Worcester Polytechnic Institute
Digital WPI

Interactive Qualifying Projects (All Years)   Interactive Qualifying Projects

May 2015

Getting on the Right Track: An Analysis of Human Factors to Improve Reliability and Safety in Operations at Namibia's Railway Company, TransNamib

Emily Elizabeth Doherty
Worcester Polytechnic Institute

James Henry Gruenbaum
Worcester Polytechnic Institute

Jessica Ann Larsen
Worcester Polytechnic Institute

Nicholas Hayward Engle
Worcester Polytechnic Institute

Follow this and additional works at: https://digitalcommons.wpi.edu/iqp-all

Getting On the Right Track

An Analysis of Human Factors to Improve Reliability and Safety in Operations at Namibia's Railway Company, TransNamib

BY:

Emily Doherty

Nicholas Engle

James Gruenbaum

Jessica Larsen

TransNamib Holdings Ltd
Transporting Namibia's success

WPI — Worcester Polytechnic Institute 1865

Getting On the Right Track

An Analysis of Human Factors to Improve Reliability and Safety in Operations at Namibia's Railway Company, TransNamib

By:

Emily Doherty

Nicholas Engle

James Gruenbaum

Jessica Larsen

Date: May 7, 2015

Report Submitted to:

Thomas Robertson

Holly Ault

Michael Feldmann

TransNamib Holdings Ltd.

IQP-TBR-D153

Abstract

This project addressed the problems of train accidents, incidents and delays caused by human factors at TransNamib, the railway provider of Namibia. We studied the company's operations through interviews, observations and examination of protocols. Our research revealed that TransNamib should focus its resources on improvements in safety, discipline and managerial training. We recommended that TransNamib implement employee evaluations, maintain an accident tracking system, conduct semiannual safety meetings and ensure all policies and procedures are updated and communicated with the employees.

Nomenclature

Common Terms:

- Shunt: The act of attaching wagons to a locomotive in order to build up a train.
- Shunter: An employee who carries out the shunting process.
- Shunting Yard: Train yard in which shunting occurs.
- Point: A segment of track that splits a rail line into two.
- Point Blade: Moving segment of track at a point that allows the switching of rail lines.
- Half Cock: When there is a gap between the main line and point blade that can cause derailments.
- Private Siding: privately owned, rail cargo loading area

Common Acronyms:

- HFACS: Human Factors Analysis and Classification System
- DoD: Department of Defense
- PEAR: People, Environment, Actions, Resources
- HTA: Hierarchical Task Analysis
- FAA: Federal Aviation Administration
- TAP: Refers to TransNamib's 180 Day Turnaround Plan.
- ROC: Republic of China
- RPA: Remotely Piloted Aircraft
- PDI: Power Distance Index
- ATC: Air Traffic Control
- GDP: Gross Domestic Product

Executive Summary

In the past two decades, TransNamib has experienced a significant increase in train accidents, incidents and delays resulting in a decrease in revenue. Since TransNamib Holdings Ltd. is solely responsible for all rail operations, it contributes greatly to Namibia's economy. It supports the Namibian mining industry by moving bulk material. Annually, TransNamib transports over 2 million metric tons of material, of which over a third directly relates to mining. However, in 2013 TransNamib lost approximately N$550 million NAD ($47 million USD) through lost or late shipments and damaged infrastructure. According to TransNamib's 2013 Annual Report, human and engineering factors caused the highest frequency of such accidents, incidents and delays (TransNamib, 2013). "Human factors" or "human errors" are human interactions and decisions that contribute to accidents and operational irregularities. Research shows that 9 out of 10 workplace accidents result from human errors (Kumar, 2008). While TransNamib launched a 180-day turnaround plan with the intention of reducing staff and increasing the number of locomotives, the plan does not address the human factors contributing to accidents, incidents and delays.

Our project goal was to address the human factors leading to TransNamib's accidents, incidents and delays by developing a plan to enhance its operational procedures. Our project was located in Windhoek, Namibia and our project goal was to improve the economic state of TransNamib and Namibia.

Methodology

To meet our project goal, we developed three research objectives:

1. *Identify and classify the human factors affecting TransNamib's accidents, incidents and delays*
2. *Analyze the operational procedures susceptible to human factors*
3. *Analyze the influence of management on TransNamib's safety culture*

To better understand the train accidents, incidents and delays TransNamib faces, we categorized the causes of accidents, incidents and delays; conducted interviews; and observed the employees' actions. We used the Human Factors Analysis and Classification System (HFACS) to classify about 500 events from six months. This classification allowed for a better understanding of the human errors that cause train accidents, incidents and delays and solutions to decrease human errors. By interviewing seven TransNamib employees from different departments and varying levels within the managerial hierarchy, we gained an understanding of TransNamib's training, operations, discipline and safety. Observing two stations, Windhoek and Walvis Bay, allowed us to understand the day-to-day operations within the shunting yard, where train wagons are attached to the locomotives, along with how TransNamib operations function on a larger scale.

Findings

Through HFACS, interviews and observations, we developed the following findings regarding TransNamib's human errors, safety culture, discipline and managerial skills:

1. Human errors caused over half of the accidents, incidents and delays, and of these, the most common causes were decision-based errors (31%), routine violations (20%), personal readiness (17%) and physical environment (15%).

We determined that decreasing human errors could be more cost effective and beneficial to the overall operations of TransNamib. Human errors resulted in 51% of all accidents, incidents and delays while technological environment only caused 31%. TransNamib can save both time and money by examining the human errors negatively influencing its operations.

2. Human factor problems occurred at the same rate in all three seasons: summer, rainy and winter.

We compiled data from each of the three seasons winter (June, August), summer (November, December) and rainy (February, March). Statistical analysis revealed no significant difference between the rates of human error related accidents, incidents and delays in each of the three seasons.

3. Insufficient training and education at a managerial and supervisory level has created miscommunication with lower level employees and misjudgments during train operations.

The managers and supervisors at TransNamib do not receive adequate training to successfully complete their jobs. Many of the managers in TransNamib receive average education and received supplemental training as they worked their way up the ranks. The training for managers does not adequately prepare the managers to face the complex situations that arise during train operations.

4. Because operator training is adequate at TransNamib, skill-based errors account for only 3% of the 308 human error related factors causing train accidents, incidents and delays.

Of the 308 human error related factors, only eight were attributed to operators lacking the necessary skill to complete the task. Through interviews, we found that operators receive training refresher courses every two years and complete further training after an accident. Before an operator can become a train driver, they complete the jobs of assistant shunter, shunter and train driver assistant. The train drivers gain 15-20 years of additional training as well before they can drive trains carrying passengers or high volatile goods. The extensive training and low incidence of skill-based errors, indicates that operator training is not a major contributing factor.

5.   TransNamib's shortage of operational locomotives because of accidents, incidents and delays, including many caused by human factors problems, impairs TransNamib's ability to complete day-to-day train operations.

Out of TransNamib's 71 locomotives, only 30 are functional. This limitation forces TransNamib's maximum operational capacity to only service about 25% of their customers' needs. Additionally, when a locomotive is taken out of commission due to an accident or incident, no spares are on standby to pick up the loss. Some days operations must come to a halt because the station has no locomotives available. Operational standstill is caused by train delays because shunting on a new train cannot begin without the arrival of the locomotive to be used. In these instances, shunters can be sent home instead of waiting around on the clock with no work.

6.   TransNamib has safety procedures set in place, but they are insufficient in preventing human error related accidents, incidents and delays.

Currently TransNamib has safety procedures but the safety standard is low. The safety standards do not eliminate all accidents, incidents and delays because even if a job is completed up to standard, corners can be cut resulting in accidents, incidents and delays.

7.   Lack of financial resources has led to a shortage of train operations personnel, forcing excessively long work shifts, potentially causing fatigue related accidents, incidents and delays.

Due to a lack of qualified staff, TransNamib is forced to schedule operations personnel for excessively long work shifts, often between 14 and 18 hours consecutively. These long work shifts can lead to fatigue, decreased concentration and unusual body stress. The physical and mental effects of fatigue can cause mistakes in judgement and actions leading to accidents and incidents.

8.   Although 35% of all human error related accidents, incidents and delays are caused by employee violations, TransNamib is unable to adequately discipline employees because the rules and regulations handbook has not been updated since 2004.

TransNamib's Industrial Relations Rules and Regulations handbook has not been updated since 2004. Amendments to the handbook are recorded by hand in a separate notebook held at the Windhoek headquarters. It is the responsibility of the individual supervisors to ensure their personnel understand the new amendments. However, because the rules are not physically updated in the handbook, employees in violation of an amendment can point to the original book and make the argument that their action was acceptable. In turn, employees who should otherwise be disciplined are let off without penalty.

Recommendations

Based on our findings, we have established the following five recommendations for TransNamib:

1.   To promote safe and reliable work in their railway operations, use evaluation forms for shunters, train assistants and drivers.

Through our research and observations, we concluded that TransNamib would benefit from periodic employee evaluations. Research shows that employee evaluations are effective in holding employees accountable for their actions whether through rewards or punishment. Evaluations would decrease the number of accidents, incidents and delays caused by routine violations and would reward those employees who are not violating procedures. The categories that should be included on this evaluation are job knowledge, quality of work, quantity of work, obtainment of performance objectives, attendance, safety, teamwork and compliance with company policies. These evaluations would be completed monthly and based on the results, employees could be sent to a disciplinary hearing. Also, these evaluations will determine which employees are performing as expected and they should be rewarded in the form of acknowledgement or an incentive.

2.   To address the mistakes of employee actions we recommend changes in the disciplinary system: stricter "strike" system, more efficient and timely investigations and full disciplinary hearings for investigations.

Currently, TransNamib has a "strike" system in place where employees receive warnings for violating procedures. These violations cost the company time and money because employees violate the same procedure multiple times before receiving strict discipline. A new system would place strict limits on the number of infractions. Our group proposed each employee could receive 2-3 "strikes" per year before being dismissed, prompt investigations and more intensive disciplinary hearings.

Main line accident investigations can last for years. We recommend TransNamib set a given deadline for all reports to be completed and disciplinary hearings should include all crewmembers. Currently, only the train driver attends a disciplinary hearing, but we recommend all crewmembers appear before the board to fully understand the cause of the accident and reprimand the appropriate crewmember.

3.   To address mistakes arising from lack of safety, we recommend the implementation of regular safety meetings at the managerial level.

In the shunting yard, weekly safety meetings occur to discuss that week's unsafe acts along with how they can be fixed for the upcoming week. We recommend that TransNamib managers hold semiannual safety meetings with the head shunter to understand the safety issues causing accidents, incidents and delays. In addition to the semiannual safety meetings, there should be a liaison to report the conclusions of the shunters weekly safety meetings to the train operations manager. This open communication will result in a better safety environment and allow for problem areas to be addressed.

4.   To aid TransNamib in better recognizing the human errors within operations, we recommend the use of an incident tracking system that will centralize reporting of all accidents, incidents and delays, including those caused by human error.

Currently, the operational staff receives daily irregularity reports detailing the accidents, incidents and delays. We recommend TransNamib create a centralized incident tracking system to categorize each accident, incident and delay by location, type of incident, cause of incident, time of delay, injuries and financial loss. This database will help TransNamib understand more common types of accidents and correlations between types of accidents and time of year. TransNamib should also classify each accident, incident and delay as one of the 19 Human Factors Analysis and Classification System categories. This will give TransNamib insight into which areas they should allocate their resources.

5.   To address recurring procedural mistakes, we recommend that the rules and regulations handbook be updated, published and redistributed every year with new amendments.

The new amendments added throughout the year, will be printed out by the managers and distributed to the employees. This will ensure all employees abide by the same policies and procedures and there is no miscommunication in terms of discipline.

Authorship

Abstract: (Emily Doherty, Nicholas Engle)
    Edits: Nicholas Engle, James Gruenbaum

Executive Summary: (Emily Doherty, James Gruenbaum, Nicholas Engle, Jessica Larsen)
    Edits: Nicholas Engle, James Gruenbaum, Emily Doherty

Introduction: (Emily Doherty, Nicholas Engle, James Gruenbaum)
    Edits: Nicholas Engle, Emily Doherty, James Gruenbaum

Background

2.1 Railway Industry in Sub-Saharan Africa: (James Gruenbaum)
    Edits: Jessica Larsen, Nicholas Engle
2.2 Human Factors Causing Accidents, Incidents and Delays: (Emily Doherty, Nicholas Engle)
    Edits: James Gruenbaum, Jessica Larsen
2.3 Literature Review of Human Factors Analysis: (Emily Doherty, Nicholas Engle, James Gruenbaum)
    Edits: Nicholas Engle, Emily Doherty
2.4 Outliers: The Ethnic Theory of Plane Crashes: (James Gruenbaum, Jessica Larsen)
    Edits: Nicholas Engle, Emily Doherty
2.5 TransNet: (Emily Doherty, James Gruenbaum)
    Edits: Nicholas Engle

Methodology

3.1 Identify and Classify the Human Factors Affecting Accidents, Incidents and Delays: (Emily Doherty, Nicholas Engle, James Gruenbaum)
    Edits: Nicholas Engle, Emily Doherty
3.2 Study the Operational Procedures Susceptible to Human Errors: (Emily Doherty, Nicholas Engle, James Gruenbaum)
    Edits: Jessica Larsen, Nicholas Engle
3.3 Analyze the Influence of Management on TransNamib's Safety Culture: (Emily Doherty, Nicholas Engle, James Gruenbaum)
    Edits: James Gruenbaum, Emily Doherty

Findings

Finding 1. (Nicholas Engle)
    Edits: Emily Doherty
Finding 2. (Emily Doherty)
    Edits: Nicholas Engle, James Gruenbaum
Finding 3. (James Gruenbaum, Jessica Larsen)
    Edits: Nicholas Engle, Emily Doherty
Finding 4. (Emily Doherty)
    Edits: Nicholas Engle, James Gruenbaum
Finding 5. (Nicholas Engle)
    Edits: Nicholas Engle, Emily Doherty

Finding 6. (Emily Doherty)
>   **Edits:** Nicholas Engle, James Gruenbaum

Finding 7. (James Gruenbaum)
>   **Edits:** Nicholas Engle, Jessica Larsen

Finding 8. (James Gruenbaum)
>   **Edits:** Nicholas Engle

Conclusions and Recommendations

Key Findings: (Emily Doherty, Nicholas Engle, James Gruenbaum)
>   **Edits:** Nicholas Engle, James Gruenbaum

Recommendations for TransNamib: (Emily Doherty, Nicholas Engle, James Gruenbaum, Jessica Larsen)
>   **Edits:** Emily Doherty, Nicholas Engle, James Gruenbaum, Jessica Larsen

Recommendations for Future Researchers: (Emily Doherty, Nicholas Engle, James Gruenbaum)
>   **Edits:** Jessica Larsen, Emily Doherty

Project Design: (Emily Doherty, Nicholas Engle, James Gruenbaum)
>   **Edits:** Nicholas Engle, James Gruenbaum

Acknowledgements

Table of Contents

List of Figures

List of Tables

1. Introduction

Globally, approximately 9 out of 10 workplace accidents result from human errors (Kumar, 2008). Human error caused a train crash in Thailand that left 200 people injured; human errors account for 62% of the railway accidents in Norway. Similarly, Namibia experienced 192 accidents and incidents in 2013, a 350% increase from 2012 (TransNamib, 2013). Train accidents and incidents cripple Namibia's train operations by causing numerous delays. More than 4 of 5 (81%) trains arrived late in 2014 (Michael Feldmann, personal communication, March 20, 2015). According to TransNamib's 2013 Annual Report, human and engineering factors cause the highest frequency of accidents, incidents and delays (TransNamib, 2013).

In the transportation industry, "human factors" or "human errors" are human interactions and decisions that cause accidents and other operational problems. Human errors cause 70% of fatal air accidents and cause more accidents in the aviation industry than mechanical failures (Schuenemann & Gesar, 2014). Recently, researchers have focused their attentions more on human factors (Flying Safety, 2008). Customers and employees can help identify human errors and reduce their negative effects on the company and its stakeholders.

A company struggling to address problems caused by human factors is TransNamib Holdings Limited, Namibia's national rail transport company. TransNamib is a company in distress. It lost N$557,000,000 ($47 million USD) in 2013, through late or lost shipments, damaged goods and damaged infrastructure. With Namibia's Ministry of Works and Transport, TransNamib developed a plan to address areas for technical improvements. In 2014, TransNamib set in place a 180 day turnaround plan to improve its efficiency and productivity by increasing the number of locomotives and decreasing the number of employees (TransNamib, 2013). None of this, however, addressed the company's human errors problem.

Our project goal was to address the human factors leading to TransNamib's accidents, incidents and delays by developing a plan to enhance its operational procedures. Our project was located in Windhoek, Namibia and our project goal was to improve the economic state of TransNamib and Namibia.

To accomplish this goal, our group pursued three objectives:

1. Identify and classify the human factors affecting TransNamib's accidents, incidents and delays.
2. Analyze the operational procedures susceptible to human errors.
3. Analyze the influence of management on TransNamib's safety culture.

We believe our research and analysis will improve the overall operations of TransNamib and decrease train accidents, incidents and delays.

2. Background

Human factors hinder companies' operations around the world and in Namibia. To support this claim, we will examine three topics: railways in Namibia, human factors in the transportation industry in general and human factors analysis. By the end of this chapter, readers will understand the economic, regulatory and human factor problems at TransNamib.

2.1 Railway Industry in Sub-Saharan Africa

A state funded enterprise, TransNamib is an essential supporter of Namibia's mining industry and thus Namibia's overall economy. Annually, TransNamib moves over 680,000 tons of bulk mining material over 2,626 km of railway lines throughout Namibia (TransNamib, 2013).

History of the Rail Industry in Namibia. Since the colonial days, Namibia's railway system has undergone changes in its infrastructure and administration. Between 1884 and 1915, German colonists constructed over 2700 km of rail lines in Namibia. Following World War I, South Africa gained control of the Namibian railway system. It added 418 km of rail lines to the Namibian railway infrastructure. In 1985, South Africa turned over all railway assets to Namibian administration. This shift in control led to the formation of TransNamib Limited, which controlled all air, rail and sea transit in Namibia. In 1998, Namibian administrators deemed that TransNamib Holdings was financially unsuitable to provide air, rail and sea services. TransNamib Limited then became TransNamib Holdings Limited under the *National Transport Services Holding Company Act*. This act restricted TransNamib Holdings Limited primarily to rail transport services (Dierks, 2004).

TransNet. The leading railway provider in South Africa, TransNet, controls approximately 80% of Africa's total railway infrastructure. Although TransNamib and TransNet were founded within six years of each other, their infrastructure and operational capacities differ dramatically. TransNet transports approximately 14 times the freight in a single day that TransNamib can transport in a week. While TransNamib's freight capacity is far smaller than TransNet, TransNamib can still learn from policies and procedures set in place by their South African counterpart. TransNet has been successful in achieving their vision statement to, "deliver freight reliably" and lessons in safety and reliability can be applied to TransNamib.

TransNamib and Mining. TransNamib offers transportation for passengers and freight, but the company focuses primarily on transporting mining related materials. As shown in Table 1, mining makes up about 33% of TransNamib's business. This number has increased from 23% in 2011 and continues to grow (TransNamib, 2011, 2012, 2013).

Table 1 Namibian Rail Traffic Figures for 2013 (TransNamib, 2013)

Bulk Material Moved by TransNamib (Tons) in 2013	
Mining	681,259
Bulk liquid (Petrol, Diesel, Jet Fuel and Sulfuric Acid)	694,417
Containers	313,748
Building	325,440
Agricultural	29,994
Total	2,044,858

Namibia's international trade is primarily built around mining. In 2012, 58% of Namibia's exports consisted of mined materials including precious stones (diamonds) and ores (uranium, zinc and copper) (Namibia Statistics Agency, 2012). Namibia's largest uranium mines include the Langer Heinrich Mine, Trekkopje Mine, Valencia Mine and the Entango Mine. Together, these four mines produced approximately 12,425 metric tons of refined uranium oxide ($U_3O_3^+$) in 2009, making Namibia the fourth largest uranium producing country in the world (United States Geological Survey, 2009).

Approximately N\$21 billion (\$1.76 billion USD) was generated by the mining sector in 2013, or 9% of Namibia's GDP. Increases in technology and a diversifying labor force resulted in a 13% increase in mining production between 2012 and 2013 (Namibia Chamber of Mines, 2013). Today, the strong and healthy mining industry continues to be a major economic driver for Namibia and its neighboring countries.

TransNamib's Large Economic Influence on Namibia. Whether it be importing the necessary equipment and resources required to mine, or delivering the final product to be exported at The Port of Walvis Bay, the railway industry has long fueled Namibia's economy. There are many avenues by which goods can be exported including by truck, air, sea or rail. Approximately 37% of all exports leave Namibia via cargo ships at Walvis Bay. Many of the goods are brought to South Africa, Namibia's most important trading partner, via locomotive transport (Simonis Storm Securities, 2006). To accommodate the 12% of exports by rail, Namibia currently maintains a railway network of 2,626 km, which is set up to effectively transport goods to and from export locations such as South Africa and Walvis Bay.

Namibia's physical network of railways is structured to support the needs of the mining industry. Sulfuric acid, coal and other mining related supplies brought in via Walvis Bay can be easily transported to mining sites around Namibia as shown in Figure 1. Additionally, rail infrastructure cuts through the majority of Namibia's mining territory, providing an efficient way to get refined products to Walvis Bay and to Namibia's northern and southern border for export.

Figure 1 Map of Namibia Mines with Railway Network ("Major Mines", n.d.)

2.2 HUMAN FACTORS CAUSING ACCIDENTS, INCIDENTS AND DELAYS

Because of Namibia's economic dependence on the railway industry, TransNamib's accidents, incidents and delays not only influence their own operations, but the entire economy. The Rössing uranium mine relies on a shipment from Walvis Bay of 2.7 million liters of sulfuric acid every day in order to meet their production requirements. When TransNamib experiences delays, so too does Rössing. This puts economic strain on both parties, TransNamib for the late goods and Rössing for overtime hours that must be paid.

Human factor problems have different definitions depending on industry and individual corporations. These factors can be broken into two categories: individual human failures and failures of systems designed, built, operated and maintained by humans (Flying Safety, 2008). The study of human factors "covers the science of understanding the properties of human capability, the application of this understanding to the design, development, and deployment of systems and services, and the art of ensuring successful application of human factor principles into the maintenance working environment" (Federal Aviation Administration, n.d.).

Effects of Compounded Errors and Cultural Differences. In *Outliers,* Malcolm Gladwell discusses how the "root causes" of plane crashes are often due to a complex series of small

events leading up to total failure. Gladwell claims that plane crashes are rarely due to large mechanical failures, but "an accumulation of minor difficulties and seemingly trivial malfunctions" can lead to more serious problems (Gladwell, 2008, p. 183). Many times individual difficulties are unrelated but when they occur consecutively throughout one flight, they can result in a plane crash, whereas if they happened independently nothing may have occurred. According to Gladwell, the human errors that usually contribute to plane crashes are communication and teamwork deficiencies, meaning pilots fail to communicate critical information correctly or do not effectively coordinate the completion of a plan.

Throughout the chapter "The Ethnic Theory of Plane Crashes", Gladwell explains multiple plane crashes and how culture affected the steps leading up to the accidents. Gladwell described the Avianca flight 052 crash in January 1990 and the multiple human errors that occurred. The main focus of the accident is the communication between the pilot, copilot and Air Traffic Control (ATC). On multiple occasions the pilot tells the copilot that they are in a state of emergency and to report to the ATC that they need to land. However, the copilot tells the ATC that they are "running out of fuel" (Gladwell, 2008, p. 193), which has no meaning to the ATC, so they tell the pilot to circle around and try to land again. The mitigated speech that the copilot used when talking to the ATC did not convey the emergency that the Avianca flight was facing. Without the copilot explicitly saying that the plane needed to land because they did not have enough fuel to stay in the air, Avianca flight crashed shortly after.

Mitigated speech is "any attempt to downplay or sugarcoat the meaning of what is being said" (Gladwell, 2008, p. 194). Culture plays a major role when it comes to using mitigated speech. In many cultures, a subordinate cannot issue a command to their boss so instead they mitigate their speech to a suggestion rather than a command. In the case of a copilot talking to the pilot, the copilot would rather give a suggestion or statement than a command to the pilot because they do not want to break cultural norms of communication to one's superior. The mitigated speech not only applies to communication between the pilot and the copilot but between the copilot and the ATC as well. In the Avianca flight, the copilot used mitigated speech when communicating with the ATC and merely suggested that the plane was in a state of emergency instead of saying it directly. The result of this was a lack of urgency to clear the runway and ultimately great loss of life.

Hofstede's Dimensions looks at different aspects of cultures such as the Power Distance Index (PDI), which shows a cultural attitude toward hierarchy, "specifically with how much a particular culture values and respects authority" (Gladwell, 2008, p.203). In some cultures there is a very high respect for authority so subordinates are not going to speak out against someone of higher authority. When communicating across different cultures, those with a higher PDI may use mitigated speech when talking to someone they believe to be in a higher position of authority. For example with the Avianca flight, the pilot and copilot were Guatemalan (High PDI), and when speaking to the ATC at New York's Kennedy Airport in the United States (Low PDI), the copilot did not want to speak out and demand that they land because they did not have enough fuel out of respect for authority.

5

2.3 METHODS FOR CLASSIFYING HUMAN FACTORS

Extensive research has been conducted on human factors by many parties in the aviation industry. There are three primary methods used to analyze and identify the negative effects of human factors: the Human Factors Analysis and Classification System (HFACS), the People, Environment, Actions and Resources (PEAR) model and Hierarchical Task Analysis (HTA).

Human Factors Classification and Analysis. The Human Factors Analysis and Classification System allows researchers to examine the causes of failures and inconsistencies in a system that results in a breakdown of the system, or an accident/incident. HFACS are primarily used in the aviation industry, but their use has expanded to other transportation sectors. In 2007, a successful railway administration, the Australian Transport Safety Bureau, used HFACS to identify the causes of incidents in their railway system. The Australian administration determined that HFACS is effective in categorizing errors from investigation reports and captures the full range of human factors in the rail industry. "It was revealed that nearly half the incidents resulted from an equipment failure, most of these the product of inadequate maintenance or monitoring programs" (Baysari, 2008). HFACS gives the observer a set of guidelines for conducting an analysis and provides a logical progression for moving through areas of a company for investigation.

Figure 2 shows a hierarchical representation of reasons for incidents beginning with organizational influences and ending with operator actions. In addition, it depicts how each decision throughout the company, including management and regulations, causes such incidents (U.S. Department of Transportation, 2007). Analysts use HFACS to identify areas for improvement within management, regulations and procedures by categorizing the human factors that cause adverse incidents. Categorizing human factors is a complex process with many different steps to achieve the ultimate goal of understanding human influences on the company of study. The four main groups of this analysis are organizational influences, unsafe supervision, preconditions for unsafe acts and unsafe acts.

6
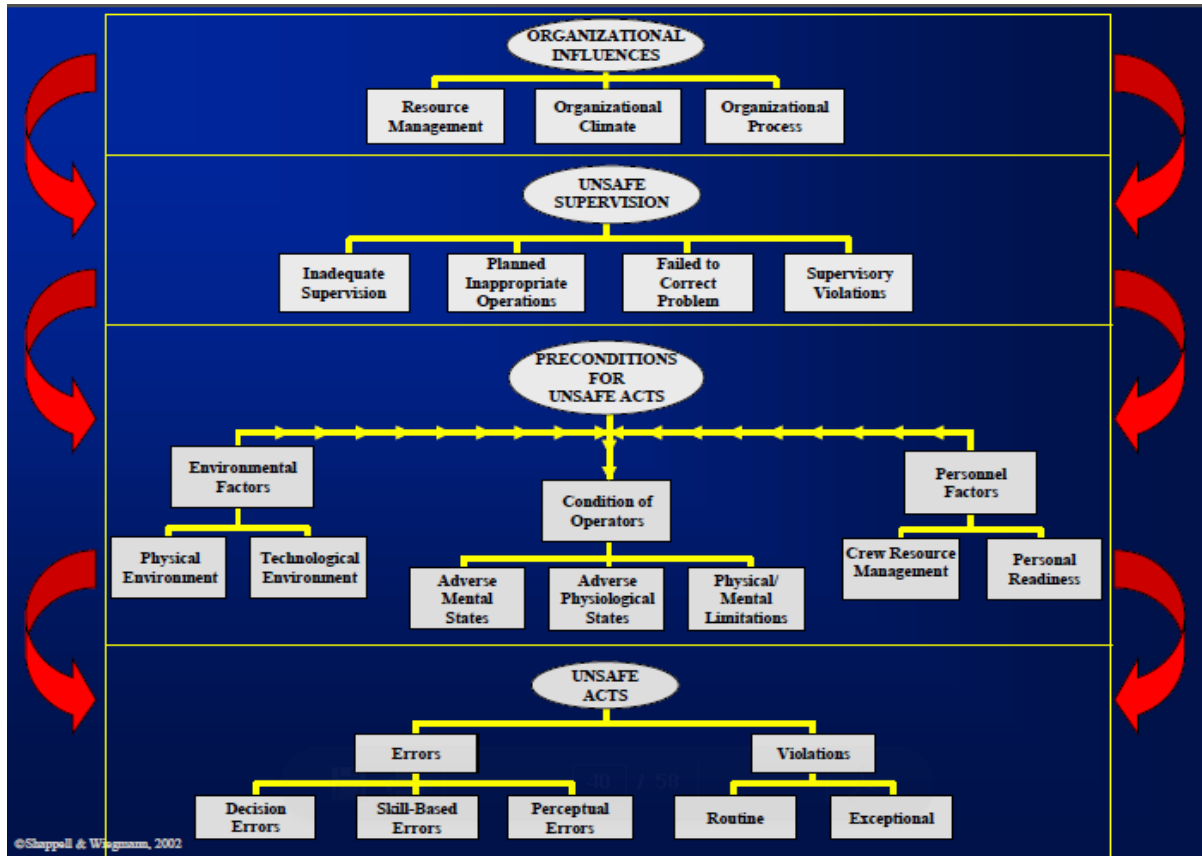
Figure 2 HFACS Analysis (Flying Safety, 2008)

Organizational influences can be broken down into three categories.
1. **Resource management:** When analyzing the resource management, it is crucial to analyze how the employees are being used as resources, the monetary resources available, the equipment and facility resources.
2. **Organizational climate:** The organizational climate is the structure, policies and culture of the company. The policies of the company are the overarching set of guidelines that could be flawed and cause human error.
3. **Organizational process:** The organizational process is comprised of operations, procedures and oversight which gives the investigator an overview of the entire operations of the company and an understanding of how the organizational rules and decisions govern the overall company.

Unsafe supervision is comprised of four categories.
1. **Inadequate supervision:** This is the failure to administer proper training and professional guidance.
2. **Planned inappropriate operations:** These include improper work tempo and poor crew pairing. Crew pairing is an important area to consider in the railway industry because many jobs require collaboration to complete a task. Sub-optimum pairings could lead to failures within the system.

7

3. **Failure to correct a problem:** When a company fails to correct known problems they are putting their company at risk. Failure to correct a problem can range from inappropriate behavior to a safety hazard.
4. **Supervisory Violations:** This analyzes if unsafe decisions by supervisors are a result of failure to comply with rules and regulations set in place.

Preconditions for unsafe acts include environmental factors, condition of operators and personnel factors.

1. **Environmental Factors:** The environmental factors can be split into physical environment: weather and light, and technological environment: equipment and controls.
2. **Condition of Operators:** The condition of operators includes the adverse mental states, adverse physiological states and physical and mental limitations of the employees. Adverse mental state looks at the worker's alertness and complacency while the adverse physiological state examines an employee's visual perception and medical condition. The physical and mental limitations include both physical capabilities such as size and strength but also address reaction time and sensory input.
3. **Personnel Factors:** Personnel factors examine the crew resource management as well as the preparedness of employees to complete their jobs.

Unsafe acts are broken down into errors and violations.

1. **Errors:** Errors are based on the decisions employees make either by choice or by procedure. Skill-based errors are the inability of an employee to perform a given task or function given their current training level, while perceptual errors are misjudgments in a common task.
2. **Violations:** Violations are broken down into two categories: routine and exceptional. Routine violations are also known as infractions and they occur when an employee intentionally does not follow procedure. Exceptional violations are violations to company code of conduct, not necessarily limited to adherence of on the job procedures.

HFACS analysis examines every department of a company and classifies the human factors into the categories outlined above. This analysis is essential to understand the underlying problems within a company and gives the researcher a more focused area to conduct additional research. The goal of HFACS is to make errors less prevalent by examining the human errors and the root causes of each incident (Flying Safety, 2008).

Other Methods to Assess Causes and Contributions of Human Factors in Accidents. While HFACS analyzes the company as a whole, Hierarchical Task Analysis (HTA) is a more specific method used to determine the human errors within a specific task. Finally, the PEAR model gives the observer a list of considerations to use when analyzing the human factors present in a given accident, incident or delay.

HTA is used in the railway industry as a method to focus on the requirements set by the organization. This method examines a single goal or objective and breaks down the steps needed to complete the task. By examining a specific task, the analysis gives the observer a more in depth knowledge and a further understanding as to which human factors potentially influence the completion of the task. This analysis examines the task as if it was to be completed by one individual and anticipates the range of concerns to be accommodated. Figure 3 depicts the overall goal of maintaining trackside equipment and showing the necessary tasks involved (Shepherd, 2005).

```
                    ┌──────────────────┐
                    │ Maintain Trackside│
                    │    Equipment     │
                    └──────────────────┘
              ┌───────────────┴───────────────┐
      ┌───────────────┐              ┌───────────────┐
      │  Prepare for  │              │  Re-commission│
      │  Maintenance  │              │   equipment   │
      └───────────────┘              └───────────────┘
       ┌──────┴──────┐                ┌──────┴──────┐
 ┌──────────┐ ┌──────────┐     ┌──────────┐ ┌──────────┐
 │  Review  │ │  Monitor │     │  Review  │ │Diagnose or│
 │Maintenance│ │ safety  │     │  Impact  │ │ repair as│
 │  Needs   │ │ systems  │     │on Services│ │appropriate│
 └──────────┘ └──────────┘     └──────────┘ └──────────┘
```
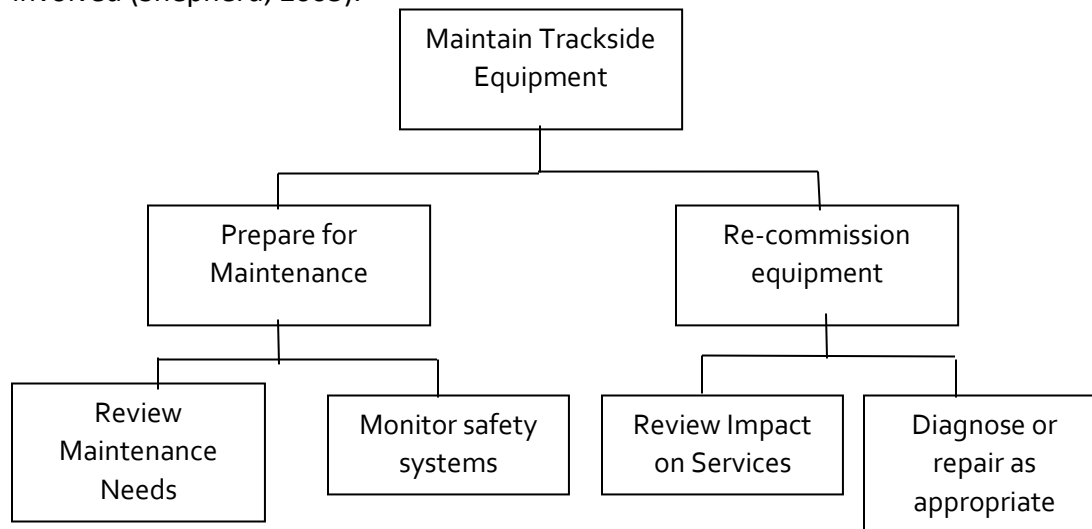
Figure 3 Hierarchical Task Analysis (Shepherd, 2005)

Finally, the PEAR model gives the observer a list of considerations to use when completing a human factors analysis. The PEAR model should not be used independently of the other methods because it will not give the observer enough information (Federal Aviation Administration, n.d.). The Federal Aviation Administration (FAA) in the United States categorizes human factors into four main categories: People, Environment, Actions and Resources, otherwise known as the PEAR model.

1. **People**: People can be physically, psychologically and physiologically incapable of completing tasks. Strength, age and physical size should all be considered in order to determine whether a person is fit to complete a task. Additionally, psychological attributes such as education level and training level should also be considered.
2. **Environment**: The environment, both physical and organizational, can impact an employee's ability to successfully complete their job. The physical environment of a company includes the weather, lighting and sound level. The organizational environment is the personnel, morale and crew structure.
3. **Actions:** The actions required to complete a task include the skill requirements and the knowledge of the steps to perform the tasks.
4. **Resources:** The resources to consider when analyzing the human factors are the tools, testing equipment and materials (Federal Aviation Administration, n.d.).

These models all serve as a tool for analyzing and classifying the human errors; however, based on the detail of the analysis and how much time an observer has, the method chosen can vary.

2.4 HUMAN FACTOR ANALYSIS

One of the most challenging aspects of examining the human factors causing accidents is the wide variety of categories used to classify events. Previous lessons can be learned from research showing how to overcome these obstacles in classification.

The literature on Human Factors reveals the following lessons:

1. *Why use HFACS to analyze human error related accidents*
2. *How to extract information using HFACS*

Reasons for using HFACS when analyzing human error related accidents.
Researchers claim that, "The HFACS framework bridges the gap between theory and practice by providing safety professionals with a theoretically based tool for identifying and classifying the human errors in aviation mishaps" (United States Department of Defense, 2005). Our project team defined mishaps as accidents, incidents and delays which happen in both TransNamib and other outside companies. HFACS analyzes and classifies the human factors that influence the transportation industry worldwide. According to the U.S. Department of Defense (DoD), human factors have been estimated as a major contributing factor in 80 to 90 percent of all military and civilian mishaps (United States Department of Defense, 2005). Case studies demonstrate the importance of HFACS within the transportation industry, when trying to analyze problem areas within operations.

First, using HFACS, researchers determined that more than half of the remotely piloted aircraft (RPA) mishaps in the United States armed services from 1994-2003 were caused by recurring human factors (Tvaryanas, 2006, 724-732). The study identified 221 mishaps and used HFACS to determine the frequency of human factor mishaps in each of the military branches. From this analysis, researchers determined which areas each military branch should improve upon; the Air Force predominantly should focus on their skill-based errors while the Army should focus on violations.

Second, from 1978-2002, researchers studied the human factors affecting flight operations within the Republic of China's (ROC) Air Force. The researchers analyzed 523 accidents by using HFACS in order to determine the frequency of each human factor category that led to each accident. From the analysis, the ROC Air Force was able to calculate the odds of each category occurring again in the future and determine areas for improvement; the ROC Air Force focused primarily on unsafe acts relating to decision errors, skill-based errors and resource management of the organization. By using HFACS, researchers were able to develop a formula that would predict the future frequency of accidents (Li, 2006).

Third, the DoD finds HFACS particularly useful because it forces the investigators of a mishap to address "latent failures" within the entire sequence of events. This means that instead of focusing on the physical cause of an accident (i.e. wheel failure), the investigators

10

address the chain of events that led up to the failure, by focusing their efforts on identifying the root cause. They found that factors such as fatigue, complacency and illness were often overlooked by investigators as a primary contributor to mishaps. Using HFACS, the DoD has successfully identified that 50 - 60 percent of mishaps that are not attributed to human factors contain human factors as a contributor in the events leading up to an accident (United States Department of Defense, 2005).

Within the context of our project, TransNamib experiences human errors which affect their operations. With the help of HFACS, we were able to analyze and classify the human factors and determine areas for improvement within TransNamib's operations.

How to extract information using HFACS. Before using HFACS, it is essential to record the cause of all mishaps as well as develop basic understanding of the company's operations. From our research, we learned how to effectively classify the causes of accidents, incidents and delays and how to use frequency charts to recommend focus areas for the company.

First, from the study of the RPAs in the United States military, we learned that the 19 HFACS categories provide a framework for classifying the causes. Each mishap can have multiple events classified under different categories. These multiple events lead to frequency charts summing up to more than the total number of unique accidents and incidents. From these categories, further analysis can be completed to identify human factor related problems (Tvaryanas, 2006).

Second, from the study of accidents within the ROC Air Force, we learned how calculating the frequency within an HFACS category can help determine areas for improvement within a company. Instead of addressing areas that don't occur often, companies can focus on areas that contain a high frequency of mishaps. Table 2 shows the frequency for each HFACS category from all 523 accidents analyzed within the ROC Air Force (Li, 2006).

Table 2 HFACS Frequency Table (Li, 2006).

HFACS Category	Sub-Category	Frequency	Percentage
Level 4, Organizational Influences	Organizational process	76	14.5
	Organizational climate	4	0.8
	Resource management	184	35.2
Level 3, Unsafe Supervision	Supervisory violation	8	1.5
	Failed correct a known problem	12	2.3
	Planned inadequate operations	24	4.6
	Inadequate supervision	177	33.8
Level 2, Preconditions for Unsafe Acts	Technology environment	44	8.4
	Physical environment	74	14.1
	Personal readiness	29	5.5
	Crew resource management	146	27.9
	Physical/mental limitation	73	14.0
	Adverse physiological states	2	0.4
	Adverse mental states	184	35.2
Level 1, Unsafe Acts of Operators	Violations	160	30.6
	Perceptual errors	116	22.2
	Skilled-based errors	226	43.2
	Decision errors	223	42.6

These case studies helped us understand how to effectively use HFACS. They showed how HFACS can be modified to best suit different situations and is effective in diverse environments.

2.5 SUMMARY

This project aims to decrease accidents, incidents and delays caused by human factors within TransNamib that are affecting scheduling and operations. Although human factors have been identified as a major contributing factor to accidents, incidents and delays, analyses can be useful in determining specific areas of improvement within operations. Such an analysis is complex and involves input from multiple departments and perspectives within TransNamib.

3. Methodology

Our project goal was to address the human factors leading to TransNamib's accidents, incidents and delays by developing a plan to enhance its operational procedures. Our project was located in Windhoek, Namibia and our project goal was to improve TransNamib and Namibia's economic state.

To accomplish this goal, our group pursued three objectives:

1. Identify and classify the human factors affecting TransNamib's accidents, incidents and delays.
2. Analyze the operational procedures susceptible to human errors.
3. Analyze the influence of management on TransNamib's safety culture.

The objectives listed above enabled us to outline a new management and training program for TransNamib. We made recommendations for redesigned policies and procedures by understanding the causes behind train accidents, incidents and delays. In addition, assessing TransNamib's current practices helped us identify areas susceptible to mishaps caused by human factors and aided us in making recommendations for change.

3.1 IDENTIFY AND CLASSIFY THE HUMAN FACTORS AFFECTING TRANSNAMIB'S ACCIDENTS, INCIDENTS AND DELAYS

Knowledge Sought. By identifying and classifying the human factors we aimed to understand the major causes affecting accidents, incidents and delays. From accident and incident reports we sought to learn the following key data points: date, location, cause, incident type, injuries and delay time. These data points gave us insight into the frequency of these events based on the season (winter, summer and rainy) as well as the location. In the end, we sought to learn which human factors categories had the highest frequency and thus which areas we should investigate further.

Method. First, we obtained accident and irregularity reports from November, February, March, June, August and December 2014. These months account for two months in each season for the past year. By investigating two months from each season we hoped to not only eliminate bias due to environmental factors (i.e. rain or heat) but also investigate which factors were more prevalent within each season, if any. Second, using the data contained within the accident and irregularity reports, we recorded the key data points in a central database. A sample data input form can be found in Appendix A.

With the cause of each accident, incident and delay recorded, we then classified each event. A full list of the classification system and example scenarios can be found in Appendix B. The project group predominantly used the "Unsafe Acts", "Preconditions for Unsafe Acts" and the "Unsafe Supervision" criteria of HFACS to classify the human factors resulting in accidents, incidents and delays. For example if the causes were related to the operators, we used the

13

"Unsafe Acts" criteria. Further, they were classified into decision errors, skill based errors, perceptual errors, routine violations and atypical violations. By classifying the human factors, we were able to focus on specific problem areas.

Analysis. HFACS was used not only as a classification system but also as an analysis method to determine the frequency of human factors appearing in each category. Histograms were used for both the seasonal analysis and the location analysis. These frequencies showed us which causes resulted from outside factors and could not be further analyzed. The categories with the highest frequencies allowed us to focus our investigation on particular problem areas within TransNamib and conduct interviews to further understand their operational procedures. The project group also analyzed the total delay time of each classification to see if these results correlated with the histograms.

Justification. HFACS revealed the frequencies for each classification and we utilized these to investigate further in specific areas. With limited time, it was not feasible for us to investigate every problem area within TransNamib. By focusing on specific areas we were able to make more useful recommendations to the company. In addition, analyzing the data points from the different Namibian seasons allowed us to determine whether or not the causes of accidents, incidents and delays would differ depending on the season they occurred in.

Limitations. We encountered two limitations while using HFACS. The first obstacle pertained to the reports being illegible due to poor handwriting. Due to the absence of proper report forms, accident investigators resort to writing out the details relating to the accident, incident or delay on plain paper. Second, many reports were not completed. This left us with an incomplete transcript of the accidents, incidents and delays. With incomplete accident reports, we encountered obstacles while applying HFACS analysis to our data. For example, some delay reports state that the locomotive arrived late from the Locomotive Depot, but no further cause was stated. Secondly, accidents, incidents and delays often have multiple personnel or events involved. This becomes a challenge when each event falls under multiple categories. Accidents, incident and delays with multiple events were broken down into single events and classified independently.

3.2 STUDY THE OPERATIONAL PROCEDURES SUSCEPTIBLE TO HUMAN ERRORS

Knowledge Sought. By studying the operational procedures we sought to understand where opportunities for human error existed. Additionally, we wanted to identify protocols set for the train operators, train assistants, shunters and shunting assistants and how violations of the protocols not only affect TransNamib but their customers as well.

Method. Interviews with employees from selected departments and varying levels within the managerial hierarchy gave us an understanding of TransNamib as a whole. The team conducted interviews with the operations executive, a human resource representative and an internal relations manager to gain information on the company's training, operations and areas they are currently addressing. See Appendices C, D and H for the interview questions.

We interviewed the train operations manager and received the current operational procedures and protocols. See Appendix F for the interview questions. The team studied these procedures and used them as guidelines for our observations. Our team first observed the employees in the shunting yards at Windhoek and Walvis Bay, where the trains are built up with locomotives and wagons to be loaded transport. Next, the team observed the train drivers in the shunting yards and the steps they took before departing from the station. Finally, while in Walvis Bay, we interviewed employees at the Rössing private siding to gain an understanding of how TransNamib affects the operations of the companies they service. The Rössing interview questions can be found in Appendix G. By looking at both Windhoek and Walvis Bay, we were able to understand how TransNamib's operations function on a larger scale.

Justification. Conducting interviews and observations allowed us to gain a baseline understanding of the state of TransNamib's operations and their goals for improvement within both management and operations for the future. By reviewing TransNamib's procedures and policies and comparing them to what was observed in the shunting yards, the group was able to determine which procedures were consistently violated and needed to be addressed. TransNamib's upper management is aware that their employee handbook is outdated, leading to violations, but they are unaware of the frequency of these events. Our analysis will hopefully provide them with the information needed to update their protocols to decrease employee violations.

Limitations. While the group performed interviews and observations, we ran into limitations that inhibited our ability to investigate company operations. These limitations included confidentiality of procedures and our ability to determine the best procedures TransNamib should follow. Some procedures are confidential to TransNamib and it was unclear what we were allowed to disclose and what needed to remain confidential because it is a state-owned and government funded agency. Since the group has not been at TransNamib for an extended period of time it was difficult to determine which procedures the employees would follow. These obstacles forced us to utilize new ways to analyze their operations.

Analysis. Using the interviews and observations results, we analyzed how the employees' actions differed from their expected actions. While conducting observations, the team had the operational procedures at hand and recorded when an employee countered or failed to perform a specific procedure. The analysis compared the observations and the procedures and determined areas in which the procedures should be modified. This concluded the data gathering stage as well as prepared us to analyze all information, which would improve safety and decrease human errors at TransNamib.

15

3.3 ANALYZE THE INFLUENCE OF MANAGEMENT ON TRANSNAMIB'S SAFETY CULTURE.

Knowledge Sought. We wanted to investigate the training for operational managers to understand if safety was emphasized as a core value at TransNamib. Additionally, we wanted to understand if the managers were trained to emphasize the importance of safety to their subordinates through supervision. In addition, the group sought to observe how training influences the managers' ability to make decisions in complex situations. If a manager is not equipped with the necessary tools to supervise their employees, an unsafe working conditioning could develop. Understanding how operational managers influence and discipline their employees is important for understanding how TransNamib views safety. Ultimately, we hoped to gain more insight to whether problems occurred from unclear procedures or inadequate supervision.

Methods. To complete this objective, our group used four methods: interviewing a representative from TransNet, interviewing TransNamib managers, studying the safety procedures and observing the workers' actions in regard to the safety procedures. We interviewed a TransNet representative hired by TransNamib to assist them in improving their operations to gain an external opinion. The interview transcript can be found in Appendix E. Along with the TransNet representative, we interviewed four TransNamib employees at different managerial levels to understand their view on TransNamib's safety culture and the supervisor's ability to enforce and adhere to procedures. These employees included an investigation board member, a train operations manager, the operations executive and the CEO. See Appendices F, I, J and K for the full list of questions asked.

We studied the safety procedures prior to our observations in the shunting yards. While observing employee safety, we documented any violations of safety procedures and when employees adhered to the rules. We observed the jobs of the shunters, train planner, train dispatcher and train controllers. In order to fully grasp the workings of the company employees, we performed observations at the Windhoek and Walvis Bay shunting yards. We compiled the observation results from each group member into a central database to analyze the results.

Analysis. We compared the TransNet's safety procedures with TransNamib's to determine areas for improvement that are culturally acceptable. Since TransNet is another Sub-Saharan railway system, much of what is considered culturally acceptable can be applied to TransNamib. We compared the routine safety discussion, the use of safety checklists and the attention from supervisors to safety.

Investigating the internal safety culture at TransNamib, we wanted to collect a diversified opinion of the current state from lower level and senior level managers. After investigation, we looked at the responses from the executive branch, including the CEO and the operations executive, as well as the operational branch, including various managers, to compare how the employees of different hierarchical rank viewed safety at TransNamib. This

16

allowed us to understand whether a difference with safety planning existed between a company and operational level.

Through observations we aimed to gain more insight to whether a problem occurred from unclear procedures or inadequate supervision. The group identified which problems were caused by inadequate supervision by sorting the observations results to find problem areas that could have been avoided with improved supervision.

Justification. We interviewed an external representative from TransNet to understand how safety is perceived in a company that transports more freight reliably than TransNamib. An external opinion of the company led to an unbiased opinion that may not be present with internal employees' responses. TransNet's operational success gave us insight on areas for improvement within TransNamib. In our interview with the operations manager, the employees recommended which actions we should detect while conducting our observations within TransNamib. Through our observations, we collected our own results on TransNamib's safety culture to ensure bias from the employees did not alter our analysis.

Limitations. The group faced three challenges while executing this objective. First, when completing the observations we could not guarantee that the employee's behavior was not compromised by our presence. When we arrived at the yards, we did not know whether employees were more cautious with their actions simply because we were conducting our research. This required significant consideration while the group analyzed our observations.

Second, due to the 180 day Turnaround Plan (TAP), employee morale was affected and our interviews could have had a negative bias towards TransNamib. The TAP's ultimate goal was to increase the number of locomotives and decrease the number of employees; this ultimately made employees doubt their job stability and be wary of the company's goals. We overcame this by asking explicit and informative questions that avoided opinionated answers.

Finally, we could not assume that the information and recommendations provided by the TransNet representative are suitable or feasible to implement in TransNamib. TransNet is a much larger, well-established company and not everything that works for them can be implemented in such a small and flexible company that is TransNamib. This required us to adapt the recommendations given to us to better suit TransNamib.

17

4. Findings

1. HUMAN ERRORS CAUSED OVER HALF OF THE ACCIDENTS, INCIDENTS AND DELAYS, AND OF THESE, THE MOST COMMON CAUSES WERE DECISION-BASED ERRORS (31%), ROUTINE VIOLATIONS (20%), PERSONAL READINESS (17%) AND PHYSICAL ENVIRONMENT (15%).

Summary of Evidence. The HFACS analysis of 498 accidents, incidents and delays yielded a total of 594 human factors given that each event can have more than one classification. Additionally, the analysis revealed that 308 of the human factors were directly related to human error, the rest being technological problems. Figure 4 shows the frequency of these human errors broken down by HFACS category.

Frequency of Incidents Caused by Human Errors in TransNamib

Category	Frequency
Decision Errors	97
Routine Violations	61
Personal Readiness	51
Physical Environment	45
Crew Resource Management	15
Inadequate Supervision	9
Skill Based Errors	8
Perceptual Errors	6
Exceptional Violations	6

N=308
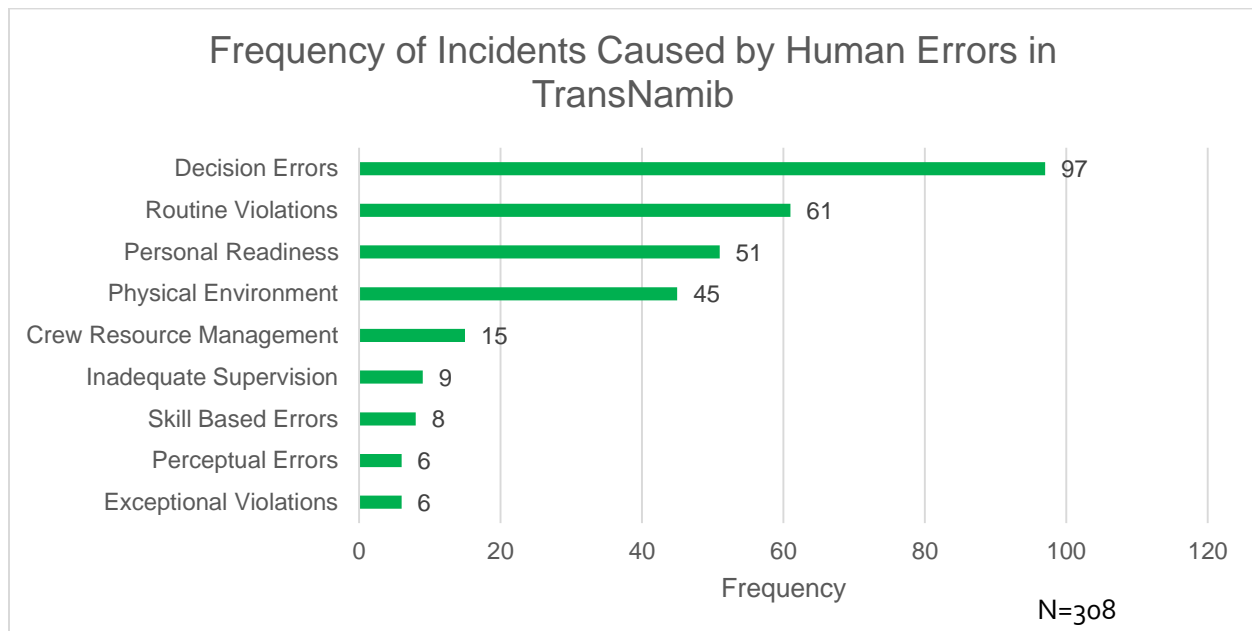
Figure 4 Frequency Human Error Related HFACS Categories for February, March, June, August, November and December 2014

Decision errors are defined as any error made by misinterpreting procedures and policies. For example, a locomotive may undergo a wheel slip due to excessive cargo because the train planners may not understand how much cargo the locomotive can carry, making estimates based on previous experiences. Routine violations are any infraction of a specifically stated procedure. When an employee does not report for duty and gives no reason to their superiors for their absence, this is recorded as a routine violation. Personal readiness examines the preparedness of employees to complete their job, such as when an employee has to leave work early due to sickness and a train is cancelled because of a lack of replacement. Physical

18

environment is defined as any issue that occurred on the rail line or shunting yard that was outside the control of TransNamib and their personnel. For example, employees who refuse to work due to the safety condition of their tasks. A full list of the 19 HFACS categories and example scenarios can be found in Appendix B.

The four most frequent human error related HFACS categories: decision errors, routine violations, personal readiness and physical environment account for 83% of the human errors classified. Additionally, this was also confirmed by looking at total delay time. In the given analysis scope, TransNamib had a total of 12,952 minutes (~9 days) of delays caused by human errors. Decision errors totaled 6,383 minutes (49%), routine violations totaled 3,095 minutes (24%), personal readiness totaled 2,235 minutes (17%) and physical environment totaled 1,112 minutes (9%). A direct comparison of frequency versus delay time can be found in Figures 5 and 6.
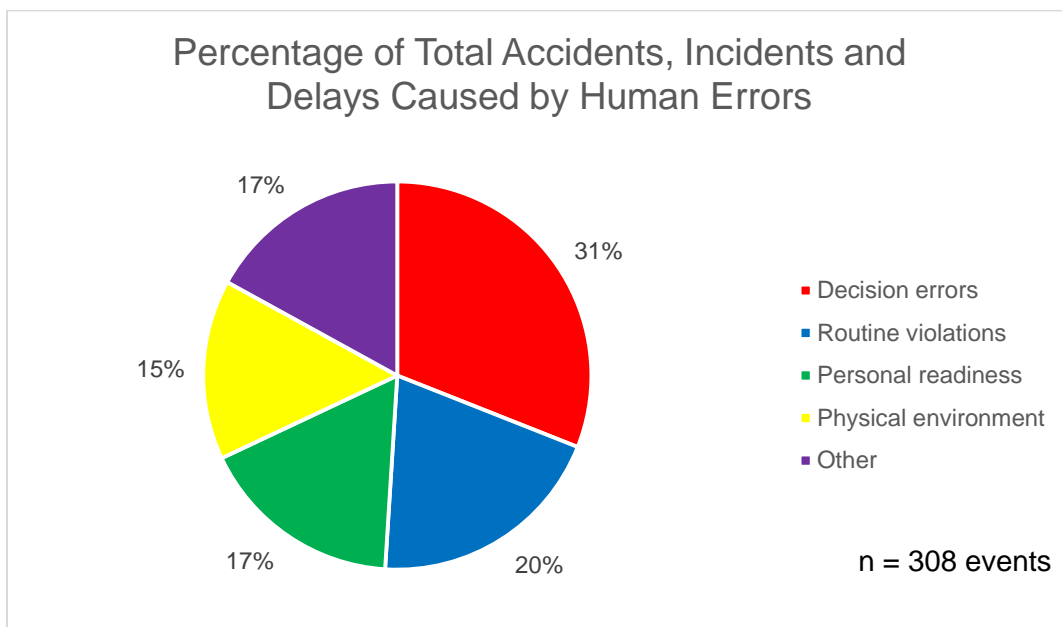

Figure 5 Percentage of Total Accidents, Incidents and Delays Caused by Human Errors

19

Percentage of Total Delay Time Caused by
Human Errors

1%

9%

17%

49%

■ Decision errors
■ Routine violations
■ Personal readiness
■ Physical environment
■ Other

24%

n = 12,952 minutes
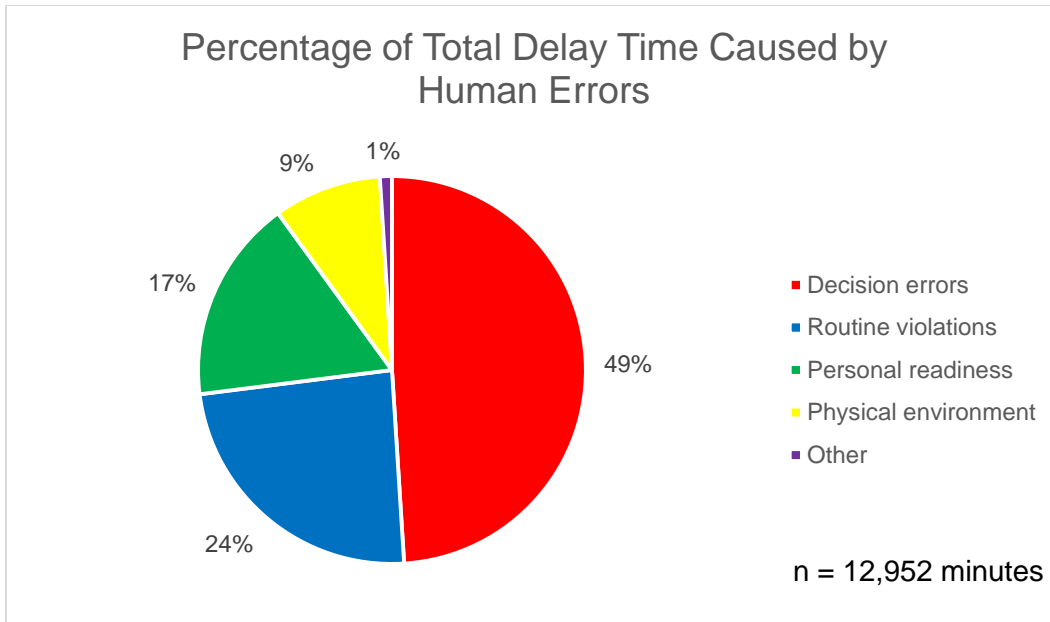
Figure 6 Percentage of Total Delay Time Caused by Human Errors

Explanation. Our analysis revealed that 308 of the 594 human factors present (51%) were directly related to human error. These human errors contribute to 31% of TransNamib's total delay time. Time lost is considered to have more of an influence on TransNamib's business and operations because it directly correlates to lost revenue. TransNamib is trying to receive more government funding for technological improvements. Figure 7 shows that over half of all accidents, incidents and delays are attributed to human factors. TransNamib can focus their resources on decreasing human factors and have more of a positive influence on their operations.

Percentage of Accidents Attributed to Technological
Environment and Human Factors

31%

51%

■ Technological
■ Other
■ Human Factors

18%

N=594

Figure 7 Percentage of Accidents Attributed to Technological Environment and Human Factors

20

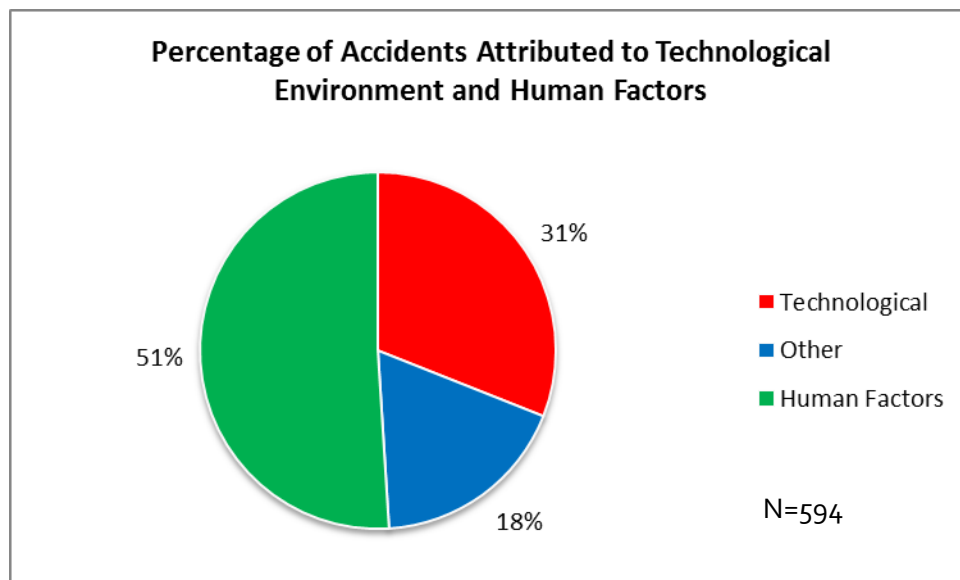## 2. HUMAN FACTOR PROBLEMS OCCURRED AT THE SAME RATE IN ALL THREE SEASONS.

Summary of Evidence. The frequency of decision based errors, routine violations, personal readiness and physical environment from each of the seasons in 2014, winter (June, August), summer (November, December) and rainy (February, March) are shown in Figure 8.
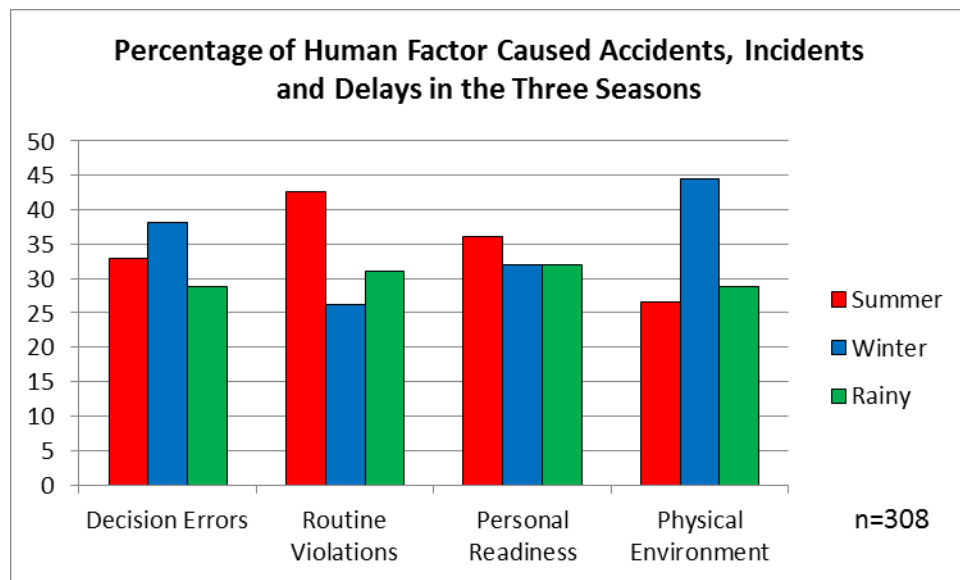
Figure 8 The Most Common Causes of Human Factor Caused Accidents, Incidents and Delays in Each of the Three Seasons

The three seasons in Namibia bring about different challenges for TransNamib. See Figure 9 for the frequency of human factor related accidents, incidents and delays in each of the three seasons. To determine whether there was a statistically significant difference between the types of human errors present in each of the three seasons, we conducted a Chi Squared test. This test compares the observed data with the averages in each season to determine whether there is a statistical difference. The Chi Squared values for each category are decision errors (0.53), routine violations (0.27), personal readiness (0.92) and physical environment (0.28). Each of these numbers is above the significance level of 0.05. From this, we concluded that there is not a statistically significant difference between the human errors present in each of the seasons.
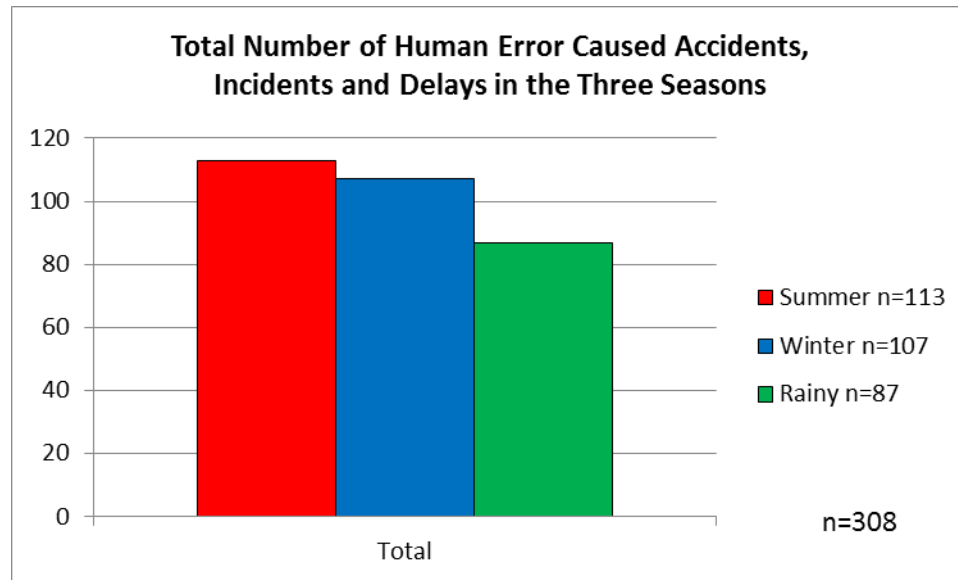
21

Figure 9 Total Number of Human Error Caused Accidents, incidents and Delays in the Three Seasons

Explanation. Although there was not a statistically significant difference between types of human errors in the seasons, we further investigated the employees' behaviors in the different seasons to understand their actions during weather changes.

Namibia experiences drastic temperature changes between the summer and winter months. The winter months experience temperatures as low as 5 degrees Celsius (41 degrees Fahrenheit). Along with the low temperatures, there are fewer daylight hours in winter. The sun sets approximately 2 hours sooner which gives the workers a dark working environment which is susceptible to more mishaps on the job. According to the investigator, low winter temperatures cause workers to be rushed in their operations leading to negligence. In the winter months, shunters often rush through their work to return to the heated buildings. During this process, wagons are not attached correctly which result in accidents or delays.

The summer months have peak temperatures reaching 40 degrees Celsius (105 degrees Fahrenheit). We found that 23% of summer cases included personnel not reporting for duty (routine violations), showing up late for duty, or leaving early. This number is up from 15% in the winter months, or an increase of 53%. The employees do not show up for work because the temperatures are very high and it makes their job harder. This was explained to us in an interview and may not be the cause of all routine violations in the summer months.

3. INSUFFICIENT TRAINING AND EDUCATION AT A MANAGERIAL AND SUPERVISORY LEVEL HAS CREATED MISCOMMUNICATION WITH LOWER LEVEL EMPLOYEES AND MISJUDGMENTS DURING TRAIN OPERATIONS.

Summary of Evidence. After conducting interviews with the operations executive, operations managers and a TransNet representative we found that many managers at TransNamib have insufficient training and education to complete their jobs. The average

22

Namibian completes 6 years of schooling, and the rest of their learning comes from on the job experience (UNDP, 2013). According to the operations executive, TransNamib, being a company with jobs that require technical experience and knowledge, finds it difficult to hire employees with proper communication and managerial skills (UNDP, 2013). Namibia also has restrictive policies for companies trying to hire foreign employees and as a result obtaining a work visa is often a complex and problematic process. Therefore, TransNamib is forced to hire local employees, which limits the number of qualified candidates TransNamib can select from.

According to the operations executive, TransNamib lacks the funding necessary to build and operate a school dedicated to operations management training. During our interview with a TransNet representative, we found that TransNet has schools dedicated to improve the managers' knowledge, communication and supervisory skills. At TransNamib, however, managers may lack the necessary skill sets to handle complex situations brought on by train operations, which leads to errors in judgment and miscommunication with lower level employees. For example, before any train is allowed to leave the station, a supervisor must approve the status and destination of the train. When the supervisor does not adequately complete the check, wagons are sometimes sent to the wrong station or locomotives leave the station with insufficient supplies.

Explanation. Compared to TransNet's managerial program, it was clear that the managers needed enhanced training to complete their job more effectively. As stated above, TransNet operates a school to develop their managers and ensure they are qualified for their daily tasks. While the education level of newly hired employees may be out of TransNamib's control, by requiring managers to continually take courses to improve their knowledge about operations and managing employees, the managers will be able to better communicate and manage their employees.

4.   BECAUSE OPERATOR TRAINING IS ADEQUATE AT TRANSNAMIB, SKILL-BASED ERRORS ACCOUNT FOR ONLY 3% OF THE 308 HUMAN ERROR RELATED FACTORS CAUSING TRAIN ACCIDENTS, INCIDENTS AND DELAYS.

Summary of Evidence. Only 9 of the 308 human errors resulted from insufficient knowledge of the task. In these cases, the operators or assistants lacked the skill to complete the given task. Employees are trained every two years and complete further training after accidents.

Explanation. Interviews with the operations executive, internal relations manager, train operations manager and a TransNet representative revealed details about the current training program at TransNamib. The training program is set in place so that each operational employee must be retrained every two years. If an employee caused an accident, they are retrained for their job. Train drivers undergo extensive training before they are qualified to drive trains. The operations executive informed us that it takes approximately five years for each operational employee to complete the sequence of assistant shunter, shunter, train driver assistant and train driver. Once the train driver completes this sequence, they are still not qualified to

23

transport passengers or highly volatile goods. It will take a driver 15-20 years of driving to be qualified for these actions.

Analysis. From the interview results, we determined that TransNamib has a sufficient training program set in place for their shipmen, assistant shunters, shunters, train assistants and train drivers. No further research should be done on this topic as it is not the main cause of accidents, incidents and delays.

5. TransNamib's shortage of operational locomotives Because of accidents, incidents and delays, Including Many caused by Human Factors Problems, impairs TransNamib's Ability to complete day-to-day train operations.

Summary of Evidence. Only 30 of TransNamib's 71 locomotives are operational, the rest are either suffering from serious mechanical issues or are beyond operational repair. With such a small fleet of working locomotives, TransNamib suffers more from delays and cancelled trips whenever human error related issues prevent a locomotive from departing, as there are no replacement locomotives to complete the job.

The lack of locomotives is affecting not only TransNamib, but also companies using TransNamib's services. Rössing Uranium Mine is a company that uses TransNamib's services to deliver sulfuric acid to their mines. Over the last 6-8 months, Rössing Uranium Mines made their employees work 20% more overtime hours to compensate for the lack of locomotives to get the sulfuric acid to the Rössing Uranium mines.

Explanation. TransNamib is currently facing a major shortage of functional locomotives. The company's fleet is made up of entirely General Electric (GE) and General Motors (GM) locomotives, which mean all of their repairs and replacements must be shipped from the United States. The locomotives are currently 50-60 years of age and breaking down with increasing frequency. These break downs occur because of old engines and parts which costs TransNamib more money in repairs. Since the parts are outdated, they cannot be bought off the shelf and must be manufactured in the United States. To compensate for time while waiting for parts, TransNamib will "cannibalize" working locomotives to make others work. This means employees will take working parts from other operational locomotives in order to fix other semi-operational locomotives. This not only decreases the number of functional locomotives, but is not a permanent solution to the problem as parts taken from other locomotives are old and break shortly after installation.

With a small fleet of aged locomotives, accidents, incidents and delays caused from human error can have a detrimental effect on the company by delaying and even stopping trains from completing their delivery services. Currently, TransNamib is only able to service approximately 25% of their customer needs because they lack locomotives. Each accident, incident and delay that is caused by human error may seem small in scale at times, but can

24

have a drastic effect on the company's operations as there are no replacement locomotives available to complete the job.

6. TRANSNAMIB HAS SAFETY PROCEDURES SET IN PLACE, BUT THEY ARE INSUFFICIENT IN PREVENTING HUMAN ERROR RELATED ACCIDENTS, INCIDENTS AND DELAYS

Summary of Evidence. Even when personnel adhere to policies and procedures, accidents can still occur from lack of comprehensive safety standards. Three operational policies TransNamib lacks are safety checklists in the train yards, safety meetings and formal discipline for unsafe acts. A train operations expert suggested regular safety conferences as a means of mitigating future accidents by using lessons learned in the past; however, the managers never reached a consensus on the implementation of such conferences.

TransNamib currently has a list of activities that must be completed before the train leaves the station. The checklist is not readily available at the shunting yard so operators do not explicitly check off the activities once they have been completed. This can lead to activities not being completed before the train leaves. For example, shunters are supposed to physically check the point blade of a switch track segment to ensure it is all the way in place after operating the point. Not checking this can result in a "half cock", in which the blade is not all the way in place and the train derails. See Figure 10 for derailment. TransNamib has recognized this insufficiency and is in the process of completing checklists to be deployed in the field. From observations, we found that common safety procedures, such as wearing appropriate safety gear, are often not followed by the shunters.

Gap between point blade and rail line results in "half cock" and derailment.

Figure 10 Picture of "halfcocked" point causing derailment

Explanation. With a lack of safety standards, short cuts occur and mistakes are made. While comprehensive procedures exist for all train operations, executing them safely needs to be emphasized as a critical step in the process. The culture at TransNamib must be focused on moving goods *safely* as opposed to moving as much material as possible. By simply changing the mentality to focus on "a successful job is only complete when it is completed safely" can be instrumental in obtaining the goal of moving more goods.

7. LACK OF FINANCIAL RESOURCES HAS LED TO A SHORTAGE OF TRAIN OPERATIONS PERSONNEL, FORCING EXCESSIVELY LONG WORK SHIFTS, POTENTIALLY CAUSING FATIGUE RELATED ACCIDENTS, INCIDENTS AND DELAYS.

Summary of Evidence. TransNamib lacks the necessary train operations personnel to keep up with demand. Financial constraints have prevented TransNamib from hiring adequate numbers of qualified personnel to keep up with demand. As a result, shunting teams are often scheduled for multiple shifts in a day, some up to 14 and 20 hours long.

Explanation. Namibian labor laws dictate a maximum work shift of eight continuous hours; however, the importance of TransNamib to the economy has allowed them to gain exemption from the government, allowing for extended shifts. These long hours are a direct result of lack of qualified personnel. Without shunters, trains cannot be built and goods cannot be moved. These critical company personnel are often scheduled for two shifts in a row just to fill the schedule and meet quota.

Analysis. According to the U.S. Occupational Safety and Health Administration (OSHA), workers should not work any longer than eight hours a day, five days a week. Any longer is considered "unusual or extended" and can lead to increased fatigue, decreased concentration and unusual body stress. "These effects lead to an increased risk of operator error, injuries and/or accidents" (OSHA, n.d.). By working long shifts, workers can become fatigued and make critical mistakes in the shunting and marshalling yards leading to accidents, incidents and delays.

8. ALTHOUGH 35% OF ALL HUMAN ERROR RELATED ACCIDENTS, INCIDENTS AND DELAYS ARE CAUSED BY EMPLOYEE VIOLATIONS, TRANSNAMIB IS UNABLE TO ADEQUATELY DISCIPLINE EMPLOYEES BECAUSE THE RULES AND REGULATIONS HANDBOOK HAS NOT BEEN UPDATED SINCE 2004.

Summary of Evidence. TransNamib's Industrial Relations Rules and Regulations Handbook has not been updated since 2004. Amendments are logged by hand into a single, external notebook by the train operations manager and are distributed to operations managers and supervisors at TransNamib sites around Namibia.

26

Currently, TransNamib addresses procedural violations with the use of a "strike" system; employees are given separate warnings based on the severity of their actions. According to the handbook, an employee is not brought to the disciplinary committee until they have been absent for work without notice on three separate occurrences. For the most severe cases, main line accidents, the event is reviewed by the disciplinary board. In instances where the drivers are found at fault, they are often not dismissed and remain with the company even in cases with extensive property damage.

Explanation. In order to avoid re-printing and distributing a new Internal Relations Rules and Regulations Handbook for every rule amendment, TransNamib keeps all rule amendments logged in an external notebook held by the train operations manager in Windhoek. These changes are then distributed via email to operational supervisors at TransNamib locations around Namibia. It is up to the individual supervisors to ensure that their direct employees are aware of these policy changes and abide by them. This system of distributing amendments is vulnerable to miscommunication in transmission of new rules to employees. According to the operations executive, some employees will reference outdated rules in the handbook instead of amendments. For example, the current employee handbook states that all work absences must be communicated; however, the amendment clearly states all communication must be prior to absence. When employees do not report their absence to their supervisor in advance, TransNamib is left with insufficient crew resources and trains are delayed.

Analysis. According to a TransNet representative working alongside TransNamib, TransNamib does not dismiss personnel for performing acts that generate great losses. This is because dismissing a driver would leave TransNamib with fewer able bodies available to run operations. For example, many times when a mainline train derailment occurs, it's due to the train driver not completing his/her job correctly. The driver then receives a warning even though the company has amassed a large sum of losses. Cases where an employee will be dismissed from the company are rare.

5. Conclusions and Recommendations

In this chapter, we discuss a summary of the key findings as well as provide recommendations for addressing the human errors affecting operations at TransNamib. Through our observations and interviews, we gained a deeper knowledge of the key areas within operations that are currently affected by human error. We believe our recommendations, although focused primarily on decreasing human error, can be a start to improving the overall operations at TransNamib. This chapter also includes a section discussing the technological and societal problems.

Key Findings.

Through our observations and research we have gained an understanding of how human factors influence the success of TransNamib's train operations. We have summarized our research in the form of the following eight findings:

1. **Human errors caused over half of the accidents, incidents and delays, and of these, the most common causes were decision-based errors (31%), routine violations (20%), personal readiness (17%) and physical environment (15%).**

    The group determined that decreasing human errors could be more cost effective and beneficial to the overall operations of TransNamib. Human errors resulted in 51% of all accidents, incidents and delays while technological environment only caused 31%. TransNamib can save both time and money by examining the human errors negatively influencing its operations.

2. **Human factor problems occurred at the same rate in all three seasons.**

    We compiled data from each of the three seasons winter (June, August), summer (November, December) and rainy (February, March). Statistical analysis revealed no significant difference between the rates of human error related accidents, incidents and delays in each of the three seasons.

3. **Insufficient training and education at a managerial and supervisory level has created miscommunication with lower level employees and misjudgments during train operations.**

    After conducting interviews of management at all levels of TransNamib's operations as well as an outside expert, we found that the education and training level of supervisors and management are not adequate to complete their jobs. The national average education level in Namibia is only about six years compared to nine years in South Africa. Additionally, Namibian immigration legislation makes it very difficult to obtain a work visa and therefore TransNamib finds it difficult to find highly qualified experts from other countries. Many of the managers in

TransNamib received average education, and were given additional supplemental training as they worked their way up the ranks.

4. **Because operator training is adequate at TransNamib, skill-based errors account for only 3% of the 308 human error related factors causing train accidents, incidents and delays.**

From HFACS, only 8 out of the 308 human factor related accidents, incidents and delays were a result of operators lacking the necessary skill set to complete the task. Operators are given refresher training courses every two years to strengthen their skill sets. This shows that operator training is not a major contributing factor to human factor influenced accidents, incidents and delays.

5. **TransNamib's shortage of operational locomotives because of accidents, incidents and delays, including many caused by human factors problems, impairs TransNamib's ability to complete day-to-day train operations.**

TransNamib currently operates 30 functional locomotives out of a total inventory of 71. This allows TransNamib to service only about 25% of their customer's needs. On any given day, TransNamib will have stations that won't have any locomotives. This becomes especially problematic for customers that rely on these trains for daily deliveries such as sulfuric acid for uranium mining. Any accidents, incidents and delays that put locomotives out of commission for any length of time are detrimental to the flow of operations because there are usually no spare locomotives to pick up the slack.

6. **TransNamib has safety procedures set in place, but they are insufficient in preventing human error related accidents, incidents and delays.**

Interviews with TransNamib management and employees revealed that the safety standards currently in place are not suitable to eliminate all accidents, incidents and delays. While these standards exist, even if a job is completed by procedure, there is still a risk of cutting corners resulting in an accident, incident or delay.

7. **Lack of financial resources has led to a shortage of train operations personnel, forcing excessively long work shifts, potentially causing fatigue related accidents, incidents and delays.**

TransNamib lacks a sufficient number of qualified personnel to complete all train operational tasks. This has forced supervisors to schedule employees for consecutive shifts, resulting in 14 to 20 hour work days. Extended work days (greater than eight consecutive hours), have been found to cause excessive fatigue and adverse physiological and mental states. According to the U.S. Occupational Safety and Health Administration (OSHA), fatigue can "lead to an increased risk of operator error, injuries and/or accidents" (OSHA, n.d.).

8. **Although 35% of all human error related accidents, incidents and delays are caused by employee violations, TransNamib is unable to adequately discipline employees because the rules and regulations handbook has not been updated since 2004.**

All TransNamib employees receive an Industrial Relations Rules and Regulations handbook upon hire. This handbook outlines all rules associated with conducting daily activities as a TransNamib employee. However, this handbook has not been updated since 2004 prior to a change in Namibian labor legislation. All amendments to this handbook are hand written in a separate notebook held in Windhoek. These amendments are then distributed to supervisors at all TransNamib locations around Namibia. It is then up to the supervisors to distribute these rule changes to their employees. However, because these amendments are not updated in the official rules and regulations handbook, employees can often get away with breaking amendments claiming that they are not in the handbook given to them upon hire.

Recommendations for TransNamib

1. To promote safe and reliable work in their railway operations, use employee evaluation forms for shunters, train assistants and drivers.

The most frequent cause of accidents, incidents and delays related to human factors were due to procedural violations. From our research and discussions with employees, we concluded that employee evaluations could be effective in holding employees accountable for their actions and rewarding them for following given procedures. If the employee performs poorly on three evaluations, they should be sent to the disciplinary board for the respective consequences. These evaluation forms would be completed monthly by the managers and would examine the employee's attendance and adherence to safety procedures.

At the end of each month, the results from the forms will show which employees should be disciplined for violating procedures and which employees should be rewarded for following procedures. From our interview with the TransNet representative, we learned that employees should face more strict consequences for not reporting to duty or arriving late. Also, employees follow procedures more frequently if they are acknowledged by their superiors. These evaluation forms will explicitly show the managers if the employees have followed the procedures and with the results, appropriate actions may be taken.

A railway company in the United States, Patriot Rail, conducts employee evaluations using the following categories: job knowledge, quality of work, quantity of work, obtainment of performance objectives, dependability/attendance/punctuality, safety, teamwork and compliance with company policies. The employees are given the ratings: unacceptable, needs improvement, satisfactory, commendable and outstanding. Based on these evaluations, employees are either reprimanded for their actions or rewarded through salary increases. Because TransNamib does not have the resources to commend the employees with salary

30

increases, TransNamib can give the employees awards or other nonmonetary incentives (Patriot Rail, 2011).

These forms will help TransNamib improve the reliability and safety of their workers. Also, TransNamib hopefully will experience fewer accidents, incidents and delays resulting from employee negligence and violations of procedures. An example employee evaluation form can be found in Appendix K.

2. To address the recurring mistakes of employee actions we recommend changes in the disciplinary system: stricter "strike" system, more efficient and timely investigations and full disciplinary hearings for investigations.

From information collected by our observations and interviews, we concluded that a lack of discipline is one of the main obstacles TransNamib faces when addressing the human errors affecting operations. The effectiveness of discipline is dependent on holding employees accountable for their actions. Changing disciplinary processes at a company can be very complex because it may lead to personnel retaliation. It is important to make changes in disciplinary actions in a fair and impartial manner so that the employees are held accountable for their actions but also are not displeased with the changes. Keeping the employees in mind, we suggest the following changes to the current disciplinary process at TransNamib.

New and more developed "strike" system. Currently, TransNamib uses a "strike" system where each employee is given multiple warnings based on actions that cost the company time and money. The system seems to have its flaws, as many times, employees will be identified in multiple incident reports. Still, the employee will remain with the company. The prevalence of this practice costs the company upwards of millions of dollars in both time and revenue. To address this problem, we propose TransNamib allows employees 2-3 "strikes" per year before dismissal. By having a fixed number of offences, TransNamib may better monitor an employee's performance as well as be able to dismiss employees before the problem escalates. This is also helpful for the employees, as it provides an incentive to work more efficiently. Instead of having the mentality that nothing will happen to them, employees will give more thought to their actions before committing to them.

We also propose that TransNamib implement a rewards program for employees. A program set in place for rewarding employees who do their job effectively and in a timely manner will possibly give more incentive for employees to do their job correctly. Currently, TransNamib does not reward those who do a good job which is deterring employee morale with the company. Having a rewards program set in place will have employees striving for greatness as they now have something to look forward to in completing their daily activities.

Completing Investigations within a timely manner. Whenever an accident, incident or delay occurs at TransNamib, there is always a thorough investigation into the root cause for the problem; however, these investigations can take years without ever reaching a verdict. We learned that TransNamib is currently far behind on their investigations. To combat reoccurring incidents, TransNamib must complete their investigation reports in a timely manner. One way to do this would be to set a time frame for completing the investigation report. This timeframe

should give the investigator sufficient time not only to gather all the information needed but also to determine the cause and who should be disciplined. If the report is not completed on time, the investigator and all employees involved in completing the report should be disciplined.

Along with having a set time frame, TransNamib should decentralize their investigation board, and allow for other investigation boards for different regions of Namibia. Currently, TransNamib has one investigation board located in Windhoek that must report to any region that has a mainline accident, incident or delay. This is both costly and time consuming as TransNamib must have their investigation board travel all around Namibia to complete thorough investigations. We propose that TransNamib train their employees so that there are full investigation boards in more regions within Namibia. There should be at least a region to the north, south and middle of Namibia in order to have an effective and timely investigation hearing.

A full disciplinary hearing for mainline accidents. Holding a disciplinary hearing for the full train crew involved in a mainline accident will allow TransNamib to further investigate the reason for the accidents. Currently, whenever a mainline derailment or accident occurs, only the driver is placed under investigation while the rest of the crew is questioned. Holding the whole crew accountable for the accidents will enable a full investigation of the entire crew so that a source of the problem can be pinpointed. Mainline accidents are very costly for the company and it is important that an underlying cause can be found for each so that an accident does not occur again.

With this recommendation, we aimed to address our findings dealing with TransNamib's disciplinary process. These three changes will hopefully not only increase employee accountability but decrease the accidents, incidents and delays resulting from human errors.

3. To address mistakes arising from lack of safety, we recommend the implementation of regular safety meetings at the managerial level.

From observations and interviews we found that the communication about safety varies at the different managerial levels within TransNamib's operations. The shunters have weekly safety meetings to discuss safety concerns of the previous week and how to decrease the occurrences. There are also daily meetings held with the shunters to review the previous day and discuss what could be improved. However, no such meetings occur with the upper level operations management. Within the manager level, discussions about the safety culture occur to determine safety practices but not as often. Also, no discussion occurs between the managers and the shunters about the safety issues surrounding the accidents and incidents. Because of limited communication between the shunters and the managers, the safety culture at TransNamib is not efficient.

By implementing semi-annual safety meetings with the head shunter and managers, the safety culture at TransNamib will improve as a result of a more adequate discussion. Meeting twice a year to discuss safety allows for the discussion between the head shunters and the

32

supervisors to be more thorough, comprehensive and critical, which will allow safety to become a higher priority within TransNamib. Along with the semi-annual meetings, a liaison should be appointed to report to the Train Operations Manager about the daily shunter's meetings to allow for a more open communication between the shunters and the managers throughout the year. By having a more open line of communication the difference between what the shunters see while working and what the managers hear will decrease. By implementing the semiannual safety meetings and appointing a liaison, TransNamib can improve the safety culture and provide a safer work environment.

4. To aid TransNamib in better recognizing the human errors within operations, we recommend the use of an incident tracking system that will centralize reporting of all accidents, incidents and delays, including those caused by human error.

Presently, there is no central database for recording human error related accidents, incidents and delays at TransNamib aside from daily irregularity reports emailed to operational staff. Centralizing this data into a single location broken down by location, type of incident, cause, time of delay, injuries and financial loss will allow TransNamib to conduct statistical analyses on accidents, incidents and delays over extended time periods. Performing these analyses would be critical in understanding what types of accidents are most common, locations with high accident rates and correlations between types of accidents and time of year. In addition, it is necessary to continually analyze and classify human factors using HFACS. By understanding which human factors continue to challenge operations, TransNamib can make a conscious decision on where to allocate resources such as further training or disciplinary action. For example, it may seem obvious that the technological problems are a major contributing factor in accidents, incidents and delays; however, by centralizing the HFACS data, TransNamib can make an opportunistic decision on the most cost effective solution that may have the same overall impact as addressing technological problems. We recommend that this tracking system be easily accessible by all operations management staff and supervisors.

5. To address recurring procedural mistakes, we recommend that the rules and regulations handbook be updated, published and redistributed every year with new amendments.

From our studies of the TransNamib Industrial Relations Rules and Regulations handbook, we determined there have been no updates since 2004. All rule amendments since have been hand-recorded into a single book and then emailed out to all operations supervisors. In talking to operations managers, we found that these rule adjustments are often not communicated to individual personnel. This allows TransNamib employees to reference an out dated rule book for any infractions that might have been covered by such amendments. For this reason, we recommend that the internal policies and procedures handbook is fully updated and redistributed every year. This will eliminate any confusion about the current rules and ensure that all employees have the most up to date standards. With this recommendation we focused on decreasing employee routine and exceptional violations.

Recommendations for Future Researchers.

We found that several areas of our research were helpful in developing solutions to aid the company. The first recommendation was tailored specifically to our study; however, it has a broad enough application to be used in other projects with similar issues. The second area of research is one we found late into our project and were unable to completely investigate, but allows for the researchers to gain a vast amount of knowledge on the subject and possibly determine alternative solutions by allowing them to completely understand the technological side of the issue. The final area of research is helpful in determining minor root causes for the human errors, but also wasn't discovered until late into the project.

1) *We recommend that HFACS be used for any future analysis of accidents, incidents and/or delays at TransNamib*

The Human Factor Analysis and Classification System allows for a more in depth analysis of accident reports and their causes relating to human error. Before using HFACS, it is essential to study numerous case studies to understand what events would be classified under each category. Adapting the categories to the industry/company being studied is important and crucial to compile accurate results. The categories used by our group are detailed in Appendix B and can be used as a guideline for future research both at TransNamib and other railway companies.

2) *We recommend further research into the technological problems TransNamib is facing in order to gain a better understanding of how the locomotives are failing.*

A more detailed look into the technological aspects of the locomotives will provide a better understanding on the locomotives and provide ideas on preventative measures for failures in the future. This project's recommendations addressed the human errors leading to accidents, incidents and delays but not the issue of technological failures. This will allow future researchers to provide possible solutions to prevent the technological problems that TransNamib faces. TransNamib is in the final stages of completing the 180-day Turnaround Plan in which TransNamib received 31 locomotives. With these locomotives, the number of failures and technological problems will decrease but all problems that TransNamib faces will not be fixed.

3) *We recommend further research into the effects of overtime and extended work shifts as a contributing factor to accidents, incidents and delays.*

As discussed in chapter 4, finding 7, TransNamib's lack of operations personnel has forced excessively long work shifts, 14 – 20 hours at the most extreme. Literature tells us that working extended hours has physical and mental affects that could lead to accidents and incidents; however, we were unable to collect adequate evidence to prove this in the timeframe of our project. Also, there was insufficient data at TransNamib to determine if fatigue was a cause of

34

the accidents, incidents and delays. To facilitate this analysis, the number of hours worked by the employee should be recorded during the investigation process. We recommend that future researchers analyze accidents, incidents and delays to see if there is a correlation to personnel that had been working for excessively long hours. In addition, it would be beneficial to research the cost-safety benefits of investing in more personnel to reduce work hours. While this may have a higher initial cost, it may be more cost-effective in reducing accidents, incidents and delays related to fatigue.

Project Design Principles

1. It is important to understand how culture influences a company's operations.

When entering a country with a different culture, it is crucial to understand how that different culture affects everyday life. Many times large-scale industries operate differently than other countries due to cultural influences. In order to fully understand how a company operates within a different setting, a group must first approach with an open mind. It is easy for groups to draw conclusions from the experiences in their home country, but many of these conclusions are not valid or feasible elsewhere. In order for our group to successfully conduct our research and analysis, we needed to discard everything we knew about American culture and enter the company with an open mind. Only by entering with an open mind were we able to search for information and provide recommendations that were tailored specifically to that company to work properly within that culture setting.

During our preliminary research, our group focused on how railroad companies are run in the United States and finding best practice examples to use in Namibia. Upon arrival, we determined that Namibia is very different from the United States and does not have the resources or infrastructure to operate their railway company in the same way as the United States. To overcome this challenge, we disregarded all preconceived ideas on how the railway company was run in the United States and we interviewed a representative from TransNet. While South Africa has more resources than Namibia, we learned about the cultural norms in large industries in sub-Saharan Africa and how we could make recommendations that are feasible for TransNamib.

2. Recommendations must be tailored to the social and cultural norms of the country.

Alterations in how a company operates that may seem "necessary" may not always align with the social and cultural norms of the company and country. It is important to understand the differences in culture prior to implementation. This culture change may not be adopted by employees which may lead to worse results than if they had never been implemented at all. For example, increasing signage at railroad level crossings can be a difficult implementation because of the high rate at which the signs are stolen for scrap metal. All proposed changes to a business environment must take full consideration of the employee demographics. This can be done by personal immersion into local culture, talking with local employees and external research. The most effective method is to get personal experience talking with employees to find out exactly what they want to change. By designing recommendations and changes around

35

the affected employees, one has a much higher chance of successfully integrating positive changes into the operational culture of the company under research.

36

Work Cited

Africa and the Middle East. (2009). In Minerals Yearbook (Vol. 3, p. 32). United States Geological Survey (USGS). Retrieved from http://books.google.com/books?id=dgU75I2-xAcC&lpg=SA32-PA2&pg=PP1#v=onepage&q&f=false

Baysari, M., McIntosh, A., & Wilson, J. (2008). Understanding the human factors contribution to railway accidents and incidents in Australia. *Accident Analysis & Prevention, 40*(5), 1750-1757. Retrieved February 8, 2015, from http://www.sciencedirect.com/science/article/pii/S0001457508001061

Dierks, K. (n.d.). 4.0 ASPECTS OF NAMIBIAN RAILWAY TRANSPORT. Retrieved February 11, 2015, from http://www.klausdierks.com/Namibia_Rail/4.htm

Federal Aviation Administration. (n.d.). Human Factors. Retrieved February 9, 2015, from https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/media/AMT_Handbook_Addendum_Human_Factors.pdf

Flying Safety (2008, July). What are "Human factors"? *64*(7), 4+. Retrieved from http://go.galegroup.com/ps/i.do?id=GALE%7CA183313674&v=2.1&u=mlin_c_worpoly&it=r&p=ITOF&sw=w&asid=e94195c50afc82034fa70a94e85cabd1

Gladwell, M. (2008). The Ethnic Theory of Plane Crashes. In *Outliers: The Story of Success* (1st ed., pp. 177-223). New York, NY: Little, Brown and Company.

Li. W. V., & Harris, D. (2006). Pilot error and its relationship with higher organizational levels: HFACS analysis of 523 accidents. *Aviation, Space, and Environmental Medicine, 77(10).* 1056-1061.

Liu, X., Saat, M., & Barkan, C. (2012). Analysis of Causes of Major Train Derailment and Their Effect on Accident Rates. *Transportation Research Record: Journal of the Transportation Research Board,* 154-163.

Ministry of Mines and Energy - Geological Survey. (n.d.). Retrieved February 11, 2015, from http://www.mme.gov.na/gsn/

Namibia Chamber of Mines. (n.d.). Retrieved April 7, 2015, from http://www.chamberofmines.org.na/

Namibia Statistics Agency. (2012). Annual Trade Bulletin. Retrieved from http://www.nmanamibia.com/fileadmin/user_upload/pdf/Annual_Trade_Statistics_Bulletin_2012.pdf

Patriot Rail. (2011, July 27). *Compensation and Performance Management.* Retrieved April 22, 2015, from http://patriotrail.com/images/pdfs/HRPolicies/Compensation_Perf_Mgt_Policy_0711.pdf

Shepherd, A., & Marshall, E. (2005). Timeliness and task specification in designing for human factors in railway operations. *Applied Ergonomics, 36*(6), 719-727. Retrieved February 8, 2015, from http://www.sciencedirect.com/science/article/pii/S0003687005000906

Simonis Storm Securities. (2006). Namibian Mining: The Economic Stronghold. Retrieved February 10, 2015, from http://www.chamberofmines.org.na/uploads/media/Namibian_Mining-The_Economic_Stronghold.pdf

Return to Table of Contents

Railway Safety Regulator of South Africa. (2009, January 1). *State of Railway Safety in South Africa.* Retrieved February 15, 2015, from http://rsr.org.za/wp-content/uploads/2014/08/State-of-Safety-2008-09.pdf

TransNamib. (2011, April). *2011 Annual Report*. Windhoek, Namibia: TransNamib.

TransNamib. (2012, April). *2012 Annual Report*. Windhoek, Namibia: TransNamib.

TransNamib. (2013, April). *2013 Annual Report*. Windhoek, Namibia: TransNamib.

TransNamib - Customer Feedback and Analysis. (2015, February 11). Retrieved February 11, 2015, from http://hellopeter.com/transnamib/customer-feedback-and-analysis

Tvaryanas, A.P., Thompson, W.T., & Constables, S.H. (2006). Human factors in remotely piloted aircraft operations: HFACS analysis of 221 mishaps over 10 years. *Aviation, space, and environmental medicine.* 77(7). 724-732.

United States Department of Defense. (2005, January 11). Department of Defense Human Factors Analysis and Classification System. Retrieved March 23, 2015, from http://www.public.navy.mil/comnavsafecen/Documents/aviation/aeromedical/DoD_hfacs.pdf

U.S. Department of Transportation, Federal Railroad Administration. (2007). Human Error Investigation Software Tool (HEIST). (Report no. DFRA. 060053). Retrieved from www.fra.dot.gov/Elib/Document/399

United States Occupational Safety and Health Administration. (n.d.). *Extended Unusual Work Shifts*. Retrieved April 29, 2015, from https://www.osha.gov/OshDoc/data_Hurricane_Facts/faq_longhours.html

Uranium production figures, 2003-2013. (n.d.). Retrieved March 20, 2015, from http://www.world-nuclear.org/info/Facts-and-Figures/Uranium-production-figures/

Appendix A.

Example Accident and Irregularity Report Data Collection

New Incident

Return to Home

Date: mm/dd/yyyy

Location: _____ and _____

Incident: _____

Cause: _____

Delay: _____   Train Cancelled: ☐ No Data: ☐

Injuries: _____

Primary Category: None ▼

Secondary Category: None ▼

Tertiary Category: None ▼

Submit

Appendix B.

List of HFACS Categories

1. **Resource Management**

    Resource management was defined as not having the resources, trains or money, to complete the job. For example, TransNamib not having the locomotives to complete shipments to their desired locations or if TransNamib fails to have adequate fuel for all their locomotives.

2. **Organizational Climate**

    The organizational climate is the structure, policies and culture of the company. The policies of the company are the overarching set of guidelines that could be flawed and cause human error. No accidents were classified under this category.

3. **Organizational Process**

    The organizational process is comprised of the operations, procedures, and oversight. The organizational process will give the team an overview of the entire operations of the company and understand how the organizational rules and decisions govern the overall company.

4. **Inadequate Supervision**

    This is the failure to administer proper training and lack of professional guidance. For example, when a train driver with inadequate training takes over a locomotive without proper supervision for guidance. Additionally, containers wrongly sent to a location would qualify as inadequate supervision of the shunters and train planners.

5. **Planned Inappropriate Operations**

    These include improper work tempo and poor crew pairing. Crew pairing is an important area to consider in the railway industry because many jobs require pairs to complete a task and if the pairs are not optimized, it could lead to failures within the system. An example of this would be train driver – shunter pairs that fail to communicate, resulting in an accident or incident.

6. **Failed to Correct Problem**

    When a company fails to correct known problems they are putting their company at risk. Failure to correct a problem can range from inappropriate behavior to a safety hazard. For example, a known broken section of rail line that is not fixed, resulting in another accident.

7. **Supervisory Violations**

    Supervisory violations analyzes if the supervision of the company is not adhering to the rules and regulations set in place. This could lead to unsafe supervisory decisions leading to accidents, incidents and delays. No occurrences were classified under this section.

8. **Physical Environment**

    Physical environment was defined as any issue that occurred on the rail line or shunting yard that was outside the control of TransNamib and their personnel. For example, a train derailing due to an excess of sand that was blown onto the railway between stations.

9. **Technological Environment**

    Technological environment was defined as any issues that occurred due to faulty or dated equipment. For example, since TransNamib's locomotives are old, these issues would occur from defective radios to ground relays getting disrupted and stopping the locomotive in the middle of the rail line, or if an employee refuses to work due to unsafe conditions.

10. **Adverse Mental States**

    Adverse mental state was defined as any employee being unfit for duty due to being unable to complete menial tasks. For example, TransNamib personnel being sent home because of intoxication at work.

11. **Adverse Physiological States**

    The adverse physiological state examines an employee's visual perception and medical condition. The group also classified employees showing up drunk to work as adverse physiological states because their visual perception is altered.

12. **Physical/Mental Limitations**

    The physical and mental limitations include both physical capabilities such as size and strength but also addresses reaction time and sensory input. No events were classified under this category.

13. **Crew Resource Management**

    Crew resource management was defined as not having the crew members needed to complete a job. For example, if a train driver, train assistant or shunter was not scheduled or wrongly scheduled resulting in their absence.

14. **Personal Readiness**

    Personal readiness examines the preparedness of employees to complete their job. Employees being sick for work is an example of personal readiness. Employees showing up late for work is also an example of personal readiness; however, we also classified this as a routine violation.

15. **Decision Errors**

    We defined decision errors as any error made by misinterpreting procedures. Decision errors included train crews not refueling the trains when specified under given procedures or train planners adding too much weight to a locomotive resulting in wheel slip.

16. **Skill-Based Errors**

Skill based errors are the inability of an employee to perform a given task or function given their current training level. For example, when TransNamib personnel cause an accident, incident or delay within the shunting yard by not operating a point correctly.

17. **Perceptual Errors**

Perceptual errors were defined as any personnel using misjudgment to complete a task or not paying attention to the task at hand. For example, when a TransNamib train driver runs over a cow crossing over the rail line due to inadequate attention or being physically unable to see it until it's too late.

18. **Routine Violations**

Routine violations are any infraction of a stated procedure. When an employee does not report their absence to their supervisor, they are violating a procedure. On the job violations would include not following the procedures in order to save time and increase production.

19. **Exceptional Violations**

Exceptional violations are any violations to the rules and regulations handbook, not necessarily limited to deviations from operational procedures. While workers showing up for work intoxicated is an example of Adverse Mental and Adverse Physiological states, we also categorized them as exceptional violation because it is a direct violation of the rules and regulations handbook.

Appendix C.

Interview questions with Executive of Operations

So we can have it on record could you please consent to us recording this interview.

After this interview you may review any references to yourself in our report before it is published

Through looking at the accident and irregularity reports we came up with a list of questions we want to ask to clarify and guide our investigation.

- We saw a few accidents with level crossing as the title. What are the current warning signals on railways to alert drivers of a train?
- Is there any work being done on this topic because we had seen a note on one of reports saying further research should be done on this topic.
- From looking at the irregularity reports we noticed that many of the delays are attributed to locomotive shortages. Do anticipate the 180 turnaround plan will decrease these delays?
- We noticed that the Locomotive Depot also caused many delays. What relation does this company have to TransNamib and why are they causing delays?
- Some of the recommendations from the review panels suggested refresher courses for the shunters. Is this a major concern of yours? Are there refresher courses for the shunters?
- Is there a possibility for us to observe other stations or sites? If so, which sites do you recommend and how would we set this up?

Thank you for your responses, please come to us if you would like to revise any of your answers.

Appendix D.

Interview Questions with Human Resources Representative

So we can have it on record could you please consent to us recording this interview.

We are a group of students from Worcester Polytechnic Institute in the United States. We would like your permission to ask questions as a part of an interview/survey for our research project. The purpose of our research is to provide an analysis of human factors in order to improve reliability and safety in operations at TransNamib. We will be proposing this analysis to TransNamib for inspection and will be publishing this information in a research paper. From this interview we hope to learn more about the train accidents and incidents at TransNamib. We want to inform you that the information we gather from you will **not** be published with your name or personal identifying factors. We will take your responses and combined them with other interviews relevant to our research and publish them within TransNamib. We will only record your current position of employment along with a unique identifying number for our initial records and then destroy this identifying number once the data is combined. This interview/survey should only take around 15 minutes and is completely voluntary. You do not need to participate if you do not wish and you can skip any question that you do not want to answer. We consider this information of great importance to our project and your help would be greatly appreciated. If there is any confusion or concern you can feel free to ask questions now.

After this interview you may review any references to yourself in our report before it is published

Through looking at the accident and irregularity reports we came up with a list of questions we want to ask to clarify and guide our investigation.

- As we were looking through the incident reports we realized that some of the delays occurred because people did not show up for work. How is this addressed?
- We also saw in some of the recommendations they mentioned that employees should be reprimanded. How is this done?
- Through our research we found that employee evaluations are a helpful tool to many companies. Does TransNamib conduct employee evaluations? If so, how often and what are these evaluations looking at?
- Are there employee handbooks and protocols that they must follow for each job position?
- Are there safety checklists set in place to ensure all acts are carried out safely?
- In the aviation industry they have a standard operating manual that ensures the same actions are completed before planes take off. Is there a procedure set in place for the employees at the start of each day to ensure all acts are standardized?

44

Thank you for your responses, please come to us if you would like to revise any of your answers.

Appendix E.

Interview questions with Representative from South African Railway System (TransNet)

So we can have it on record could you please consent to us recording this interview.

We are a group of students from Worcester Polytechnic Institute in the United States. We would like your permission to ask questions as a part of an interview/survey for our research project. The purpose of our research is to provide an analysis of human factors in order to improve reliability and safety in operations at TransNamib. We will be proposing this analysis to TransNamib for inspection and will be publishing this information in a research paper. From this interview we hope to learn more about the train accidents and incidents at TransNamib. We want to inform you that the information we gather from you will **not** be published with your name or personal identifying factors. We will take your responses and combined them with other interviews relevant to our research and publish them within TransNamib. We will only record your current position of employment along with a unique identifying number for our initial records and then destroy this identifying number once the data is combined. This interview/survey should only take around 15 minutes and is completely voluntary. You do not need to participate if you do not wish and you can skip any question that you do not want to answer. We consider this information of great importance to our project and your help would be greatly appreciated. If there is any confusion or concern you can feel free to ask questions now.

After this interview you may review any references to yourself in our report before it is published

- The team has little experience in the railway industry and we were wondering if you could answer some of our questions to help us learn about how other train companies run their operations.
- We looked through TransNamib's safety checklists. Do you have any examples of these from the South African Railway system?
- Do you have an example of an employee handbook?
- Are there any major areas in operations where the South African Railway system and TransNamib differ?

Thank you for your responses, please come to us if you would like to revise any of your answers.

46

Appendix F.

Interview questions with the Manager of Train Operations

So we can have it on record could you please consent to us recording this interview.

We are a group of students from Worcester Polytechnic Institute in the United States. We would like your permission to ask questions as a part of an interview/survey for our research project. The purpose of our research is to provide an analysis of human factors in order to improve reliability and safety in operations at TransNamib. We will be proposing this analysis to TransNamib for inspection and will be publishing this information in a research paper. From this interview we hope to learn more about the train accidents and incidents at TransNamib. We want to inform you that the information we gather from you will **not** be published with your name or personal identifying factors. We will take your responses and combined them with other interviews relevant to our research and publish them within TransNamib. We will only record your current position of employment along with a unique identifying number for our initial records and then destroy this identifying number once the data is combined. This interview/survey should only take around 15 minutes and is completely voluntary. You do not need to participate if you do not wish and you can skip any question that you do not want to answer. We consider this information of great importance to our project and your help would be greatly appreciated. If there is any confusion or concern you can feel free to ask questions now.

After this interview you may review any references to yourself in our report before it is published

We had talked to a human resource representative and he referred us to you to answer some of our questions regarding operational procedures.

- Are there safety checklists set in place to ensure all acts are carried out safely?
- In the aviation industry they have a standard operating manual that ensures the same actions are completed before planes take off. Is there a procedure set in place for the employees at the start of each day to ensure all acts are standardized?
- Michael had mentioned that the employee handbook is outdated. Is there any work being done to modify this book?
- Gabes mentioned that there are employee evaluations but they are not being used. Do you have an example evaluation form we could see?
- We have seen a lot of accident causes as locomotive depot. What is happening at this stage in particular that is causing delays?

Thank you for your responses, please come to us if you would like to revise any of your answers.

47

Appendix G.

Interview questions with Manager at Rössing Private Sidings

So we can have it on record could you please consent to us recording this interview.

We are a group of students from Worcester Polytechnic Institute in the United States. We would like your permission to ask questions as a part of an interview/survey for our research project. The purpose of our research is to provide an analysis of human factors in order to improve reliability and safety in operations at TransNamib. We will be proposing this analysis to TransNamib for inspection and will be publishing this information in a research paper. From this interview we hope to learn more about the train accidents and incidents at TransNamib. We want to inform you that the information we gather from you will **not** be published with your name or personal identifying factors. We will take your responses and combined them with other interviews relevant to our research and publish them within TransNamib. We will only record your current position of employment along with a unique identifying number for our initial records and then destroy this identifying number once the data is combined. This interview/survey should only take around 15 minutes and is completely voluntary. You do not need to participate if you do not wish and you can skip any question that you do not want to answer. We consider this information of great importance to our project and your help would be greatly appreciated. If there is any confusion or concern you can feel free to ask questions now.

After this interview you may review any references to yourself in our report before it is published

- How does TransNamib fit into the success of your operations?
- What does TransNamib transport for you?
- How often does TransNamib transport said goods for you?
- Has there ever been a time where there have been no locomotives to service you?
- *If response to above is yes:* how does a locomotive shortage affect your operations?

Thank you for your responses, please come to us if you would like to revise any of your answers.

Appendix H.

Interview questions with Manager of Internal Relations

So we can have it on record could you please consent to us recording this interview.

We are a group of students from Worcester Polytechnic Institute in the United States. We would like your permission to ask questions as a part of an interview/survey for our research project. The purpose of our research is to provide an analysis of human factors in order to improve reliability and safety in operations at TransNamib. We will be proposing this analysis to TransNamib for inspection and will be publishing this information in a research paper. From this interview we hope to learn more about the train accidents and incidents at TransNamib. We want to inform you that the information we gather from you will **not** be published with your name or personal identifying factors. We will take your responses and combined them with other interviews relevant to our research and publish them within TransNamib. We will only record your current position of employment along with a unique identifying number for our initial records and then destroy this identifying number once the data is combined. This interview/survey should only take around 15 minutes and is completely voluntary. You do not need to participate if you do not wish and you can skip any question that you do not want to answer. We consider this information of great importance to our project and your help would be greatly appreciated. If there is any confusion or concern you can feel free to ask questions now.

After this interview you may review any references to yourself in our report before it is published

Through looking at the accident and irregularity reports we came up with a list of questions we want to ask to clarify and guide our investigation.

- We talked with Gabes about employee discipline. How are employees reprimanded if they were to not show up to work or leave early?
- What is the discipline process for the different misconducts (i.e. train accidents, not showing for work, etc.)
- Is there a disciplinary committee?

Thank you for your responses, please come to us if you would like to revise any of your answers.

49

Appendix I.

Interview with a Member of the Investigation Board

So we can have it on record could you please consent to us recording this interview.

We are a group of students from Worcester Polytechnic Institute in the United States. We would like your permission to ask questions as a part of an interview/survey for our research project. The purpose of our research is to provide an analysis of human factors in order to improve reliability and safety in operations at TransNamib. We will be proposing this analysis to TransNamib for inspection and will be publishing this information in a research paper. From this interview we hope to learn more about the train accidents and incidents at TransNamib. We want to inform you that the information we gather from you will **not** be published with your name or personal identifying factors. We will take your responses and combined them with other interviews relevant to our research and publish them within TransNamib. We will only record your current position of employment along with a unique identifying number for our initial records and then destroy this identifying number once the data is combined. This interview/survey should only take around 15 minutes and is completely voluntary. You do not need to participate if you do not wish and you can skip any question that you do not want to answer. We consider this information of great importance to our project and your help would be greatly appreciated. If there is any confusion or concern you can feel free to ask questions now.

After this interview you may review any references to yourself in our report before it is published

Through looking at the accident and irregularity reports we came up with a list of questions we want to ask to clarify and guide our investigation.

- We noticed in the recommendations that it often said to reprimand someone for not completing the accident report. What sections are not being completed? Are the sections completed at a later date?
- Are they not being completed because they are unclear or because the employee chooses not to complete them?
- Is there a standard form that must be completed?
- Do accident reports have to be completed within a certain time of the accident?
- We saw in the accident reports that the winter season had the highest number of irregularities. Do you know why this is?
- Do you have any suggestions on what we should look for in the shunting yard?

Thank you for your responses, please come to us if you would like to revise any of your answers.

50

Appendix J.

Interview questions with Executive of Operations

So we can have it on record could you please consent to us recording this interview.

After this interview you may review any references to yourself in our report before it is published

From our research and interviews, we have developed a list of questions to aid our further research.

- What qualifications must you have to be a manager? Is there a management training system set in place?
- Is it possible if we could get a company org chart?
- Is there a priority of safety at TransNamib?
- Besides the safety checklists which Henry is working on what else is in the works for improving the safety at TransNamib?
- Why does winter have the highest frequency of accidents, incidents and delays?
- With the 180 day turn-around plan which employees is TransNamib trying to reduce?

Thank you for your responses, please come to us if you would like to revise any of your answers.

51

Appendix K.

Interview questions with Chief Executive Officer

Do you mind if we record this interview?

Start Recording

So we can have it on record could you please consent to us recording this interview?

After this interview you may review any references to yourself in our report before it is published.

Through looking at the accident and irregularity reports we came up with a list of questions we want to ask to clarify and guide our investigation.

- What is the disciplinary process at TransNamib?
- After talking to the representative at TransNet, we were wondering if there is a system set in place to reward the workers who have completed their job with little to no mistakes?
- Where do you think TransNamib stands in terms of priority of safety?
- Are there any programs set in place to improve the safety at TransNamib?
- Through talking with other employee's and supervisors, we've found that investigations for any accidents, incidents, and delays take too long, even to a point where they aren't complete. Is there currently a plan to have investigations completed on time?

Thank you for your responses. Please come to us if you would like to revise any of your answers.

Appendix L.

Employee's Name: _____

Date of Evaluation: _____

Name of Manager: _____

How many days did the employee arrive late to work?_____

How many days did the employee leave before his job was complete?_____

During your 3 observations during the month was the employee wearing appropriate safety gear?

☐ Yes

☐ No

If no, please explain what safety gear they were not wearing and the date of the occurrence(s).

_____

Were there any other unsafe acts the employee performed during this evaluation period?

☐ Yes

☐ No

If yes, please explain the unsafe acts and the procedures being violated.

_____