Achieving and maintaining an improved safety performance in a petrochemical laboratory

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By

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DECLARATION

I, Adrian Peter Darling, hereby declare that:

- The work in this thesis is my own original work;

- All sources used or referred to have been documented and acknowledged; and

- This paper has not been previously submitted in full or partial fulfilment of the requirements for an equivalent or higher qualification at any other recognised educational institution.

Adrian Peter Darling   Date: 14 May 2012

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ABSTRACT

The question of how an improved safety performance was achieved and what needs to be done to maintain such a performance is investigated. The is done using the example of a laboratory that turned from a bad and worsening safety performance to the best in the organisation. Aspects of transformational leadership, employee empowerment and incident reporting and investigation were examined as contributing factors. In a survey of the laboratory employees, an independent level of safety culture maturity was found, indicating a successful and complete cultural transformation. High levels of employee empowerment were found. Barriers to incident reporting are suggested. In order to maintain a high level of safety performance, the next higher level of safety culture maturity is suggested, together with other recommendations. Further research is suggested from having identified some key factors describing a group having achieved and seeking to maintain an exemplary safety performance.

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Acronym	Meaning
PPE	Personal protective equipment
RCR	Recordable case rate

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CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1.   INTRODUCTION

Organisations attempting to improve safety should focus on changing the work environment to motivate people to actively participate in safety, as opposed to blaming and punishing individuals for non-compliance to rules (Neal & Griffin, 2006).

There are ever stricter targets being set on safety performances of companies in a competitive environment where customers and employees, both prospective and current, are ever more intolerant of poor safety records of companies. This is also supported by legislation imposing stricter penalties on the employer in their personal capacity and on the company involved.

The research that will be further discussed in this document is that of achieving and maintaining an improved safety performance by means of a culture transformation initiative with specific reference to a laboratory department of a large multinational petrochemical and energy company. This department was chosen specifically for this study as it had improved from being amongst the worst performers in the company to the best, in a period of one year.

This section discusses the context of the topic, and upon problem review, identifies key themes from which a problem statement and research objectives are then formed. A number of limitations of this research are also discussed. Despite these limitations, this research may have some benefits and importance for improving safety performance in the context of this study and elsewhere. The outline of the rest of the document is then given.

1.2.   PROBLEM IN CONTEXT

A company's safety performance is an important indicator of how well managed it is. One frequently used measure of the safety performance of an organisation is the recordable case rate or RCR. This term is used internationally to describe the number of work-related injuries, beyond first-aid cases, that occur per 200 000 man hours worked (Sasol, 2006). This number of man hours is based on 100 employees working 40 hours per week for 50 weeks of a year (U.S. Bureau of Labour Statistics, 2011).   This safety performance measure is often benchmarked against other similar industries, in order to gauge how well an organisation is managing safety.   It is also used internally for best practice sharing and for senior management focus.   Improved safety performance is demonstrated by the ability to

continually reduce an RCR until it approaches zero or best-in-class performances by other similar organisations.

In this context, Sasol has been striving to improve its safety performance to that of international oil and energy companies against which it competes. The latest target set is 0.31 by 2013 from 0.51 currently (Sasol, 2006). The quest, nonetheless, is to have zero harm to employees, so an RCR target should be seen more as a milestone on a journey towards the ideal safety performance of no injury and harm to employees.

The laboratory section of Sasol has improved its safety performance from being amongst the worst RCR's in the organisation in mid 2010 to the best, at a value of zero, since September 2011. The reason for the improved safety performance is generally credited to a cultural transformation initiative started in October 2010 with a leadership transition.

The cultural transformation initiative included better personal accountability for safety for all staff, better visibility of leadership in the workplace, and a greater sense of urgency with all safety-related corrective actions. Most importantly, the belief was instilled with the employees that an RCR of zero could be achieved and sustained.

In forming its safety strategy, the following items were identified to drive an improved safety performance:

- Entrench the habit of 'if you see it you own it';
- Immediately spread the word and the learning as wide as possible;
- Demonstrate seriousness by taking urgent action and practice zero tolerance, knowing that actions speak louder than words;
- Re-implement the hazard identification process and on-the-spot corrective actions, without any administration;
- All leaders to set the example by participating instead of managing;
- Celebrate what is right with safety and balance rights and wrongs.

At the time of the last recordable case in October 2010, there was a voluntary retrenchment process underway in the laboratory in order to reduce the staffing from around 225 personnel to around 190. This was in response to growing pressure to reduce costs in the overall organisation in general and to reduce laboratory costs in particular, following a global recession. This retrenchment process led to greater span of control for supervisors and

managers and a need for greater productivity in the employees. This may have put the safety performance targets under pressure with employees being exposed to less familiar workplace situations, less time allocated for training, and time constraints with routine activities, leading to shortcuts being taken.

Despite the zero-rating since the last recordable case incident in October 2010, there have, nevertheless, been many near-miss incidents where someone could have been injured, as well as minor first aid cases that could have been more severe. It may be deemed fortunate that no one was more seriously injured or that the necessary protective systems were better utilised. With better utilization of personal protective equipment or PPE, and the application of zero tolerance with its usage, this may have played a significant role in preventing injury or reducing the severity of the injury.

No additional systems have been included for managing safety that could explain the improved safety performance. Existing systems may have been better utilised, especially an incident reporting system that investigates all incidents, near-misses or otherwise, to improve and correct deficiencies. Included with this is a deviation management system where corrective actions are targeted, assigned to a responsible person, and tracked to completion. People are openly encouraged to report all incidents, however trivial. These are then investigated thoroughly in order to ascertain root causes, thus generating corrective actions that can be generalised throughout the department. One typical corrective action is so called awareness creation, where the learning from the incident or accident is shared with all affected employees.

A behaviour based safety system has been in place for a number of years, involving peer-to-peer observation. The observation process includes the identification of barriers or obstacles preventing individuals working safely. A previous criticism of this system was that the data collected was not used to create valuable information for improving safety in that barriers were not followed up and trends not identified and tackled systematically. This may have changed in recent times, where corrective actions are identified and more actively pursued than previously. A minimum number of observations are set for each employee. The motivation to participate may thus be for compliance but should preferably be for everyone to positively participate in a company wide safety initiative.

An informal peer-to-peer observation system is also used whereby hazardous situations are identified on the spot and addressed informally. This system seeks to engage all personnel in

safety and address issues that would otherwise not be picked up either by inspection or in a formal behaviour based observation setting. This system also engages the personnel best positioned to address a problem with ownership for the solution being delegated to the employee, excluding managerial involvement.

The laboratory is criticised for the large number of incidents that are reported, even though no injuries resulted from them. These are termed near-miss incidents. Other sections with a worse RCR performance have fewer near-miss incidents reported, which does not support the principle that for any particular number of workplace injuries, there are an even greater number of near-miss incidents. It may be demonstrated that all injuries and accidents are preceded by near-misses, which could otherwise have led to injury.

The laboratory section has a great diversity of activities performed, due the different analyses done to support the business units served. The scale of these activities is not such as to endanger many lives, as is the case of a production unit. Nevertheless, there is great risk to the individuals doing the tasks, compounded by the difficulty of having a much greater diversity of chemical hazards than in the case of a production unit. The standardisation and focus on each activity is not as great as in a production environment, but yet a better safety performance is achieved.

The laboratory seeks an explanation of what the improved safety performance can be attributed to and what it needs to keep doing to maintain its safety performance at its current levels. In order to prevent complacency, momentum needs to be maintained to continue the current safety performance using the most important aspects of the current systems employed, and possibly other initiatives.

1.3.   PROBLEM REVIEW

A number of emerging themes can be identified from the problem in context. They are:

- Cultural transformation;
- Employee empowerment;
- Incident reporting.

The cultural transformation may have shifted the focus from implementation of systems and their maintenance to a more people-orientated effort. System

measurements include time to close deviations and the number of task observations done, amongst others. This may have ignored the people in the department and how engaged and committed they are to their own safety and that of their colleagues. Stated differently, people may have become participative due to internal motivation than by compliance to a set of rules. The accountability for individual safety may have shifted from management or a 'them' concept to an 'I' concept that engages all personnel.

The personnel empowerment programme, with the aim of achieving an improved safety performance, has been extended to individual participation being for the benefit of the group. Personnel observe and engage with one another, as well as management, to highlight safety deviations and improved methods of working. There are both formal and informal peer-to-peer observations systems that are utilised.

Laboratory personnel are encouraged to take the initiative to rectify safety deviations themselves rather than leaving them for management to find out or expecting management alone to solve them. The opinions and viewpoints of personnel are thus given air to be expressed and are respected as an individual contribution to safety.

In reporting near-miss incidents, personnel may previously have felt vulnerable to repercussions from their having been negligent or having violated safety rules. This resulted in near-miss incidents not being reported or unreliable event descriptions being presented. With a greater openness for near-miss incident reporting, the focus is on improving systems, noting that the person was not a perpetrator but an involved party whose experience can be used to prevent a more serious injury, in changed circumstances, to someone else. Investigations are driven by a need to prevent reoccurrence and to generalise aspects of the incident to improve safety performance throughout the laboratory.

1.4.   PROBLEM STATEMENT

From the improved safety performance, clarity is required on how this was achieved, in order to maintain the current RCR of zero. The important aspects need to be highlighted in order to ensure they have the necessary focus. Without this focus, certain aspects contributing to the

improved safety performance may drift backwards and ultimately be identified as a root cause to some future accident with severe injury. Alternatively, key aspects might be currently overlooked, which may lead to incidents at some time to come.

Reflecting on the identified emergent themes during the problem review, the problem statement that will be further discussed can be stated as:

How can a cultural transformation initiative, employee empowerment and better use of incident reporting systems be used to maintain an improved safety performance?

1.5.   RESEARCH OBJECTIVES

The objectives of this research are:

- To investigate the impact of a cultural transformation on safety performance;
- To investigate the impact of employee empowerment on safety performance;
- To investigate the effectiveness of a near-miss incident reporting system on safety performance;
- To identify other factors contributing to maintaining an improved safety performance.

1.6.   IMPORTANCE AND BENEFITS OF THE STUDY

Business research plays the key roles of providing decision makers with data on the effectiveness of strategies and insight on changes required (Coldwell & Herbst, 2004: 5). To this end, this research will provide feedback on the impact and importance of a cultural transformation and associated employee empowerment on safety performance. If other aspects of safety management are similar, it may be generalised to other departments in the group and to other companies.

Much research has been done of the impact of transformational leadership and other safety climate factors on safety performance. This will be discussed later in chapters two and three. Little or no research seems to have been done specific to a group which has transitioned from a bad and worsening safety performance to a zero RCR or similar ideal safety performance. This research seeks to characterise this group by investigating what led to an improved safety performance and what it should continue doing. From this research, causal relationships

could be established to gauge what the most effective safety interventions are to improving safety, especially in turning a poor safety performance around.

Investigation of near-miss incident reporting may lead to better system implementation and conducting of such investigations. The number of near-misses reported is orders of magnitude lower that what is suggested from the number of serious injuries and fatalities at Sasol, and perhaps elsewhere.

This research also aims to demonstrate the effectiveness a successful near-miss incident reporting system has in reducing the number of instances of more serious accidents. It explores what hinders people from using such a system and how people perceive its influence in improving safety performance.

Overall, this research seeks to position cultural aspects of leadership as an important contributor to an improved safety performance that can be sustained beyond the achievement of a set safety performance target.

1.7. LIMITATIONS AND DELIMITATIONS

Questionnaires will be utilized to gather the data required for the research. Limitations of this method of data collection include the introduction of bias by the wording of the questionnaire. This research is limited by the honesty of the participants and the extent to which they discuss their perceptions and viewpoints. The use of questionnaires requires that the question be correctly understood and that the answer be comprehensive enough. A poor response rate may also lead to incorrect conclusions being drawn about the population from the group that do respond.

The research does not imply any causal relationships but seeks to characterise a group of employees that are defined by having an improved safety performance that is sought to be sustained. It examines the perceptions of the participants of the study who may give biased answers. There may be other factors that accounted for the improved safety performance of the studied group which may have been omitted.

The scope of the study will be on around 200 laboratory personnel. The results are thus limited to one department in a company. The results of the research may be applicable to the laboratory service function only, but may also be applied in general to the entire organisation.

1.8. RESEARCH DESIGN CONCEPTS

The nature of the research to be done uses mixed methods. The participants will be all the 200 employees in a laboratory of a particular company. Use will be made of questionnaires to the whole group. By using questionnaires, the viewpoints and opinions of a larger group may be sought, in order to improve how representative the data is of the entire group.

1.9. CHAPTER OVERVIEWS

Chapter one provides an introduction to the research, providing the context and background of the study. It outlines the objectives of the research and what it seeks to achieve, within a stated set of limitations.

Chapter two provides a theoretical background of the research and evaluates the problem against certain business models. It provides a business case for the research.

Chapter three is a review of relevant academic literature and provides diverse opinion on the problem, particularly on the effect cultural transformation has on safety performance in particular and employee performance in general. This chapter provides an academic case for the research.

Chapter four details the research methodology employed, how it was performed and the participants of the research. It positions the research methods applied against the relevant theory of business research.

Chapter five analyses and discusses the results of the research in detail.

Chapter six draws conclusions from the research and makes recommendations for further research and to the organisation studied.

1.10. SUMMARY

The context of the research problem shows a number of themes, including cultural transformation, employee empowerment, and incident reporting. In exploring these themes further, a set of research objectives has been established, setting the foundation for the research to be discussed. The research has been delineated and the importance of research discussed. An overview of the rest of this document has been given.

CHAPTER 2: THEORETICAL FRAMEWORKS

2.1.   INTRODUCTION

From the previous problem review, cultural transformation, personnel empowerment and incident reporting were identified as themes. These themes will next be examined and discussed against various theoretical models.

2.2.   CULTURAL TRANSFORMATION

In order to establish the extent of the cultural transformation that the laboratory underwent, it will be evaluated against a number of models.

Organisational   culture   may   be   divided   into   3   levels   as   illustrated   below (Valuebasedmanagement.net, 2011a):
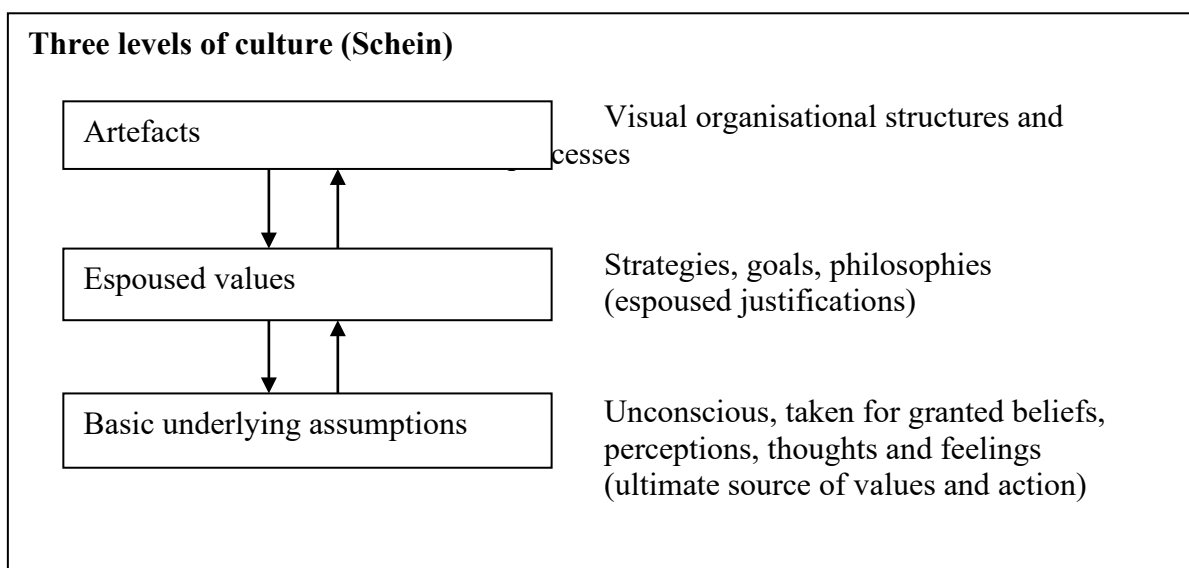
Figure 1: Schein's three levels of culture (Source: 12Manage, 2012).

Artefacts appear at the surface but are hard to understand (Valuebasedmanagement.net, 2011a). Underlying these artefacts are strategies, goals and philosophies. Under these, in turn, are beliefs and perceptions. Culture should be inquired of in an iterative clinical manner.

It may thus be difficult to understand what the beliefs and perceptions of the laboratory employees were prior to the cultural transformation.   The artefacts included shortcut procedures being used, a lack of awareness of hazards, and an expressed external locus of control.   Incident investigations did not necessarily establish the underlying goals and

philosophies. These may have included timesaving, including the belief by individuals that they would not be found out. Lack of awareness of hazards may have included complacency from having done a particular task, without incident, many times. This external locus of control may have been founded on a lack of employee engagement on safety.

From the time the cultural transformation was effected, the state of the laboratory's safety performance can be evaluated against a pattern for strategic development. This is depicted in the figure below.
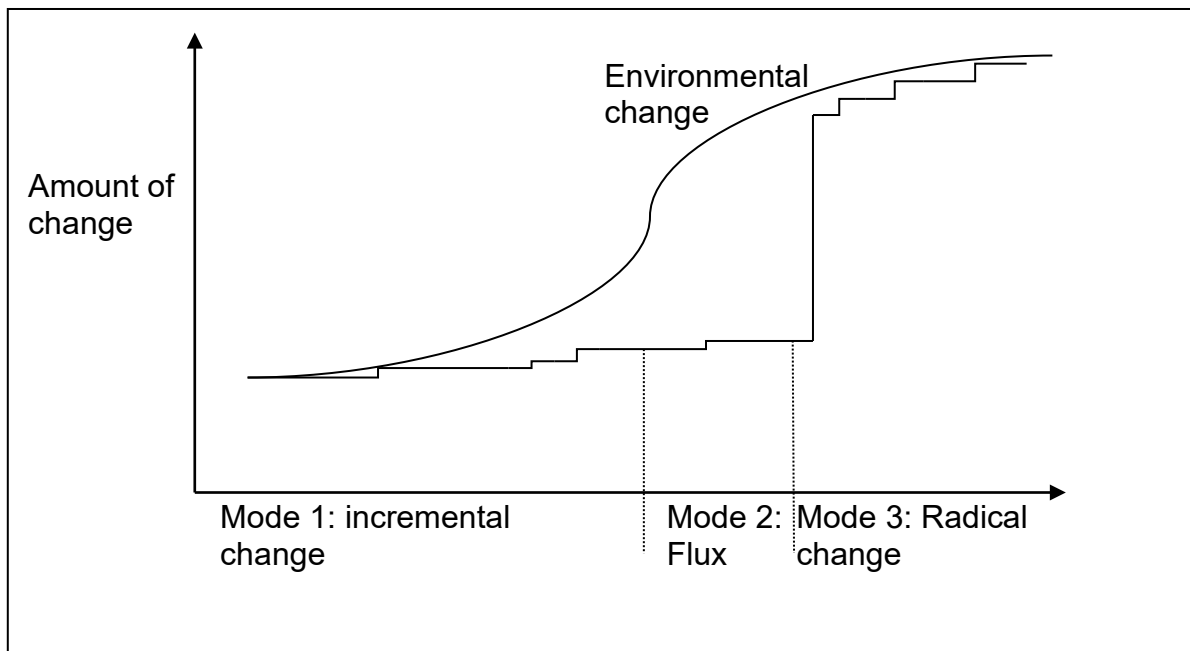
Figure 2: Patterns of strategic development (Source: Johnson, 1992)

The environmental change under consideration was ever stricter targets for safety performance, particularly a lower RCR. The laboratory was falling behind in its safety performance leading to a large change being required. It was even moving in a direction opposite to the environmental change.

A radical change is required to bridge the gap, amounting to a change in paradigm (Johnson, 1992). This includes creating a climate for change, intervention by outsiders and providing new symbols. Part of the radical change in the safety performance may be attributed to a change in management, effectively bringing about a climate for change and an intervention from an outside party.

This model demonstrates and supports how a cultural transformation could effect radical change.

A number of considerations are proposed for changing an organisational culture (Valuebasedmanagement.net, 2011b). These are each discussed in turn as relevant to the cultural transformation done at the laboratory.

- Propitious moments should be capitalised on (*ibid.*). Throughout the period of transformation, each small success was celebrated, such as a month without a recordable case. The reporting of near miss incidents were also celebrated as an opportunity identified where we could share in the learning from the investigation amongst all colleagues. This culminated with an award within the business unit for best safety performance for the calendar year 2011.

- Caution should be combined with optimism (*ibid.*). In striving towards an improved safety performance, it was recognised that it would only take a momentary lack of concentration for an accident to occur with injury to a colleague. Against this caution, nonetheless, was the belief that an RCR of zero could be achieved and sustained. The achievement should not be taken for granted; indeed, a sustained effort is required to maintain the high performance.

- Resistance to cultural change should be understood at both the personal and group level (*ibid.*). This resistance was manifested in people not trusting the ability of the team to achieve a goal of an RCR of zero and expecting management to offer solutions to existing problems. The legacy of having the worst safety performance in Sasol would take some time to overcome. Part of the legacy included a belief that that there may be repercussions for reporting near miss incidents, especially if there was negligence on the part of the involved person.

- Many elements should be changed but some maintained for continuity (*ibid.*). Previously, management inspections formed a major part of the laboratory safety management process. This often generated many corrective actions but did not engage personnel. The actions were slowly acted upon, if at all. The impersonal nature of how safety was managed was changed to an engaging style where inspections were substituted with walkabouts, discussing safety concerns with all staff. Actions were agreed upon with the focus shifting from administration to ownership of the situation to be rectified by the involved person. One key element from the existing system was maintained, namely peer observation, both formal and informal, in order to drive engagement by all personnel in safety.

- The importance of implementation needs to be recognised. The steps required to carry change forward include adoption, implementation and institutionalisation (*ibid.*). In this context, implementation required the understanding of everybody's role and the actions they are specifically responsible for. Implementation of a different safety strategy required the participation of all personnel. The concept of personal ownership of safety and the need for urgent corrective action became institutionalised over time. Further institutionalisation included the belief that a sustainable zero RCR was possible.

- Appropriate cultural forms need to be selected, modified and created. These include symbols, stories and rituals (*ibid.*). With the leadership transition in the laboratory, some stories and symbols were introduced into the environment. These included the phrase 'if I see it, I own it' as part of an engagement drive, and the imagery of a meerkat immediately disseminating information to the group, as was expected with the occurrence of an incident in a particular area.

- Socialisation tactics need to be modified (*ibid.*). Since there have been no new recruits to the laboratory for the past three years, this is not applicable. However, a set of six expected behaviours supporting the safety culture are well established and displayed. These behaviours include personal ownership of safety, belief in a zero RCR, a sense of urgency, leadership by example, and celebrating successes continuously. This could be considered to be the material upon which new employees could be familiarised with, and as a constant reminder to current personnel.

- Innovative leadership needs to be found and cultivated (*ibid.*). This leadership style is characterised by self-confidence, strong convictions and a dominant personality, able to convey a vision eloquently and dramatically. It may be argued that the current manager is self-confident with an exuberant personality and the ability to engage with people. This matches with the suggested leadership character.

In reviewing the eight considerations in changing organisational cultures, the laboratory transition has evidence of all of them, suggesting it to have undergone a relatively extensive cultural transformation.

The leadership required to drive the cultural transformation can be assessed against ways in which leaders can transform followers and the moral foundations of transformational leadership (Bass, 1990). Followers can be transformed in three ways:

- Broadening and elevating interests of employees;

- Generating awareness and acceptance of team goals;

- Emphasising group over personal interest.

In the laboratory cultural transformation, a group goal was set of achieving a zero RCR. The vision of the leader that this could be achieved was shared amongst all employees. The goal was not merely an improved performance, but an ultimate goal as far as safety performance was measured. The interest of employees was elevated to going home to one's family unharmed, not just to achieve some organisational goal but a personal mission with an internal locus of control. The purpose of incident reporting and subsequent investigation was escalated from being procedural to being for the development of corrective actions that would benefit the entire group so as not to have a similar incident elsewhere.

Examples of all three manners of transformation are evidence of transformational leadership being used to drive the cultural transformation in the laboratory.

The following characteristics have been proposed for transformational leaders (Bass, 1990):

- Charisma, providing vision and a sense of mission, gaining trust and respect;

- Inspiration, communicating high expectations using symbols and simplifying important purposes;

- Intellectual stimulation, promoting intelligence and careful problem solving;

- Individualised consideration, treating each employee as an individual.

Examples of each of these characteristics can be seen in the current leadership style used in the laboratory. Charisma is manifested in the vision of a sustainable zero RCR performance, with the confident and infallible view that the team could achieve this. The communication of an improved safety performance was simplified to the expression of a zero RCR goal.

The detail of how this was to be achieved was not communicated in detail beyond the reintroduction of a process previously applied. With this process, hazards are identified in an informal manner and a discussion held between the person identifying the hazard and the person exposed to it. The conversation was then guided on the principle that the person experiencing the hazard was to suggest solutions and take ownership thereof. The problem solving approach by the affected individual was thus an example of the intellectual stimulation aspect of transformational leadership characteristics.

As an example of individual consideration, management walkabouts were encouraged, where every employee was to be personally greeted and engaged on what obstacles they personally experienced regarding safely. Participation by all employees was encouraged in both formal and informal settings.

The characteristics of transformational leadership thus seem to have been demonstrated during the cultural transformation.

The cultural transformation may be viewed as a change process that can in turn be assessed against a change model. One such model has it as an eight step process consisting of the following steps (Kotter, 1995):

1. Create urgency by instilling the desire for change, to spark the motivation to start things moving;
2. Form a powerful coalition using strong leadership and support from key people;
3. Create a vision for change that is clear to everyone;
4. Communicate the vision often and demonstrate the behaviours required from others;
5. Remove obstacles to the change process;
6. Create short term wins with short term achievable targets;
7. Build on the change, recognising that quick wins are the start of a longer term process;
8. Anchor the change in corporate culture.

With this model, it is argued that the change can become part of the organisational culture (*ibid.*).

During the cultural transformation, there is evidence that characteristics of each of the steps in the above change model were followed, though not necessarily purposefully. The latter two steps leading the entrenchment of the change as part of the culture may be most important. Many quick wins were recognised and built upon, such as recognising the importance of yet another month, for example, without a recordable injury. The change was further anchored in the introduction of the concept that a zero RCR was part of the laboratory culture and that it could be assumed that it would continue. Personnel may have got used to the idea that what was previously a goal to achieve, had become part of the laboratory culture.

2.3.   PERSONNEL EMPOWERMENT

The level to which employees are empowered can be evaluated against relevant models. A leadership continuum can be used to classify leadership behaviours, as illustrated below.

Continuum of leadership behaviour

Boss-centred   Subordinate centred

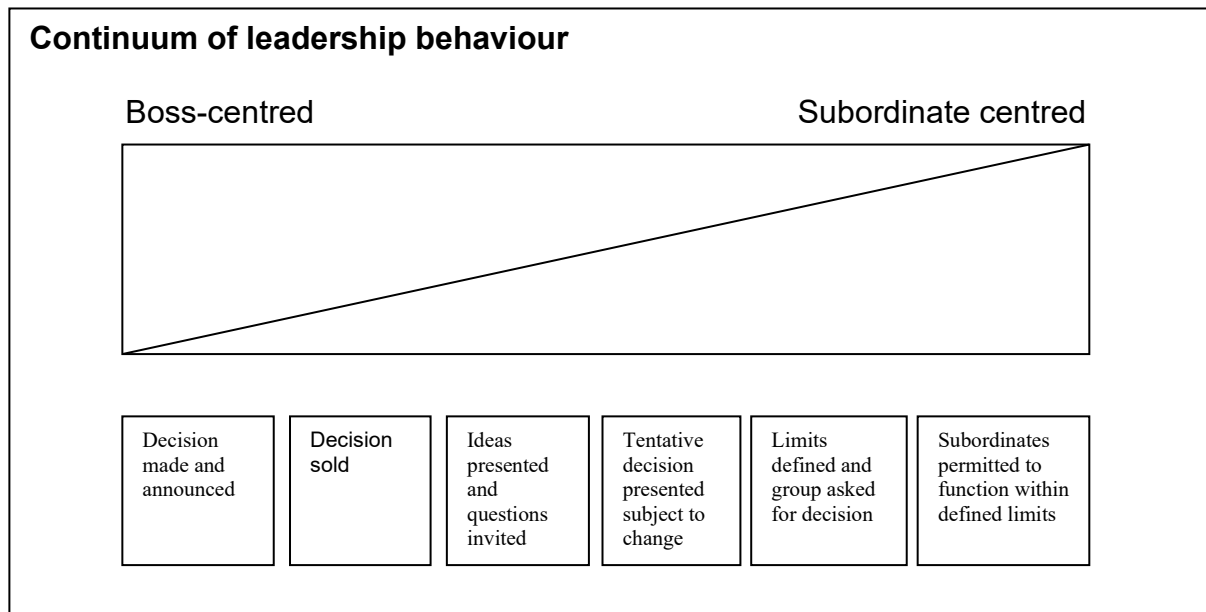| Decision made and announced | Decision sold | Ideas presented and questions invited | Tentative decision presented subject to change | Limits defined and group asked for decision | Subordinates permitted to function within defined limits |

Figure 3: Continuum of leadership behaviour (Source: Tannenbaum & Schmidt, 1973)

At the one extreme, the manager makes and announces decisions, whilst at the other extreme, subordinates function within defined limits. The choice the manager needs to make in a situation can be based on which forces are at work in the manager and the subordinates (Tannenbaum & Schmidt, 1973).

Prior to the leadership transition, decisions were taken by management in isolation and instructions given without employee engagement. More systems were imposed that employees had to subscribe to. This was an example of autocratic leadership. Following transition, there was greater employee involvement. This is appropriate when employees have high needs for independence (*ibid.*). The leadership transition gave ownership of safety to employees with, for example, a cultural phrase of 'if I see it, I own it'. The improved safety performance suggests that the new leadership style was appropriate.

Employee empowerment can be categorised as follows (Wilkinson, 1988):

- Information sharing – from management to employees, encouraging buy-in;
- Upward problem solving – informing management of problems or initiating innovation;
- Task autonomy – where the work group decides on tasks and their allocation;
- Attitudinal shaping – through changed behaviour;

- Self-management – decision-making at employee level.

Examples of employee empowerment arose with the leadership transition in the laboratory. Information might not have been better shared, but was simplified into terms that could be understood by employees. Rather than having a goal to achieve, without any mechanism given on how this was to be achieved, individual contributions to safety were defined for all, including peer-to-peer observation and reporting of all incidents.

People were previously not consulted on solutions to problems but were instructed. With the leadership transition, people were consulted on what they thought needed to be done to improve safety. They were given the freedom to implement solutions. Due to legal requirements, certain activities had to continue, such as regular inspection and conducting of regular safety meetings.

One of the earliest manifestations of employee empowerment with the leadership transition was with the frequently repeated phrase, 'if I see it I own it'. The importance with this was the changed behaviour from leaving an event or hazard to be discovered, to taking personal accountability, either by elevation to management or considering a next step that could be taken at a personal level. In this phrase were elements, as listed above, of task autonomy, attitudinal shaping, and of self-management. Clear examples thus exist in all categories of employee empowerment in the laboratory.

A set of five stages has been identified in the process of empowerment (Conger & Kanungo, 1988):

- Stage 1: diagnosis of conditions leading to a psychological stage of powerlessness – organisational factors and supervision;
- Stage 2: use of empowerment strategies by management – goal setting, participative management;
- Stage 3: provision of self-efficacy information to subordinates – removal of conditions leading to stage one, and emotional arousal;
- Stage 4: empowering experience of subordinates – strengthening of effort by performance expectancy or personal efficacy;
- Stage 5: behavioural effects of empowerment noted – persistence of behaviour to accomplish objectives.

With the leadership transition in the laboratory department, there might have been a diagnosis of conditions. Certainly, a less bureaucratic approach to safety was taken, where inspection was replaced by conversations between management and employees. This, together with setting a target of a zero RCR, constituted evidence of stage one. The introduced slogan of 'if you see it, you own it' is an example of stage 3, together with the belief being instilled in the employees that attainment of a zero RCR was possible. Stage 4 may have been characterised by better employee participation in safety related efforts and a possible mindset change. Stage 5 may be characterised by having achieved the goal of a zero RCR with a view to sustaining it by having it be seen as second nature or as a value subscribed to by all employees.

In the DuPont Bradley curve model (DuPont, 2012), a maturing safety culture is described, where injury rates can be reduced to near zero, as illustrated below.
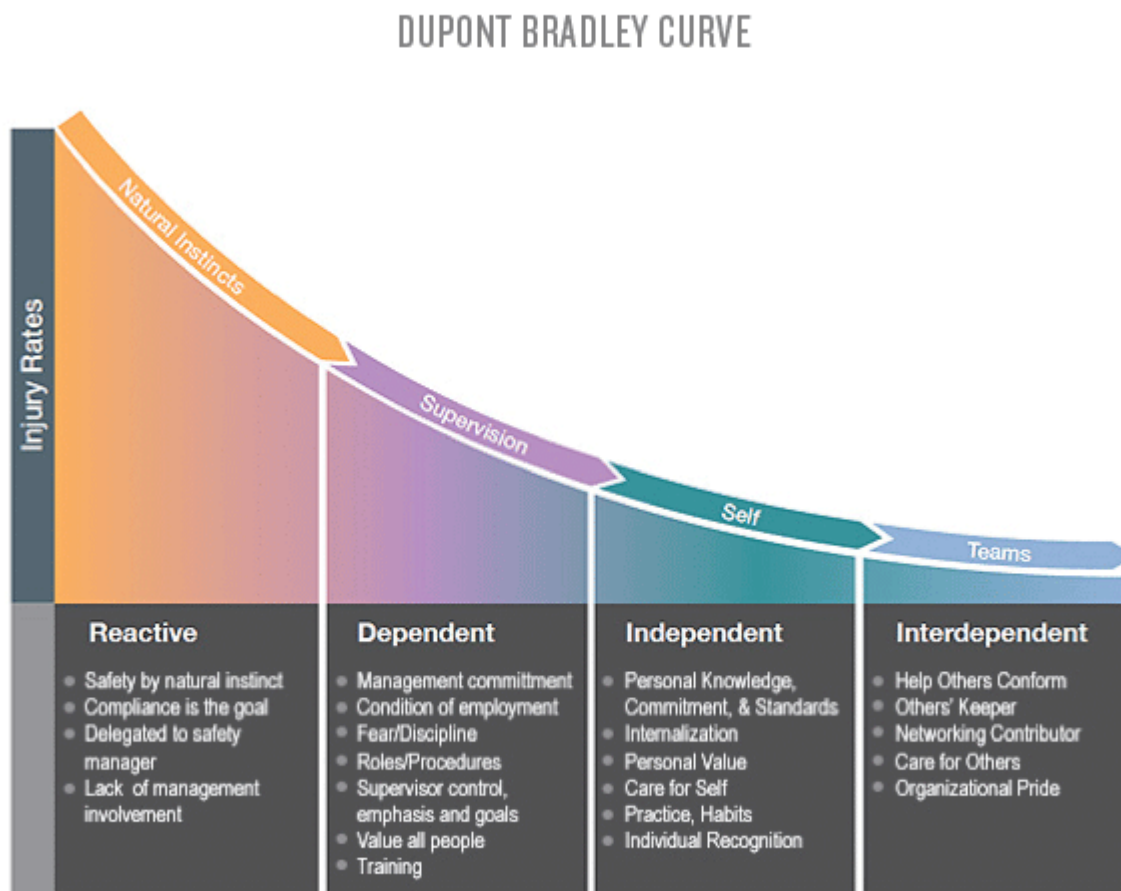

DUPONT BRADLEY CURVE

Figure 4: DuPont Bradley safety curve (Source: DuPont, 2012)

The dependent stage may have been typical of the laboratory prior to the leadership transition. Key characteristics here were following rules set by others. Transitioning through to an interdependent stage, employees begin to take responsibility for their own safety and that of others (DuPont, 2012).

2.4.   INCIDENT REPORTING

The importance of incident reporting can be judged according to the notion that underlying every fatality is an increasing number of less severe injuries, followed by near misses and risky behaviours (Rockwell Automation, 2007)

Figure 5: ConocoPhilips Marine safety pyramid (Source: Rockwell Automation, 2007)

By reducing the number of at risk behaviours and near-misses, the number of more serious injuries can be reduced. In the context of the laboratory, the occurrence of 1 recordable injury could be associated with 10 near miss incidents. However, if near-miss incidents are not reported, no corrective actions can be taken that would later prevent an injury, in a similar scenario.

2.5.   SUMMARY

The improved safety performance in the laboratory has been evaluated against a number of models. This analysis shows that the improved safety performance can be attributed to a

cultural transformation. The cultural transformation was demonstrated to have most of the key elements of its implementation. This was also attributed to a change in management style, characterised by greater employee involvement. A key benefit of the greater employee engagement was the liberty for near-miss incidents to be reported, with positive benefits to the overall safety performance of the laboratory.

CHAPTER 3: LITERATURE REVIEW

3.1.   INTRODUCTION

A number of opinions from academic literature are discussed below, related to the impact the following aspects can have on an improved safety performance:

- cultural transformation;
- employee empowerment;
- incident reporting.

The theory that these aspects can reduce accidents is also tested against documented findings. How existing academic literature impacts on the research documented is discussed in detail.

3.2.   CULTURAL TRANSFORMATION

The concept of a safety culture may have become a fuzzy concept (Guldenmund, 2010), and is used to encompass everything related to safety features that cannot be defined in any other way. It has been considered by safety practitioners as the cause for unsafe work practices.

The study of safety culture has a number of research approaches (Guldenmund, 2010), namely:

- academic – by field research or ethnography;
- analytical – by self administered questionnaires;
- pragmatic – study of structure, culture and processes.

The analytical approach, investigating the present status of safety in the organization is relevant to the research presented in this document. The purpose of such assessments should be on getting recommendations for improving the underlying culture to bring about safety improvements. Other approaches include ethnography, involving observation of people, and are useful to study past performance. Similarly, a pragmatic approach is required to position an organisation for the future.

Since the research documented here is a study of the current situation with safety performance, a survey questionnaire seems to be appropriate. In order to bring about safety improvements, the opinion will be sought of what needs to be done to continue with the current safety performance as perceived by the employees of the section being researched.

In order to achieve a safety culture, it is proposed that people must take personal accountability for safety (Geller, 2000). Leadership, as opposed to management, is required, with the key difference being getting the people engaged to meeting the goal of zero injury, as opposed to being instructed. A proactive approach is required to hold employees accountable for preventing injuries. It is argued that management is required to prevent injury, but that leadership is required to achieve a total safety culture. If people are self-directed towards safety, then no external system is required to keep them performing safely.

The degree to which employees are self motivated towards safety and the extent to which they take personal accountability will be examined as part of the survey used in the research being done. As part of this, it may thus also be important to examine whether they would report incidents, as part of their commitment to actively participating in safety.

The use of questionnaires for conducting research into safety culture has been criticised for not being successful in exploring the core of the culture (Guldenmund, 2007). Many factors have been explored and linkages explored which have not been well replicated. A number of proposals are offered to what should be measured as opposed to what has been previously measured. Safety values are explained to not have been well assessed through questionnaires.

Utilising this information, the research discussed in this document will not seek to add factors or explain causal relationships but identify motivational factors for working safely and identifying, for further exploration, what an exemplary safety performance could be attributed to.

A framework for examining the development of organisational safety culture has been developed (Parker, Lawrie & Hudson, 2006). Characteristic features of each maturing level of safety culture are proposed. The levels of safety culture are (Parker, *et al*, 2006):

- Pathological;
- Reactive;
- Cumulative;
- Proactive;
- Generative.

Each of these levels has proposed descriptors for each of these levels, covering aspects of incident reporting, unsafe acts and training, amongst others. This is for an organizational level and is applicable to the oil and gas industry. The descriptors arose from interviews with senior management in the industry and not from the level of other employees. The features from the framework will be used later for assessing some of the results from the questionnaire used in this research.

Safety culture and power are intertwined to the extent that any research into safety culture should investigate power and conflict too (Antonsen, 2009). Using the Challenger space shuttle disaster as an example, it is argued that abuse of power was a contributing factor to the tragedy but was not fully explored to higher and unseen dimensions in the subsequent enquiry. In researching a safety culture, the shared and unshared views between management and employees should be explored. It was chosen in this research to not have different questionnaires for management and employees and to not distinguish between the responses. This would thus be a weakness in the research and would need to be further explored. However, in light of the safety performance achieved, it is assumed that there is alignment between management and employees, otherwise an improved safety performance could not have been achieved.

It is argued that safety incentives should be used cautiously (Williams, 2008). This may cause the non-reporting of incidents as doing this could negatively impact monetary rewards. It is recommended that rewards should be process oriented and not goal oriented.

It may be difficult to establish the reasons for not reporting incidents so the research discussed will seek to establish whether individuals would report incidents or not. The obstacles to reporting incidents may include negative impacts on bonuses or other reasons.

Research strategies for investigating the impact of organisational culture on safety include the following approaches (Hopkins, 2006):

- Ethnographic method involving direct observation of activities;
- Perception survey;
- Review of material from investigation into major accidents.

The survey method has the disadvantage of measuring perceptions and not what actually happens. It is seen by Hopkins, however, that the survey method is appropriate for studying

individuals' attitudes and perceptions. It is stated that the deepest insights into the effect of organisational culture results from investigations following major incidents.

This was typified in the investigations into the Challenger Space Shuttle disaster (Hopkins, 2006). What was lacking in the culture at NASA towards safety was investigated retrospectively. It is advocated that an examination of the contribution of culture to safety be measured proactively, by survey, against a high reliability organisation (Hopkins, 2006). Some characteristics of such an organisation are documented and include commitment to a safety culture, a wariness of success and recognition of the importance of communication. In their review of safety culture (Hopkins, 2006), it was argued that cultural elements led to a major incident, but this does not necessarily mean that the positive form of such cultural elements would have prevented accidents.

The alternative research methods described by Hopkins, suggest that a survey is most appropriate in the setting of this research. An ethnographic study would require much more resources to execute than is immediately available and should be done by an external party with a setting to prevent bias. It is unfortunate that the deepest insights into a safety culture only emerge following a major tragedy. This research will seek to establish any pressing concerns, as perceived by the affected individuals that would compromise the current peak safety performance.

Many authors emphasize the importance of a safety culture, but without constructive or predictive validity (Guldenmund, 2000). Moreover, there is no comprehensive theory on safety culture. Investigations into a safety culture have usually been done via self-administered questionnaires. It is concluded in this study that safety climate be considered as an alternative safety performance indicator. A framework is proposed against which a safety culture can be investigated (Guldenmund, 2000). This framework examines culture at the three levels of visibility as described earlier. It also specifically examines various facets of assumptions and attitudes towards hardware and systems.

There may have been progress since the article from Guldenmund in establishing the relationships between various aspects of safety and the extent to which they indicate safety performance. With this in mind, this research will aim to characterise a particular group of people and establish what they perceive to have been most important in achieving a peak safety performance.

The use of questionnaires is criticised as a means of evaluating a safety climate due to the dynamic interactions and relationships involved (Mylett, 2010). It is proposed that a critical realist method is used, where interactive relationships and context are emphasised. In previous studies by other authors, Mylett notes that some organisations performed well on safety surveys, but were fundamentally unsafe. It thus makes it appropriate in the research being discussed that other factors be explored to what a peak safety performance could be attributed to, and not be limited to an exploration of cultural aspects only. For future research, the interaction of identified factors could be further explored.

Safety culture has been demonstrated to be an antecedent to safety performance (Griffin & Neal, 2000). Safety compliance and safety participation were seen to be separate components of safety performance. A number of dimensions of safety culture were measured, including:

- Values;
- Communication;
- Practices;
- Training;
- Equipment;
- Knowledge.

No direct linkage to safety performance factors of compliance and participation were found. This suggests for this research study, that similar aspects of a safety culture should be examined and tested. It may be useful to examine key aspects that changed over time, but would require a longitudinal study. This research does not have clear information about what the key characteristics of the group under study were at the stage when its safety performance was at its worst.

In a retrospective approach to researching safety culture, a number of factors were identified that could be associated with occupational accidents (Stave & Törner, 2007):

- Deficiencies in physical environment;
- Deficiencies in work organization;
- Insufficient communication and learning;
- High responsibility with low control;
- Conflicting goals;
- Gap between procedures and practice.

Although their research is specifically related to the food industry, a parallel can be drawn to the laboratory function as it also involves much manual manipulation and exposure to the risk of hand injury. It may be that if these factors are addressed, that a lower injury incidence may result. From this, questions will be included in the survey to ascertain the extent to which these factors are present in the survey group.

It has been shown that transformational and passive leadership have divergent effects on safety climate (Kelloway, Mullen & Francis, 2006). In this context, passive leadership was characterised by management by exception and a laissez-faire style. They found in a study amongst part time employed students that passive leadership had a negative impact on safety climate and consciousness. The key finding was that there was a negative rather than a null impact on safety. Safety specific transformational leadership was demonstrated to have positive impact of similar magnitude to the negative impact of passive leadership.

Transformational leadership does not need to have a safety specific focus to motivate employee participation (Inness, Turner, Barling & Stride, 2010). This leadership style did not, however, show a relationship between safety compliance and safety performance. This was explained to be due to the greater latitude given to employees to use their discretion to comply with safety procedures. The implication from this finding is that zero tolerance in breaking safety rules, especially in wearing PPE, may be threatened. Transactional leadership thus has a role to play in ensuring compliance to inviolable safety rules.

The implication to the research being conducted is that transactional style management activities also need to be explored as a possible explanation for an improved safety performance.

In another study, safety specific transformational leadership was demonstrated to predict safety climate and safety consciousness (Barling, Loughlin & Kelloway, 2002). The results were generalised to a number of workplace situations and groups of people. The results showed an indirect relationship between transformational leadership to occupational safety via safety climate. The research covered instances where there were recorded injuries but with non-zero and questionable injury rates being used.

Perceptions of safety climate have been demonstrated to positively influence safety performance by affecting knowledge and motivation (Neal, Griffin & Hart, 2000). Safety climate in this context is defined as perceptions of the value of safety in the work

environment (Neal *et al*, 2000). This study was limited to a hospital so might not be applicable in another setting. Amongst the findings was that the relationship between motivation and compliance was stronger than that between motivation and participation.

It has been hypothesized that safety climate has a lagged effect on safety motivation which in turn has a lagged effect on individual safety compliance and participation (Neal & Griffin, 2006). This was tested in a hospital setting and the findings supported the first hypothesis, but the second only partially, with only the participation aspect supported. A lag of up to two years was suggested in the relationship between motivation and participation.

This suggests that a safety climate survey should be conducted in a longitudinal form as the participation of employees may increase over time, as opposed to some quick change. A snapshot survey may thus have limited use and should be redone over a two year period at least.

It has been demonstrated in a manufacturing organisation setting that both transformational and transactional leadership had a significant relationship with safety participation (Clarke & Ward, 2006). This again shows, as with other studies, that both managerial approaches are required to improve safety performance in an organisation.

The role of supervisory safety practices has been demonstrated to have a positive effect on safety records and in improving safety climate (Zohar, 2002). In this transactional type leadership role, the use of PPE and strict adherence to procedures was monitored on an ongoing basis. It is also argued that both approaches are required for improved safety performance.

The surveyed literature shows that transformational leadership has a positive influence on participation and safety performance, but that compliance to rules requires other leadership styles. The implication from this is that incidents involving rule violation or non-compliance with procedures may still occur. This suggests that motivation to participate positively with safety needs to be supplemented with knowledge of procedures to be followed and a zero-tolerance approach to rule violation. Both transactional and transformational leadership approaches are required, but possibly at different levels of management.

Some of the articles discussed so far suggest an approach to improving safety in general. Many things can be attempted to improve safety but the impact of each of these factors is not

discussed. What is clearly demonstrated, however, is the need to have the engagement of employees to improve safety performance.

In reviewing literature related to transformational leadership, a need was identified to closely examine the extent to which employees take accountability for their own and others' safety.

3.3.   PERSONNEL EMPOWERMENT

It is argued that safety problems need to be addressed and fixed in a timely manner for it to be demonstrated that management cares about safety (Williams, 2008). Actions speak louder than words. If corrective action cannot be taken, this needs to be communicated. Although the approach for addressing corrective actions is not discussed, it seems that it may be viewed that management should be responsible for this. This important feature of a safety culture will be further examined in the safety survey being done, by examining perceptions of whether corrective actions are done in time.

A positive safety culture is characterised by active employee involvement in safety management efforts (Williams, 2008). The employee participation is manifested as them having the purpose of having zero injuries (Geller, 2002). This is amongst ten principles proposed, based on empirical research. Other principles include feedback and elevating safety to a value, instead of a priority.

Desired safe behaviours in a workplace are usually uncomfortable, inconvenient and inefficient (Geller, 2010). Thus, without self-motivation, shortcuts may inevitably be taken. With autonomy, relatedness and competence, self motivation may be assured. A series of guidelines are then offered to guide self-motivation to drive an injury free culture. In the research being conducted, the motivational factors for participation in working safely will be explored.

In a broad study using historical data, it was found that high quality jobs, characterised by being employee centred and empowering to employees reduces the frequency of injuries directly and indirectly through job satisfaction (Barling, Kelloway & Iverson, 2003). These results suggest that empowering employees by training, introduction of variety, and other aspects associated with employee empowerment will have positive benefits to safety.

In a study amongst hospital staff, psychological empowerment was demonstrated to have a positive relationship to safety participation (Ford & Tetrick, 2011). A negative relationship

was shown between empowerment and occupational hazards, with people in the most hazardous positions feeling the least empowered. This suggests that employees faced with the greatest hazards should be consulted in improving their own safety in order to improve their sense of empowerment and overcome their negativity towards safety. For the research to be conducted, the extent to which employees feel consulted will be further explored.

In creating a tool for diagnosing safety climate, it was concluded that measures of management safety empowerment should be included (Kines, Lappalainen, Mikkelsen, Olsen, Pousette, Tharaldsen, Tomasson & Törner, 2011). Empowerment was seen as a means to convey trust and to reinforce safe working practices. It demonstrates that management value employees' contributions to safety. It can be concluded from this article that empowerment of employees is a key contributing factor to creating a safety climate.

Employees of an organization are uniquely placed to identify hazards no one else can see (McClay, 1995). They need to be involved in the hazard control process and be able to do something about the hazards and if necessary stop production to have the hazard addressed. A number of success stories are discussed where a new level of safety performance was reached with the introduction of a variety of schemes where employees were empowered to take an active role in managing their own safety and that of their co-workers.

In an investigation in a chemical company operating on multiple sites and involving 500 employees (Hechanova-Alampay & Beehr, 2001), positive correlation was found between the level of empowerment and safety performance. The uniqueness of this study is that this research was done two years after a managerial delayering process which increased span of control. This research suggests that despite a reduction in workforce that empowerment can be achieved, with a positive benefit to safety performance amongst departments in a single organization.

In a meta-analytic review, a stronger relationship was found between safety participation, rather than safety compliance, and safety culture (Clarke, 2006). This demonstrates across previous authors' findings, that a positive safety culture would lead to employees participating towards safety out of choice rather than from being compliant to set of instructions. It was also seen that the role of safety participation in enhancing safety may be underestimated because it is usually only associated with lower accident occurrence. It will have a positive effect on other safety aspects such as better work design and physical environment.

Employee empowerment was consistently associated with a lower injury incidence rate (Shannon, Mayr & Haines, 1997). Empowerment in this context was seen to be the extent to which employees used their own initiative as opposed to instruction. This study summarised finding from research over more than 20 years. Other factors such as those associated with a transactional leadership style had contradictory results when associated with a lower injury incidence rate.

3.4.   INCIDENT REPORTING

Creating a culture of fear drives the reporting of incidents underground with incidents not being reported (Williams, 2008). Mistakes need to be seen as learning opportunities (Williams, 2003).

The way in which an organisation handles information from safety relevant issues is crucial (Hopkins, 2006). This information needs to be analysed and communicated within the organisation. Near miss incident reporting is thus a crucial opportunity to disseminate learning to prevent reoccurrence which may have greater impact.

The usefulness of incident reporting can be based on the safety pyramid discussed earlier. However, this assumes that disaster is inevitable (Williamson, 2003). A better proposition is engineering out unsafe behaviours. This suggests that incident reporting should not be the only focus for learning, but attention should be paid to their precursor, namely, at-risk behaviours.

It may be argued that unsafe behaviour can be a contributing factor to accidents (Geller, 2011). Labelling it as such would invite further discussion to discover more factors leading to an injury. From this alternative viewpoint, engineering out at-risk behaviours may be idealistic and an oversimplification of the factors leading to injury. The participation in a behaviour based safety system is to be included in the safety survey to be conducted.

Employee empowerment may lead to non-reporting of near-miss incidents (Lauver, Trank & Le, 2011). A hypothesis that greater empowerment would lead to more reporting of near-miss incidents was unsupported. In fact, fewer near-miss incidents we reported. Although the research was limited to two organisations and 300 employees, it does suggest that empowerment may lead to non-reporting of safety events, including near-miss incidents. If empowerment leads to the delegation of the decision to report an incident or not, the reporting of incidents then needs to be encouraged. A limitation of their research, however,

is that near-miss incidents might not have been adequately understood by the respondents (Lauver, *et al*, 2011). It thus needs to be made clear in the safety survey to be conducted in this research what the difference is between near-miss incidents and accidents and treat them as separate issues when discussing the results.

Many ways of improving and increasing incident reporting can be listed (Johnson, 2006). It is mentioned that the aviation industry has had great success in increasing the number of incidents reported. Included in the list is clarifying what incidents should be reported and convincing employees what the benefits are of reporting all incidents. These benefits include better understanding that leads to a prevention and reduction in injuries.

Organizations with a poor safety climate have a higher rate of unreported injuries according to a study on a large construction project (Probst & Brubaker, 2008). Although there might be other reasons for the underreporting of injuries, this study does suggest that there needs to be a safety climate for all injuries to be reported. If visible injuries are not reported, the implication is that minor injuries and near- miss incidents will not be reported at all. The suggestion is also that the definition of what constitutes any particular injury classification might not always be clear.

For the research being conducted, a distinction will be made between the reporting of accidents involving injury, and near-miss incidents, not involving injury. The relative frequency of the responses to these will be indicative of the extent to which both types of safety events would be reported.

It has been shown that a no blame approach to the reporting of near miss incidents enhances organizational learning (Provera, Montefusco & Canato, 2010). Here, a no blame approached is defined to be an organizational approach where a constructive attitude is held towards the reporting of near-misses. This type of incident reporting was previously limited to high reliability organizations with limited research having been done in other organizations. The driver in high reliability organisations is that even minor error can have tragic consequences than in other organisations.

The positioning of a laboratory may have some aspects of high reliability organisation in that explosive and highly dangerous materials are used, that could lead to extensive injuries to employees. It is left for another study to ascertain the extent to which a blaming culture exists and the liberty felt by the group to reporting all near-miss incidents.

The literature surveyed has mixed findings on incident reporting, showing that the factors leading to it being done are dependent on many factors including cultural aspects and leadership style. A climate supporting incidents being reported needs to exist, but with encouragement from leadership to do so without fear of repercussion to the employees of the organisation.

3.5. SUMMARY

A number of supporting arguments presented demonstrate how cultural transformation, employee empowerment and incident reporting can contribute to an improved safety performance. However, there are contradictory results and a demonstration that these aspects alone will not necessarily lead to an improved safety performance. There are unclear relationship between the involved factors and safety performance. Nonetheless, definite activities and supporting approaches can lead to the necessary conditions required to maintain a high safety performance. A review of the literature has led to certain relevant lines of questioning in a survey, also establishing a basis against which the research results can be evaluated.

CHAPTER 4: RESEARCH DESIGN

4.1.   INTRODUCTION

What follows is a discussion on the various aspects of the design of the research done, including why a certain approach was followed. The choice of approach is determined by the objectives of the research.   Issues of validity and ethics, sampling and limitations are also discussed. The data collection method is described as well as the methodology followed in analysing the data. Advantages and disadvantages of various approaches are discussed together with what was done in order to limit the impact of certain disadvantages.

4.2.   RESEARCH APPROACH AND METHOD

The main types of research strategies include descriptive, exploratory, and causal (Coldwell & Herbst, 2004):

- Descriptive research is applicable where description of a situation may provide important information;
- Exploratory research does not start with a specific problem and is suited to new or vague topics;
- Causal research attempts to demonstrate that a change in one specific variable causes a certain outcome.

The research to be conducted will be most suited to the descriptive approach. The topic to be covered is not new, as demonstrated by previous discussion of research by other authors. It is thus not suited to the exploratory research approach. There are many complexities and perspectives on the topic to be covered suggesting that causal research is not applicable. Causal research normally follows on from descriptive and exploratory research (Coldwell & Herbst, 2004). This research seeks to identify factors that contribute to an improved safety performance in a certain set of conditions as well as the impact of certain predetermined factors.

The descriptive research approach aims to answer who, what, where and when type questions (Coldwell & Herbst, 2004). Descriptive research also attempts to profile a group. In this context this research aims to describe the perceptions of laboratory personnel as to what led to an improved safety performance and what would be required to maintain a zero RCR. The intent of this research is to describe characteristics of a group of people who have achieved an

ideal RCR or particular measure of safety performance from a previously worst in class safety performance. The descriptive approach does not provide evidence of a causal relationship (Coldwell & Herbst, 2004).

A research design specifies the methods and procedures by which data will be collected, measured, and analysed (Coldwell & Herbst, 2004). One descriptor of design is observation, where activities of a subject are inspected and interrogation or communication where subjects are questioned and responses collected. This research will use an interrogation design, using questionnaires that respondents can fill in and return.

Research design may also be categorised as exploratory or formalised (Coldwell & Herbst, 2004). The exploratory design is suitable where developed data is limited. Formalised studies include causal and descriptive research design. This research can thus be categorised as being formalised.

Design can also be categorised as experimental or *ex post facto* (Colwell & Herbst, 2004). With experimental design, variables are manipulated by the researcher. With *ex post facto*, researchers report what has happened or has happened to the variables. Since this research is descriptive of characteristics of a population and has no variable manipulation, it can be classified as *ex post facto*.

In cross-sectional studies, a study is conducted once, whilst a longitudinal study is repeated over a period of time, tracking changes in variables (Coldwell & Herbst, 2004.). This research is cross-sectional, being conducted once off, but in a particular set of circumstances. These circumstances are where a peak safety performance has been achieved following a period where the group had one of the worst safety performances in the particular company. Although cross-sectional, this survey could form part of some future longitudinal study based on changes in safety performance or continued high safety performance.

Research approaches may also be categorised as qualitative and quantitative (Coldwell & Herbst, 2004). The qualitative approach is used to examine the perceptions of the subjects. With the quantitative approach, data can be statistically analysed. A mixed method approach was chosen, where qualitative data is collected and subjected to categorisation and mathematical description leading to quantitative description.

Good research designs have the following characteristics (Coldwell & Herbst, 2004):

- Experimental in nature (or closely resembling that) – the less experimental it is the more difficult the validity of the findings become;

- Feasible in terms of available time and measurement problems – sequence and event timing are thought through to prevent later problems;

- Flexible by duplication of essential design features to ensure validity of the overall study;

- Efficient by minimising threats to validity, at minimum cost.

As previously discussed, this is descriptive research and not experimental. However, the other characteristics can be met. It is feasible in a limited time to conduct a survey of a certain population. The subjects are local to the researcher, are known and thus approachable. Efficiency will be later discussed under validity.

4.3.   VALIDITY AND RELIABILITY

Consistency is a key characteristic of reliability (Coldwell & Herbst, 2004). To thus ensure reliability for the research being conducted, one identical questionnaire is to be used for the survey group. It was decided not to have separate types of questions for different levels in the organization as it meant to investigate the overall safety climate of the survey group and not make any distinction between any employee categories.

Validity can be subdivided into internal and external validity (Coldwell & Herbst, 2004). Internal validity refers to the purpose of the study and external validity to the study's generalisability. There are a number of validity issues (Coldwell & Herbst, 2004), namely:

- Face validity – do the measurement items measure what they are supposed to;

- Content validity – do the items on the measurement scale fully represent the area under study;

- Construct validity – how well the items in the measurement are measured;

- Concurrent validity – how well do the measurements correlate to those of another at the same time.

With the research conducted, employees' perceptions and opinions about various aspects related to safety are to be measured. A combination of closed and open questions are to be used to ensure that qualitative information includes broad opinion and agreement and disagreement to certain statements regarding safety. This combination is chosen to ensure face validity.

In order to improve content validity, a number of themes of questioning have been chosen to broaden the area under study. The study is not intended to be universal, but to cover certain important themes related to safety, identified previously.

Construct validity will be addressed by providing a number of options in a Likert scale for a series of closed questions. This is to be complemented with a series of open questions to allow for other factors to be explored that may account for the current safety performance and what would be required to maintain it. Some degree of anonymity can also assist in assuring construct validity.

A series of themes of questions were developed, with two or three questions per theme. The questions were then randomised before being set out in a questionnaire. The purpose of this was to avoid having the survey group tick blocks off in a pattern but concentrate on each question individually. This also serves to further improve construct validity.

Concurrent validity is tackled by asking questions in a number of ways to ensure they are not misinterpreted. As an example, the adequacy of processes is assessed by asking whether there are enough or too many.

4.4.   DATA COLLECTING METHOD

Data collection methods include questionnaires, interviews, documentation reviews, observation, focus groups and case studies (Coldwell & Herbst, 2004). Each has advantages and challenges. Considering the purpose of each, relevant to the objectives of the research, a survey by questionnaire seems most suitable. A survey can be an excellent way to get peoples' opinions and attitudes (Hofstee, 2006).   This approach has the advantages of anonymity, inexpensive administration, easy analysis, and the ability to collect much data from many people (Coldwell & Herbst, 2004). The intention of the research is descriptive, making a survey appropriate.

Surveys have a number of disadvantages including (Coldwell & Herbst, 2004):

- Reactivity – respondents tend to give socially acceptable responses to make them look good or to seem what the researcher requires;
- Sampling frame – difficulties in accessing the proper number and type of people needed for the sampling to be representative of the population;
- Non-response rate – many people approached will opt not to participate or drop out;

- Measurement error – surveys have many systematic biases.

In order to limit these disadvantages, the respondents were requested to be as honest as possible. The sampling frame did not pose a problem as all were easily accessible with all making use of email and being locally situated. The non-response rate was expected to be high, so no sampling was used. Reminders were sent out twice and peer managers requested to remind individuals to participate. Since much of the laboratory is shift operation, the due date was set such that all shifts could participate during at least one complete shift cycle. The timing of the questionnaires was set to be after completion of a project where operations were relocated and just before a series of holidays where many employees would take leave.

Questionnaires have challenges of not getting careful feedback, and not getting the full story. The wording of questions may also bias responses. To address these challenges, open ended questions are used to get a fuller, but not necessarily complete story. To minimise bias from wording, some closed questions were repeated, phrased both positively and negatively.

A combination of closed and open questions was chosen in order to have both specific aspects of safety answered, and to allow respondents to offer their own opinion on various aspects. Open questions were also necessary to meet the objective of establishing other factors that led to an improved safety performance. It was also thought that the combination of questioning would stimulate interest in responding.

The questionnaire used is appended in appendix 1.

4.5. SAMPLING

A population is defined as a group of people or items under investigation (Coldwell & Herbst, 2004). Due to practical difficulties in researching a population, a sample is usually drawn from a population. This sample is then studied and inferences made to the population. For the purpose of this research, the population is defined as the employees of the laboratory. The study is limited to that group of people that participated in achieving a zero RCR. The approach is to include the entire population in the research as this can be readily done with the data collection method used.

Reasons for sampling include economy, timelines, population size and accessibility (Coldwell & Herbst, 2004). Sampling has not been opted for as the population size is small enough to question in its entirety in a reasonable time. This approach then avoids some of the

errors associated with sampling from a population. Accessibility does not pose a problem, as all members are located in close proximity to the researcher.

4.6.   ETHICAL ISSUES

In the research process, three parties are involved, including the researcher, the user of the research results and the respondent (Coldwell & Herbst, 2004). The researcher has a number of rights and obligations, including:

- Fairness – data to be objective and factual;
- Non-distortion of findings – facts to analysed fairly and reported accurately;
- Confidentiality – preserving privacy and anonymity of respondents;
- Disclosure of defective information and erroneous conclusions – conclusions to be justifiable from the data.

To meet these rights and obligations a number of steps have been taken as part of the research.

From a fairness and non-distortion perspective, the data was gathered from a number of respondents with no replies being rejected. All data gathered is presented elsewhere in summary form, but is available in its entirety.

To ensure confidentiality, the questionnaires sent out did not require anyone to divulge their name. To further preserve anonymity, the option of returning completed questionnaires via a collection box was offered. Furthermore, the questionnaire was sent out to the potential respondents with an email of informed consent (appendix 2), committing the researcher to neither divulge any individual's response and offering a mechanism of anonymous return of the completed questionnaire. It is acknowledged that the option of return email may have led to respondents giving responses that were socially desirable.

Specific analysis methods, described in detail later, are to be applied to the data in its entirety to ensure that it can both be reproduced and to ensure that that the results can be recalculated or be available for scrutiny.

The respondent has a number of rights and obligations (Coldwell & Herbst, 2004), including:

- The obligation to be honest;
- Privacy;

- Concealment.

Honest responses were requested from the participants and the anonymity mechanisms offered were aimed at ensuring respondents were able to be honest. The informed consent sought to preserve their privacy.

In handling the data, as returns were emailed back to the researcher or were collected from boxes, a unique number was written on each questionnaire, as a means of preserving its uniqueness and anonymity. No list was maintained in which the respondent was linked to any particular survey returned by email. No distinction was made during the course of surveys which were emailed back and which were placed in collection boxes. It was assumed that where anonymity was an issue that the researcher was trusted to maintain this or that collection boxes could otherwise be used.

Concealment was addressed by discussing in the email of informed consent what the data would be used for, indicating its use to be both for safety improvement objectives and as part of research.

4.7.   ANALYSIS OF DATA

The purpose of data analysis is to create meaning from data (Coldwell & Herbst, 2004). Common methods of data analysis include:

- Descriptive statistics including number such as frequencies, central tendency such as mean, and variation such as standard deviation;
- Correlations to investigate relationships between variables;
- Comparisons between groups;
- Trends of data over time.

Due to this research being descriptive of nature, analysis will be limited to descriptive statistics.

Before data analysis can be done, some preparatory work is required, namely editing, coding and tabulation (Coldwell & Herbst, 2004). The purpose of editing is to ensure data quality including completion, accuracy, legibility and consistency. To this end, all questionnaires were checked and none rejected. Some questionnaires were incomplete with the open questions not being answered but were still included as closed ended sections were complete.

Coding is a procedure by which data is categorised or grouped into classes (Coldwell & Herbst, 2004). It is necessary for efficient analysis of a large number of responses. Coding was applied to the open ended questions in this research in order to categorise the type of response given.

Categories can be established using the following criteria:

- Appropriateness to the research problem, by positioning the data correctly for deriving relationships;
- Exhaustiveness, to ensure that the categories are not limited, and that a category of 'other' has limited content;
- Mutual exclusivity, where data fits in one category only;
- Single dimension, where categories are defined by one concept.

With this research, the response to each open ended question was reduced to a particular key word or theme that was linked to the themes of the closed questions. Some responses covered many facets and were thus included in more than one category. As some of the answers were incomplete or demonstrated a clear misunderstanding of the question, they were categorised as 'not used'.

4.8. LIMITATATIONS AND DELIMITATIONS

The purpose of the descriptive research conducted was not to test hypotheses nor establish causal relationships. The purpose was to describe a population of respondents from a setting where a peak safety performance, as measured by an RCR, was achieved and what they perceived it to have arisen from. Their opinion in what would be required to maintain it was also sought.

To make the research useful, however, a number of characteristics of such a group were tested both by closed and open questions to ensure a comprehensive basis was achieved from which further research could possibly be conducted.

The scope of the analysis was a department in a petrochemical industry and the results might not be generalisable to the whole company or industry, due to differences in characteristics and operational settings of such departments. Other departments have different risk profiles and track records in terms of safety performance, which may affect their current characteristics. This research does, however, seek to demonstrate key characteristics of a

group of individuals having a particular safety performance, which may suggest interventions or approaches required to improve safety performance and to subsequently maintain such a standard.

4.9.   SUMMARY

Key aspects of the research have been discussed with detail on why certain approaches were taken in conducting it, and how data was collected and analysed. This may also serve as a basis for replication and for conducting further research.

CHAPTER 5: DATA ANALYSIS AND FINDINGS

5.1.   INTRODUCTION

What follows is a detailed discussion of the research done and the data collected. Based on the data collected, an analysis of the data will be presented from which certain conclusions may be drawn. The findings will be tested against theory for understanding and clarifying similarities and differences.

5.2.   POPULATION AND SAMPLE

The subject of the research was limited to a department of a petrochemical company which had achieved an RCR of zero. Since the purpose of the research was descriptive in nature, the population was defined to be the employees of this department. All 200 employees were requested to participate in the survey and since all had access to email; this mechanism was used to distribute the survey.

Of the 200 employees requested to participate, a total of 58 people responded. Responses were by a mixture of return email and anonymous collection boxes. These collection boxes were already in place for gathering data for an ongoing behaviour based safety system and were conveniently situated and well known to all potential participants.

Surveys have a high non-response rate (Coldwell & Herbst, 2004) with many opting not to participate. This survey had a low response rate of 29% which might invalidate the results if the opinions are not representative of the entire population of 200 employees.

5.3.   RESEARCH INSTRUMENT

A questionnaire was used with a combination of closed and open questions. A Likert scale was used for the 24 closed questions. After the closed questions, three open questions were presented, with space left for individuals to type or write answers.

The 24 questions were derived from a series of previously identified categories of aspects of safety identified from models of safety management and a literature survey. The questions were categorised as follows:

- Consultation;
- Empowerment;
- Incident reporting;

- Learning;

- Motivation;

- Processes;

- Responsibility;

- Training;

- Corrective actions;

- Optimism.

Between two and three questions were posed per category. The questions were then put in random order so as to ensure that each was answered individually without a pattern of questions being discernable. The questionnaire is appended (Appendix 1).

5.4.   DATA ANALYSIS

A Likert rating scale was used for the closed set of questions, including the options of 'strongly agree', 'agree', 'disagree', and 'strongly disagree'. Scale values of 4, 3, 2 and 1 were then assigned respectively to each of the responses. A neutral option or non-response was deliberately excluded to ensure that the data set consisted only of positive and negative responses.

Likert scale data is treated as interval data by some researchers but should be treated as ordinal data (Coldwell & Herbst, 2004). The reason for this is that although the scores are numerical, they are not equidistant from one another. For this reason, measures of central tendency were applied to the data using the mode statistic.

For each closed question, the most frequent response, or mode, was found and the number of instances of the modal value for each question counted. The frequency of the other responses is not presented as it would not order the data any differently if taken into consideration. The mode response for each question is tabulated below (Table 1) in decreasing order and in decreasing order of occurrence.

Table 1: Closed question response: mode and frequency

No.	Statement	Mode	Frequency
1	I choose to work safely	4	50
2	I am responsible for my own safety	4	47

3	PPE is available to me	4	43
4	I am equipped to work safety	4	40
5	I understand how to work safely	4	39
6	I believe we can maintain a zero RCR	4	39
7	I am able to work safely	4	37
8	I am responsible for my teams safety	4	35
9	I am trained to work safely	4	35
10	I understand my role towards safety	4	34
11	We share our learning from incidents	4	33
12	We learn from our incidents	4	32
13	I am motivated to work safely	4	31
14	I would report all incidents and accidents	4	31
15	I am knowledgeable in working safe	4	31
16	My contributions to safety are valued	3	34
17	My safety concerns are listened to	3	32
18	We have enough safety procedures	3	30
19	I am consulted on safety issues	3	29
20	I would report near miss incidents	3	28
21	Corrective actions take too long	3	27
22	Corrective actions are done in time	3	27
23	We have too many safety procedures	3	23
24	We need more safety processes	2	31

The relatively high response for choosing to work safely suggests that the reason for working safe has been internalised by most of the respondents. This is indicative of a subordinate centred leadership style being applied, according to the previously discussed leadership continuum model. It also indicates a safety maturity level of independence on the DuPont Bradley curve. The independence is further supported by a relatively high number of 'strongly agree' responses to the question of 'I am responsible for my own safety'.

The next highest most frequent modal responses to the questions of having PPE available and being equipped to work safely show that systems of personal protection are seen to be adequate. It was expected that these questions should have had similar responses as PPE is the most important type of safety equipment used in the laboratory.

The relatively high strong agreement with the statement that a zero RCR can be maintained suggests that there is confidence in the employees that the current performance can be maintained, but also indicative that there may be opportunity for complacency in having achieved such a high safety performance.

The relatively lower frequency of occurrence of strong agreement with responsibility towards team safety as opposed to individual safety may indicate that the level of interdependence of safety on the DuPont Bradley curve is yet to be attained and might require more emphasis going forward. This maturity in safety performance is however much higher than the lower category of dependence on this curve.

There is a relatively lower frequency of high agreement with reporting of accidents and incidents. Even lower is the agreement in reporting near miss incidents. This may be because the reporting of accidents becomes mandatory when injury is involved, due to the high exposure. The possibly lower inclination to report near miss incidents may be due to the ability to decide not to report them and possibly a system that is not yet fully supportive of reporting all near miss incidents whether by convenience or fear of repercussion to the involved party.

Next lower on the table of responses are consultative questions such as being listened to as individuals, if consulted in the first place. This suggests that full engagement of all personnel has not yet been achieved. This may be due not only to the lack of consultation but also to a lack of comfort in being able to voice opinion within the current framework of safety systems available to employees.

The responses to the questions of exhaustiveness of safety procedures support one another in that there are deemed to be adequate procedures governing safety and that more are not required. The lowest response of not requiring more safety processes is not unexpected in that there are a number of safety processes in place used to manage safety and to have participation by all employees in safety.

The results of duration to completion of corrective actions are contradictory. It is seen that they both seen to take too long and to take place timeously. This may indicate that there may be quick indication of corrective actions but that the final completion may take longer than expected. This may nonetheless indicate that this previously identified crucial aspect of managing safety needs some more attention.

Responses to a category of questions are presented below with the mode of the component questions and the average frequency thereof. This are listed in decreasing order of mode and frequency.

Table 2: Closed question category response

No.	Statement category	Mode	Frequency
1	Empowerment	4	40
2	Motivation	4	40
3	Responsibility	4	39
4	Optimism	4	39
5	Training	4	35
6	Incident learning	4	33
7	Incident reporting	4	29
8	Consultation	3	32
9	Processes	3	30
10	Corrective actions	3	27

The highest frequency of high agreement responses relates to empowerment. Similar high frequency responses for the categories of motivation and responsibility all suggest that employees felt empowered in their role towards safety.

To a slightly lesser extent, optimism was shown towards being able to maintain a zero RCR. This suggests some caution to be present with the current safety performance.

Responses to the open questions deemed to be of a similar nature were categorised into themes in order to limit the number of data points to be interpreted.

Table 3: What motivates you to work safely? Closed question category of responses.

Category	Frequency	%
Wanting to return home safely	32	29.9
Not wanting to get hurt	25	23.4
Not used	13	12.1
Not wanting others to get injured	12	11.2
Maintain safety record	6	5.6
Wanting a long life	5	4.7
Compliance	3	2.8
Pride in work	3	2.8
Commitment to safety slogan	2	1.9
Incentive scheme	2	1.9
PPE availability	2	1.9
Company cares for and respects me	2	1.9

The most frequently occurring category of response is in line with the closed question response demonstrating the internalisation of wanting to work safe. Again this suggests the prevalence of a subordinate centred leadership style.

Many of the responses could not be used as the answer was incomplete, difficult to interpret or clearly demonstrated misunderstanding of the question. This suggests that the question was not clear and may have been interpreted to mean why one is working safe.

The current safety record is a slight motivational factor for the employees and may be a basis for continuing with the current safety performance.

With the low occurrence of compliance related answers, the internalisation of wanting to work safe is supported.

Table 4. What is the most important reason for our zero RCR performance? Closed question category of responses.

Category	Frequency	%
Employee commitment and accountability	16	15.4
Not used	13	12.5
Safety communication	11	10.6
Intolerance of unsafe acts	10	9.6
Incident reporting and investigation	10	9.6
Participation by all	10	9.6
Believing a zero RCR is possible	9	8.7
Believing in rewards of working safe	5	4.8
Management visibility	4	3.8
BBS system	4	3.8
Safety focus	4	3.8
Concentrating on activity being done	3	2.9
Employee empowerment	1	1.0
Rules and procedures	1	1.0
Luck	1	1.0
Don't know	1	1.0
Knowledge about safety	1	1.0

The most frequent category of responses shows that the employees themselves rather than some external system accounted for the group's safety achievement. This was generally not credited with management. Similar to the previous findings, this demonstrates a subordinate centred leadership style being applied.

Many responses again could not be utilised due to being unclear, or demonstrating a misunderstanding of the question. Communication featured strongly as a reason for the zero RCR, but is difficult to interpret as it is multifaceted. Communication could be of incident learning, constant reminders of the safety performance and other content in a variety of forms.

The intolerance of unsafe acts demonstrates the prevalence of a non-negotiable attitude towards safety, where chances are not taken. These may also be indicative a transactional leadership style where grey areas are removed and clarity is present on how things should be done.

The relatively high frequency of incident reporting and investigation as a contributing factor suggests that there is buy in by the employees to the system and that it is seen as beneficial to the safety performance of the group.

Management visibility occurs with a low frequency and may again support the independence of the group in terms of maturity of safety culture and that management presence is seen as less important than personal accountability and responsibility towards safety.

The lowest frequency of occurrence of 'luck' and 'don't know' is encouraging but indicative that safety participation is not shared by all members of the group surveyed.

Table 5: What do we need to do to maintain our zero RCR? Closed question category of responses.

Category	Frequency	%
Communication	15	13.4
Not used	14	12.5
Safety consciousness	13	11.6
Incident reporting	10	8.9
Commitment to safety	10	8.9
Continued safety focus	9	8.0
Know consequences of unsafe work practices	6	5.4
Positive attitude to safety	6	5.4
Follow safety procedures	6	5.4
Look out for one another	6	5.4
Report unsafe acts and conditions	4	3.6
Keep believing in a zero RCR	3	2.7
Keep investigations up to date	2	1.8
Management visibility	1	0.9
Keep doing the right things	1	0.9
Make safety a way of life	1	0.9
Make safety a priority	1	0.9
Zebra observations	1	0.9
Speed up corrective actions	1	0.9
Improve training procedures	1	0.9
Reward good behaviour	1	0.9

From the results above, communication is seen to be the most important aspect of maintaining a zero RCR safety performance. Similar to the previous question's response, this may take many forms including the sharing of incident learning and general high frequency discussion of safety in the workplace.

Many responses could not be used as they were unclear and did not make any specific contribution to what is needed to be done to maintain the current safety record. Some instances also demonstrated a misunderstanding of the question.

The high frequency of safety consciousness may be difficult to interpret and could be suggestive of empowerment of employees taking personal accountability for safety or a vigilant approach to safety. It may also link to the motivational factor where employees want to return safely to their families and not be harmed. It also supports the independence level of safety culture maturity from the DuPont Bradley curve.

Incident reporting occurs with high frequency also showing a maturity of the incident reporting system and buy in from employees. It also suggests that there may be a relative lack of complacency with the current safety performance. This is also supported with the relatively low occurrence of blind belief in a zero RCR.

The low occurrence of the behaviour based safety system as opposed to the higher response of the informal hazard identification system shows that the compliant approach should be reconsidered.

5.5.   RESEARCH RESULTS

The results of the research will be discussed against each of the research objectives in turn.

Objective 1:   To investigate the impact of a cultural transformation on safety performance

In effecting a cultural transformation, caution should be combined with optimism (Valuebasedmanagement.net, 2011b). The results of what employees see as necessary for maintaining the current safety performance indicate such caution to be present in the group.

The steps to implementing a cultural transformation include institutionalisation. The results of the survey show that such a level may have been achieved with high commitment towards safety being displayed together with safety consciousness. This shows an effective completion of the implementation.

From a follower perspective, transformation includes broadening and elevating employees' interests and emphasis of group over personal interest (Bass, 1990). The high level of internalisation of the need to work safe by the surveyed employees demonstrates such elevation. The high occurrence of team related responses also suggests cultural transformation completion.

At the highest level of safety culture, levels of commitment and care should be at a very high level (Parker, *et al,* 2006). The results of the survey show such a high level of commitment.

Some factors associated with occupational accidents (Stave & Törner, 2007) include insufficient communication and learning. The high frequency of occurrence of communication as a contributing factor to the zero RCR performance could thus be expected in the survey group.

Safety climate was demonstrated to have a lagged effect on safety motivation (Neal & Griffin, 2006). With the survey discussed in this report, the high levels of self motivation may have started at a much earlier stage in the transformation process that occurred.

It has been demonstrated in a manufacturing organisation setting that both transformational and transactional leadership had a significant relationship with safety participation (Clarke & Ward, 2006). The high levels of participation found in this survey might thus not necessarily be attributable to transformational leadership only.

The role of supervisory safety practices has been demonstrated to have a positive effect on safety records and in improving safety climate (Zohar, 2002). Examples of this transactional leadership style may have manifested in the relatively large occurrence of intolerance to unsafe acts in the survey.

Employee participation is manifested with them having the purpose of having zero injuries (Geller, 2002). There was a high frequency strong agreement in the survey with having such a supporting statement as a motivator for safe working.

Objective 2:   To investigate the impact of employee empowerment on safety performance

In the continuum of leadership behaviour used as a model for employee empowerment (Tannenbaum & Schmidt, 1973), the two extreme leadership approaches are boss centred and subordinate centred. The research results supported the subordinate centred approach being prevalent.

Some of the categories of employee empowerment include information sharing, upward problem solving and decision making at employee level (Wilkinson, 1988). They survey results showed a high frequency of responses indicating communication as a reason for an improved safety performance, reporting of incidents and accountability for safety.

In the process of empowerment, the last stage demonstrates an empowering experience by subordinates (Conger & Kanungo, 1988). The survey results provide evidence of this level of empowerment with a high level of commitment and consciousness being contributing factors for the zero RCR achievement and as a means of remaining at this performance level.

In the DuPont Bradley curve model, the ideal level of safety culture is termed interdependent and is characterised by helping others to conform, being other's keeper and caring for others

(DuPont, 2012). This is preceded by a level of independence characterised by internalisation and caring for self (DuPont, 2012). They survey results strongly show characteristics of the level of independence but that of interdependence to a lesser extent.

In order to achieve a safety culture, it is proposed that people must take personal accountability for safety (Geller, 2000). The high frequency of responses demonstrating personal accountability for safety supports this proposal.

It is argued that safety problems need to be addressed and fixed in a timely manner for it to be demonstrated that management cares about safety (Williams, 2008). With the survey results, it was shown that corrective actions take too long. This may thus show a lack of management commitment to safety.

A negative relationship was shown between empowerment and occupational hazards (Ford & Tetrick, 2011), with people in the most hazardous positions feeling the least empowered. With the relatively low frequency in the survey showing adequate consultation, there may be a cause for concern.

Objective 3: To investigate the effectiveness of a near-miss reporting system on safety performance.

According to the safety pyramid model, (Rockwell Automation, 2007), the occurrence of one recordable case is preceded by ten near-misses and a thousand at-risk behaviours. With the survey results showing a relatively high commitment to reporting near miss incidents, possible recordable injury cases could be avoidable. To a much lesser extent, participation in a formal and informal system that would address at-risk behaviours is noted.

Employee empowerment may lead to non-reporting of near miss incidents (Lauver, *et al*, 2011). Against this, the survey shows a high prevalence of employee empowerment together with a high commitment to reporting near-miss incidents. It is difficult to establish, however, whether all incidents are reported. It is indicated from the survey results that there is not a unanimous agreement to reporting all near-miss incidents, supporting the finding by Lauver, *et al*.

The frequency of high agreement responses associated with the reporting of accidents as opposed to near-miss incidents, suggests that only those issues that cannot be hidden would

be reported. Alternatively, the value of reporting near-miss incidents may be misunderstood or lacking clarity to the surveyed group.

It has been shown that a no blame approach to the reporting of near miss incidents enhances organizational learning (Provera, *et al*, 2010). The lack of full agreement with the reporting of near-miss incidents suggests that there may be a residual sense of repercussions for reporting incidents in the surveyed group.

Objective 4:   To identify factors contributing to maintaining an improved safety performance.

Other factors, with a large frequency of occurrence, identified to be important contributors to having achieved and in maintaining the current zero RCR performance include:

- Communication – although not clear what this all should include;
- A continued focus on safety – suggesting that complacency should be guarded against;
- Following safety procedures.

5.6.   SUMMARY

The results of the survey have been presented and analysed against relevant theoretical models and against findings in previous studies in literature. Some of the key findings were:

- Support for a level of independence in safety culture maturity has been demonstrated;
- Some indication of a more idealistic level of interdependence demonstrated;
- Confidence in the survey group that the current zero RCR performance can be maintained;
- Perceptions of inadequate consultation with employees;
- A somewhat low support for reporting accidents and near-miss incidents;
- Evidence of high levels of employee empowerment;
- In combination, the low propensity to report near-miss incidents and high levels of employee empowerment is as per findings in previous research;
- Dissatisfaction with the time taken for corrective actions to be completed;
- A high occurrence of answers that could not be utilised due to incomplete answers or question misunderstanding;
- Communication seen as important component in having achieved the current zero RCR and as a factor in maintaining it;

- Behaviour based safety system not seen as a major contributing factor to the zero RCR safety performance;

- Evidence of institutionalisation of a cultural transformation;

- Transactional style leadership seen as a contributing factor to the current safety performance and as a requirement for its continuation;

- Evidence that complacency is relatively absent for continuing the current safety performance.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1.   INTRODUCTION

From the findings of the research done, when weighed against theoretical models and previous research documented in literature, a number of conclusions can be made. A number of recommendations for further research are described as well as improvement opportunities for the group studied.

6.2.   CONCLUSIONS

A cultural transformation of the laboratory has been demonstrated to have been a contributing factor to the improved safety performance in the laboratory studied. It succeeded in improving the maturity of the safety culture to a level of independence with employees demonstrating an internalisation of safety, motivating them to work safely. The next higher level of safety maturity, interdependence, is only partially supported. The confidence shown by the surveyed group shows that they are positioned to move to the next level of maturity in safety culture.

The results show that the cultural transformation process has been completed to the extent that the safety culture has been institutionalised.

The research findings show that it is not transformational leadership alone that can account for an improved safety performance but that transactional leadership also plays a key role.

There is evidence of high levels of empowerment in the group which may also partially account for the zero RCR safety performance. However, as found in previous research, this may also lead to the found lower propensity to report all near-miss incidents and accidents. The reporting of near-miss incidents was, however, seen as an important contributing factor to the improved safety performance and for maintaining the current safety performance.

There is evidence that not all employees feel adequately consulted. Empowerment may thus not be prevalent with all employees, especially those facing greater hazards than others.

Corrective actions are not seen to be timeous, which may show a relative lack of caring by management to their employees.

Many answers were not usable showing a deficiency in the chosen research approach. It may have been more suitable to clarify the question or supplement the survey method with interviews.

Communication was seen as an important contributor to the safety achievement and a key component of maintaining the safety performance. It is unclear what this all entails but may include sharing incident investigation learning and a constant high featuring of safety on employee communication.

The relatively low indication of the formal behaviour based safety process as a contributing factor to the safety performance may suggest that its use be investigated and substituted by a more informal employee engagement process.

It may be seen as encouraging that the surveyed group showed a relative lack in complacency with the current safety achievement. This also provides an opportunity with the confidence shown to mature to a level of interdependence in safety culture maturity.

6.3.   RECOMMENDATIONS

In the first set of recommendations, further research will be suggested.

Causal relationships should be better established for groups or organisations having zero RCR performances. Although research has been done on high-reliability organisations, this could be extended to other organisation types.

The reasons for not reporting near-miss incidents needs further investigation with clearer understanding required of how this needs to be addressed in a group that is empowered.

Since communication is seen as an important aspect of having achieved a zero RCR and as a factor in maintaining such a performance, it may warrant investigation what such effective communication should consist of.

The next set of recommendations are specific to the group studied and should be considered as part of a program to maintain the zero RCR and pursue a target of zero harm, successively removing all incidents and at-risk behaviour.

The key aspects of what comprises an interdependent safety culture should be identified and used to set up a safety strategy going forward. These have been identified by other authors

and could be used as a basis. With the confidence present in maintaining the current performance, this could be seen as a high priority.

The barriers to reporting near miss incidents should be investigated further with the benefits of reporting communicated often. It should also be emphasised in such communication that it is not sought in the investigation to assign blame. This obviously needs to be supported in practice for a no blame culture with incident reporting to develop.

With the relatively low perception of consultation, a better effort needs to be made to engage all personnel in safety conversation, especially with those facing greater hazards than others.

Corrective actions need to be speeded up and barriers to getting actions completed identified. Supportive systems to managing and tracking corrective actions may need to be improved and feedback loops on status investigated for improvement.

The components of what should be communicated to employees could be surveyed. This is seen as a crucial part of maintaining the current safety performance and should be optimised and improved upon.

The current implementation of a behaviour based safety system should be addressed and possibly reduced in frequency of use, or made voluntary. A more informal type system seems to be favoured and could be considered as an alternative approach.

Finally, a follow up survey is recommended to evaluate further development of a maturing safety culture and whether other identified recommendations have corrected underlying problems identified.

6.4.   SUMMARY

With a number of further research opportunities identified, the effectiveness of transformational leadership, employee empowerment and incident reporting could further improve safety performances by actively engaging all personnel in organisations.

If identified recommendations are addressed, the laboratory investigated in this report may be assured of maintaining their zero RCR and continue on a journey to zero harm to employees and an elimination of all at-risk behaviours.

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APPENDICES

APPENDIX 1:   **QUESTIONAIRE**

<u>**Safety survey – March/April 2012**</u>

Please mark the block that most correctly describes your opinion related to the statement on the left

No	Statement	Strongly agree	Agree	Disagree	Strongly disagree
1	I am equipped to work safely				
2	I choose to work safely				
3	I am responsible for my team's safety				
4	I would report near miss incidents				
5	We share our learning from incidents				
6	We need more safety processes				
7	I am trained to work safely				
8	PPE is available to me				
9	My safety concerns are listened to				
10	We have too many safety procedures				
11	I am motivated to work safely				
12	I understand my role towards safety				
13	I am able to work safely				
14	We learn from our incidents				
15	I am responsible for my own safety				
16	I understand how to work safely				
17	I would report all incidents & accidents				
18	Corrective actions take too long				
19	We have enough safety procedures				
20	My contributions to safety are valued				
21	Corrective actions are done in time				
22	I am knowledgeable in working safe				
23	I am consulted on safety issues				
24	I believe we can maintain a zero RCR				

Please give your honest opinion on each of the following in the text block.

a)   What motivates you to work safely?

b)   What is the most important reason for our zero RCR performance?

c)   What do we need to do to maintain our zero RCR?

Thank you for your time and inputs.

APPENDIX 2: EMAIL OF INFORMED CONSENT

Dear Colleagues

As part of research required for my MBA studies and as part of our Infrachem Laboratory safety improvement plan, your participation is kindly requested in a safety survey. The attached questionnaire should take no more than 5 to 10 minutes to complete.

Your response will be kept entirely confidential. Data and results will be discussed and presented only in summary form. This survey will be used to identify areas of strength and improvement opportunities, to maintain our zero RCR.

Please complete the attached document and email back to me or, to ensure anonymity, place in a Zebra datasheet box for later collection. The due date for completion is April 4th 2012.

Thank you for your support and contact me if there are any questions.

Thanks
Adrian

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