

The following graph contains the reported sleeping hours of employees working at Almar and at Furnaces production who are on shift.



**Figure 3-11: Histograms of sleep for employees on shift at Almar and employees on shift at Furnaces production.**

Based on these histograms it is clear that the hours that employees who are on shift sleep at Almar are about the same as what employees are sleeping who are on shift at Furnaces production. At the time the data was gathered employees at Almar were working extended 12 hour shifts. It was thus expected that employees at Almar would report sleeping much less.

### 3.4.3 Comparison between the variables

The following table contains the statistics for hypothesis testing for the difference between the means for subjective feelings of fatigue.

**Table 3-3: Statistics for hypothesis testing the difference between means.**

Statistics for Fatigue						
Variables		N	Mean ( $\mu$ )	Std. Deviation	p-value	Effect sizes
Questionnaire	Eng.	151	2.558	.674	0.453	0.09
	Twana	137	2.619	.710		
Gender	Male	261	2.598	.681	0.762	0.08
	Female	16	2.531	.852		
Ethnicity	Black	253	2.581	.701	0.515	0.11
	White	29	2.506	.574		
Department	Production	175	2.589	.701	0.493	0.10
	Almar	50	2.521	.592		
Shift	Shift (A, B, C or D)	198	3.581	1.072	0.076	0.04
	Day	78	3.628	1.118		
Do you take annual leave of two consecutive weeks every year?	Yes, I do	164	2.572	.678	0.788	0.03
	No, I do not	122	2.595	.708		

The following hypothesis can be formulated for gender:

$$H_0: \mu_{\text{male}} = \mu_{\text{female}}$$

$$H_a: \mu_{\text{male}} \neq \mu_{\text{female}}$$

Since the p-value for gender is 0.762 and is larger than  $\alpha=0.05$ , the null hypothesis cannot be rejected. This means that at a significance level of 0.05 there is no evidence that the mean level of fatigue differs between men and woman at Wonderkop. Similarly to this it can be checked whether there is a statistical difference between the means for the different variables in table 3-3.

It was expected that there would be a difference between the level of fatigue between Production and Almar. At the time the survey was conducted Almar's employees were striking and the participants were working 12 hour shifts for a period of four weeks. Since the p-value for department is however 0.493 and this is larger than  $\alpha=0.05$ , the null hypothesis cannot be rejected. It can thus not be said that there is any difference between the mean level of fatigue for Almar and Production. The effect size is also small which indicates that even if there was a statistical difference between the two means it would not have had any practical importance.

It was also expected that there would be a difference of fatigue levels between the different shifts. According to literature the level of fatigue for employees working shifts should be higher since their circadian rhythms are disrupted. What was unexpected was that the mean level of fatigue for employees on day shift should be higher than the mean level of fatigue for employees on shift. The p-value is 0.076 which means that at a significance level of  $\alpha=0.05$ , there is no statistical verifiable difference between the means. The effect size also indicates that even if there was a statistical difference, it would not have been of practical importance.

#### 3.4.4 Relationships between the variables

The following table contains the statistics to test whether there are correlations between certain variables and subjective feelings of fatigue.

**Table 3-4: Statistics for hypothesis testing the relationship between variables with fatigue.**

	Statistic	Age	Employment duration	Commuting time	Overtime	Patterson grade	Annual leave	Hours of sleep
<b>Fatigue</b>	Correlation Coefficient	-.082	-.028	.110	-.076	-.002	-.058	-.219
	p-value	.174	.648	.064	.206	.973	.347	.000
	N	280	273	283	277	188	269	278

The correlation coefficient indicates the strength of the relationship between the variable and fatigue as well as whether it is a positive or a negative relationship. The p-value once again indicates whether at a certain significance level there is a statistical relationship between the variables.

None of the relationships between fatigue and age, employment duration, commuting time, overtime, Patterson grade and annual leave were statistically verifiable. The correlation coefficient for all these variables indicated that there was a weak relationship. The p-value did not indicate that any of the relationships were significant at either the 0.01 or 0.05 level. The effect size also indicated that none of these variables had any practically important correlation with fatigue.

The only statistically significant relationship that was identified was between the hours of sleep and subjective feelings of fatigue. The fact that the correlation coefficient is negative 0.219 indicates that there is a fairly weak negative relationship between hours of sleep and subjective feelings of fatigue. This means that with a decrease of sleep, fatigue will increase.

The fact that the p-value is 0.000 indicates that this relationship is significant at the 0.01 level. This means that an increase in the one variable is significantly related to decreases in the other

variable. The effect size for a correlation coefficient of negative 0.219 is significant but not yet practically important according to table 3-2.

### **3.5 SUMMARY**

It was clear that the sleeping hours of employees on shift differed substantially from the employees who were on day shift. Employees on shift tend to sleep much less. The employment duration at Furnaces production is indicative of a healthy workforce with a fairly low turnover. If the three groups, namely Furnaces production, Almar and Outside recovery are considered, then it is also clear that employment duration at Almar and Outside recovery is much less than at Furnaces production.

It was expected that there would be a statistical relationship between fatigue and sleep as well as fatigue and overtime since there is a causal connection between these variables. However no relationship between fatigue and overtime were found in the study. The only variable that had a correlation with Subjective feelings of fatigue is sleep. This was expected, since there is a causal connection between fatigue and sleep.

The correlation between sleep and Subjective feelings of fatigue was significant but did not have practical significance according to the effect size.

## **CHAPTER 4**

### **CONCLUSIONS AND RECOMMENDATIONS**

#### **4.1 INTRODUCTION**

The conclusions were based on this research, while the recommendations were based on this research as well as literature. Both the conclusions and recommendations aim to provide information that is relevant for the management of fatigue.

#### **4.2 CONCLUSIONS**

The only variable that showed a statistical relationship with fatigue was sleep. The effect of sleep on fatigue is significant but not of practical significance. It was expected that there would be a relationship between fatigue and overtime, since there is a causal connection. The fact that a statistical relationship between fatigue and overtime was not proven does however not disprove the relationship. There are numerous possible explanations for the fact that no statistical relationship could be determined. These include:

- Study design
- Employee`s inability to recall their overtime accurately

It is tempting to conclude that, due to the fact that only sleep could be correlated with fatigue and not overtime, it means that the main responsibility of managing fatigue lies with the employee, since the employee is solely responsible for ensuring that he or she rests out properly. Such reasoning will not be correct because it is firstly clear that employees cannot report their own overtime accurately (thus this study could not determine whether there is a relationship), and secondly, in numerous other studies, a relationship was found between overtime and fatigue.

#### **4.3 LIMITATIONS**

Only one of the four subscales of the CIS20 questionnaire was reliable according to Cronbach`s alpha. This subscale, Subjective feelings of fatigue, is the most important subscale when measuring fatigue.

It was expected that there would be a relationship between fatigue and overtime, since there is a causal connection. There was however not a relationship. One of the explanations can be that it is difficult for an employee to recall the hours that he or she worked overtime and thus the overtime data does not have integrity.

## **4.4 RECOMMENDATIONS**

### **4.4.1 Recommendations from the study**

A fatigue management policy should be drafted with the involvement of all stakeholders. Such a policy should have a holistic approach in dealing with fatigue. Different systems should be used in a fatigue management system and different levels of defences need to be identified.

Since sleep is the only variable that is correlated with fatigue and because employees on shift sleep much less than employees on day shift, fatigue should be more prevalent on shift. The circadian rhythm of employees on shift is also disrupted, which further implies poor quality sleep and higher levels of fatigue. The company should empower employees, especially those on shift, by giving them the right knowledge to adequately manage their rest. This can be achieved by:

- Screening employees to determine who has insomnia
- Training employees on practices to ensure they rest out properly

It is expected that, if employees know the importance of getting enough rest and they have the ability to manage their sleep, they will ensure that they are rested out properly.

Different shift rule options have also been identified in the literature. When designing a shift rule option it is important to take all stakeholders into consideration and also different variables like fatigue and work life balance. In the current shift rule option used at Glencore only one weekend on the shift cycle coincides with an actual weekend i.e. Saturday and Sunday. Other shift rule options have two weekends on the shift cycle per month that coincides with an actual weekend. In such a shift rule option employees on shift can spend more time with their families. Disadvantages of these shift rule options are however the fact that they have an anticlockwise rotation at some point during the shift cycle and there are usually a few 12 hour shifts which means that there is very little time to rest out. These types of shift cycles can actually lead to an increase in fatigue.

### **4.4.2 Recommendations for further research**

It is recommended that another instrument should be identified to measure fatigue or that only the 8 items that measure subjective fatigue in the CIS20 should be used in future research. It is also suggested that the study should be designed in such a way that certain information can be externally validated.

Once it is possible to externally validate certain data or retrieve data from external sources it will not be possible to uphold complete anonymity of employees. There are numerous advantages to retrieving external data, like:

- a. Reliable data
- b. Assist and counsel employees that are identified with high levels of fatigue

#### **4.5 SUMMARY**

The correlation that was identified between fatigue and sleep is also supported by literature. The fact that there were no relationship between fatigue and overtime might be explained by recalling personal overtime could be subjective if no record is kept. Data might not be reliable as a result.

Fatigue is a complex phenomenon with numerous causes. In an uncontrolled environment such as a general working population it is impossible to design a study in such a way that certain variables can be kept constant in order to determine the correlation of other variables with fatigue.

## BIBLIOGRAPHY

Andrea, H., Beurskens, A. J. H. M., Kant, I. J., Davey, G. C. L., Field, A. P., & van Schayck, C. P. 2004. The relation between pathological worrying and fatigue in a working population. *Journal of psychosomatic research*, 57(4):399-407.

Andrea, H., Kant, I. J., Beurskens, A. J. H. M., Metsemakers, J. F. M., & Van Schayck, C. P. 2003. Associations between fatigue attributions and fatigue, health, and psychosocial work characteristics: a study among employees visiting a physician with fatigue. *Occupational and environmental medicine*, 60(suppl 1):i99-i104.

Beurskens, A.J.H.M., Bultmann, U., Vercoulen, J.H.M.M., G Bleijenberg & Swaen, G.M.H. 2000. Fatigue among working people: validity of a questionnaire measure. *Occupational and environmental medicine*, 57(5):353-357.

Bright, L. F., Kleiser, S. B., & Grau, S. L. 2015. Too much Facebook? An exploratory examination of social media fatigue. *Computers in Human Behavior*, 44:148-155.

Bültmann, U., de Vries, M., Beurskens, A. J., Bleijenberg, G., Vercoulen, J. H., & Kant, I. 2000. Measurement of prolonged fatigue in the working population: determination of a cutoff point for the checklist individual strength. *Journal of occupational health psychology*, 5(4):411.

Bültmann, U., Kant, I., Kasl, S. V., Beurskens, A. J., & van den Brandt, P. A. 2002. Fatigue and psychological distress in the working population: psychometrics, prevalence, and correlates. *Journal of psychosomatic research*, 52(6):445-452.

Cryer, P. 2006. The research student's guide to success. 3rd ed. Berkshire: Open University Press.

Dawson, D., & Reid, K. 1997. Fatigue, alcohol and performance impairment. *Nature*, 388(6639):235-235.

Dembe, A. E., Delbos, R., & Erickson, J. B. 2008. The effect of occupation and industry on the injury risks from demanding work schedules. *Journal of Occupational and Environmental Medicine*, 50(10):1185-1194.

Dembe, A. E., Erickson, J. B., Delbos, R. G., & Banks, S. M. 2005. The impact of overtime and long work hours on occupational injuries and illnesses: new evidence from the United States. *Occupational and environmental medicine*, 62(9):588-597.

Dembe, E.A., Delbos, R., Erickson, J.B. & Banks, S.M. 2007. Associations between employees' work schedules the Vocational Consequences of Workplace Injuries. *Journal of occupational rehabilitation*, 17(4):641-651.

Ellis, S. M., & Steyn, H. S. 2003. Practical significance (effect sizes) versus or in combination with statistical significance (p-values): research note. *Management Dynamics: Journal of the Southern African Institute for Management Scientists*, 12(4):51.

Emerson, R. W. 2015. Causation and Pearson's Correlation Coefficient. *Journal of Visual Impairment & Blindness*, 109(3):242.

Hartley, J. 2008. Academic writing and publishing: A practical guide. Oxon, OX: Routledge.

Hewlett, S., Dures, E., & Almeida, C. 2011. Measures of fatigue: Bristol Rheumatoid Arthritis Fatigue Multi-Dimensional Questionnaire (BRAFMQ), Bristol Rheumatoid Arthritis Fatigue Numerical Rating Scales (BRAFNRS) for Severity, Effect, and Coping, Chalder Fatigue Questionnaire (CFQ), Checklist Individual Strength (CIS20R and CIS8R), Fatigue Severity Scale (FSS), Functional Assessment Chronic Illness Therapy (Fatigue)(FACIT-F), Multi-Dimensional Assessment of Fatigue (MAF), Multi-Dimensional Fatigue Inventory (MFI), Pediatric Quality Of Life. *Arthritis care & research*, 63(S11):S263-S286.

Holland, P. W. 1986. Statistics and causal inference. *Journal of the American statistical Association*, 81(396):945-960.

Huibers, M. J. H., Beurskens, A. J. H. M., Prins, J. B., Kant, I. J., Bazelmans, E., Van Schayck, C. P., ... & Bleijenberg, G. 2003. Fatigue, burnout, and chronic fatigue syndrome among employees on sick leave: do attributions make the difference?. *Occupational and environmental medicine*, 60(suppl 1):i26-i31.

International Labour Organisation. 2015a. About the ILO. <http://www.ilo.org/global/about-the-ilo::en/index.htm> Date of access: 1 Oct. 2015.

International Labour Organisation. 2015b. Unemployment convention. [http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100\\_ILO\\_CODE:C001](http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C001) Date of access: 1 Oct. 2015.

International Labour Organisation. 2015c. Conditions of work and employment programme. [http://www.ilo.org/wcmsp5/group/public:::ed\\_protect:::protrac:::travail/documents.htm](http://www.ilo.org/wcmsp5/group/public:::ed_protect:::protrac:::travail/documents.htm) Date of access: 1 Oct. 2015.

- Leone, S. S., Huibers, M. J., Knottnerus, J. A., & Kant, I. 2009. The temporal relationship between burnout and prolonged fatigue: a 4-year prospective cohort study. *Stress and health*, 25(4):365-374.
- Leone, S. S., Wessely, S., Huibers, M. J., Knottnerus, J. A., & Kant, I. 2011. Two sides of the same coin? On the history and phenomenology of chronic fatigue and burnout. *Psychology and Health*, 26(4):449-464.
- Lerman, S.E., Eskin, E., Flower, D.J., George, E.C., Gerson, B., MD, Hartenbaum, N., Hursh, S.R. & Moore-Ede, M. 2012. *Journal of Occupational and Environmental Medicine*, 54(2): 231-258.
- Maree, K. 2007. First Steps in Research. Pretoria: Van Schaik Publishers.
- Maslach, C. 1976. Burnout. *Human behavior*, 5(9):16-22.
- Maslach, C., & Jackson, S. E. 1981. The measurement of experienced burnout. *Journal of occupational behavior*, 2(2):99-113.
- Pearl, J. 2009. Causal inference in statistics: An overview. *Statistics Surveys*, 3:96-146.
- Roodt, G. & Fouche, C. 2004. Guidelines for writing a research proposal. University of Johannesburg.
- Salkind, N. J. 2008. Exploring research 7th ed. NJ: Prentice Hall.
- Schutte, S. 2011. Workplace Fatigue: Behaviour. *Emergency services SA/Occupational risk*, 2(1):26-30.
- South Africa. 2014. Guideline for a mandatory code of practice for risk based fatigue management at mines. (Notice 1025). Government Gazette, 38339, 19 Dec.
- Steyn, H. S. 2000. Practical significance of the difference in means. *SA journal of industrial psychology*, 26(3):1.
- Van Amelsvoort, L. G. P. M., Kant, I. J., Beurskens, A. J. H. M., Schröer, C. A. P., & Swaen, G. M. H. 2002. Fatigue as a predictor of work disability. *Occupational and environmental medicine*, 59(10):712-713.

VASKE, J. J. 2002. Communicating judgments about practical significance: Effect size, confidence intervals and odds ratios. *Human Dimensions of Wildlife*, 7(4):287-300.

Wright, S. 1921. Correlation and causation. *Journal of agricultural research*, 20(7), 557-585.

## APPENDIX A: THE QUESTIONNAIRE

### Questionnaire

Gender	1. Male	2. Female
--------	------------	--------------

Age group	1. 18-24	2. 25-34	3. 35-44	4. 45-54	5. 55-64	6. 65+
-----------	-------------	-------------	-------------	-------------	-------------	-----------

Race	1. Black	2. White	3. Coloured	4. Indian	5. Other
------	-------------	-------------	----------------	--------------	-------------

Employment duration (at Wonderkop)	1. 0-2 years	2. 3-5 years	3. 6-10 years	4. >10 years
---------------------------------------	-----------------	-----------------	------------------	-----------------

Department	1. Production	2. Almar
------------	------------------	-------------

Shift	1. Shift (A, B, C,D)	2. Admin Day	3. Eng. Day
-------	-------------------------------	-----------------	----------------

Commuting time (Time spent travelling to work)	1. less than 30 min	2. 30-60 min	3. 61-90 min	4. 91-120 min	5. 2 hours or more
--	---------------------------	-----------------	-----------------	------------------	--------------------------

Overtime, hours (average overtime for the past 4 months)	1. 0	2. 0-9	3. 10-19	4. 20-29	5. 30-39	6. 40+
--	---------	-----------	-------------	-------------	-------------	-----------

Job grade	1. B1	2. B2	3. B3	4. C1-C3	5. C4	6. C5
-----------	----------	----------	----------	-------------	----------	----------

Do you take annual leave of 2 consecutive weeks or more every year?	1. Yes	2. No
--	-----------	----------

Previous annual leave (two consecutive weeks or more)	1. Within the past 3 months	2. Three or less than six months ago	3. Six or less than nine months ago	4. Nine or less than twelve months ago	5. Twelve months ago or more
--	--------------------------------------	---	--	---	--

How many hours do you sleep between shifts	1. less than 5	2. 5 or less than 6	3. 6 or less than 7	4. 7 or less than 8	5. 8 or more
--	----------------------	---------------------------	---------------------------	---------------------------	-----------------

With the following 20 statements we wish to get an impression of how you have felt during **the past two weeks**.

Do not skip any statement and place only one cross for each statement:

	Almost always	Sometimes	Every once in a while	Rarely	Never
1. I feel tired					
2. I am very active					
3. Thinking requires effort					
4. Physically I feel exhausted					
5. I feel like doing all kinds of nice things					
6. I feel fit					
7. I do quite a lot within a day					
8. When I am doing something, I can concentrate quite well					
9. I feel weak					
10. I don't do much during the day					
11. I can concentrate well					
12. I feel rested					
13. I have trouble concentrating					
14. Physically I feel I am in a bad condition					
15. I am full of new ideas					
16. I get tired very quickly					
17. I have a low productivity					
18. I feel no desire to do anything					
19. My thoughts easily wander					
20. Physically I feel in good shape					

# Pampiri ya Dipotso tsa Patlisiso

Bong	1. Monna	2. Mosadi				
Dingwaga tse o welang mo go tsone	1. 18-24	2. 25-34	3. 35-44	4. 45-54	5. 55-64	6. 65+
Setšhaba	1. Montsho	2. Mosweu	3. Mokhalate	4. Mo-India	5. Setšhaba se sengwe	
Lobaka mo tirong (kwa Wonderkop)	1. Dingwaga tse 0-2	2. Dingwaga tse 3-5	3. Dingwaga tse 6-10	4. >Dingwaga tse 10		
Lefapha	1. Tlhagiso-dikungo	2. Almar				
Sifiti	1. Sifiti (A, B, C, D)	2. Letsatsi la Tsamaiso	3. Letsatsi la Boenjenera			
Nako ya go ya tirong (Nako e o e fetsang o le mo tseleng go ya tirong)	1. Ka fa tlase ga metsotso e le 30	2. Metsotso e le 30-60	3. Metsotso e le 61-90	4. Metsotso e le 91-120	5. Diura tse 2 le go feta	
Nako e e okeditsweng, diura (palogare ya nako e e okeditsweng ya dikgwedi tse 4 tse di fetileng)	1. 0	2. 0-9	3. 10-29	4. 20-29	5. 30-39	6. 40+
Maemo a tiro	1. B1	2. B2	3. B3	4. C1-C3	5. C4	6. C5
A o tsaya malatsi a khunologo a ngwaga a dibeke tse 2 ka go latelana kgotsa go feta moo ngwaga le ngwaga?	1. Ee	2. Nnyaa				
Malatsi a a fetileng a khunologo a ngwaga (dibeke tse pedi ka go latelana kgotsa go feta)	1. Mo dikgweding tse 3 tse di fetileng	2. Dikgwedi tse tharo kgotsa tse di ka fa tlase ga tse thataro	3. Dikgweditse thataro kgotsa go feta tse robonngwe tse di fetileng	4. Dikgwedi tse robonngwe kgotsa tse di ka fa tlase ga tse somepedi tse di fetileng	5. Dikgwedi tse somepedi tse di fetileng kgotsa go feta	
O robala diura tse kae fa gare ga dišifiti	1. Ka fa tlase ga tse 5	2. Tse 5 kgotsa ka fa tlase ga tse 6	3. Tse 6 kgotsa ka fa tlase ga tse 7	4. Tse 7 kgotsa ka fa tlase ga tse 8	5. Tse 8 kgotsa go feta	

Mo dipolelong tse 20 tse di latelang fano re batla go tlhaloganya gore o ne o ikutlwa jang mo dibekeng tse pedi tse di fetileng.

O se ka wa tlola polelo epe mme o beye sefapaano se le sengwe fela sa polelo nngwe le nngwe.

	E batla e le ka metlha	Ka dinako tse dingwe	Gangwe morago ga sebakanyana	Ka sewelo	Ga go ise go direge
1. Ke ikutlwa ke lapile					
2. Ke matlhagatlhaga thata					
3. Go akanya go batla matsapa					
4. Ke ikutlwa ke tsenwe ke letsapa mo mmeleng					
5. Ke ikutlwa ke batla go dira dilo tsotlhe tse di monate					
6. Ke ikutlwa ke nonofile sentle mo mmeleng					
7. Ke dira ka natla tota mo tsamaong ya letsatsi					
8. Fa ke dira sengwe, ke kgona go tlhoma mogopolo sentle mo go sone					
9. Ke ikutlwa ke le bokoa					
10. Ga ke dire dilo tse dintsi motshegare					
11. Ke kgona go tlhoma mogopolo sentle					
12. Ke ikutlwa ke lapologetswe					
13. Ke na le bothata jwa go tlhoma mogopolo					
14. Ke ikutlwa ke se mo boemong jo bo siameng mo mmeleng					
15. Ke na le dikgopolo tse dintsi tse dintšha					
16. Ke lapa ka bonako					
17. Ga ke na matswela a mantsi mo tirong					
18. Ga ke na keletso ya go dira sepe					
19. Mogopolo wa me o a ebela					
20. Ke ikutlwa ke itekanetse sentle mo mmeleng					