ROSA TENGVALL
SAFETY LEADERSHIP ASSESSMENT AND IMPLEMENTATION
OF SAFETY CULTURE TRANSFORMATION CONCEPT

Master's thesis

ABSTRACT

Safety performance is driven by leadership in the organization. The leaders translate the company's safety vision into concrete safety actions and procedures in the facilities and in daily work. Safety vision is integrated to the Key performance indicators, yet the full knowledge of the benefits of safety to the employees and to the company is seldom completely understood. Company's safety culture is built on the safe working practices, behavior and competence of all employees. HSE statistics shows that still the majority of incidents occur as a consequence of unintentional or intentional violations of safe working practices and not as a consequence of lacking safety procedures. This underlines the importance of behaviors and attitudes in development of safe working culture. Safety leadership is therefore the key to true Safety culture transformation in the organization.

The aim of this thesis is to provide a training concept for future Safety leaders and help them to enable a sustainable Health, Safety and Environmental cultural transformation of safety by choice and not by chance. The main goal of the concept is to develop Safety leadership competencies of line managers and create commitment, ownership and accountability across the organization. The concept harnesses the managers with tools that help them to improve the safety performance and safety culture of their facilities and provides information and support for leading successful change. The concept builds on theoretical framework and case studies. The theoretical framework introduces theories of Safety culture, Safety Leadership and Management of Change but also tools to measure and analyze safety performance.

The concept is constructed to two modules for General Managers and HSE managers. The first module is for General Managers and includes training on leadership and culture change, provides tools to improve safety and supports drafting of the HSE strategic plan. The second module is designed for HSE managers and includes training on HSE culture and tools to improve it, introduces the challenges managers might face in this culture change and discusses the roles and responsibilities HSE managers have in this change. This thesis also acts as an additional information of the topic to managers participating in the concept.

TIIVISTELMÄ

ROSA TENGVALL: Turvallisuusjohtaminen ja turvallisuuskulttuurin muutoskonseptin implementointi
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Avainsanat: Turvallisuusjohtaminen, turvallisuuskulttuuri, muutosjohtaminen, turvallisuuden mittaaminen

Yrityksen turvallisuuskulttuuri heijastaa organisaation normeja, perusarvoja, olettamuksia sekä odotuksia, jotka sisältyvät yrityksen toimintaperiaatteisiin. Turvallisuuskulttuuriin vaikuttaa erityisesti yrityksen työntekijöiden tapa toimia ja työskennellä, heidän käyttäytymisensä sekä pätevyys. Turvallisuusjohtamisella ohjataan yrityksen toimintatapoja haluttuun suuntaan. Näin ollen hyvän turvallisuusjohtamisen tärkeimpänä lähtökohtana tulisi olla turvallisuuskulttuurin kehittäminen. Johdon sitoutuminen turvallisuuteen heijastuu suoraan henkilöstön sitoutumiseen ja sitä kautta vaikuttaa suoraan yrityksen turvallisuuskulttuuriin. Yrityksen johto on siis avainasemassa kehitettäessä yrityksen turvallisuuskulttuuria parempaan suuntaan.

Tämän työn tavoitteena on suunnitella yrityksen turvallisuusjohtajille suunnattu koulutuskonsepti, jonka avulla he saavat ohjattua yrityksen turvallisuuskulttuuria suuntaan, jossa turvallinen työskentely kuuluu yrityksen perustoimintaperiaatteisiin. Konseptin päätavoitteena on kehittää johtajien turvallisuusjohtamistaitoja ja näin ollen turvata kestävä muutos parempaan yrityksen turvallisuuskulttuurissa. Johtamistaitojen lisäksi konsepti esittelee useita työkaluja turvallisuuden mittaamiseen sekä muutoksenhallintaan.

Konseptin suunnittelussa hyödynnetään laajaa teoriakatsausta sekä yrityksen aiempien turvallisuuskulttuurin muutosprojektien tuloksia. Koulutuskonsepti rakennetaan kahteen eri moduuliin, joista ensimmäinen on suunnattu yrityksen tehtaanjohtajille ja aluejohtajille. Tämä moduuli keskittyy turvallisuusjohtamisen kehittämiseen, turvallisuuskulttuurin muutokseen sekä strategian valmisteluun. Toinen moduuli on suunnattu työturvallisuusasiantuntijoille. Tämä moduuli painottuu muutosjohtamiseen sekä konkreettisiin työkaluihin, kuinka yrityksen turvallisuutta voidaan mitata, parantaa sekä seurata.

PREFACE

It all started with seeing this incredibly smudged ex-white Teekkaricap in the marketplace of my hometown Kuopio. Naturally the first thought was "Ew, what is that?" The second, How do I get one?

This event triggered a cascade of insanely interesting and amazing times of my life.

Being part of the Teekkari-culture, experiencing the five-days-no-nights, the endless joys of studying with friends and learning new things have so far being the most educating and fun experiences of my 24-year-old history. Special thanks for these experiences go to my nearest and dearest friends, the AK/C-musketeers and all the other Teekkarit that have been part of my student life. But no fun lasts forever. It gets even better!

This was proven by Juha Huhtinen who offered me a chance to work in ABB and realize in practice the learnings from TUT. Thanks to him, I have had the chance to do the most interesting work that a young student can hope for. Also this thesis have been unacceptably inspirational and fun to work on. But I could not have done this without my colleagues in the US. Special thanks to my Grand Master Ed Stephens for help, support and all the good times in the late-afternoon Skype-meetings and to Marta Golden for steering us in the right direction. Compliments also to my other colleagues in ABB for preventing me to hit the bottom of the Sine wave and instead having a great time in the office.

So this is it. Is it? Definitely not. The graduation and the MSc-title is just the first milestone that my supervising Professor Jouni Kivistö-Rahnasto will grant me in this journey. Finally I can spread my wings and with the support from my family experience the winds of the world. I just can't wait!

Helsinki the 14th of June, 2016

Rosa Tengvall

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1. INTRODUCTION

Safety performance is driven by leadership in the organization. The leaders translate the company's safety vision into how safety can actually be executed in the facilities and in daily work. Safety vision is integrated to the Key performance indicators, yet the full knowledge of the benefits of safety to the employees and to the company is seldom completely understood. Company's safety culture is built on the safe working practices, behavior and competence of all employees. HSE statistics shows that still the majority of incidents occur as a consequence of unintentional or intentional violations of safe working practices and not as a consequence of lacking safety procedures. This underlines the importance of behaviors and attitudes in development of safe working culture. Safety leadership is therefore the key to the true Safety culture transformation in the organization.

The aim of this thesis is to provide a training concept for future Safety leaders and help them to enable a sustainable Health, Safety and Environmental cultural transformation of safety by choice not by chance. The main goal of the concept is to develop Safety leadership competencies of line managers and create commitment, ownership and accountability across the organization. The concept harnesses managers with tools that help them to improve the safety performance of their facilities and provides information and support for leaders to manage change. The concept is built on theoretical framework and case studies from previous safety improvement projects in the target company. Since the scope of this research is in the creation of Safety culture transformation concept, the theoretical framework of this study finds solutions for the following themes;

- How to evaluate Leadership and its influence on safety performance
- How to assess and measure Safety culture in facilities
- What kind of tools provide help in Safety culture transformation
- What is the role of Management of Change in Safety culture transformation

In Figure 1 the theories affecting the construction and design of the concept are introduced.
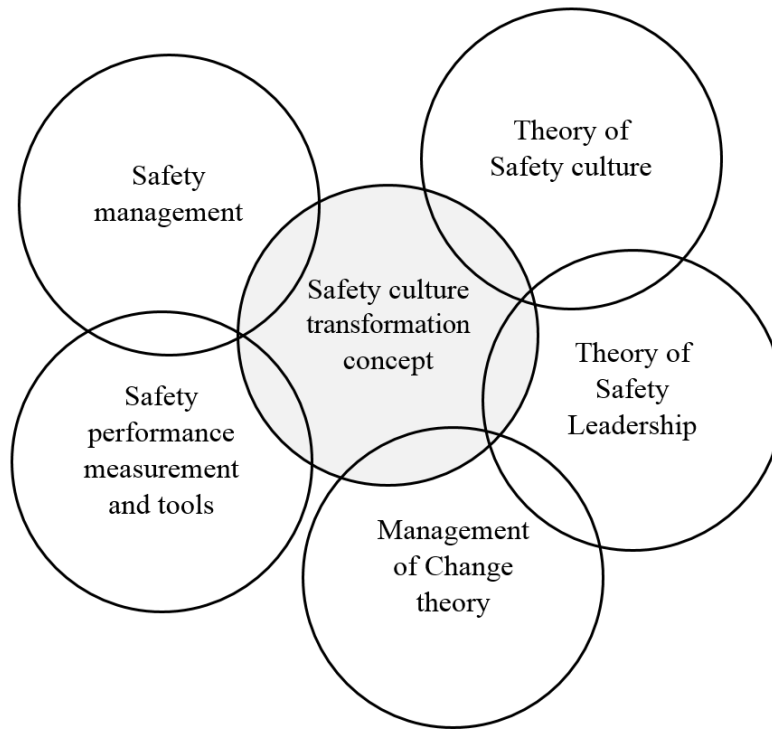
Figure 1 *Theoretical framework*

The main focus in the theoretical part is in the theories of Safety culture, Safety Leadership and Management of Change since they provide the main solutions for concept's content. The theoretical background of Safety management and Safety performance measurement and tools are also presented to be able provide the managers the tools to improve safety performance and safety culture in their facilities. Main Key performance indicators of safety are presented together with common safety processes used in technology companies. The second part of the thesis introduces the target company and the previous safety improvement projects executed in the company. The concept development starts with analyzing the case studies and creating the requirements for the concept. The requirements of the concept are derived from best practices used in the cases and information provided by theoretical framework.

In the third part, the data from previous safety improvement projects are introduced to verify the methods used to improve safety as good practices. The final design and content of the concept is presented together with the execution and pilot plan. Importantly the content what was incorporated in the concept and why is discussed and evaluated in this part. Pilot is designed and executed to get feedback from the participants to further analyze and improve the concept content and design. The practical and scientific contribution of the study is discussed throughout the discussion chapter and the possible improvements of the concept introduced in the results.

2. THEORETICAL BACKGROUND

The scope of this research is to find applicable theories to support the safety culture transformation in the organization. To be able to understand what is safety, how to manage safety and essentially to improve the safety performance in the organization, many theories must be analyzed and evaluated. The theoretical framework of this study finds solutions for the following themes;

- How to evaluate Leadership and its influence on safety performance
- How to assess and measure Safety culture in facilities
- What kind of tools provide help in Safety culture transformation
- What is the role of Management of Change in Safety culture transformation

2.1 Managing safety

Managing safety is about protecting people, environment and assets but is also a continuous process of safety improvements (Heinrich et al. 1980; Visser 1998). Managing safety is based on two different approaches; Safety management and Safety leadership (Hämäläinen & Anttila 2008). Safety management can be described as the "organized efforts and procedures for identifying workplace hazards and reducing accidents and exposure to harmful situations and substances. Safety management also includes training of personnel in accident prevention, accident response, emergency preparedness, and use of protective clothing and equipment". (Businessdictionary). Safety leadership on the other hand is defined as a process of interaction between leaders and followers, through which leaders can exert their influence on followers to achieve organizational safety goals (White 2016). Traditionally safety improvement efforts have focused on the engineering aspects of safety. Unsafe mechanical or physical conditions are however responsible for relatively few accidents (10%) while the most accidents and injuries appears to result from employees' unsafe acts. (Wilpert 1994) Also Pidgeon (1991) states that while human errors does contribute to accidents, the behavioral causes of failure plays the bigger part when causes of the incidents are analyzed. Therefore, managing safety is about mastering the both aspects of Safety management and Safety leadership described in Figure 2.
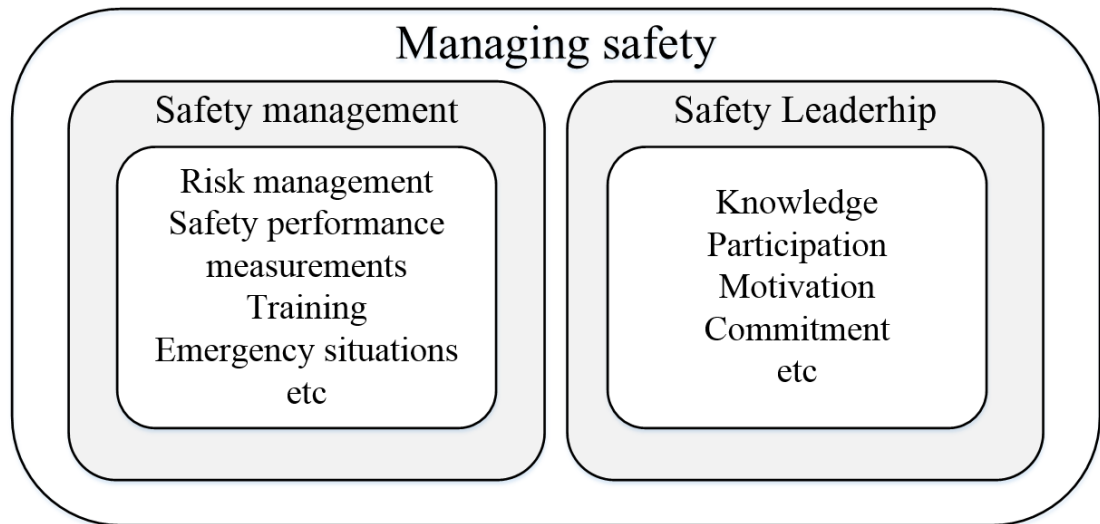
Figure 2 *Approaches for managing safety, adapted from Hämäläinen & Anttila (2008)*

 In this chapter first Safety management systems are introduced. The theories and practices of each system is described and the benefits of them argued. The chapter is concluded by evaluating the different aspects of managing safety. In the second chapter the principles and demands of Safety leadership are described. Different leadership models and theories are introduced and the effectiveness of these different approaches are studied. Following questions are answered: How different leadership styles affects the motivation, safety participation and safety compliance of employees? How managers' engagement to safety reflects the safety performance of employees? Is there a link between safety leadership and safety performance?

2.1.1   Safety Management systems

Safety management systems are the first key element together with Safety leadership to effectively manage safety in organizations. Safety management can be described as the "organized efforts and procedures for identifying workplace hazards and reducing accidents and exposure to harmful situations and substances". (Businessdictionary) Safety management system (SMS) is a term used to refer to a comprehensive business management system designed to manage safety elements in the workplace. Safety management system's main purpose is to educate and train employees at all levels to understand and identify the hazards in the workplace and to control the hazards and associated risks. (Crutchfield & Roughton 2014)

Several industrialized countries introduced in the 1970s a detailed occupational health and safety (OHS) regulatory initiatives aiming to dramatically reduce workplace injuries and work-related ill health. The OHS strategy proved to be unsuccessful and inefficient in reducing workplace injuries since it was mainly passive and fragmented strategy. (Walters et al. 2002) The strategy where government authorities dictated to employers what

should be done to reduce workplace injuries was replaced in the 1990s. The new strategy promoted manager's role in occupational health and safety management (OHSM) to reduce incidents in the workplace. (Frick and Wren 2000) Since then, several international and national level of directives, standards and guidelines for OHSM systems have been introduced.

The OHSMS can be divided to mandatory and voluntary systems. Mandatory OHSMS arise from government legislation and dictates the core principles of these systems. One example of a mandatory OHSMS is the Framework Directive 89/391/EEC, which obligates the employers to evaluate the risks to the health and safety of employees and also implement preventive measures into all of the activities carried out in the organization at all hierarchical levels. (EU OHSA 2012) The voluntary OHSMSs are not state-regulated and are generally in the form of standards or guidelines. They provide guidance on good management practice for OHS and sets the requirements for certification. The standards and guidelines can be international for example ILO-OHS 2011, or national e.g. OHSAS 18001:2007. (EU OHSA 2012) Therefore the framework for organizations' OHS management systems comes from mandatory requirements as well as international and national guidelines as presented Figure 3. (ILO-OHS 2001)
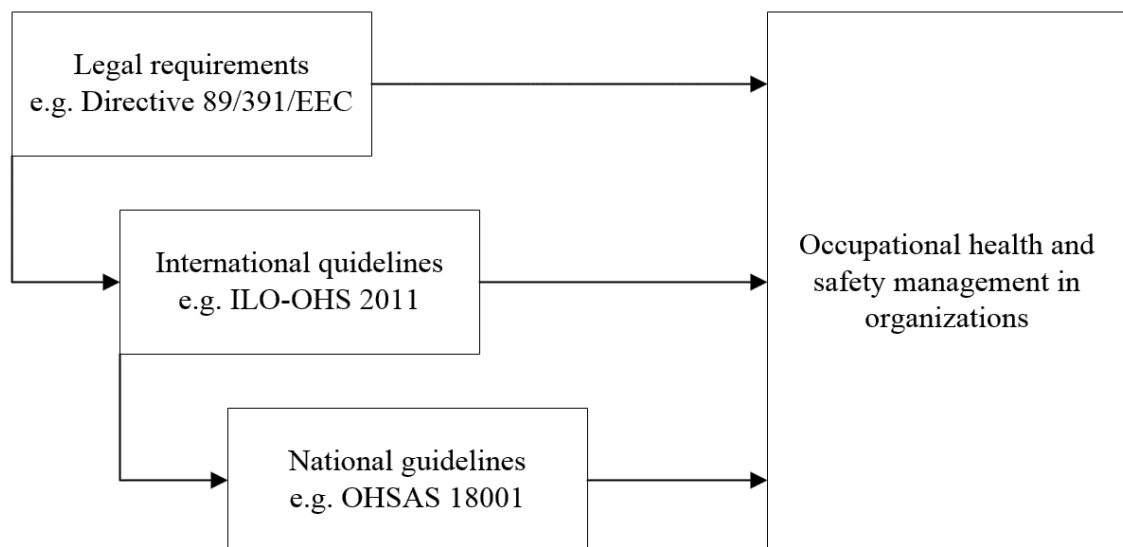
Figure 3 Elements of organization's OHSMS

One of the most used voluntary international guideline is developed by The International Labor Organization (ILO). ILO is a specialized agency of the United Nations that has developed its guideline ILO-OHS 2001 for occupational health and safety management systems. The guideline builds on five different principles of policy, organizing, planning and implementation, evaluation and action for improvement. One example of national guideline is The British occupational health and safety management standard OHSAS 18001 that establishes the formal consensus criteria for OHS management systems. The standard reflects the problems of changing an organization and recognizes the importance

of planning and managing the changes that are involved in introduction of OHSMS. The requirements set in the standard includes general requirements, requirements for planning, implementation and checking as well as review requirements. These two voluntary guidelines are further described in Table 1.

Table 1 Description of ILO-OSH 2001 and OHSAS 18001

ILO-OSH 2001	OHSAS 18001
Policy	**General requirements**
Occupational health and safety policy	Establishing an OHSMS for your organization
Worker participation	
Organizing	**Planning requirements**
Responsibility and accountability	Analysis of OHS hazards and selecting controls
Competence and training	Legal and non-legal requirements
OHSMS documentation	OHS objectives and programs
Communication	
Planning and implementation	**Implementation requirements**
Initial review	Responsibilities and accountability
System planning, development and implementation	Competence and training
OHS objectives	Communication and participation
Hazards prevention	OHSMS documentation
	Implementation of control measures
	OHS emergency management process
Evaluation	**Checking requirements**
Performance monitoring and measurement	OHS performance monitoring
Investigation of injuries, ill health and their impact on health and safety performance	Legal compliance
	Incident investigation
	Corrective and preventive actions
	OHS records
	Internal audits
Action for improvement	**Review requirements**
Preventive and corrective actions	Review of the performance of the OHSMS
Continual improvement	

The mandatory and voluntary occupational health and safety management system guidelines provide the basic outline of safety management but in order to understand what makes the OHSMS truly effective, the theories behind these systems needs to be understood. There are many safety management theories that are applied to improve organizational safety. First, two frequently used theories are presented: the safety management system (SMS) theory from Hale et al. (1997) and the resilience engineering theory from Hollnagel (2012). According to Moorkamp et al. (2014) these theories can be distinct by two paradigms, "minimizing uncertainty" in SMS theory and "coping with uncertainty"

in resilience engineering theory. Grote (2012) defines the "minimizing uncertainty" as an approach to achieve high level of predictability, standardization and specialization. The "coping with uncertainty" approach emphasizes the flexible adaptation to uncertainty by providing options for actions rather than fixed plans or standards.

The safety management systems theory from Hale et al. (1997) can be defined as "minimizing uncertainty" approach since the theory sees safety issues as a result from deviations that have to be removed to ensure stable organizational safety. (Moorkamp et al. 2014) The theory aims to generate criteria and scenarios for inputs, outputs and resources and steer the behavior of the activities to steady-state. This is done by creating a detailed description of the production processes and implementing barriers to steer the safety behavior and procedures. Good and efficient SMS according to Hale (2003) includes a clear understanding of the company's primary production processes, structures and related hazards that can lead to significant harm. A life cycle approach that considers how all the system elements are designed, purchased, used, maintained and disposed of should be used. Also a problem solving cycle is necessary in effective SMS, a cycle that identifies, controls and monitors at three levels; at the people in direct control of the risk, at procedures and plans and at a policy level. Feedback and monitoring loops are incorporated and the system is linked to staff and line function of the organization. (Hale 2003)

Another safety management theory is the resilience engineering theory, described as a "coping with uncertainty" paradigm since instead of reducing deviations in order to ensure stability and safety, the theory emphasizes that it might be impossible to remove all the uncertainty in organizations. Therefore the organizations should learn to cope with uncertainty in a safe manner. Resilience engineering therefore aims to manage safety by accounting the constantly changing nature of dynamic operational conditions and ensures the organizations safe adaptation to the conditions. (Moorkamp et al. 2014) In the resilience engineering theory Hollnagel (2012) proposes a functions approach instead of structuring the processes of a company. The different functions interacts with each other and creates resonance. To identify potential sources of resonance effectively and prevent safety incidents Hollnagel (2012) argues that functions that are required in every day work should be identified and the variables of these functions characterized. The specific state of the function should be determined and ways to manage the possible occurrences of performance variables proposed.

Gallagher (1997) combines in his theory the safety management principles and the OHS control strategies. Gallagher divides the management styles to traditional and innovative management. In traditional management the key persons in health and safety are the supervisor and/or the OHS specialist. Therefore there is a low level of integration between the OHS and the broader management system. The employees are not genuinely involved in the system and not seen as a critical factor in the OHSMS. In innovative management approach the senior and line managers have the key role in health and safety, thus the OHS is integrated into the broader management system. Employee involvement is viewed

as critical factor effecting the effectiveness of the OHSMS. The control strategies are divided to "safe person control strategy" and "safe place control strategy". In safe person control strategy the focus is to control of employee safety behavior on contrary to the safe place control strategy where hazard identification, assessments and controls are in focus. (Gallagher 1997) The four types of OHSMSs, management styles and OHS controls strategies are illustrated in Figure 4.
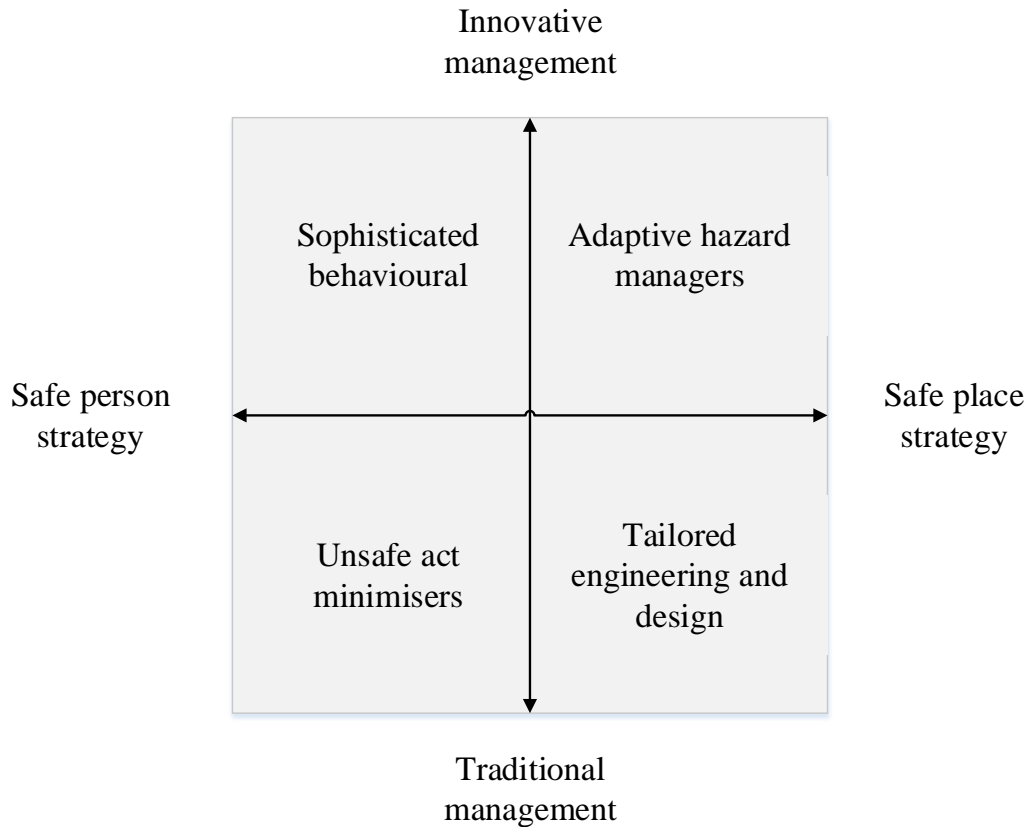
Figure 4 Gallagher's (1997) typology of OHSMSs

From these two dimensions of OHS controls strategies and management styles Gallagher (1997) identifies four types of OHS management systems; unsafe act minimizers, traditional engineering and design, adaptive hazards managers and sophisticated behavioral. The unsafe act minimizers system is characterized by reactive responses to unsafe acts and limitations to employee risk taking. The traditional engineering focuses on safe place and traditional management but health and safety consultative arrangements are less important than in adaptive hazard managers-style. The hazard managers' approach focuses on high level of integration and employee involvement by combining a safe workplace strategy and innovative OHS management. The sophisticated behavioral system tries to influence the employee behaviors and attitudes and have a high level of employee involvement. This system integrates the OHS and broader management system in high

level. Gallagher (1997) studied the effectiveness of these four types of OHSMSs and concluded that organizations adopting the adaptive hazard managers approach then to perform better than those adopting other type of OHSMSs.

Not only the effectiveness of the OHSM system makes safety management effective, also management principles plays a key role. According to Wachter and Yorio (2014) the presence of a safety management system in organizations is the necessary foundation for achieving safe working environment. However, to be able to reach to safety excellence, human performance approach and certain management principles should be associated with the OHSMS. Many other studies also associate some managerial principles with better OHS performance. These key management principles includes workforce empowerment, encouragement of long-term commitment, good relations between management and employees, the delegation of safety activities and employees decision making, training and active management role are these essential elements. (Shannon et el. 1997; Gallaher et al. 2001; Wachter & Yorio 2014) Wachter and Yorio (2014) studied ten management practices and their relationship to safety performance. They found a significant negative relationship between worker engagement and accident rates and stated that worker engagement levels act as mediators between the safety management system and safety performance outcomes. The ten key safety management principles are described Table 2.

Table 2 *Ten safety management principles and system practices, adapted from Wachter & Yorio (2014)*

	Description	Safety management system practices
Employee involvement	As employee influence over safety management system increases they are more likely to defend their existence and adopt the value of working safely and encouraging others to do so.	Employees are involved in the process of creating safe work instructions. Employees can influence STOP work criteria. Employees are involved in devising solutions to incidents that resulted from human error. Employees are involved in performing safety observations of other employees. Employees are involved in conducting accident investigations.
Pre- and post-task safety reviews	When employees perform routine tasks, they are more likely to become complacent and fall into the cognitive decision-making traps such as - anchoring bias (relying primarily on the outcome of previous task executions) - knowledge bias (relying primarily on current knowledge and overlooking the safest options) - Optimism bias (the tendency to underestimate true risk involved in a task) - Overconfidence bias (overestimation of one's own ability to avoid potential harmful outcomes of a task), and other biases.	How often are pre-task safety reviews done? When pre-task safety reviews are done, a review of critical steps is conducted. When pre-task safety reviews are done, the worst thing that could happen is discussed. After finishing a task, employees participate in reviewing the safety aspects of their task.
Safe working procedures	Safe work procedures are developed to provide the steps necessary to safety execute tasks free of injury and illness. They provide important and consistent information to workers of what is expected of them from a safety perspective.	Percent of routine tasks that safe work procedures have been developed for. Percent of high risk jobs for which hazard analyses have been completed. Safe work safe work procedures are reviewed and updated when necessary. Safety "lessons learned" are considered when reviewing and updating safe work procedures.
Hiring for safety	Selective hiring for safety works by hiring employees who are less likely to get injured and who have an intrinsic value for safe work.	The safety values and beliefs of the organization are discussed in the interviews with potential employees

Cooperation facilitation	Safety can be viewed as a personal and or collective endeavor. If work tasks are interdependent, employees need to rely on one another for information and cooperation to perform tasks successfully and without incident.	Employees are encouraged to cooperate with each other on resolving safety issues. Formal communication mechanisms among co-workers are robust enough to ensure that information being shared covers all necessary safety information. Formal mechanisms are utilized to ensure that key safety information is communicated between off-going and on-coming shifts
Safety training	Safety training is a fundamental safety practice emphasized by most national safety and health legislative bodies. Safety training works by increasing knowledge and awareness of safety and health in the workplace.	Employees are formally trained on the safety aspects of their job Employee safety training incorporates elements of hazard recognition and avoidance.
Communication	Communication and information sharing is tied to the frequency and methods of emphasizing knowledge and the importance of safe work.	Employees are informed of new or revised safety rules and safe work instructions Employees are informed about potential hazards in the workplace or their tasks Information about the importance of working safely is communicated to employees Employees are informed about safety incidents experienced in other similar organizations When safety incidents do occur, the results of the investigation are shared among the workforce.
Accident investigation	When safety incidents occurs, organizations can investigate those accidents with the ultimate goal of reducing the probability of the event occurring again	Incident investigations seek to uncover root causes Accident investigations are conducted by a team of individuals consisting of employee representative(s), a safety representative, and the injured employee's immediate supervisor.
Detection and monitoring	Organizations can create and utilize checklists used by supervisors and other employees to detect situations and behaviors that may not be in line with the safety rules and requirements in place	Safety checklists have been developed corresponding to possible workplace hazardous conditions and risk behavior Safe work instruction deviations result in negative consequences for employees Deviations from safe work instructions are tracked and monitored.
Safe-task assignment	Organizations may take into account how well suited an employee is for a particular task in order to maximize the likelihood that the task will be executed successfully without incident.	Supervisors are provided with the flexibility to assign the right employee to the task When flexibility is allowed, the risk associated with stress, fatigue or distraction is considered.

Legislation, mandatory and voluntary OHSM systems, different OHS control strategies and management principles set the framework for organizations' safety management systems. The benefits of these systems have been discussed previously but one important factor still has to be taken into account in order to create an effective OHSMS. According to Drais et al. (2002) the benefits of an OHSMS in terms of OHS outcomes depends less on guidelines or standards followed to implement the OHSMS, and more on the manner in which they are implemented. The study showed that the implementation of OHSMS is highly determined by the organizations' structure, size, activity and technology but also by the objectives of the organization. The successful implementation therefore depends on the type of control that organization has e.g. central versus local control and the management practices the organization uses. The OHS management therefore doesn't follow a model but four different tendencies; cascade, innovative, applied and ideological. These four approaches to implementation of OHSMS are described in Table 3 with aspects of decision flow, goals of different approaches and the roles and responsibilities in each OHSMSs. (EU OHSA 2012; Drais 2002)

Table 3 *Implementation of OHSMS, different approaches, adapted from Drais et al. (2002)*

	Cascade	Innovative	Applied	Ideological
Origin of decision	Senior management	Supervisory level management	HSE department	Senior management
Expected goal	Integration of OHS into local policies	Integration of OHS into practices	Formalization of OHS management	Integration of OHS into individuals behavior
Leaders and partners	National management and safety line managers	Supervisory level management and staff together with safety line managers	Supervisory level management and safety line managers	Senior and supervisory level management
Method of implementation	Information and awareness-raising meetings	Working groups with staff	Supervisory level management meetings	Human resources and individual assessment
Resources	Limited	Negotiable	Limited	Extensive
Employee involvement	Low	High to start with	Limited	High at the end

Cascade approach refers to the OHS policy developed by senior management for implementation across the group. The approach includes overarching safety measures and responsibilities that are distributed throughout the hierarchy. This approach is perceived as a bureaucratic amongst employees, and is often implemented in a merely formal fashion. The study shows that this approach delivers minimal benefits for the safety and health of workers. Innovative approach is an opportunity to rethink the organization's activities and responsibilities to genuinely integrate OHS into broader management system. The organizations want to have a well-defined OHS policy but analyses afresh the definition and organization of health and safety-related aspects. The risk in this approach is the loss of momentum if management support declines. Third approach is the applied approach, where safety line managers apply the safety guidelines to organization with help of effective risk analysis. The drawback of this approach is that the safety approach will remain only as a technical process and have little impact on the working practices and safety behaviors of employees. The fourth approach is ideological, where organizations awareness of OHS issues is driven by moral values as opposed to managerial or technical considerations. The focus is on employee empowerment and changing their attitudes and uniting them along a common safety culture. (EU OHSA 2012; Drais 2002)

Summing up this chapter, the effective implementation of the OHSMS requires both system associated approach and different management principles. Defining the OHS policy sets the framework for the safety management system. The policy must be driven by senior executives' a genuine desire to make the organization safer. The policy should include defined objectives that are consistent with other organizational policies, determined management responsibilities, resources, plans for employee engagement and required guidelines for the OHS management system. The policy should also state the indicators how safety performance is measured and how the performance is reported. The OHS roles and responsibilities in delivering the policy must be specified to enhance ownership. Continuous improvement of the process is essential to improve the safety performance in organizations. Risk assessment is one of the key elements in continuous improvement and also enhances the employee involvement in safety. Last but not least, in effective safety management the leading and lagging OHS indicators should be used to measure, monitor, audit and review of the OHS management system. (EU OHSA 2012)

2.1.2 Principles and demands of Safety Leadership

Safety leadership is the second element in managing safety and often not that clearly understood as the safety management. Safety leadership is defined as a process of interaction between leaders and followers, through which leaders can exert their influence on followers to achieve organizational safety goals (White 2016). Safety leadership is a key factor in promoting safety performance in organizations (Bass 1985; Barling 2002; Tappura 2014; Kapp 2012). Many studies have stated that safety leadership not only promotes safety participation and safety compliance of employees but also has a positive effect to

the productivity in organizations (Kapp 2012; Lewis 2009, Tappura et al. 2013; Hale 2010). The definition for Safety leadership is previously described but in order to fully understand the terminology and their correlation to each other the terms safety performance, safety compliance and safety participation is defined next. Safety performance is the concept of safety-related actions and behaviors that workers exhibit in almost all kinds of work in order to promote the safety and health of themselves or others (Burke et al. 2010). Safety related behavior includes a range of activities performed by individuals to maintain a safe working place and is divided to two dimensions by Griffin and Neal (2000), the task dimension of safety compliance and the contextual dimension of safety participation. Safety compliance refers to the essential activities that must be performed in order to maintain safety in workplace. It includes the adherence to requirements defined in standards, policies and procedures and therefore refers to the behavior which is about engaging people in core safety tasks. Safety participation on the other hand refers to the employee's voluntary participation in safety activities, which aims to contribute to the development of a supportive safety environment. (Griffin & Neal 2000)

The practical and academic interest in leadership styles and employee safety related behavior in literature is extensive. However, what comes to Safety leadership and leadership in its entirety the most comprehensive and well tested model of leadership styles is the full range leadership model by Bass and Avolio (1994). (Kirkbride 2006) The full range leadership model depicts the whole range of leadership styles from passive and ineffective non-leadership to effective and active transformational styles as described in Figure 5. Transactional leadership focuses on establishing goals and actively monitoring the employee's performance towards these goals. Transactional leadership also provides corrective feedback and rewarding system to employees to sustain and improve performance (Bass 1985, Kapp 2012). Transformational leadership relies upon the leader motivating employees to perform beyond their self-interest towards the greater good (Barling et al. 2002). According to Bass (1985) transformational leadership achieves results through raising followers acceptance of some goals, thus altering the followers need level on Maslow's hierarchy for accomplishing that goal.

Effective

Transformational

Idealized influence

Inspirational motivation

Intellectual stimulation

Individualized
Consideration

Passive — — — — — — — — — — — — — — — Active

Transactional

Contingent Reward

Management by
exception

Laissez-Faire

Nonleadership

Ineffective
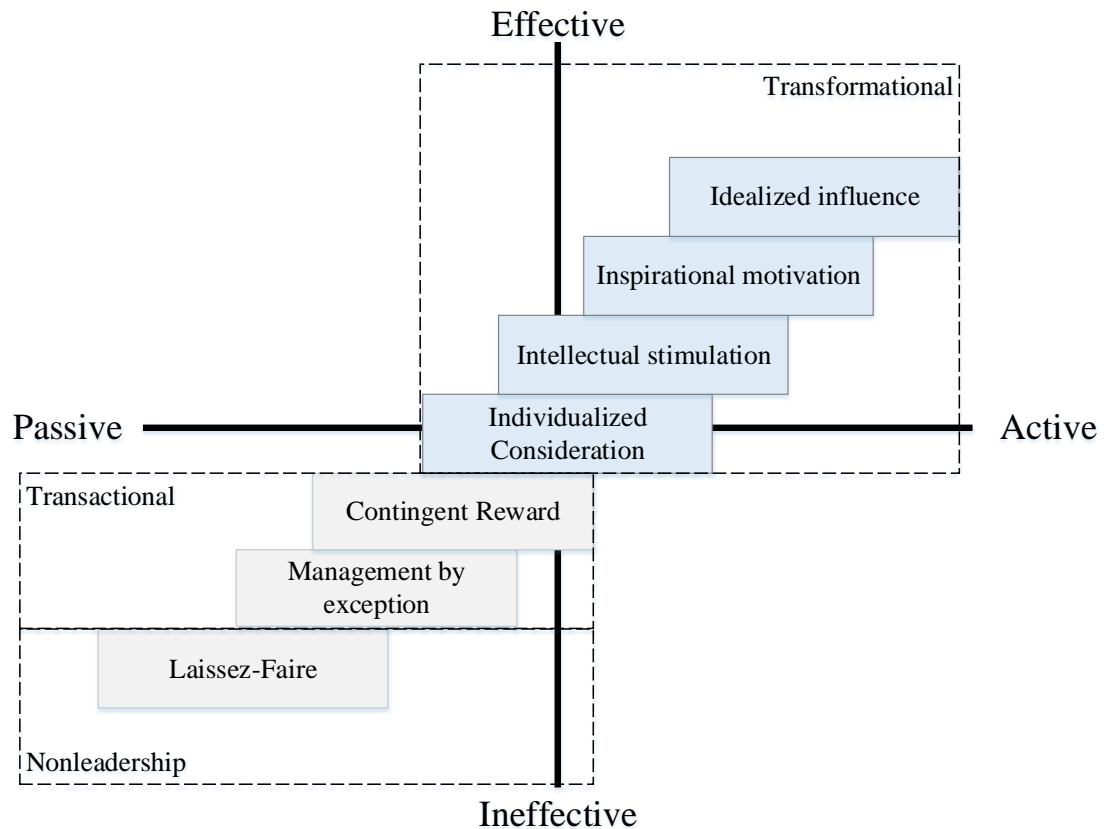
***Figure 5** Full range leadership model, adapted from Bass & Avolio (1994)*

Full range leadership model divides the three leadership styles; Nonleadership, transactional and transformational leadership to seven different approaches seen in Figure 5. Starting with the nonleaderhip style, laissez faire-leader is essentially a non-leader. This type of manager offers little in terms of direction or support and is often "absent" to the needs of their followers. The manager avoids making decisions, abdicates responsibilities, refuses to take sides in dispute and shows lack of interest in what is going on. (Kirkbride 2006, Bass & Avolio 1994) The transactional leadership style is divided to two different approaches which are management by exception and contingent reward. Management by exception can be seen as active or passive management. Passive management by exception focuses to the deviations from standard. This type of manager takes action only when problem occurs and tends to be relatively laissez-faire under the normal circumstances. The manager enforces corrective actions when mistakes are made and places energy on maintaining status quo. Thus the manager has a wide performance acceptance range and poor performance monitoring systems. However, management by exception can also be active. Active leader pays very close attention to any problems or deviations and teaches followers how to correct mistakes. Therefore the active management by exception has an accurate monitoring and control system to provide early warnings of problems but still even as done well the style tends to provide only moderate performance. (Kirkbride 2006, Bass & Avolio 1994)

Contingent reward is the classical transactional leadership style where the leader sets clear goals, objectives and targets and clarifies what rewards can be expected from successful completion. This type of leader recognizes what needs to be accomplished and follows up the performance. This type of leader provides support and resources to meet the objectives and gives recognition to followers when they perform and meet the goals. The rewards may not only be financial but also a wide range of non-financial rewards like time off, holidays, praise or visible recognition. If done successfully, this leadership style produces performance at required levels. (Kirkbride 2006, Bass & Avolio 1994) However, in order to get the employees to "walk that extra mile" transformational leadership styles are a necessity. Transformational leaders are intellectually stimulating, directing followers to look at the things from new perspectives. (Hetland et al. 2011) They recognizes the followers' individual needs and abilities and therefore stimulates their intellectual development. Transformational leaders also exert influence on their followers by communicating an idealistic vision of the future. (Bass 1985) Transformational leadership styles employs four components, individual consideration, intellectual stimulation, inspirational motivation and idealized influence.

Individual consideration is the first of the transformational leadership styles. These type of leaders recognize differences among their follower, their strengths and weaknesses, likes and dislikes. Thus the leader assigns projects to followers based on their individual abilities and needs. The leader also demonstrates concern for the followers and encourages to two-way exchange of views and ideas. The second style of transformational leadership is intellectual stimulation involves the leader to stimulate the followers to think through the issues and encourages to question the possible problems and their solutions. The leader re-examines assumptions, is willing to put forward also ideas that seem foolish at first and creates a readiness for changes in thinking. (Kirkbride 2006, Bass & Avolio 1994) The third style of transformational leadership is the inspirational motivation where the leader challenges and inspires the subordinates to go beyond their personal interests and focuses their attention on the goals of the collective. The leader has the ability to motivate the followers to superior performance by articulating a vision of the future in an exciting and compelling manner. The inspirational leader mounds expectations and shapes meanings, reduces complex matter to key issues using simple language and creates a sense of priorities and purpose. (Kapp 2012)

The final transformational leadership style refers to the leaders that have become an idealized influence or in other words a role model to people around them. The leaders exhibit certain personal characteristics or charisma and demonstrate certain moral behaviors. The attributes of this type of a leader are that the leader demonstrates unusual competence, uses power for positive gain and celebrates genuinely followers' achievements. (Kirkbride 2006) The leader has an enhanced, two-way interaction with followers (Hale 2010). Idealized influence can also be seen in safety related activities since the leader has an elevated commitment to safety and he emphasizes the importance of safety with words

and actions (Hale & Hovden 1998; Shannon et al. 1997). The different leadership styles are gathered in Table 4 with description of the styles and examples from the research literature.

Table 4 *Leadership styles and examples from research, adapted from Tappura et al. (2014)*

	Description	Examples from research
Management by exception	Passive management focuses to the deviations from standard Active leader pays very close attention to any problems or deviations	Monitoring safety of working practices (Griffin 2013; Shannon 1997; Zohar 2002) Enforcing and teaching corrective actions (Lu 2010) Sanctions for violating safety standards (Hale & Hovden 1998)
Contingent reward	Leader sets clear goals, objectives and targets and follows up performance	Following performance (Bass & Avolio 1994) Providing support and resources (Bass 1985) Rewarding and giving feedback to followers (Hale & Hovden 1998; Zohar 2002)
Individual consideration	Leaders recognize differences among followers	Assigning projects to followers based on their individual abilities (Bass & Avolio 1994; Hale & Hovden 1998) Culture of caring (Hale & Hovden 1998) Redesigning work e.g. after employees accident (Shannon et al. 1997) Enhancing two-way exchange of views and ideas (Bass & Avolio 1994; Kirkbride 2006)
Intellectual stimulation	Leader stimulates followers to think through the issues, supports ideas and problem solving	Creating readiness for changes in thinking (Bass & Avolio 1994) Motivating problem solving and learning (Hale & Hovden 1998; Griffin 2013) Distributing safety roles and responsibilities (Shannon et al. 1997)
Inspirational motivation	Leader challenges and inspires followers to go beyond their personal interests towards a collective goal	Motivating followers to superior performance (Kapp 2012) Articulating a compelling vision of the future (Kapp 2012; Bass & Avolio 1994) Creating a sense of priorities and purpose (Bass & Avolio 1994, Kirkbride 2006)
Idealized influence	Leader as a role model to followers	Enhanced interaction with followers (Hale 2010) Emphasizing the importance of safety (Hale & Hovden 1998) Elevated commitment to safety (Shannon et al. 1997) Celebrating followers' achievements (Kirkbride 2006)

Based on the study of Tappura et al. (2014) all the traditional leadership facets of transactional and transformational leadership are relevant to safety leadership. Also several other studies suggest that both transformational and transactional leadership is a suitable construct for safety leadership (e.g. Barling et al. 2002, Kapp 2012, Clarke 2013). The study of Clarke (2013) indicates that active transactional leadership is important in ensuring safety compliance with rules and regulations, whereas transformational leadership is associated with enhanced safety participation. Transactional leadership not only ensures safety compliance but also shapes employees' perceptions of the importance of safety. Zohar (2002) states that transactional leadership, more precisely contingent reward has beneficial effects on safety outcomes, leading to fewer injuries. Another transactional leadership style, the passive management by exception leadership has demonstrated negative effects on workplace safety and thus reduced safety compliance and participation. (Mullen 2011)

Barling et al. (2002) argues that a safety specific transformational leadership can affect the subordinates' awareness of safety issues at workplace as well as their perception of organizations' policy and practices concerning safety. This was seen to lead to less safety related incidents. Also Mullen and Kelloway (2009) stated that this type of safety-specific transformational leadership improved safety outcomes and enhanced the safety participation of employees. Therefore the study shows the link between transformational leadership and enhanced safety performance. Judge and Piccolo's (2004) study shows that transformational leadership is also positively correlated to followers' job satisfaction and motivation. Many other researchers links the transformational leadership to enhanced employee engagement, organizational commitment and proactive behavior. (Griffin 2013; Xu et al. 2011, Lee 2005)

Griffin (2010) further studied the impact of specific leader behaviors on employee's safety performance. He examined how the leader behaviors of safety inspiring, safety monitoring and safety learning impacted the safety compliance and safety participation of employees. These leadership behaviors can be grouped to transformational and transactional leadership styles. The safety inspiring, as a transformational leadership style refers to the degree to which leader presents a positive vision of safety that is appealing and inspiring to the employees. The safety monitoring, a transactional style refers to the degree on which the leader monitors and responds to mistakes in relation to safety. Safety learning is the behavior where the leader encourages and promotes safety related learning. The study of Griffin (2010) shows that safety inspiring is specifically related to safety participation whereas safety monitoring and safety learning relates to safety compliance showed in Figure 6.
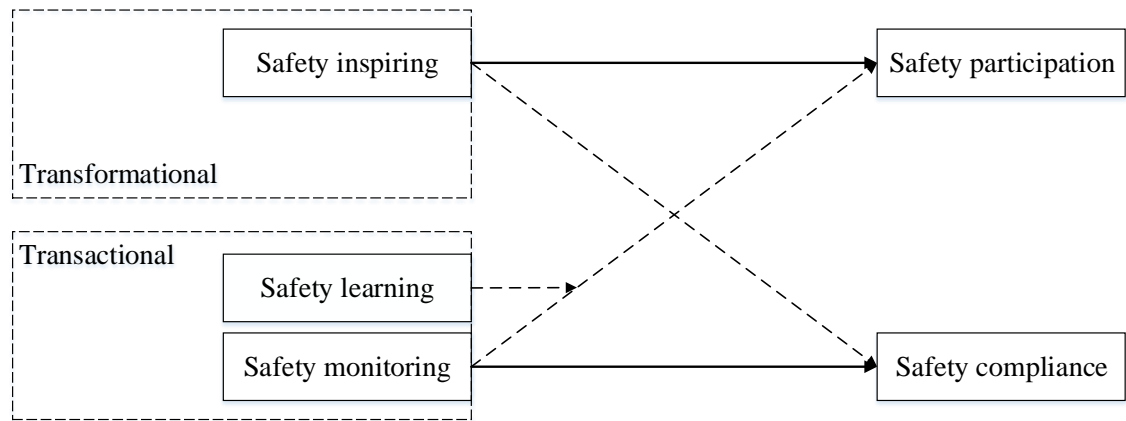
Figure 6 *Link between safety inspiring, safety monitoring and safety learning in pre-dicting safety performance, adapted from Griffin (2010)*

Clarke (2013) also studied the link between leadership styles and safety performance but took also into account the safety climate factor. Safety climate can be defined as employees' perceptions of the relative priority of safety in relation to other organizational goals. (Zohar 2000) Safety climate can also be seen as an individual-level construct, where perceived safety climate represents individuals' perceptions of policies, procedures and practices relating to safety in the workplace. (Clarke 2013) The safety climate and safety culture is covered in more detail in chapter 2.2. The study from Clarke (2013) showed that transformational leadership had a positive association with both perceived safety climate and safety participation of employees. Active transactional leadership on the other hand had a positive association with perceived safety climate and safety compliance. The link between transformational leadership and safety compliance as well as the link between active transactional leadership and safety participation were non-significant. The model from Clarke (2013) is presented in Figure 7.
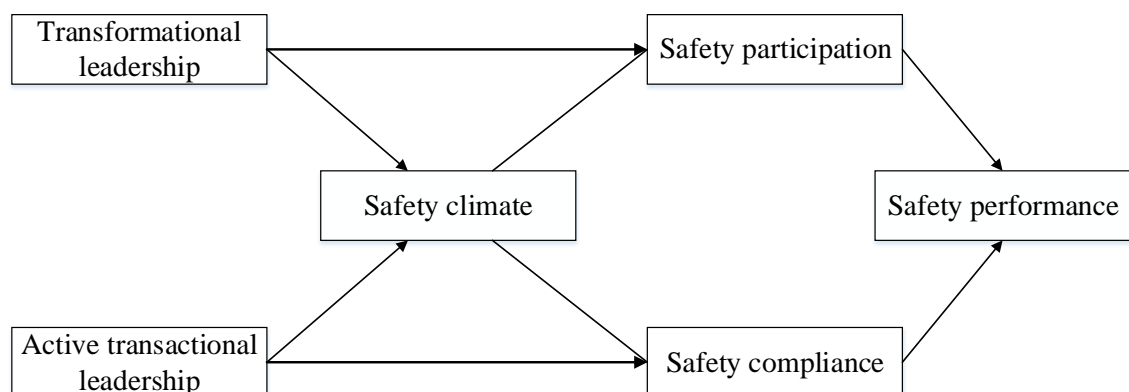
Figure 7 *Relationship between leadership, safety climate and safety, adapted from Clarke (2013)*

It can be argued that an effective safety leadership should incorporate the principles of both transformational and transactional leadership styles. (Bass & Avolio 2003; Barling et al. 2002; Kapp 2012; Clarke 2013; Griffin 2013; Tappura et al. 2014; Wu et al. 2008)

Effective safety leadership is not only the sum of transformational and transactional leadership styles but also depends on the credibility and vision of managers as well as their safety commitment. Credibility of management depends on the employees trust in management. The importance of employees' trust in management for workplace safety has received increasing attention within the literature. (Conchie et al. 2013; Conchie & Donald 2009; Zohar 2000) These studies show that trust in management increases employees' engagement in safety behaviors and therefore reduces rates of accidents. Conchie and Donald (2009) stated that the qualities like honesty, openness and concern for others' safety and welfare are the key factors of employees' trust in management.

Krause and Bell (2015) argue that consistency between manager's words and actions plays the key role in the management credibility. Credibility of the manager can be enhanced via honest feedback. According to Cavazotte et al. (2013) one significant factor that also affects the safety performance of employees seems to be the feedback provided by leaders. Survey of literature performed by Bass (2008) suggest that the feedback from the supervisor about the performance of his subordinates is a driving stimulus and important factor for improving safety performance. Several other studies also shows that positive feedbacks increase the prevalence of safety behavior and even improves the skills and motivation of employees regarding safety (Blackmon 1995; Cavazotte et al. 2013; Bass 2008)

Neal and Griffin (2004) defines the management's safety commitment as the extent to which management is perceived to place a high priority on safety and communicate and act on safety issues effectively. Many studies show that the senior management's safety commitment has a crucial influence on organizational safety (Fruhen et al. 2014; Michael et al 2005; Christian et al. 2009; Krause & Bell 2015) Studies show that safety commitment is reflected from five aspects of management actions. These aspects are managers' decision- and policy making, their involvement and communication with workforce and safety values. (Zohar 2005; O'Toole 2002; Griffin & Neal 2004) The study of Fruhen et al. (2014) indicated that also two other factors affects positively on the perception of the management's safety commitment; the managements' ability to understand and solve safety related problems and the managements' social perception, the ability to understand the emotions of others. The safety knowledge on the other hand was not associated with behavior that demonstrates safety commitment of management. Zohar (1980) argued that the management commitment can manifest itself through such things as job training programs, participation in safety committees and taking safety in consideration in job design.

Since the safety commitment of managers plays the key role in organizational safety, what can then hinder the engagement of managers to safety and safety leadership? According to Conchie et.al (2013) both individual factors and contextual factors influences the engagement in leadership. Two individual factors such as personality and emotional intelligence are seen important antecedents of engagement (Barling et al. 2000) but the contextual factors are no less important since research suggests that these factors may

account for between 41% and 70% of variance in leadership behaviors. (Arvey et al. 2006) Contextual factors can be considered as either demands that deplete the manager's energy and consequently engagement in safety leadership, or as resources that facilitate manager's engagement. Job demands refers to the physical, social, or organizational aspects of job that require sustained mental or physical effort from a person. Job resources on the other hand refers to the physical, social and organizational aspects of a job that aid in the completion of tasks, reduce the negative consequences of job and contributes to personal growth. (Conchie et al. 2013)

The study of Conchie et al. (2013) concludes that work overload, production demands, formal procedures and some workforce characteristics hindered supervisor's engagement in safety leadership. Work overload has been associated with reduced safety citizenship behaviors and an increase in unsafe behavior also in other research. (Barling et al. 2002; Nahrgang et al. 2011) The study of Conchie et al. (2013) suggests that reducing demands placed on supervisors in one way for organization to promote supervisors' safety leadership. Also the negative effect of job demands can be decreased by offering a training in supervisory role. Supervisors' engagement in safety leadership is enhanced through social support from organization and co-workers and through perceived autonomy. Perceived autonomy refers to the sense of independence while carrying out a task and encourages ownership of the task. Engagement also comes from the understanding of safety leadership and the different leadership styles. According to Kirkbride (2006) managers should understand that they don't have to be "perfect" leaders, instead all that is required is a subtle change of balance from the transactional leadership style towards transformational style via coaching, training and support from the organization.

2.2 Safety culture

Organizational culture is a concept used to describe the organizational values that affect and influence members' attitudes and behaviors. Safety culture is often described as a sub-facet of organizational culture, which affects the member's attitudes and behaviors in relation to organization's ongoing health and safety performance. (Cooper 2000) According to Cullen (1990) Safety culture is used to describe the corporate atmosphere or culture in which safety is understood to be, and is accepted, as the number one priority. Cullen argues that unless safety is the dominating characteristic of organizational culture then the safety culture can be seen as sub-component of organizational culture, which alludes to individual, job and organizational features that affect and influence health and safety. Turner et al. (1989) defined Safety culture as "the set of beliefs, norms, attitudes, roles, and social and technical practices that are concerned with minimizing the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious." Another often used definition for Safety culture comes from The Confederation of British Industry (CBI 1991) that defines safety culture as "the ideas and beliefs that all members of the organization share about risk, accidents and ill health".

According to Cullen (1990) the definitions of Safety culture reflect the view that safety culture 'is' something in the organization rather that something that the organization 'has'.

Another closely related concept to organizational culture and safety culture is the safety climate. Safety climate is generally accepted term to describe the collective view of Safety within an organization that is manifested by recent or current events. According to Zohar (1980) and Cooper (2000) safety climate is therefore the accumulation of beliefs, values, and perceptions about safety that are shared within a specific group. In contrast to safety culture, safety climate is often significantly influenced by recent events and can be considered as a 'snap-shot' of the organization's safety culture. (Cooper 2000, Flin et al. 2000, Hale 2000) For example, the safety climate of an organization can experience an immediate negative impact if a major workplace incident such as a serious injury occurs. Although this event may eventually also impact the safety culture, it tends to have a significant latency and it requires years to accurately evaluate the impact. (Goulart 2013) In this chapter first the different methods to assess the safety culture are introduced, followed by an introduction to different models of safety culture. Since the concepts of safety culture and safety climate are closely related, in this thesis the term safety culture refers later on to a combination of both safety culture and safety climate.

2.2.1 Assessment of Safety culture

The need to assess organization's safety culture can derive from many different sources. Safety culture assessment can be done after a serious incident to get a better understanding of the true causes behind the incident. On the other hand, safety culture assessment can form the base for normal organizational improvement or be performed according to the orders from authorities. The methods for assessing safety culture can be divided to two categories, quantitative and qualitative methods. Quantitative methods focus on the comparison of the safety culture to some scale. Typically quantitative methods are preferred since they are easy to perform and the data is comparable. Examples of quantitative methods are audits or questionnaires. Qualitative methods can be also used to assess safety culture. In qualitative methods the question forming is more descriptive, seeking answers to questions like "what kind of safety culture do we have" or "why our safety culture is what it is". Examples of qualitative methods are interviews, workshops and observation. The quantitative and qualitative methods generate different kind of information thus both of them should be used when assessing safety culture since the information gain from these methods usually completes one another. Quantitative methods are suitable when the culture development and trend are under examination. Qualitative methods can act as a base for improvement projects since they provide more profound information of the actual causes behind the state of the safety culture. (Reiman & Pietikäinen 2008)

Most used assessment method is the quantitative questionnaire since it is easy to use and to perform. (Clarke 2000; Glendon & Stanton 2000) Usually questionnaires are performed anonymously since it ensures that the answers are truthful and describe the actual state of the safety culture. The questionnaires assess the different cultural dimensions of the organization by gathering answers to different statements. Usually the statements are answered on a Likert-scale, which goes from "I disagree" to "I agree". (Reiman & Pietikäinen 2008) The answers and parameters gain from the questionnaire can be used to assess the level, strength and scope of the organization's safety culture. According to Zohar (2007) the level of safety culture describes how safety is prioritized in the organization and reveals whether the safety culture is good or bad. The strength describes the unanimity of the employees on how they perceive the safety culture. The scope of the safety culture shows whether there are large differences between the perception of safety culture's level or strength.

Even though questionnaires are most used assessment method to assess the safety culture they are also criticized. Questionnaires are argued to only show the surface of the culture, the safety climate that is affected by resent events. (Glendon & Stanton 2000) However, even if the results are only a snap-shot of the safety culture, they have an important practical use. Organizations can use the results to compare e.g. the safety culture in different facilities. The comparison helps the organization to see the strengths of different facilities and also the improvement areas where safety can be further developed (Sorra 2007). Glendon (2001) introduced a large set of safety culture questions that comprises of six factors. The factors are introduced and further discussed in chapter 2.2.2. but some examples of the questions are introduced below:

- Safety rules are followed even when a job is rushed
- Safety rules can be followed without conflicting with work practices
- Workers can express their views about work problems
- Workers are spoken when changes in working practices are suggested
- Work problems are openly discussed between workers and supervision

Another quantitative method, safety audit can be used together with questionnaires. In the safety audits organization's processes are assessed usually with checklists. The aim of the audit is to find out whether the organization has the ability and intention to work safely. The resources, work instructions and safety management system amongst others can be assessed and some conclusion of the safety culture can be made on a certain extent. (Reiman & Pietikäinen 2008) However, according to Lee (1998) safety audits are more of a self-assessment of leaders and therefore Lee emphasizes the need for supporting questionnaires where the employee's voice can also be heard. Observation is also used as a quantitative method to assess safety culture. First the wanted safety behavior is described, evaluated and scored. (Cooper 2000; Zohar 2007) Then the employees are observed to notice the deviations in working behavior. The problem of this method is that it is rather concise. For example if employees are observed to walk without a helmet the

conclusion that the employee does not understand the meaning of safety and the risks in his work cannot be made directly. (Reiman & Pietikäinen 2008)

Another way to assess the safety culture is to use qualitative methods. Instead of questionnaires or audits organization can perform interviews to a smaller group of employees. It is important to allocate the interviews correctly and select the people for interviews so that they are a descriptive subset of a larger group of employees. Interviews can be performed in two different ways. The interviewee can be asked to describe the safety matter to a person unfamiliar with the subject. Another way is to ask work content related questions, thus the context understanding of the employee is emphasized. The organization can also use group work methods. In the workshop people from different operations of the organization can be asked to discuss about safety issues and perform evaluation where improvements could be made. (Mengolini & Debarberis 2007; Reiman & Pietikäinen 2008)

2.2.2 Models for Safety culture

A number of attempts have been made in recent years to map or describe the main features of safety culture. Different models describe the safety culture as a derivative of different factors or dimensions. In a study from Reiman and Pietikäinen (2008) over 25 studies of safety culture are introduced and described. This emphasizes the amount of interest from researches to this theme but also states the variability of the perspectives what researches have on safety culture. In this thesis three models are introduced in order to present a basic outlook to the subject; Cooper's reciprocal safety culture model, IAEA's model and the model from Reiman and Pietikäinen that resulted from an extensive literature research.

Cooper's model (2000) forms the basic theory in understanding safety culture. Cooper's reciprocal safety culture model contains three elements which encompass subjective internal psychological factors, observable ongoing safety-related behaviors and objective situational features presented in Figure 8. In this model for example the management engagement to safety can be seen in psychological level as the manager's personal appreciation and engagement to safety. In behavioral level the engagement appears as concrete actions and the way the manager talks about safety. In situational level the safety engagement can be seen in safety management system elements, work instructions or process descriptions. (Reiman & Pietikäinen 2008) The three different factors can be evaluated with quantitative and qualitative assessment methods. The internal psychological factors can be assessed with safety related questionnaires, the behavioral factors with observation and checklists. Audits can be used to assess the situational features like safety management system elements. (Cooper 2000)
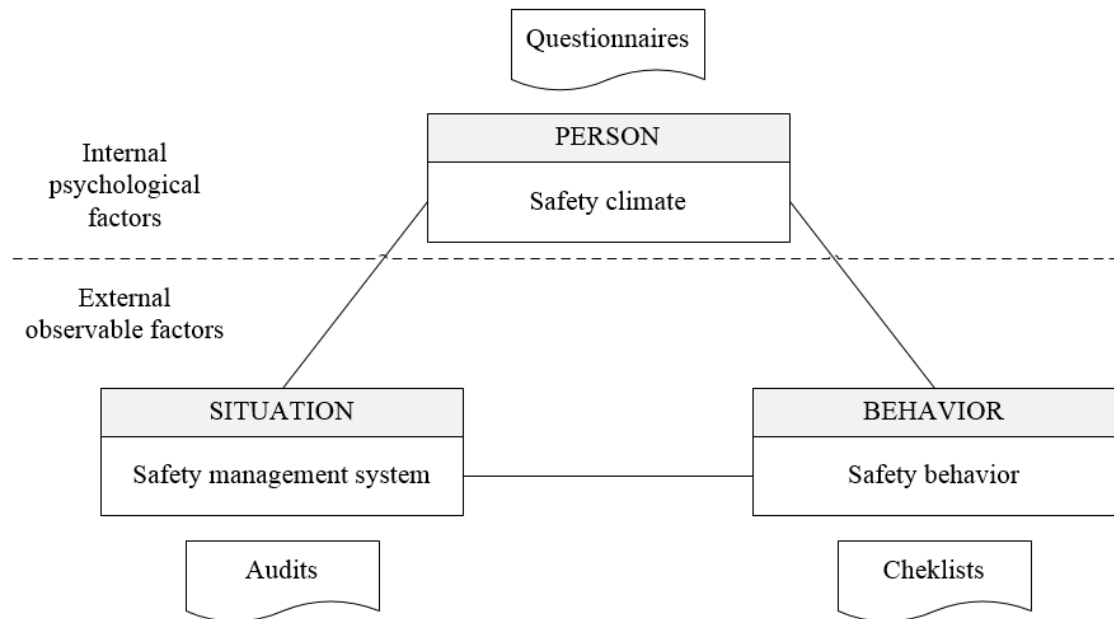
Figure 8 Cooper's reciprocal safety culture model, adapted from Cooper (2000)

Another safety culture model from the International Atomic Energy Agency (IAEA) is widely used as common understanding and assessment of safety culture within nuclear power facilities. Although IAEA's role is purely advisory, its model of safety culture is becoming a reference for regulatory bodies. (López de Castro et al. 2012) The safety culture model of IAEA is composed of 37 attributes clustered into five dimensions. These five dimensions are "safety is clearly recognized value, Leadership for safety is clear, Accountability for safety is clear, Safety is integrated into all activities and Safety is learning driven". The attributes of these five dimensions characterizes the strong safety culture and are created in a form of a short description of the dimension. Safety culture of the organization can be assessed with the help of this model since the attributes covered in this model should also be covered when developing interview questions or questionnaires. (IAEA 2006) Even though the safety culture model of IAEA is widely accepted, some caution should be used when deciding whether to use this model as a reference for organization's safety culture. López de Castro et al. (2012) studied the validity of the IAEA's safety culture model and concluded that "the five dimensions of the model may appropriately reflect the essence of safety culture, but some of the attributes may not be adequate to assess these dimensions". Therefore the model could be improved or re-formulated.

The third model for safety culture is derived from an extensive literature research made by Reiman and Pietikäinen (2008). In this model the safety culture composes of three dimensions; organizational dimension, psychological dimension and social processes. Organizational dimensions are important to understand but also psychological factors must be taken into consideration to be able to attain the full picture of safety culture. Psychological factors refers to employee's experiences of work and the conception the employee has on safe working practices and risks. Besides these two dimension, the social

processes show the mechanisms how people interpret safety, what kind of work practices exist and how the meaning of safety is created amongst employees. The three dimensions of the safety culture model is shown in Figure 9.
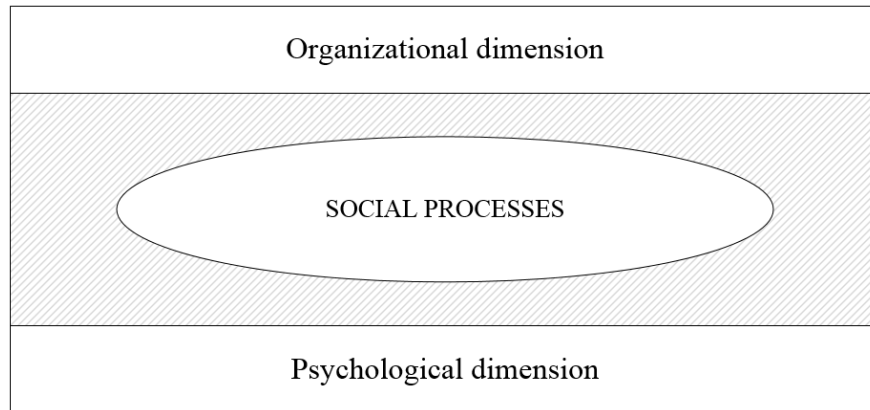
Figure 9 Safety culture model by Reiman and Pietikäinen (2008)

The organizational dimension includes many common key elements found from the literature research. The management engagement to safety tends to be an important element in almost every safety culture model. The engagement can be divided to four sectors including the safety management system definition, management's actions for ensuring safety as well as actions of immediate superiors and safety communication. Safety training, resourcing and management of change are also found as an important part of the organizational dimension of safety culture. The psychological dimension reflects the functioning of the key elements in the organizational dimension. The psychological factors include safety motivation and responsibility of safety. Important factor is also that the employee understands the hazards, risks and potential consequences in his own work and is able to control the risks. The third dimension of the safety culture model are the social processes. The social processes describe how the organizational processes affects the employees on different times and how the psychological states derived from the organizational processes affects the performance of employees and how they perceive safety. (Reiman & Pietikäinen 2008) The three dimensions of this safety culture model and the key elements of the dimensions are described in Table 5.

Table 5 *Safety culture model dimensions and elements, adapted from Reiman and Pietikäinen (2008)*

Dimension	Elements
Organizational dimension	Definition and maintenance of safety management system
	Management's actions for ensuring safety
	Safety communication
	Supervisor's actions for ensuring safety
	Collaboration and information flow between immediate work community
	Collaboration and information flow between facilities
	Reconciliation of know-how from different occupational groups
	Practices for organizational learning
	Ensuring competence and training
	Resource management
	Work instructions
	Management of external workers
	Management of Change
Psychological dimension	Safety motivation
	Understanding of the hazards, risks and potential consequences in own work
	Responsibility in organizational safety
	Work management
Social processes	Role in daily actions
	Formation of norms and social identity
	Optimization of working practices
	Normalization of deviations
	Institutionalization of work and safety related conceptions

2.3   Management of Change in Safety culture transformation

Change involves moving from the known to unknown. According to Murthy (2007) change is an alteration in the way things are done, that affects people, structure and technology. Nowadays change is an ever-present feature of organizational life, both at an operational and strategic level states Burnes (2004). Change management is therefore "the process of continually renewing an organization's direction, structure and capabilities to serve the ever-changing need of external and internal customers" (Moran & Brightman 2000). Since the rate of change in business environment is greater than at any time in the history, mastering strategies for managing change is becoming a very important managerial skill (Moran & Brightman 2000; Senior 2002; Carnall 2003). Managing change as a manager is much more than just planning, resourcing, implementing and reviewing the change. Managing change is about managing people that are facing change. Therefore the known role of a manager is developing from manager to leader to change manager and ultimately to change leader in cases where change is followed through successfully. (Moran & Brightman 2000; Anderson & Anderson 2002, p.183) In this chapter different theories and methods of Change management are introduced together with arguments what

makes Change management process effective. These theories introduce different strategies for true organizational or cultural change and provides managers key information about Change management. The second section of this chapter focuses on the managerial role in leading change and seeks answers to questions like; what are the difficulties when facing change? How can a leader change behaviors of people and manage the resistance that relates to the change? And most importantly, what are the elements of successful change?

2.3.1 Strategies for cultural transformation

Literature in Change management is extensive. Many authors have developed their own Change management methods in the past decades and many more have studied and reviewed them. Kurt Lewin (1946) first developed a Change management process for a planned change. In this theory the planned change is seen to go through three different phases; Unfreeze, Act and move and Refreeze. Lewin suggested that the change process starts with unfreezing the current state of the organization by exposing the organization for change, after which the desired changes are implemented with a right leadership style. The Change process ends when the desired state of change has been reached and the organization refreezes again. Since the rate of change in business environments has been increasing since the 1940, also different approaches to Change management models have been introduced. In the 20th century many of the most famous theories of Change management have been represented.

Kanter et al. (1992) created a method for implementing change that emphasizes the employee participation and team-orientation. In this ten phase method, first the organization's current state and its need for change is evaluated. Top management then creates a vision of the future and the direction, where the change is heading. It is important to separate the vision from the past and create a sense of urgency for the change. Since the role of employees and individuals are enhanced, the role of a strong leader must be supported from the top-management. Besides the support from top-management other sponsorships for the change has to be lined up. With this power line up the implementation plan is then crafted and enabling structures developed. According to Kanter et al. (1992) it is important that the information flows effectively across organization and therefore supports the adaptation of the change amongst employees. Employee participation and employee involvement in planning the change also makes the adaptation and institutionalizing more effective.

While Kanter et al. (1992) emphasizes the participation of employees in change, Judson reviews the subject from a different viewpoint. Judson (1991) identifies the barriers that might occur in different phases of change and suggests actions that can be taken to minimize the effects of such barriers. He states that the resistance of change from the employee and manager side is the biggest possible barrier. In his model the Change process has five

phases starting with analyzing and planning the change, communicating it and then rein-forcing it by gaining acceptance of new behaviors. Changing from status quo to desired state includes overcoming the resistance barrier. At last the change is consolidated and institutionalized.

Kotter started to develop his own approach to manage change after so many change ini-tiatives in different companies had failed. He analyzed the reasons for unsuccessful change attempts and developed an eight step method for managers to avoid the common mistakes. In Kotter's (1996) model the change is implemented in highly top-down manner and the role of the manager is emphasized. First the sense of urgency and desire for change is established among the management teams and guiding coalitions created. En-couraging the guiding coalition to team work improves its chances to lead the change initiative. Creating the vision is a crucial step and the lack of it the most common reason why the change initiative fails. The vision should be clear and understood in all levels of the organization and therefore the strategies for achieving the vision play an important role. After communicating the vision managers should empower a broad based action that addresses and removes all possible obstacles throughout the organization. This means not only changing the systems or structures that are undermining the vision but also that no single manager can counteract the change. The motivation for change is enhanced by generating short-term wins like visible performance improvements and rewards for em-ployees. Using the credibility of change more improvement and changes are imple-mented. The last step is to anchor the new approaches to the culture by articulating the new connections between new behaviors and performance and also aligning e.g. the KPI's to fit the new approach.

Luecke (2003) states that change won't happen without urgency. Therefore he stresses the importance of "why" in any change initiative. By answering the why properly, people are motivated to the change. Besides the "why", the "how" in problem identification plays also a significant role. Luecke (2003) argues that "the motivation and commitment to change are greatest when people who will have to make the change and live with it are instrumental in identifying the problem and planning its solution". From these arguments Luecke created a seven step approach to manage change. After the first step of answering the "why" and the "how" a shared vision of how to organize and manage competitiveness is stated. Identifying the leadership and focusing on results and not so much on activities are the next phases of the model. In Luecke's model the change is started in peripheries and from there it is let to spread without pushing from top-management. The success is instilled through policies and procedures and then reviewed. New strategies are then ad-justed to meet the possible new problems.

Cummings (2009) has organized a summary model from the diversity of theories for man-aging change into five key elements. These key elements combine the theories of identi-fying and overcoming resistance, the models that create visions and desired futures and theories of leader roles and learning practices. First element is about motivating change

and creating a readiness for change. By describing the core ideology of change the vision is created and political support is developed by identifying and influencing key stake-holders. Next element is about managing the transition with the help of management structures and commitment. Sustaining the momentum is done by providing needed resources for change, developing new competencies and skills and staying at the right course for change to happen. All of the theories and models that are presented in this chapter are summed up in Figure 10.

Lewin's Method	Kanter's theory	Judson Method	Kotter's Eight Steps	Luecke's Method	Cumming's theory
1. Unfreeze	1. Analyze organisations need for change	1. Analyze & plan change	1. Establish sense of urgency	1. Identify problems in teams	1. Motivate change
2. Act & Move	2. Create a vision and direction	2. Communicate change	2. Form powerful guiding coalition	2. Develop a shared vision	2. Create a vision
3. Refreeze	3. Separate from the past	3. Gain acceptance of new behaviours	3. Create the vision	3. Identify leadership	3. Develop political support
	4. Create sence of urgency	4. Change from status quo to desired state	4. Communicate the vision	4. Focus on results, not activities	4. Manage transition
	5. Support strong leader role	5. Institutionalize change	5. Empower others to act on the vision	5. Start change at peripheries, let it spread	5. Sustain momentum
	6. Line up political sponsorship		6. Create short-term wins	6. Instill success through policies & procedures	
	7. Implementation plan		7. Consolidate improvents & create new change	7. Review&adjust strategies to arising problems	
	8. Develop enabling structures		8. Institutionalize new approaches		
	9. Communicate and involve people				
	10. Institutionalize change				

Figure 10 Change management methods, adapted from Al-Haddad (2015)

Many of these theories and models share the same key elements yet they differ in the way change is managed. Roughly divided into two groups the Lewin's, Judson's, Kotter's and Cumming's theories concentrate on the top-down management of change while Kanter and Luecke emphasizes the employee participation and team work, in other words a bottom-up approach to change. However, all of the theories emphasizes the importance of management role and leadership in change management. To be able to choose the right model for change management, the type of change must be understood. Al-Haddad (2015) suggest that the Change method and the change type must be aligned to have an effective change outcome. Change type describes the kind and form of change and the characteristics that make the change what it is. Change types can be classified according to scale and duration of change. Meyer (*et al.* 1990) classifies the change types according to two dimensions. First dimension states the level at which change is occurring, whether the change effects the whole industry or just the organization. The second dimension describes the change to either continuous or discontinuous change. Burnes (2004) identifies continuous change as the ability to change continuously in a fundamental manner. Luecke (2003) specifies the discontinuous change as onetime events that take place through widely separated initiatives that are then followed by long periods of stillness. Luecke also describes discontinuous change as "single, abrupt shift from the past". Burnes (2004) differentiates also a third type of change called incremental change. Burnes refers to incremental change when the individual parts of the organization deal separately with one problem and one objective at a time.

Changing the Safety culture rests on the Safety leadership as well as Management of Change theories as stated previously in chapter 2.1. The change type for safety culture change could be described as an incremental change, since the turnaround concept is first run in selected units. Changing the safety culture means changing the behaviors and attitudes of employees and management. Therefore the focus in the change management model should be in motivation and participation of employees without forgetting the leader's role in Change. Kanter's (1992) and Luecke's (2003) models emphasize the Leader's role as well as the role of the employees so therefore these two models are further investigated and compared to each other. Kotter's (1996) top-down manner in leading change is also compared to the previous models to have a better understanding of the manager's role in change. The models and their linkages are described in Figure 11. Todnem (2005) states that these three models also offer more practical guidance to organizations and managers than the other theories in the extensive field of change management literature.

Kanter's theory	Luecke's Method	Kotter's Eight Steps
1. Analyze organisations need for change	1. Identify problems in teams	3. Create the vision
2. Create a vision and direction	2. Develop a shared vision	1. Establish sense of urgency
3. Separate from the past		2. Form powerful guiding coalition
4. Create sence of urgency	3. Identify leadership	6. Create short-term wins
5. Support strong leader role	4. Focus on results, not activities	5. Empower others to act on the vision
6. Line up political sponsorship	5. Start change at peripheries, let it spread	4. Communicate the vision
7. Implementation plan	7. Review&adjust strategies to arising problems	7. Consolidate improvents & create new change
8. Develop enabling structures		
9. Communicate and involve people		
10. Institutionalize change	6. Instill success through policies & procedures	8. Institutionalize new approaches

Figure 11 *Comparison of Kanter's, Luecke's and Kotter's Change management theories, adapted from Todnem (2005)*

All three models compared in Figure 11 emphasize the importance of a shared vision. Clear vision guides the change efforts and motivates people in change (Kotter 1996; Kanter 1992; Luecke 2003). Another point that all theories agree on is the importance of institutionalizing the change. The change success should be instilled through policies and procedures and new approaches and behaviors anchored into the organization. The new connections between new behaviors and performance should be communicated and e.g. the KPI's aligned to fit the new approach. (Kotter 1996; Kanter 1992; Luecke 2003). Luecke (2003) and Kotter (1996) share the common idea of short-term wins, the visible

results of improvement projects. They also propose a rewarding system that further motivates employees to get involved in a change. In Luecke's method the good results of improvement projects in peripheries are thought to act also as motivation agents that spread the enthusiasm of change to other parts of the organization. Kanter (1992) and Kotter (1996) suggests that first a sense of urgency and desire for change has to be established among the management teams to be able to get political support to the idea and form a guiding coalition that manages the change. Communication is also emphasized in both theories. Leadership role and the top-management support for the leader are clearly stated in Kanter's (1992) and Luecke's (2003) theories but it also plays a crucial part in Kotter's (1996) method. Therefore the leadership role has to be further analyzed and its link to effective Change management identified.

2.3.2 Leading cultural change

> *"...there is no more delicate matter to take in hand, nor more dangerous to conduct, nor more doubtful in its success, than to set up as a leader in the introduction of changes. For he who innovates will have for his enemies all those who are well off under the existing order of things, and only lukewarm supporters in those who might be better off under the new"*
> *(Machiavelli, 1469-1527)*

Machiavelli described the problem of change in his book The Prince already in the 16th century and even nowadays the issue is familiar for many Change managers. Rajan (2000) states that the culture change programs are about "changing hearts, minds and souls" of employees. To be able succeed in this leader needs many attributes. Gill (2003) discusses the requirements of leadership and divides them to four different dimensions; the intellectual/cognitive dimension, the spiritual dimension, the emotional- and behavioral dimension. He argues that effective change leadership requires the cognitive abilities to understand given information, reason with it, and make judgements and decisions based on this information. With these abilities the leader can produce a vision and a mission, the strategies how to follow the vision and also create shared values. The spiritual dimension focuses on the meaning and the sense of urgency of the change. According to Gill (2003) effective leadership also requires well developed emotional intelligence. The emotional intelligence can be understood as an ability to understand oneself and other people and therefore to be able to use personal power to lead change. Behavior dimension focuses on leading by doing, where the manager acts as a positive example to others.

Moran and Brightman (2000) argues that the most effective change leaders share a number of common characteristics. Effective change leaders describes the change in terms of how it effects the organization but also its individual effect. They allow the people to experiment and test the change and generate recommendations. They act as role models by leading the change with words and actions and display a constant dedication to the realization of change. Effective change leaders also interacts constantly with individuals and groups to legitimize the necessary change by communicating with employees and answering their questions. Kanter (1999) states that the most important attributes of a leader are the passion, conviction and confidence in others. The study of Chrusciel (2008) states that an effective change leader must have "the personal self-driven sense and willingness" to promote the change as well as the ability to work with others. The change leader should also favor intrinsic values, like eagerness to learn and willingness to challenge himself over extrinsic rewards like recognition and praise from management.

Besides the change leader attributes there are also other factors that contributes to the success or failure of a change initiative. Kotter (1995) has studied the critical mistakes that managers often do in the different phases of change. He argues that the critical errors managers make in the beginning of the change initiative is that they underestimate how hard it is to drive people out of their comfort zones and often lack patience. In worst case managers are paralyzed by the downside possibilities of change. Moran and Brightman (2000) also discusses about the management fears on putting themselves on record as a leader of change since they fear what happens if the change initiative fails and who is to blame. Therefore it is important to form a political support and guiding coalition with shared commitment according to Kotter (1995). Kotter further argues that a coalition powerful enough to support change should include the chairman or division general manager plus another 5 or 15 top-managers at least.

The coalition should be able to sell their dream, the vision of change with the same passion and deliberation as an entrepreneur states Kanter (1999). The vision should be a clear and compelling statement about where the change is leading argues Kotter (1995). He states that often the vision is too blurry or complicated to be communicated effectively. Moran and Brightman (2000) discusses that people are goal-oriented and are pulled along by a sense of purpose, desire and value. Also Sullivan et al. (2001) state that people move towards those goals that they are attracted to, while withdrawing from those that would conflict their values. Therefore the vision should be in line with the values of the organization as well as the values of individual employees.

Resistance to change occurs when the change violates a person's sense of purpose (Moran & Brightman 2000). Resistance to change has long been recognized as a critical factor that influence the success of an organizational change effort (Waddell 1998). Gill (2003) describes the most powerful resistance as emotional, which derives from the dislike of surprises, lack of confidence or respect to those who are leading the change as well as the fear of moving out of the comfort zone. Kotter (2008) diagnoses the types of resistance

to parochial self-interest, lack of trust, different assessments and low tolerance for change. Self-interest is the fear of losing something and is shown as a focus of own best-interest and not on those of the organization. Lack of trust in the motives of the change leaders and a different assessment of the current situation can lead to failure of the change initiative. Resistance can be managed in different ways. Kotter (2008) proposes six methods for managing change that includes education, participation, facilitation, negotiation, manipulation and explicit and implicit coercion. These methods are presented in Table 6.

Table 6 *Methods for dealing with resistance to change (Kotter 2008)*

	Commonly used in situations	Advantages	Drawbacks
Education + communication	Where there is a lack of information of inaccurate information and analysis	Once persuaded, people will often help with the implementation of the change	Can be very time consuming if lots of people are involved
Participation + involvement	Where the initiators do not have all the information they need to design the change, and where others have considerable power to resist	People who participate will be committed to implementing change, and any relevant information they have will be integrated into the change plan	Can be very time consuming if participators design an inappropriate change
Facilitation + support	Where people are resisting because of adjustment problems	No other approach works as well with adjustment problems	Can be time consuming, expensive, and still fail
Negotiation + agreement	Where someone or some group will clearly lose out in a change, and where that group has considerable power to resist	Sometimes it is a relatively easy way to avoid major resistance	Can be too expensive in many cases if it alerts others to negotiate for compliance
Manipulation + co-optation	Where other tactics will not work or are too expensive	It can be relatively quick and inexpensive solution to resistance problems.	Can lead to future problems if people feel manipulated
Explicit + implicit coercion	Where speed is essential, and the change initiators possess considerable power	It is speedy and can overcome any kind of resistance	Can be risky if it leaves people mad at the initiators

Cummings (2009) states that the first step in overcoming resistance is learning how people experience change. This requires empathy, support and active listening from the change leader's side. He argues that when people feel that the change leaders are genuinely interested in their feelings they are likely to be less defensive. Cummings also emphasizes the importance of communication and the involvement of employees to overcome resistance. Also Lewin (1991) concludes that involvement in learning, planning and implementation stages of change process lowers the employee resistance to change. But resistance can be also a constructive tool for Change management states Waddel (1998). Waddel argues that resistance points out that it is a fallacy to consider change itself to be inherently good. Therefore resistance influences the organization towards greater stability and critically observes the potential outcomes of change. Resistance can "draw the attention to aspects of change that may be inappropriate, not well thought through or perhaps plain wrong" states Waddel (1998). Therefore management should also see the positive sides of resistance, benefit from it and utilize the criticism to further improve the change initiative.

Resistance and other barriers of change can be overcome also by systematically planning and creating short-term wins. Kotter (1995) argues that most of the people won't go on the long march to change it they don't see compelling evidence of good results. Managers often fail in this because they don't differentiate from hoping for short term wins and actually creating them. Therefore in successful change the managers should actively look for ways to get performance improvements, achieve clear objectives and reward the people with recognition. Also Kanter (1992) emphasizes the importance of recognition and argues that it is the most underutilized motivational tool in organizations. Recognition not only brings the change cycle to logical conclusion but also motivates people to make a change again in the future. But change process should not be declared concluded or successful before the changes are sank deeply into a company's culture argues Kotter (1995). He states that until the new behaviors are rooted in social norms and shared values, also described as "the way we do things around here", the change is subject to degradation as soon as the pressure for change is removed. The change success should be instilled through policies and procedures, and new approaches and behaviors anchored into the organization. The new connections between new behaviors and performance should be communicated and e.g. the KPI's aligned to fit the new approach. (Kotter 1996; Kanter 1992; Luecke 2003). Kotter (1995) also states that sufficient time should be given to make sure that also the next generation of top-management really personifies with the new approaches.

Even though the change leaders have avoided the mistakes in the different phases of change, the change initiative can still fail because of the differences in national cultures. Kirch et al. (2010) argues that the national cultures influence the way in which organizations are structured, how employees are motivated and also what kind of change approach can be successful. Therefore management methods and techniques are not generally

cross-culturally transferable states Molinsky (2007). The best known studies of cultural dimensions are from Hofstede (1980, 2000), who conducted a large research project in multi-national corporations. Hofstede (2000) identified and validated five dimensions for national culture differences; individualism vs collectivism, masculinity vs femininity, uncertainty avoidance, power distance and long-term vs short-term orientation. In individualistic countries people tend to prioritize themselves over group success. The emotional roles between genders are divided to competitive males and caring females. Uncertainty avoidance refers to the extent to which members of a culture prefer to avoid uncertainty and feel uncomfortable or comfortable in unstructured situations. The dimension of power distance is stated as the extent to which unequal distribution of power is accepted. In this dimension the less powerful members in high power distance cultures accepts that the supervisors have more power than they do. Long-term orientation refers to the way how people accept the delay of results.

Kirch (2010) argues that the most organizational change approaches have been developed in highly individualistic and low power distance cultures, as for example in the United States. Therefore different approaches are needed to have a successful change in other cultures. Harzig and Hofstede (1996) states that the strongest resistance to change is in cultures that are characterized by high power distance, low individualism and high uncertainty avoidance e.g. in Korea and Latin America. Therefore the lowest resistance to change is in cultures with low power distance and high individualism as for in Nordic counties. The different culture dimension and suggestion for modified approaches as well as example counties are presented in Table 7.

Table 7 Cultural dimensions and modified approaches, adapted from Kirch (2010)

	Power distance	**Individualism**	**Masculinity**	**Uncertainty avoidance**
High	Remedial actions will be fast Stress and distress level of employees should be monitored	Provide high level of information Increase understanding of vision Provide leadership training Ensure that people have clear roles and objectives	Provide leadership training Provide training for team work Focus on more supporting strategies	Reduce the amount and pace of change Progress slower through the phases of change Provide large amount of information from supervisors Ensure confidence in company Ensure that people feel recognized and rewarded
Counties	Arabic counties Russia China India	Nordic countries USA Australia Singapore Hong Kong South Africa	Japan Italy Germany USA	Greece Korea Latin America Japan Arabic counties Catholic countries
Low	Ensure that people have clear performance objectives and roles Allow high level of employee involvement Increase the trust in leadership Motivate and reward	Communicate the need for change and vision clearly Ensure adequate information	Provide team work opportunities More direct communication from direct supervisor	Ensure employees have clear roles
Counties	Nordic countries USA Australia Singapore Japan Hong Kong South Africa	Korea Latin America Japan Arabic counties	Sweden Spain Thailand Korea	Singapore Nordic countries USA Hong Kong South Africa Protestant countries

To have a successful change many different aspects need to be considered as previously stated in this chapter. The most important role in success of the change initiative plays the skills of the leader. But successful changes seems to have also many other common characteristics argues Moran and Brightman (2000). They state that a successful change consists of a series of closer and closer approximations to increasingly ambitions goals and are embraced by increasing amount of people in the organization. The change is at the same time top-down and bottom-up should be a shared responsibility of everyone in the organization. Therefore the values of both organization and individuals plays an important role. Unless people can integrate the change in personal level, they cannot sustain it organizationally (Moran & Brightman 2000). Sullivan et al. (2002) has created a Logical Levels model, where the level of change is described as a triangle presented in Figure 12.

IDENTITY

VALUES

BELIEFS

CAPABILITY

BEHAVIOUR
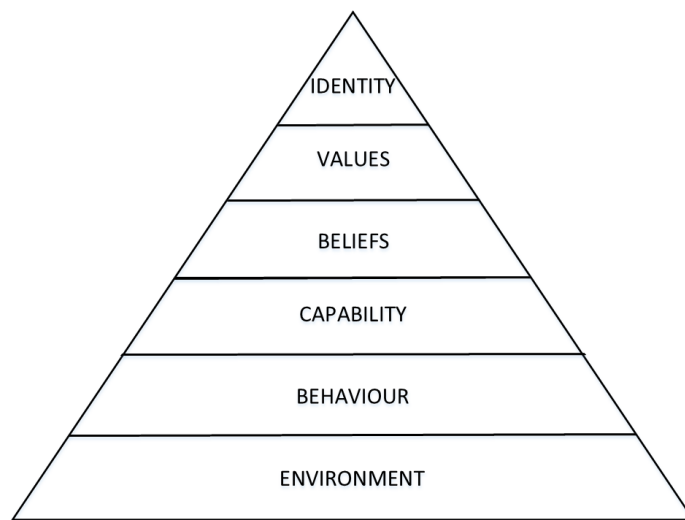
ENVIRONMENT

Figure 12 *Logical Levels model (Sullivan et al. 2002)*

Sullivan et al. (2002) argues that the lower the level of change, the easier it is to effect. Changing environment or capabilities are easier for organization than changing its identity and core values. Rajan (2000) states that the culture change programs are about "changing hearts, minds and souls" of employees. Therefore these values, new approaches and behaviors are important to be anchored into the organization. The change success should be also instilled through policies and procedures and the new connections between new behaviors and performance should be communicated to all employees. All of these elements are the core of successful change. (Kotter 1996; Kanter 1992; Luecke 2003).

2.4   Safety performance measurement and Tools

Measurement is a key action in any management process and forms the basis for continuous improvement. The dilemma between organizational performance measurement and safety performance measurement is that usually the organizational performance measurement is positive in nature e.g. return of investment and profit percentage while safety

performance measurement generally lies on injury statistics, the measures of failures. However, even if the organization has a low injury rate, it is no guarantee that the work-place is safe and the risks are being controlled. Therefore safety performance measurement should include various safety indicators and an efficient process to measure the indicators. According to United Kingdom's Health and Safety executive (HSE 2011) the Health and safety performance measurement should seek answers to the questions as:

- Where are we now relative to our overall health and safety aims and objectives?
- Where are we now in controlling hazards and risks?
- How do we compare with others?
- Why are we where we are?
- Are we getting better or worse over time?
- Are we doing the right things?
- Are we doing things right consistently?
- Is our management of health and safety proportionate to our hazards and risks?
- Is an effective health and safety management system in place across all parts of the organization?
- Is our culture supportive of health and safety, particularly in the face of competing demands?

In this chapter first the processes for measuring health and safety are introduced and answers for questions like why to measure performance, who should measure it and how, when to measure and what to measure are answered. In the following chapter the differences between active monitoring and reactive monitoring are argued and different safety indicators introduced. The key focus of the chapter is to provide an extensive set of safety indicators and examples of their range of usage. Thus enhance the knowledge of safety indicators and the safety performance measurement in its entirety.

2.4.1   Processes for measuring and sustenance of Safety

Measuring safety performance is one key element in an effective safety management. Safety measurement evaluates the organization's ability to manage safety. Not only is safety measurement required in guidelines e.g. ILO-OHS 2011 and OHSAS 18001 but it also provides important information about how the risks are controlled in the workplace. The primary purpose of safety measurement is to provide information on how the safety management system operates in practice, to identify areas that need improvements, to provide basis for continuous improvement and to provide feedback and motivation. Health and safety performance should be measured at each management level of the organization and the responsibilities for measuring and execution of actions allocated clearly. Most importantly senior management needs to ensure that the control measures to control the risks are in place, complied with and effective. (HSE 2011)

One general model of how to measure safety performance consists of nine steps (HSE 2011).

1. Identify key processes
2. Analyze safety management system and risk controls
3. Identify critical measures for each components of the safety management system and risk controls
4. Establish baselines for each measure
5. Establish goals or targets for each measure
6. Assign responsibilities
7. Compare actual performance to targets
8. Plan and implement corrective actions
9. Review the measures

The first step to measure the safety performance was to identify the key processes. The two key processes in managing safety are the safety management system of the organization and the risk control systems that control the hazards. These key processes should be analyzed with the help of people that have implemented the systems. The idea is to evaluate how the key processes operate in practice. For each key process critical measures are identified. These critical measures should be meaningful to those who use them, understandable, capable of showing trends and timely. These critical measures can be identified by answering questions as:

- What outcome do we want?
- When do we want it?
- How would we know if we achieved the desired outcome?
- What are people expected to do?
- When should they do it?
- What result should it produce?
- How would we know that people are doing what they should be doing?

For every critical measure the baselines and targets are established and the actual performance compared against these targets. Important is also to analyze the reasons behind the abnormal performance and identify the root causes. After that the corrective actions can be designed and implemented and the results re-evaluated. This to become an effective process, the safety performance measurement should be build and balanced between three different elements: the input, process and outcome. Input monitoring focuses on the nature, scale and distribution of hazards that the organizational activities create. The process element provides information about the risk controls, safety culture and management arrangements. Management arrangements measurement evaluates the performance of the individual components of the safety management system while safety culture measurement focuses on the positive health and safety activities in the organization. Measuring

risk controls provide information about how well the hazards in the workplace are controlled. The outcomes must be also effectively measured to see the possible failures in the health and safety management system, the injuries and accidents that resulted from these failures. (HSE 2011) The elements of an effective health and safety measurement process are presented in the Figure 13.
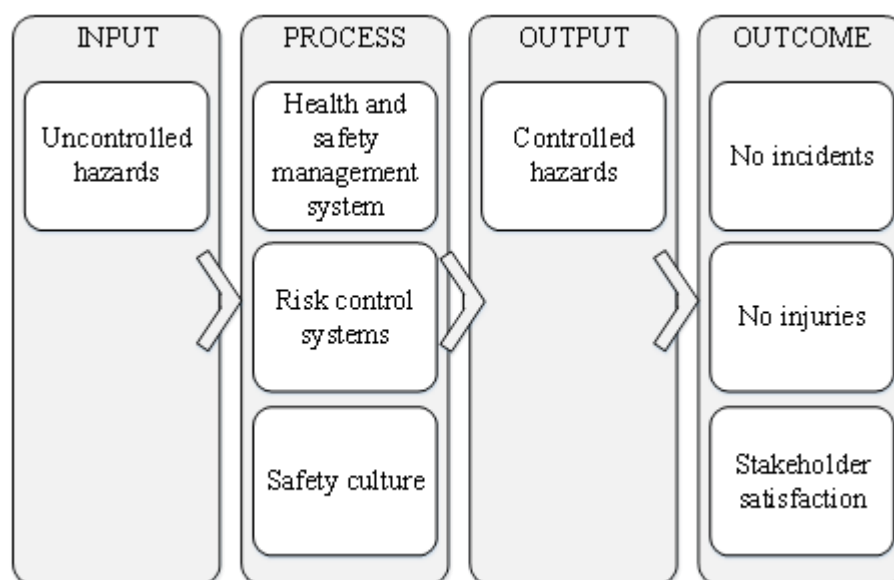
Figure 13 *Elements of an effective health and safety measurement process, adapted from HSE (2011)*

To have the process for health and safety measurement in place is the first step in monitoring and measuring safety successfully. However, in order to retrieve the information about the actual safety performance of an organization, one needs to know how to measure the critical factors. Since an effective health and safety measurement process includes elements of input, process and outcome measurements, also the indicators for measuring the performance of these elements should be understood. In the next chapter different key performance indicators of safety are introduced. First the key performance indicators (KPI's) for process measurement are described, followed by the KPI's that are commonly used in evaluation of risk control systems. Last, an extensive summary set of KPI's for measuring the health and safety measurement process elements are introduced.

2.4.2   Key performance indicators of safety

An indicator can be considered any measure, quantitative or qualitative, that seeks to produce information on an issue of interest. Safety indicators therefore provide information on current organizational safety performance. Different categorization for safety performance indicators exist in the literature yet many distinctions have the same principles. Most commonly used is the distinction between leading and lagging indicators. Typically the leading and lagging indicators are considered on a time scale where leading indicators precede harm and lagging indicators follow harm. (Reiman & Pietikäinen 2012) Leading

indicators can be though as precursors to harm that provide early warning signals of potential failures and therefore offer the opportunity to detect and mitigate risks before accidents or incident occurs (Sinelnikov et al. 2015). Leading indicators can also be viewed as measures of positive steps that organizations take that may prevent an incident occurring (Grabowski et al 2007). According to Blair and O'Toole (2010) the leading indicators "measure the actions, behaviors and processes, the things that people actually do for safety". Leading indicators can therefore be used to measure the input and process performance of the health and safety measurement process described in Figure 13.

Despite the many positive aspects that leading indicators bring to the safety measurement process, the most commonly used safety performance indicators are the lagging indicators. Lagging indicators measure the outcomes of activities or events that have already happened. (Reiman & Pietikäinen 2012) Lagging indicators are therefore the measures of OHS outcomes or outputs like incidents or accident and provide a measure of past performance. (Erikson 2009) The importance on lagging indicators is that they provide opportunities for organizations to check safety performance, learn from failures and improve the overall health and safety management. (HSE 2011) Therefore both of the safety performance indicators should be used to effectively measure and monitor the safety performance of an organization.

Health and safety management system is the core in an effective safety management and therefore an important factor to monitor. The study of Podgórski (2015) introduces different KPI's to measure the individual components of the occupational health and safety management system. The components of the OHSMS are derived from the ILO-OSH 2001 guideline, which divides the elements of OHSMS to policy, organizing, planning and implementation, evaluation and action for improvement. The study showed that leading indicators should be prioritized in developing the KPI's for OHS management system. The set of KPI's to measure the effectiveness of each OHSMS elements are described in the Table 8.

Table 8 *KPI's to measure the individual components of OHSMS, adapted from Podgórski (2015)*

OHSMS component		Example KPI's
Policy	OHS policy	Number of OSH policy reviews carried out by top management
		Percentage of workers declaring good knowledge of OSH policy
		Number of safety walkthroughs performed by top managers
	Worker participation	Number of OSH improvements proposed by workers
		Number of OSH Commission meetings on regular OSH issues
Organizing	Responsibilities and accountability	Percentage of work posts with defined OSH responsibilities and duties
	Delivering OSH training	Percentage of workers participating in OSH refresher courses
		Number of hours for OSH training per person
	OHS training programs	Percentage of OSH training courses reviewed and improved for their quality and effectiveness
	OHSMS documentation	Percentage of OSH MS procedures improved due to corrective actions
		Percentage of workers participating in trainings on OSH MS structure, procedures, etc.
	Communication	Number of meetings conducted by managers to inform workers on OSH issues
		Rating of the effectiveness of OSH communication via workforce survey
		Number of issues of company's OSH bulletin or other internal OSH publications
Planning and implementation	OSH goals and improvement plans	Number of measurable OSH improvement goals established
		Percentage of tasks in OSH improvement plans verified and accepted with regard to the quality and effectiveness
	Risk assessment processes	Percentage of periodically verified risk assessment processes with regard to their validity of risk control measures applied
	Implementation of risk control measures	Percentage of workers informed on risk levels and risk control measures applied
		Number of risk control measure implementations with hierarchy of measures considered
	Management of change	Number of analyses of impact on OSH carried out with regard to changes in OSH regulations, technologies and knowledge
		Percentage of workstation with risk assessment verified in course of introduction of new machinery, materials, changing work method etc.
	Emergency preparedness and response	Percentage of workers trained on emergency procedures, including rescue activities and first aid
	Procurement	Percentage of periodically verified OSH requirements applied in purchase specifications
		Percentage of purchased larger objects for which risk assessment has been carried out prior to bringing them into use
	Contracting	Number of contractors assessed for their compliance with OSH management requirements

	Performance monitoring and measurement	Percentage of definitions of leading and lagging performance indicators subject to periodical review and update
Evaluation	Investigation of work-related accident, diseases and incidents and their impact on OSH	Number of corrective and preventive actions carried out as a result of root cause analyses of work-related accidents, diseases and incidents Percentage of medical consultations carried out within the programme of workers' health surveillance
	Management system audit	Percentage of OHSMS components or processes subject to assessment during internal OHSMS audits
	Management review	Percentage of recommendations formulated by top managers at OHSMS reviews considered in OSH improvement plans
Action for improvement	Preventive and corrective action	Percentage of completed corrective and preventive actions in relation to all actions initiated by OHSMS audits and reviews, OSH performance monitoring, and root cause analyses of work-related accidents, incidents and diseases Percentage of completed corrective actions reviewed and evaluated for their effectiveness
	Continual improvement	Number of new OSH goals and objectives established in the framework of OHSMS continual improvement Number of OSH management KPIs subject to benchmarking with other companies

Risk control systems is the second measurable element in the process of health and safety measurement. Risk control systems are identified by identifying the hazards that can cause accidents. For every hazard a control system is placed and the critical activities of the control systems stated. To be able to evaluate that the control system works properly, a leading indicator is set for every critical activity of the control system. Important is also to set the performance tolerance, where the activity of the control is acceptable or not. However, even if the performance is in acceptable level an incident might still occur. Therefore it is also important to monitor the overall performance of the risk controls systems with lagging indicators. Lagging indicators show the errors and failures of the system after an incident has happened. Lagging indicators are important to be able to further improve the risk control systems. (HSG254 2006) The process for setting KPI's for risk control systems is described in Figure 14.
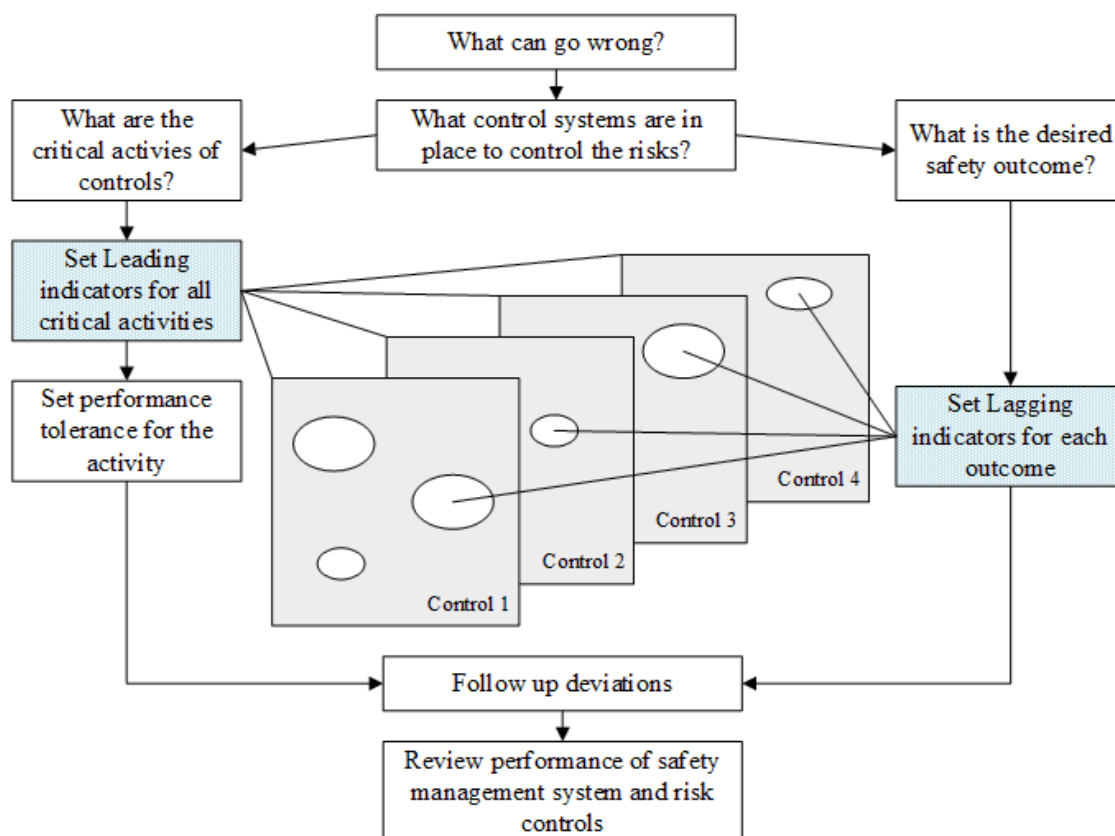
Figure 14 *Process for setting KPI's for risk control systems*

Safety culture is the third measurable element in the process of health and safety measurement. Safety culture is an indicator of the whole organizational safety performance as previously stated in chapter 2.2. Therefore it is logical to measure with leading indicators. Reiman and Pietikäinen (2012) divides the leading indicators to two groups, the lead monitor indicators and drive indicators. This distinction also helps to understand the method to measure the safety culture. The lead monitor indicators indicate the potential and the capacity of the organization to achieve safety. These indicators measure the internal dynamics of the sociotechnical systems and provide information on the activities of the system that affects also the safety culture. The drive indicators in turn indicate the development activities of the organization at improving safety. Therefore the drive indicators are measures of the fulfillment of the selected safety management activities and directs the sociotechnical activity by motivating certain safety-related activities. These drive indicators and monitor indicators can also be used in measuring the first two elements, the management system and risk controls of the health and safety measurement process. Examples of monitor and drive indicators are presented in Table 9 and Table 10.

Table 9 *Lead monitor indicators, adapted from Reiman & Oedewald (2009)*

Monitor indicator	Example KPI's
Work and safety motivation	1. The extent to which the personnel report that their work is meaningful and important 2. The extent to which human performance tools are utilized in daily practice 3. The extent to which personnel consider safety as a value that guides their everyday work
Controllability of work	1. Employees' reported sense of control over their work 2. The extent to which work is carried out in accordance to the processes described in the management system 3. The amount of slack resources to cope with unexpected or demanding situations
Understanding of hazards	1. The extent to which the personnel understands the hazards that are connected to their work 2. The extent to which the personnel has been trained in accordance with the planned training program 3. The extent to which the personnel are aware of the limitations of human performance capacity 4. The extent of personnel's awareness of the technical /physical condition of systems, structures and components 5. The findings from external audits concerning hazards that have not been perceived by personnel/management previously
Understanding of safety	1. The extent to which the personnel have basic knowledge of human performance issues 2. The extent to which the defense-in-depth principle is understood among the personnel 3. The extent to which Human Factors are considered neutral phenomena and not something to be avoided (i.e., a negative phenomenon) 4. The extent to which changes and improvements are considered at system level as opposed to unit or group level
Felt responsibility for the entire organization	1. The extent to which the personnel are willing to spend personal effort on safety issues and take responsibility for their actions 2. The extent to which the personnel make initiatives in improving organizational practices or report problems to the management
Mindfulness and vigilance	1. The extent to which the personnel continuously seek to identify new risks and enhance their view on the hazards of their work 2. The extent to which the personnel at all levels exhibit a questioning attitude 3. The extent to which external audits provide results that are in accordance with the findings in internal audits or prevalent conceptions of the personnel
Social interaction and activities	1. The extent to which safety-conscious behavior and uncertainty expression is socially accepted and supported 2. The extent to which the gap between work as prescribed and work as actually done is known and monitored in the organization 3. The extent to which the personnel perceive that they have to make tradeoffs between safety and economy in daily work
Technology	1. Continuous measures of the current condition of systems, components and structures 2. Percentage of safety–critical equipment that fail inspection/test
Environmental variability	1. Extreme weather phenomena for process plants 2. Age distribution of the population for healthcare organizations

Table 10 Drive indicators, adapted from Reiman & Oedewald (2009)

Drive indicator	Example KPI's
Safety management and leadership	1. Management is actively committed to, and visibly involved in, safety activities 2. Number of management walk arounds per month 3. Number of times safety is a topic in the management meetings
Strategic management	1. Safety is visibly and systematically considered in the organization's official plans and strategy documents 2. Systematic ageing management program exists for systems, components and structures 3. Program of preventive maintenance is in place and it is revised according to maintenance history 4. There is a system for documenting history data on equipment and their maintenance actions
Supervisor activity	1. Superior provides positive feedback on safety-conscious behavior of the personnel
Proactive safety development	1. System for reporting and analyzing incidents is implemented 2. Independent safety reviews and audits are carried out regularly and proactively 3. There is a system for gathering development initiatives from the personnel 4. There is a system for analyzing the common safety-related findings (trends, root causes, changes, variety of corrective actions, generalizability to other components/equipment) from the maintenance history as well as events and near misses in the organization
Competence management	1. An adequate system exists for the identification of current competence profiles 2. There are clear objectives established for training programs 3. A mechanism is in place to ensure that the scope, content and quality of the training programs are adequate 4. Feedback is gathered from the trainees and is utilized in developing the training program
Change management	1. There is a clear definition of what constitutes a technical change or an organizational change in the safety policy of the organization 2. Risk assessment is done for organizational changes 3. There is a procedure for planning, implementing and follow-up of technical and organizational changes 4. The effects of the implementation period to organizational practices is monitored during the change
Work conditions management	1. The availability of sufficient workforce is controlled 2. Procedures are updated regularly
Work process management	1. The bottlenecks of information flow are identified and controlled 2. Tasks and situations where routines may develop and where they might have consequences for safety are identified
Contractor management	1. There is a process for purchasing outside work 2. A record of contractor safety performance is utilized in decision making concerning contracts 3. Contractors are trained on safety culture issues and work practices of the client organization

Hazard control	1. A systematic corrective action program is in place to deal with deviations 2. Hazard identification and risk assessments are used to develop policies, procedures and practices 3. Adequate barriers are set against the identified hazards 4. The organization has analyzed potential accident scenarios and set barriers to prevent them 5. There are adequate human performance tools (HPT) to facilitate safe behavior
Contingency planning and emergency preparedness	1. The organization has an adequate on-site emergency preparedness plan 2. There is regular training on emergencies on-site

Lagging indicators are the measures of OHS outcomes or outputs, the final elements of safety measurement process. The importance of lagging indicators is that they provide opportunities for organizations to check the safety performance of the safety management system and risk control systems, learn from failures and improve the overall health and safety management process. Lagging indicators can be negative e.g. incidents or accident or positive e.g. employee satisfaction. Examples of the Lagging indicators are presented below. (EU OHS)

- Injuries and work-related ill health in terms of Lost time incidents
- Lost Time Incident Frequency (Rate)
- Production days lost through sickness absence
- Incidents or near misses
- Complaints about work that is carried out in unsafe or unhealthy conditions
- Number of early retirements
- The percentage of productive planned work days realized
- Number of hours worked by the total work force without lost time injury
- Number of working days since the last accident
- Employee satisfaction

An effective health and safety measurement process includes elements of input, process and outcome measurements. The indicators for measuring the performance of these elements are previously described in this chapter. Both leading indicators and lagging indicators should be used to effectively monitor the process elements of the health and safety measurement process. However, measuring performance for measurements sake is not the way to improve performance. Every organization should design and implement performance measurement processes according to the genuine need for monitoring. For this, this chapter has provided many tools and examples of key performance indicators to monitor the safety performance of the organization.

3. RESEARCH METHODOLOGY AND EXECUTION

3.1 Target company and prior Safety development projects

The target company of this thesis is ABB Group, one of the global leaders in power and automation technologies. Currently ABB has an extensive group of safety procedures and KPI's to measure the safety performance yet in some facilities the safety performance is lagging from the average safety performance of the company. The plans for improving the safety performance have been targeted to single processes and actions. However, the notable improvements in safety performance have not been reached in certain facilities. The tools to improve safety in workplace are provided, safety performance is measured and reported but the overall picture of the meaning of safety is still lacking. To be able to truly improve the safety performance the leadership behavior must be evaluated and improved.

In 1988, Swedish corporation Asea and Swiss BBC Brown Boveri merged resulting ABB Group. Nowadays ABB Group operates in around 100 countries across three regions: Europe, the Americas, Asia and Middle East and Africa. ABB Group has more than 300 manufacturing sites around the world employing 135 000 people. ABB Group is organized to four global divisions:

- Electrification Products
- Discrete Automation and Motion
- Process Automation
- Power Grids

These divisions are made up of specific business units focused on particular industries and product categories. In addition ABB Group has group functions that organizes the general functions and services related e.g. to finance, communication, human resources and sustainability. ABB Group is one of the few large companies that have implemented the matrix structure in the organization successfully. In this thesis ABB Group is referred as ABB which includes the four divisions and the group functions. (ABB 2016, pp.70-77)

The direction of business in ABB is defined by the Board of Directors. The board determines the organization of the ABB Group and appoints, removes and supervises the persons entrusted with the management and representation of ABB. The Board has delegated the executive management of ABB to the CEO and the other members of the Executive

Committee. The CEO and under his direction, the other members of the Executive Committee are responsible for ABB's overall business and affairs and day-to-day management. Division managers and Region managers in the Executive committee are responsible of their technology and geographical area. In countries, management organization consist of country managers, local business unit managers and local product group managers. (ABB 2016, pp.31)

This thesis focuses on the global Discrete Automation and Motion Division, later referred as DM Division. The DM division has approximately 29,700 employees as of December 2015 and operations in Europe, the Americas, Asia, Middle East and Africa. DM Division generated $9.1 billion of revenues in 2015, total of 24% of the ABB Group revenues in 2015. DM Division is divided into four different Business units: (ABB 2016, pp.70-73)

- Motors and generators
- Drives and controls
- Power Conversion
- Robotics

One part of DM Division in North America is Baldor Electric Group, later referred as Baldor. ABB acquired Baldor in 2011 aiming to penetrate the North American industrial market. Baldor was a leading power and automation technology group and was a leader in industrial motors in North America. The transaction positioned ABB as a leading supplier of industrial motion solutions and enabled ABB to tap a potential for rail and wind investments in North America. (ABB 2011) In 2013, ABB acquired a company called Power-One, the world's second largest manufacturer of photovoltaic inverters. As a result, ABB represented the most comprehensive solar value proposition on the market and one of the industry's broadest inverter product portfolios. Power-One's facility in North America is located in Phoenix and therefore also later on in this thesis referred as Phoenix. (ABB 2013)

3.2 Work tasks for concept construction

The concept design and construction is built on three individual work tasks. First, the theoretical background forms the base for the concept. The theories of managing safety, safety culture, management of change and safety performance measurement sets the perimeter on which the concept is constructed. Thus, all legal requirements or guidelines are fulfilled and theories for potential building blocks of the concept are taken into consideration. However, theory is only one part of a successful concept, also practical information about different approaches should be evaluated and included in the concept requirements. Therefore, prior Baldor and Phoenix safety development projects are analyzed and evaluated and information about the benefits and drawbacks of both cases are gathered. From these three work tasks the concept can be developed. Concept development is divided into three different elements; the concept's requirements, the construction

of the concept and last the concept piloting. The work tasks and concept's elements are presented in Figure 15.
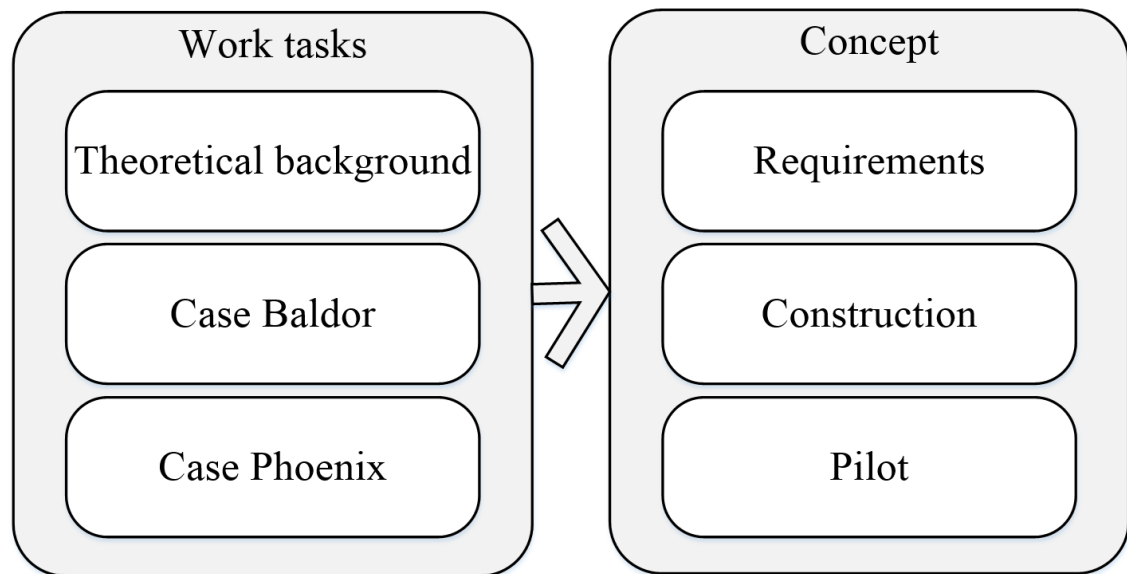
Figure 15 Work tasks and elements of the concept

The objective of the work tasks Case Baldor and Case Phoenix is to seek information about the safety improvement projects. These work tasks identifies the practical information about different approaches in safety culture improvements and forms the essential part together with the theoretical framework for concept construction. The target is to find suitable actions or trainings that can also be used in the new concept. The information about the safety improvement projects in Baldor and Phoenix was collected from interviews, intranet and database analysis. The past safety performance data was gathered from the Global Incident Database (GID), used in ABB to collect data in leading and lagging indicators. GID is updated on a monthly basis by local HSE or general managers and therefore enables to see the performance variation both in short and long term. The database analysis enables to review the validity of the information also in the future. The same channels and databases can be also used later on if additional information about these cases or other projects within ABB is required. Therefore the used concepts, trainings and approaches can be identified and analyzed and their suitability to the concept can be later evaluated.

The DM division HSE manager and the Director of HSE, DM Division North Americas were interviewed about the safety improvement projects and information about the used procedures and executed actions in these projects was gathered. The interviews were performed in three different timeslots. In the first interview the persons described the safety improvement projects in their own words while notes were taken. In the second interview the transcript of the first interview was gone through and additional information included. This was important to ensure that all the information about the actions was recorded and

the timetable of the actions was verified. The third interview acted as the final review of both recorded safety improvement projects. All the collected information and final transcript was later reviewed and validated by the Director of HSE, Baldor NAM.

3.3   Development of Safety culture transformation concept

The development of the concept is divided to three elements, listing the requirements of the concept, construction of the concept and concept piloting. In this chapter the requirements of the concept are introduced followed by the description how the concept was built and who was participating in the construction. The requirements of the concept are built according to the knowledge attained from the theoretical parts as well as according to the good practices from Baldor and Phoenix's safety improvement projects. The process for creating the requirements of the concept is presented in Figure 16.
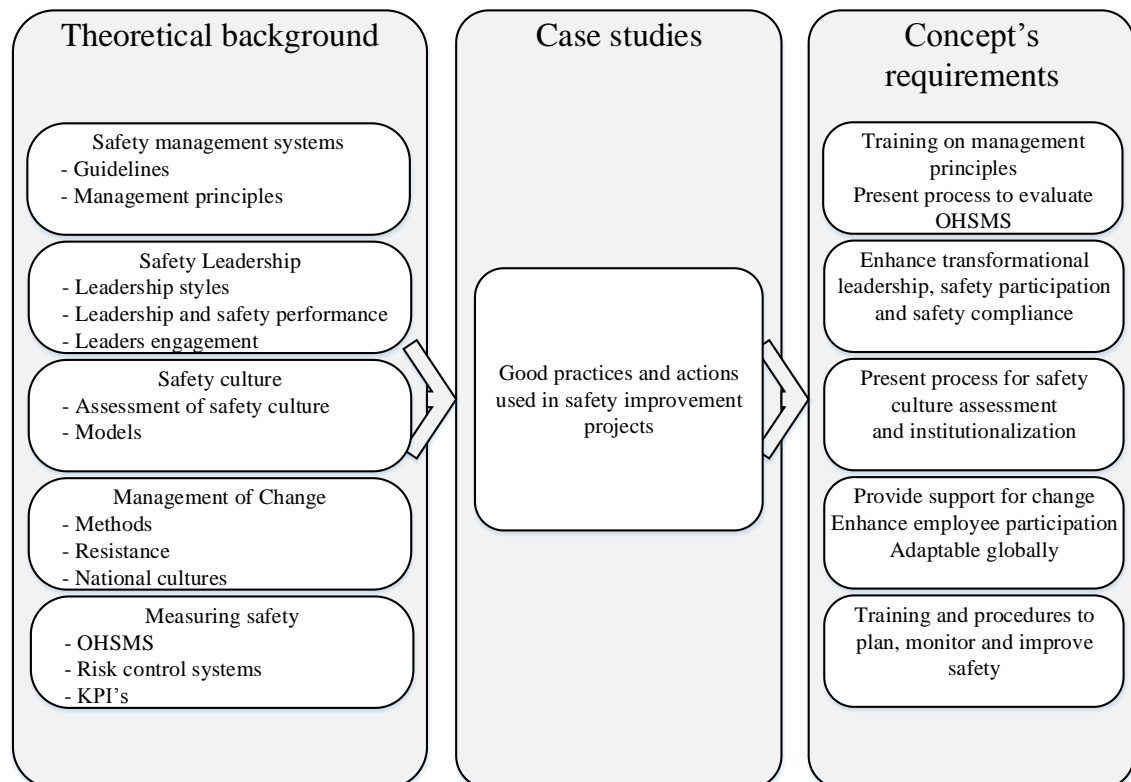
Figure 16 Requirements of the concept

From the theory some key points are emphasized in the concept development. Safety management system theory presented the guidelines and legal requirements of the OHSMS and provided information about the best practices found in literature for management principles. Safety leadership part introduced different leadership styles, linked the leadership to safety performance and provided examples of leadership engagement. Safety culture theory focused on assessment of the safety culture and on different models how the safety culture can be developed. For this also the management of change theory provides support as well as information about the methods to implement change and the

actions to beat resistance. One important part was also the national organizational differences that were introduced in the management of change theory. Last the safety performance measurement piece provided concrete examples on how to measure the safety performance of organization with leading and lagging indicators.

The theoretical framework and the good practices from Baldor and Phoenix case studies forms the base for the concept's requirements. The concept to meet the requirements of safety management systems and management principles there should be an organized training both on OHSMS and management principles. The concept should present managers a process with what they can measure the performance of their OHSMS and also test their ability to meet the requirements of management principles. To fulfill the Safety leadership requirements the concept should enhance transformational leadership by providing training for managers on how to become transformational leaders. Support and concrete actions should be presented how to improve the safety participation of employees and also actions how to improve safety compliance. Concept should also take into consideration the personal leadership engagement, the concept should motivate the managers to be more a transformational leader than manager.

Concept should provide information on how managers can measure the current situation of the safety culture in their facilities, how to analyze the results and multiple examples of possible improvement actions. Important is also to provide managers a tool kit how they can institutionalize the safety changes in their organization. For this also management of change theories should be presented to enhance the knowledge of possible barriers and troubles the managers might face when leading change. Concept should therefore provide both theoretical knowledge as well as practical support for the managers. Practical support can be arranged with mentors that are available for the managers in case of need. Since the success of change depends also of the national culture the concept should be designed so that it is adaptable around the world. Methods to enhance employee participation in change amongst with other trainings should be designed so that they are universally understood and trainable.

The construction of the concept started with discussing the objectives of the concept with DM Division HSE manager and the Director of HSE, DM Division North Americas. Already was known that incidents tend to happen in specific local business units. Even though the safety performance in these locations was improving over time, there were still too many lost time and serious incidents. Therefore the objective was to create a concept to support the local business units in managing incidents and creating a true safety culture improvement in their facilities. Different options for the design of the concept was discussed. First option was to create different modules according to the safety culture the plants were already having. For dependent cultures the concept should provide more basic training on safety, for interdependent cultures the concept could concentrate more on leadership and commitment. Because ABB has not yet the process for measuring the safety culture in facilities, this option was not available at this time.

Another option was to build the concept according to organizational levels. Since processes and programs in ABB are implemented via line management, also the concept implementation would be most efficient this way. The concept should provide targeted trainings for managers and employees on different organizational levels. To have an effective safety culture change, leadership plays critical role. Because of this, the concept was planned so that its main focus is on managers that are responsible for the safety performance as well as HSE managers that are working with safety issues on a daily basis. The first proposal of the concept was accepted by DM Division head thus the planning of the concept and its content was started. Plan and timetable for concept development was created together with the Director of HSE, DM Division North Americas and the first draft of the training concept was prepared.

Since the concept was going to be targeted to plant's General Managers and HSE managers, also the content of the concept should be designed to meet the needs of both. General Managers usually use information about overall safety performance and info about the progress of the safety improvement projects while HSE managers may need more detailed training on how to actually improve safety in the facility. Because of the differentiating needs, also the concept was to be separated to two different modules. The first module is targeted to General Managers and should include training on how to measure current safety performance, how to lead change and what type of programs General Managers could implement to improve safety in their facilities. The second module, targeted to HSE managers should include information about their roles and responsibilities, challenges in improving safety culture and concrete actions and trainings HSE managers could use to improve safety in plant level.

For both modules content development was started together with Director of HSE. To be able to design the concept to look as professional as possible, help from Learning and Development department of ABB was acquired. Learning&Development Consultant's professional skills were used to create the design and appearance of the concept. With the help of the consultant presentations and training material templates were created as well as inter-company advertisement about the coming concept. For the concept's training content training materials from previous case studies were collected and their possible use in the concept evaluated. Theoretical framework was taken into consideration when selecting the training materials.

Pilot was designed to ensure that the concept requirements and construction design reach the objective to support the local business units in creating a true safety culture improvement in their facilities. Together with the Director of HSE and Learning&Development Consultant a plan and timeline for the pilot was constructed. Since a cultural change in a facility is a long-term process that can last for years, the objective of the pilot was defined to only collect feedback from the participants on the concept itself. Since the concept builds on personal development as well as concrete tools the feedback for both should be acquired. The pilot was designed for both modules, first pilot was going to be arranged

to General Managers and the second for HSE managers. Thus the needs of both managers could be taken into consideration and develop the concept further from their feedback.

The feedback was going to be collected after each training session by providing the participants the chance to freely comment the training content, how it was presented and whether the participants found it useful. From the discussions, notes should be taken and after the first pilot for General Managers, the improvement actions made according to the feedback. Also an overall evaluation of the concept should be gathered via anonymous questionnaire. For the evaluation of the feedback, the development team of the concept should meet and make modifications and improvements on the second pilot for HSE managers. However, since the pilot content for General Managers and HSE managers differ, only applicable modifications should be made. After both modules has been piloted, the overall feedback should be evaluated and adjustments and improvements made for the whole concept. Also the concepts ability to adapt globally should be ensured.

4. RESULTS

In this chapter first the results of the case studies are presented. The safety performance of Baldor and Phoenix is evaluated before and after the improvement projects. Also the actions and procedures taken in Baldor and Phoenix are presented. Later, the concepts final design is described and the content of the concept evaluated. The training materials' success to meet the requirements of the concept is reviewed. Also the success of the construction and the pilot is discussed.

4.1 Case Baldor

The safety performance of Baldor was measured during one year between November 2013 and November 2014 prior the safety improvement project. Baldor, with 6 500 employees and 22 plants, had six serious injuries in this time period and 134 other recordable injuries, which was 74 more than predicted. 786 more Near misses and First aids were reported than expected, covering total of 1386 cases. Reported hazards of 9682 though surpass expectations with 3682 hazards. Safety observation tours were conducted in total 2922 times. The Total Recordable Incident Frequency Rate (TRIFR), covering the Serious incidents, Restricted work day cases, Lost Time incidents, Medical Treatments and First Aids and calculated per 200 000 hours worked was 2,15. The Lost time performance rate was 0,154.

Taking a longer time period to analyze the trend in TRIFR it is important to notice that the TRIFR has been decreasing already before November 2014 and therefore before the safety improvement project. The overall safety performance was getting better but still Baldor suffered from serious injuries. The Total Recordable Incident Frequency Rate, covering Serious incidents, Restricted work day cases, Lost Time incidents, Medical Treatments and First Aids was improving but the share of serious injuries was not decreasing. The trend was improving and going downwards until end of May 2014. In the summer 2014 the TRIFR started to increase and in November Baldor suffered again a serious incident. This was the turning point for developing new approach to improve the facilities' safety performance. Baldor's previous safety performance in TRIFR from February 2012 until January 2015 is shown in Figure 17.
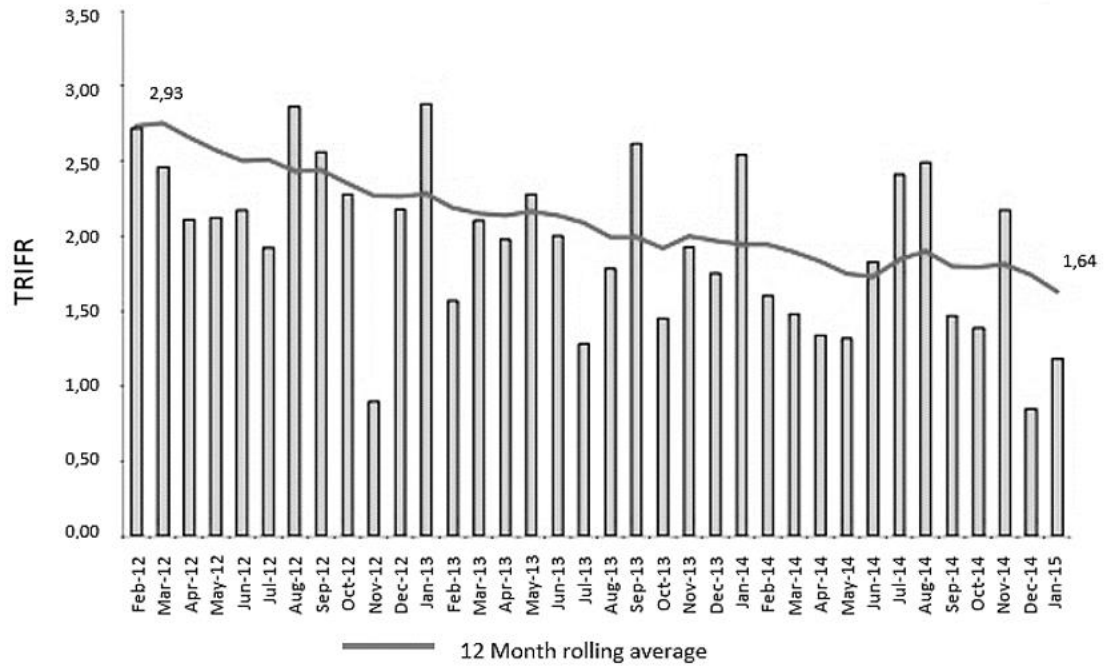
Figure 17 *Baldor's safety performance between Feb-12 and Jan-15*

Baldor, with 6500 employees and 22 facilities, tried to improve its facilities safety performance for several years but was not successful in eliminating the serious injuries. Therefore a new approach to tackle the safety issues was initiated. The execution started with gathering a committee of managers to plan and execute safety improvements. The management committee consisted of plant managers, directors, as well as managers from health and safety, environment, human resources, production and quality. The idea was to work non-stop for fourteen days and do a comprehensive investigation of the plant's safety culture and identify and address the issues the plants were having. During the 14 days, the plants were required to report on the progress of the safety improvements on a daily basis. After the 14 days, the plants had three months' time to implement and complete the required actions. The same procedure with management committee and the 14 day process was executed in all Baldor's 22 plants during the year 2014.

Before the fortnight management execution phase, current reality check about the plants' safety culture was made. The survey was conducted as a questionnaire for employees about their safety attitude. The survey consisted of twelve questions that were answered by "Agree" or "Disagree". The questions were as follows:

1. I am aware of Baldor's 2015 health, safety and environmental initiatives
2. We put safety first
3. I am clear that my supervisor puts safety concerns first
4. Our senior managers set the example in safety
5. I am not asked to perform operations that are unsafe
6. Our managers are concerned with our safety, not just safety numbers
7. Our managers clearly communicate out safety goals

8. The safety discipline process is applied fairly and effectively
9. Bringing up safety issues is OK in our culture
10. We regularly check for safety hazards before accidents happen
11. Our work environment is as safe as technology can make it
12. I am comfortable reporting an accident, injury or near-miss to my supervisor

The results from the questionnaire were collected and the percentage of the "Agree" answers calculated. From these results, a three-color matrix was created that showed the results as green if over 90% has "Agreed", yellow with "Agree" answers between 80-89% and red if less than 80% has agreed. Only four plants of the 22 came up with good results, having no more than one question result in yellow. The other 18 plants were having troubles with multiple areas as shown in Figure 18. The survey showed the urgency for safety culture change and the need for new safety improvements.

SAFETY SURVEY RESULTS	Plant 14	Plant 4	Plant 15	Plant 6	Plant 16	Plant 7	Plant 9	Plant	Plant	Plant 17	Office	Plant 1	Plant 18	Plant	Plant 11	Plant 19	Plant 12	Plant 20	Plant	Plant 3	Plant 13	Average
Question 1	100	99	98	100	97	98	98	95	97	96	89	98	99	97	99	99	98	99	99	97	97	98
Question 2	99	96	98	99	96	97	95	93	96	91	86	96	100	96	97	97	92	98	94	97	97	96
Question 3	98	94	99	97	96	95	94	93	99	97	96	96	99	89	97	97	90	97	96	90	93	95
Question 4	93	80	96	95	90	91	81	84	96	85	92	89	95	75	91	92	71	86	92	89	90	88
Question 5	93	89	96	94	92	91	88	91	99	93	96	91	98	90	95	96	82	88	88	94	93	92
Question 6	95	82	95	93	92	91	79	81	99	85	94	88	99	75	90	92	71	91	87	90	89	88
Question 7	98	94	98	98	95	92	92	90	96	92	92	94	100	89	96	97	85	95	95	93	95	94
Question 8	91	79	93	88	85	89	76	78	91	72	88	83	92	70	83	88	61	76	84	72	85	82
Question 9	96	91	98	97	99	96	92	90	100	95	97	95	99	87	97	97	87	93	98	94	96	95
Question 10	92	78	94	89	80	87	81	87	90	84	81	82	98	66	92	89	71	76	88	91	85	85
Question 11	80	69	81	68	59	79	66	73	87	77	84	68	94	36	72	74	53	72	44	66	75	70
Question 12	94	84	94	92	95	94	83	88	99	91	96	94	96	83	90	90	76	89	88	93	87	90
Average	94	86	95	93	90	92	85	87	96	88	91	90	97	79	92	92	78	88	88	89	90	90
No OF PARTICIPANTS	117	437	126	193	105	270	1125	315	396	252	416	504	128	92	202	216	219	162	126	77	405	5883

Figure 18 *Safety Survey*

After the safety survey, the safety performance of the 22 plants was evaluated. Number or Serious incidents, Total recordable incident frequency rate, Near miss and Hazard reporting and Safety observation tour performance was evaluated against the year 2014 targets. Also the current status of Risk assessments were evaluated as well as the plant's risk level that was based on the safety performance, level of proactive management approach, risk profile of the activities and plant's audit results. From these results a "heat map" was created that showed the current performance status of plants. This three-color matrix is also later referred as heat map and is shown in Figure 19.

	Actions Completed from F1 Review (Clio)	Serious Incidents during past 24 months	Total Recordable Incident Frequency Rate (Serious + Restricted + Lost Time + Medical Treatment + First Aid)		Near Miss and Hazards Reporting	SOT Activity	Risk assessments up-to date	Plant Risk Level based on facts: - Safety performance - Proactive management approach - Risk profile of the activities - Plant audit results
(Red)	No	Yes	> 5% Above the target	Rolling 12 Month average: Increasing	Below the target	Below the target	No	High
(Yellow)			+/- 5% of target	Rolling 12 Month average: flat				Medium
(Green)	Yes	No serious incidents	< 5% Below the target	Rolling 12 Mont average: decreasing	In OR above the target	In OR above the target	Yes	Low
			Performance 2014	Trend	Performance 2014	Performance 2014		
Plant 1	Green	Red	Red	Red	Red	Green	Green	Yellow
Plant 2	Green	Green	Red	Yellow	Red	Green	Green	Yellow
Plant 3	Green	Green	Red	Green	Green	Green	Green	Yellow
Plant 4	Green	Red	Red	Green	Green	Green	Green	Yellow
Plant 5	Green	Green	Green	Green	Green	Green	Green	Red
Plant 6	Green	Green	Green	Green	Green	Green	Green	Green
Plant 7	Green	Green	Red	Green	Green	Green	Green	Yellow
Plant 8	Green	Red	Green	Green	Green	Green	Green	Yellow
Plant 9	Green	Green	Green	Green	Green	Green	Green	Green
Plant 10	Green	Red	Green	Yellow	Green	Green	Green	Red
Plant 11	Green	Green	Green	Green	Green	Green	Green	Green
Plant 12	Green	Green	Yellow	Green	Green	Green	Green	Red
Plant 13	Green	Green	Green	Green	Green	Green	Green	Green
Plant 14	Green	Green	Green	Green	Green	Green	Green	Green
Plant 15	Green	Green	Yellow	Red	Green	Green	Green	Green
Plant 16	Green	Red	Yellow	Yellow	Red	Green	Green	Red
Plant 17	Green	Green	Green	Green	Green	Green	Green	Green
Plant 18	Green	Green	Green	Green	Green	Green	Green	Yellow
Plant 19	Green	Green	Green	Green	Green	Green	Green	Yellow
Plant 20	Green	Green	Red	Green	Red	Green	Green	Yellow
Baldor Total	Green	Red	Red	Yellow	Red	Green	Green	Yellow

Figure 19 Heat map of safety performance

A Plan for tackling the safety issues was created within the management committee. This plan consisted of seven different projects that were designed and launched during these 14 days. These projects were small group meetings, span of control, safety audits, non-standard work, compliance, training and safety competence. The progress of these projects was also followed with the heat-map previously presented. The idea of small group meetings was to enhance the information flow and communication from the management committee all the way to the shop floor. The small groups helped to execute the required actions and improvement projects.

Span of control refers to the number of subordinates that a manager or supervisor can directly control. This number varies with the type of work; if the work is complex or variable it reduces the number of subordinates supervisor can control, whereas in routine work the number of subordinates can be greater. In Baldor's case the management committee evaluated every supervisors' span of control and found out that the subordinates were not evenly distributed to supervisors. A new structure was planned, where the supervisors had an equal number of subordinates depending on the type of work they were performing. The span of control was also balanced between plants which enabled a clear communication of the coming safety improvement projects.

Safety audits were also started. Staff group walks were performed aiming to identify and remove as many safety issues and hazards as they could prior to the management audit.

The management committee performed the audits in their plants during the first ten days of the fortnight. The safety audits included also quality- and operations audits that further highlighted the issues that the plant was having. After the ten days of auditing, the results were summarized and action plan created to remove and mitigate the safety issues. At the same time supervisors were trained to identify the non-standard work in their work environment. Daily self-audits were performed and first steps for implementing "Stop Take 5" taken. Stop Take 5 is a process that identifies hazards prior to starting task, based on the principle of thinking before you act. This process was seen as one key element in reducing the risk in non-standard work.

The next project was to evaluate the safety, health and security compliance of the plants. This was done with a compliance audit questionnaire that evaluated the plant's safety program, management procedures, facilities and work procedures. It also took into account the hazardous substances, the PPE and the machinery that were used in the plant. The results and issues were communicated both to employees and managers and improvement plans were made. The objective was to forge every plant 100% compliant with this audit in three months' time. This required a lot of training and re-evaluation of many work procedures. First, Managers were trained for Incident Learning Process. The objective of this process is to identify and describe the true course of events that lead to the incident, to identify the root causes and contributing factors and to identify the risk reducing measures in order to prevent future accidents. After the training the managers were asked to go through every recordable incident that has happened in their plant in that one year time period. Managers had to make a throughout investigation of the root causes of incidents and implement measures to prevent the incidents to happen again.

Subsequently, perhaps the most profound, most important and most difficult change was made when supervisors' and managers' competence was re-evaluated and organizational structures adjusted to apply to the new safety organization. The job-descriptions were reviewed and redesigned. The new competencies that supervisors and managers should have in order to truly have a safety-first management approach in the plants were defined. Previously managers could have had multiple areas they were responsible of e.g. engineering, health and safety and environment. Now, in the new safety organization the managers would only be responsible of one sector, enabling the focus to be full-time on one management area. After the re-design of the job-descriptions, every supervisor and manager was interviewed and their competence evaluated against the new requirements. The persons were offered training to reach the new requirements but if the competence was too far from the new job-description the person was moved to another position. By re-designing the organizational structures and job-descriptions, Baldor was able to uniform the management approaches and improve communication, implementation and safety in the plants.

To ensure that the new safety approach would also institutionalize in the culture, Baldor created a set of rules; the "Cardinal rules" and the "10 Things I always do and never do".

The Cardinal rules are zero tolerance rules since a violation could result in a fatality or serious injury. Employees violating these rules were subject to immediate disciplinary measures and even termination. The Cardinal rules involve instructions on electrical safety, control of hazardous energy, working at height, confined space, machine guarding and load lifting. "10 Things I always do and never do" was a set of rules that enhanced good processes, management practices and habits that concerned safety. The plants also launched a "SafeStart" program after they had finished the previous safety improvement projects and actions in the heat-map by the end of the year 2014. SafeStart is a Canadian consulting service of workplace safety. The consultants train managers to become stake-holders of the process and helps them to implement the program in their organization. The objective of the program is to improve peoples' safety awareness and personal safety skills both at work and in free time. The program therefore focuses on human factors that are involved in the majority of incidents and injuries. In Baldor's case, the program was used to further develop the safety performance and genuinely implement the safety-first idea to the organization.

After the 14 days of management committee's work and three months' execution time the plants had time to implement the changes by the end of the year 2014. Follow-up study about the results of the program was made between December 2014 and July 2015. The safety performance of Baldor, with 6500 employees and 22 plants, was measured and significant improvements were shown. In the 7 months study period, Baldor had only one serious incident and 48 other recordable injuries. Near misses and First aids were reported total of 886 cases. Hazards were reported 15 700, and Safety observations tours were conducted 6717 times. The Total Recordable Incident Frequency rate, covering the Serious incidents, Restricted work day cases, Lost Time incidents, Medical Treatments and First Aids was 1,15. The past performance and the results are seen in Figure 20.
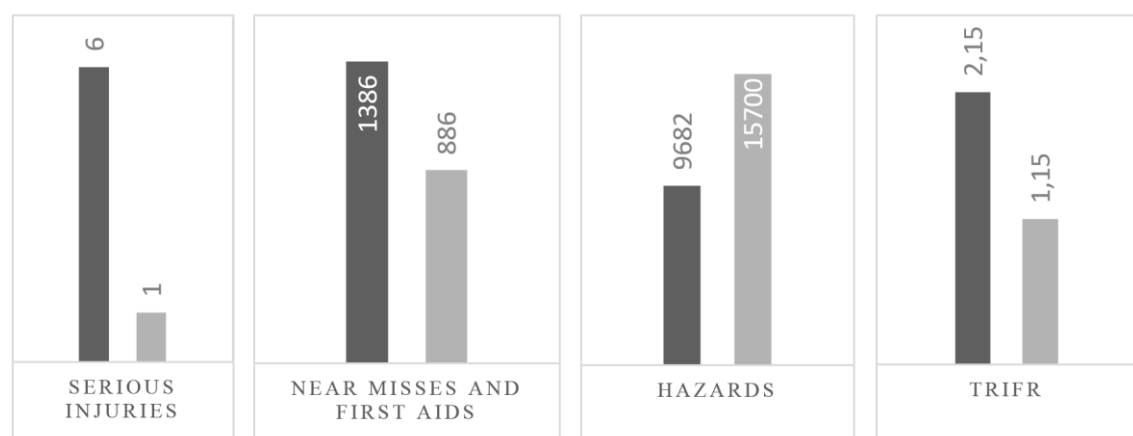
Figure 20 *Baldor's safety performance before and after safety program*

The results show major improvements in safety performance. However, since the study period of 7 months is quite short compared to the actual speed of safety culture transformation, no final conclusion of the success of the improvement project can be made. There are many different variables affecting to the total safety performance e.g. deviations in production capacity and number of employees so further analysis would be required. However, the TRIFR had an decrease of 46% thus the TRIFR target of 1,5 was reached and improved after the safety initiative. The reduction in Near misses and First aids was 36%, and an increase in Hazard reporting performance of 62%. Further study of the long-term results of the safety initiative was made by measuring Baldor's safety performance between February 2015 and 2016. The Total recordable incident rate has further decreased and reach a record of 1,03 shown in Figure 21. However, the high TRIFR in February 2015 is still a result from the high rate in summer 2014. Therefore the TRIFR trend shows major decline to February 2016. But taking into consideration the declining TRIFR trend from February 2012 it can be argued that the safety improvement project institutionalized the improvements already made before and further improved the safety performance of Baldor.
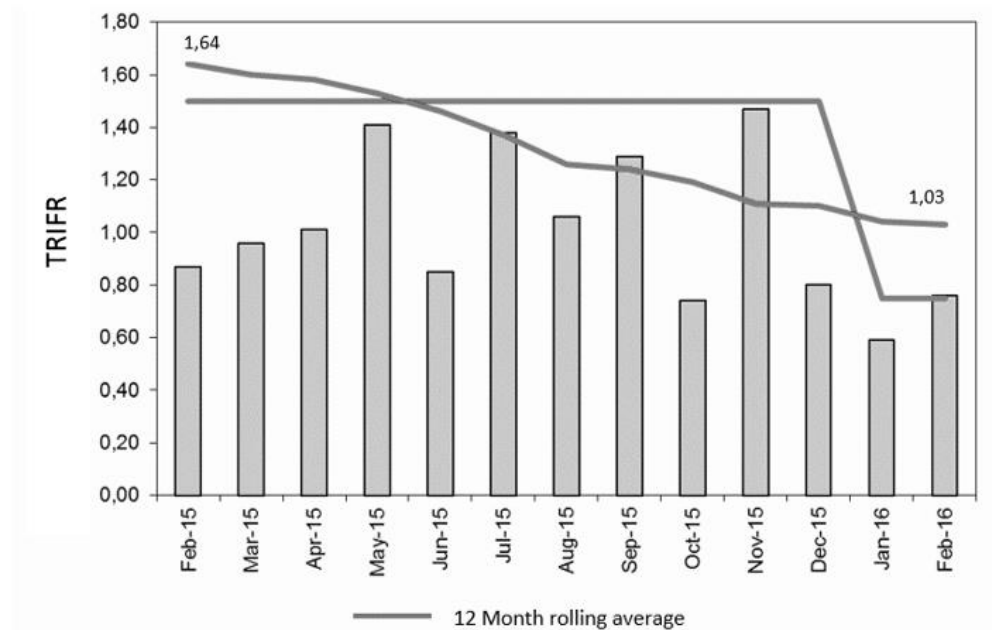
Figure 21 Baldor's safety performance between Feb-15 and Feb-16

The objective of the analysis of Case Baldor is to state the reasons behind the decrease in TRIFR and also find the good practices affecting to the safety performance. Since there is no reliable scientific way to prove that a certain procedure or action would directly affect the safety performance or safety culture, the analysis of good practices was made during the interviews. According to the DM division HSE manager and the Director of HSE, DM Division North Americas the most important part of the safety improvement

project was the management commitment. The management commitment is also emphasized in the theoretical part of the study and therefore it can be stated to have an effect to the improved safety culture. Another key activities in Baldor's case were the Safety survey that assessed the current situation of the safety culture, the plan for improvement actions, the Incident Learning process as well as the Heat map to ensure the follow-up of the improvement activities. These procedures have also an effect to the management commitment and are therefore also included in the new safety culture transformation concept. SafeStart was seen to be crucial in the institutionalizing change and therefore it should also be included in the new concept. The other actions or procedures used in Baldor's case can be presented in the new concept as an alternative approaches in improving the safety culture and actions that can also be included in the HSE strategic plan. The procedures to be used in the new concept are presented in Table 11.

Table 11 *Procedures from Case Baldor included in the new concept*

Included in the new concept		Provided as alternative actions to the HSE strategic plan
Safety Survey		Small group meetings
Management committee		Span of control
HSE plan		Safety audits
Heat map		Non-standard work
Incident Learning process		Compliance audit
SafeStart		Competence evaluation
		Cardinal rules
		10 things I always and never do

4.2   Case Phoenix

The safety performance of Phoenix plant was measured during one year between November 2013 and November 2014 prior the safety improvement project. Phoenix, with 300 employees, had two serious injuries in this time period and 16 other recordable injuries. Near misses and First aids were reported in total 8 cases. No Hazards had been reported but Safety observation tours were conducted in total 54 times. The TRIFR, covering the Serious incidents, Restricted work day cases, Lost Time incidents, Medical Treatments and First Aids was 8,19. The Lost time performance was unknown.

For Phoenix, the planned culture change was started by creating a realistic HSE strategic plan for the plant managers to follow, including actions that would start creating change. The goal was to work with management and provide support in the execution of the strategic plan to ensure they could resolve all the issues and barriers they might face. Together with the strategic actions to improve safety, the goal was also to "re-program" the safety mindset of the line managers. The program had three major steps; first the creation and

launch of HSE strategic plan, the competence evaluation of the line managers and last the deployment of SafeStart program.

In the HSE strategic plan targets for Recordable injuries and lost time days was set, both having target zero by the end of the year 2015. The strategic plan included multiple new programs, processes and trainings that were to be launched and implemented by the end of the year 2014. First, to improve the visibility of the new safety programs, safety communication boards were installed to show the safety performance, best practices and improvement projects that were on-going in the plant. The goal of these boards were also to motivate employees to communicate the safety issues and share ideas. The importance of safety was further stressed with the zero tolerance Cardinal rules, previously represented in Baldor. The safety training started amongst employees with safety orientation procedure and ergonomic training. For managers, all operations managers including plant manager, direct managers, engineering managers, plant supervisors, line supervisors and field service managers were required to complete in-house "Back to Basics" safety training. Managers were also trained to use the Incident Learning Process for all identified recordable and serious injuries. The results from these investigations were to be tracked for system and safety improvements. For all field service managers and field service personnel general industry safety training was conducted as well as Electrical safety training.

Competence evaluation for line managers was performed as in Baldor's case. The job-descriptions were reviewed and re-evaluated and the competence of the line managers and HSE manager was evaluated against the new requirements. Through this evaluation it was determined that the current HSE manager did not have the skills needed to create the culture change and therefore the HSE manager was let go and a new HSE manager was hired five months later. While in search for a new HSE manager the Country HSE manager supported the line manages in continuing the execution of the HSE strategic plan. Safety audits were conducted in the plant and current health and safety documentation reviewed. All of the audit findings had to be closed and work procedures and documentation updated to reach safety compliance. Also a plant wide focus on the top 5 hazards associated with the Phoenix facility were identified, including electrical hazards, working at height, machine safe guarding, fire prevention and material handling. To mitigate and remove the risks, control systems were developed and implemented via training and safety improvement actions. To help to implement safety continuous improvement projects, a Safety council team was gathered and monthly meetings scheduled. Managers were also trained to use Safety Management of Change procedure when introducing significant modifications to processes and procedures or when new products were introduced to the manufacturing. The aim of the Safety Management of Change procedure was to enhance the information flow about new changes and improve the planning and the execution of these changes.

Collecting frustrations- the visual 6S program was also launched during that year. The objective of the 6S was to create and maintain safe, orderly, clean and efficient workplace

and to motivate employees to participate and give feedback. The plant was divided to 19 zones and every zone had to report 4 frustrations per month. The findings were kept posted on the communication boards to enable employees and managers to correct the issues quickly. In the third quarter (2015) 428 frustrations were collected and 375 were closed reaching to 89% closure success. To further motivate people to identify the hazards and safety issues in their work environment, ABB Good catch program was launched. Every full time employee was required to identify 3 "Good catches" also known as hazards that had to be corrected. Each Good catch was rewarded by 100 dollar gift certificates that were quarterly drawn. The safety improvements were tracked with management Safety observations tours which every manager had to conduct at least 2 per month.

The HSE strategic plan also included major improvements in the area of environment and sustainability. Environmental audits were performed and environmental procedures evaluated. Key environmental reporting dates were set, guidance and reminders of company policy was provided and regulatory requirements assessed. The processes and products were also to be re-designed in accordance with the environmental and sustainability considerations. The execution of the health, safety and environmental improvement projects and programs of the HSE strategic plan was on-going for eight months. The deployment of SafeStart program was only then announced, when the management team was convinced that the culture was ready to receive the program. SafeStart steering committee was set up to plan and complete the training modules. All operations managers including plant manager, direct managers, engineering managers, plant supervisors, line supervisors and all facility employees were required to learn the SafeStart mythologies focusing on human factors that are involved in the majority of incidents and injuries. The first three training modules were completed in quarter 3 (2015). The processes, programs and trainings that were included in the HSE improvement program in Phoenix are summarized in Table 12.

Table 12 *Phoenix's HSE safety improvement programs and trainings*

Processes and programs	Trainings
HSE strategic plan	Employee Safety orientation
Risk assessments	Ergonomic guidance
Safety audits	"Back to basics"-safety training
Health and safety document Reviews	Incident Learning Process
Environmental procedures	Safety Management of Change
6S –Collecting Frustrations	Electrical safety training
Good catch-program	Machine safety training
Safety observation tours	Ladder safety training
SafeStart	Material handling

From these programs and trainings few was highlighted and included in the new concept. For Phoenix, the planned culture change was started by creating a realistic HSE strategic plan for the plant managers to follow, including actions that would start creating change. The goal to work with management and provide support in the execution of the strategic plan is an essential part of successful change initiative also highlighted in the theory. Therefore the HSE plan and the supportive organization should also be built in the new concept. I Phoenix's case the goal was also to "re-program" the safety mindset of the line managers. Also according to the DM division HSE manager and the Director of HSE, DM Division North Americas the most important part of the safety improvement project was the management commitment. Personal commitment and mindset are the key issues when leaders speak about change and safety. Thus actions to harness the managers with right "safety broadcast" e.g. how they talk and act about safety should be underlined also in the new concept. One key element in successful change is the participation and engagement of employees. Collecting employee frustrations –procedure was considered to be very successful in Phoenix. The success of this procedure was analyzed via interviews of the Safety champions and therefore validated. The frustrations can act as a leading indicators for managers about the performance in their facilities and therefore should be also presented as a useful procedure to launch also in their facilities. The other procedures and programs from Phoenix are presented in the new concept as examples for action that can be included in the HSE strategic plan.

The safety performance results of Phoenix was measured after the implementation of the HSE improvement program between December 2014 and July 2015. The time period to analyze the success of the project is very short considering the speed of a genuine culture change. However, for Phoenix there is no data available for long-term TRIFR evaluation and therefore the safety performance improvements are presented in these "snapshots" seen in Figure 22. Notable is also that there are many different variables affecting to the total safety performance e.g. deviations in production capacity and number of employees so further analysis of the safety improvement would be required.
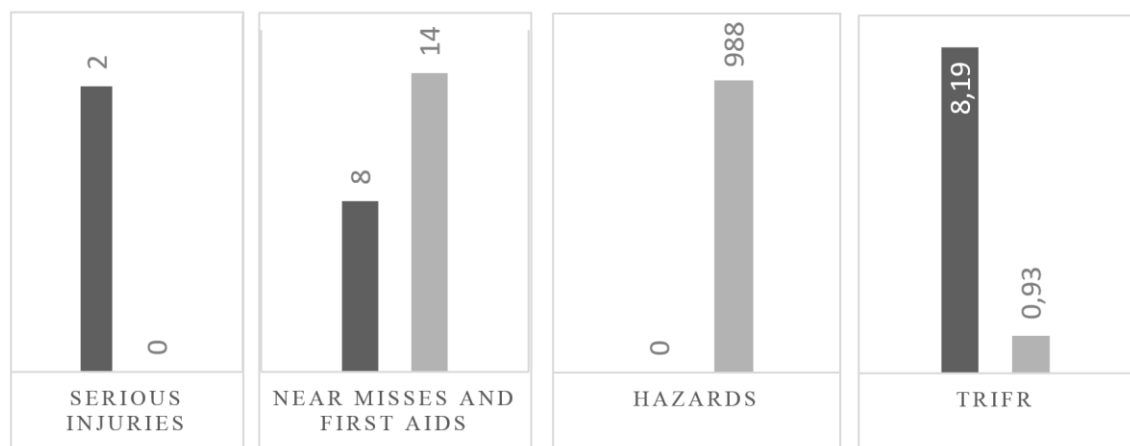

Figure 22 *Phoenix's safety performance before and after safety improvement project*

Phoenix, with 300 employees, managed to reach the target of zero Serious injuries and had only two other Recordable injuries in the study period between December 2014 and July 2015. Near misses and First aids were reported 14 cases, which was 6 more than before the HSE improvement program. Hazards were reported total of 988, which was a major improvement since the past performance showed zero reported Hazards. Safety observation tours were conducted in total 411 times. TRIFR, covering the Serious incidents, Restricted work day cases, Lost Time incidents, Medical Treatments and First Aids was dropped to 0,93 which was an decrease of 87%. The Lost time performance was zero. The safety performance improvements of Phoenix are shown in Figure 22.

4.3   Safety culture transformation concept

In this chapter first the requirements of the concept are evaluated, whether they meet the objective of the concept as well as fit in the theoretical framework. The content and its ability to reflect the theory and good practices from previous cases is also reviewed. Later on the final design of the concept is presented and the construction evaluated. Last, pilot results are introduced and their possible effect on the design and construction of the concept discussed.

The requirements of the concept was built according to the information provided in the theoretical framework as well as according to the good practices from previous safety improvement projects in Baldor and Phoenix. After selecting the good practices from previous cases, the analysis of possible gaps between the existing training materials and the requirements of the concept was done. By comparing the already existing training materials to the theoretical framework and later to the requirements of the concept, it was found that a few key themes were missing. Previous case studies didn't provide information or training materials about Safety leadership and therefore some additional content should be developed for the concept. Also to meet the requirements in safety culture part, some theoretical material should be designed to enhance the knowledge especially on how to assess and improve safety culture. Additional support and training for management of change piece is also required to be able harness the managers with abilities to lead a successful change. For HSE managers some additional training on their roles and responsibilities in managing the change in safety culture should be provided. Additionally to ensure that they have the right skills and methods to analyze safety performance a training for data analysis should be incorporated to the training concept.

The requirements of the concept take into consideration both theoretical knowledge and practical information. The aim of this concept was to provide support and tools for future Safety leaders to enable a sustainable Health, Safety and Environmental cultural improvement in their facilities. To meet this objective the requirements state clearly what kind of trainings, processes or information the concept should provide to meet this objective. Therefore can be stated that the requirements meet the objective of the concept, the demands stated in theory but also takes into consideration the findings from previous case

studies. Since the findings from case studies were collected via multiple interviews and validated also by the Director of HSE, Baldor NAM the concepts requirements can be considered as reliable and correct. The concepts requirements and results of the content design are shown in Figure 23.

Theoretical background	Concept's requirements	Concept content
Safety management systems - Guidelines - Management principles	Training on management principles Present process to evaluate OHSMS	HSE strategic plan Safety compliance audit
Safety Leadership - Leadership styles - Leadership and performance - Leaders engagement	Enhance transformational leadership, safety participation and safety compliance	Book on Safety Leadership Reflection questions on book General Management Model Leadership broadcast
Safety culture - Assessment of safety culture - Models	Present process for safety culture assessment and institutionalization	Safety Survey, Bradley Curve Caradinal rules, SafeStart Challenges in creating culture Role as a HSE consultant
Management of Change - Methods - Resistance - National cultures	Provide support for change Enhance employee participation Adaptable globally	Role in Change Management Best practices in driving Change MOC Form Harvesting frustrations
Measuring safety - OHSMS - Risk control systems - KPI's	Training and procedures to plan, monitor and improve safety	Risk assessment Incident learning process Safety and compliance audit Statistical data analysis

Figure 23 Concept content results

Content of the concept was designed according to the requirements of the concept. The content reflects the theoretical framework of the study as well as the good practices collected from previous case studies. For each training or process presented in the concept there can be found a reason from the theory or from the good practices. Especially the processes or programs acquired from the Baldor and Phoenix cases can be stated as practically adaptable since they are currently known and in use in ABB. The content built specifically to this concept can be further evaluated against the feedback from the pilot. Since the content derives from theory and good practices it can be argued that the content of the concept is reliable and useful when aiming to change and improve the safety leadership and safety culture in the organization.

The construction of the concept is described in Figure 24. The 12 Month culture transformation concept includes separate training modules for General Managers and HSE managers and an execution phase. Important part of the construction is the sponsorship that extends from the first module to the execution phase. The role of the sponsor is to support and advice managers in their culture change. Each facility attending this concept has their

own sponsor to use as a guiding resource throughout the change but also a team of sponsors at their service. Sponsors not only support and give guidance but also make site visits to help the managers to concur barriers they might face on site. Sponsors are gathered from different professional areas e.g. quality, HSE, operations and production so that the support is as wide-ranging as possible. Sponsorship plays an important role in success of change stated in theory of management of change. Therefore it is also implemented in this concept to ensure that the managers have all the possibilities to create and execute this change.
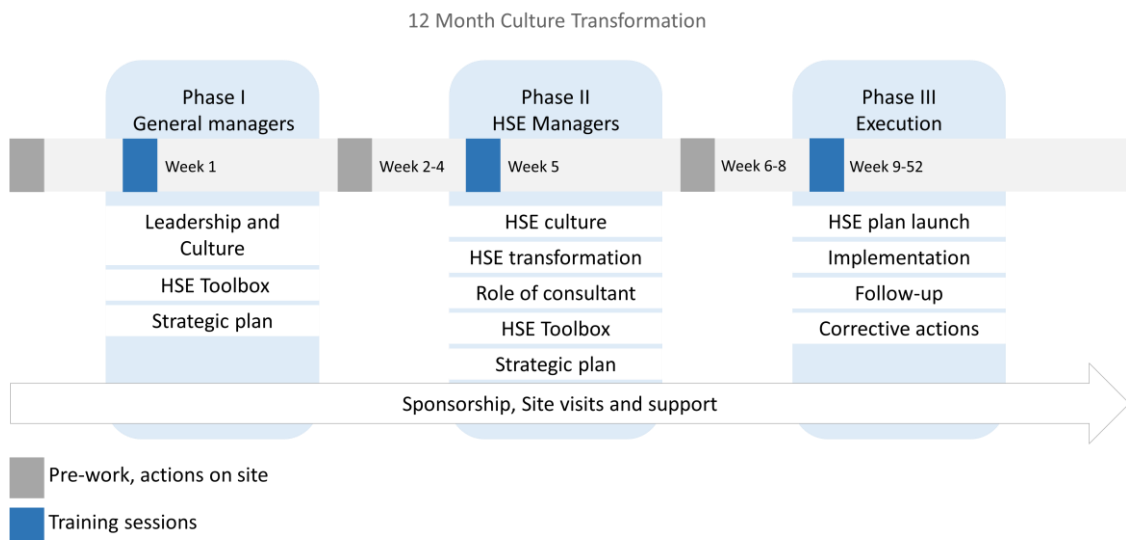
Figure 24 *Construction of the concept*

Before managers participate in the training modules, they perform pre-work in their facilities. The idea of the pre-work is to gather information about the current situation of the safety performance in their facility. This works as a reality check to managers and also highlights the problems the facilities are having. With this information the managers already have an idea what kind of support and training they need from the concept before they participate to the training modules. The first module is for General Managers and includes training on leadership and culture change, provides tools to improve safety and supports drafting of the HSE strategic plan. After the training General Managers return to their plants with the drafted strategic plan and refines the plan with HSE and line managers. General Managers also design a heat map that states the current situation and the desired state of safety performance. This heat map is also used to follow-up the progress of the actions as well as the improvements of the performance.

The second module is designed for HSE managers. The module includes training on HSE culture and tools to improve it, introduces the challenges managers might face in this culture change and discusses the roles and responsibilities HSE managers have in this change. After the training HSE managers return to their plants and together with General

Managers finalize the HSE plan so that it meets the set targets. The HSE plan is then presented to the sponsors for approval. As approved the 11 month execution phase starts. HSE plan is launched and implementation of the improvement actions started. Important is to keep the follow-up up-to-date and implement also the corrective actions. The construction of the concept with training modules and one year sponsorship supports successful change in safety culture. Many researches emphasized the importance of support and long-term actions in culture change and for this the concept provides practical solutions. The final design of the concept for General Managers is presented in Figure 25 and for HSE Managers in Figure 26.

In General Manager's module the pre-program and Day 1 concentrates on the reality check of current safety performance and personal management commitment. The objective is to awake the interest of managers to make improvements both in safety performance and personal level. The discussions about Safety Leadership provides the participants the opportunity to change views and ideas with others and therefore enhances the knowledge of leadership role. The leadership styles are presented together with the General management model to introduce the link between leadership and culture. Participants are given the chance to reflect the styles to their own behavior thus noticing gaps and improvement areas. This part of the module plays an important role, since the success of culture change depends on the leader's ability to notice the need for change and understand his role in it.

Pre-Program	HSE Summit Program Module I - General Managers				Post-Program
Safety Survey	**Day 1 - Culture**		**Day 2 - HSE Toolbox & Planning Forward**		Complete Heat map template
Risk Assessment	08:00-08:20	Why the culture change concept	08:00-08:15	Reconnect	Establish 12 Month HSE Strategic Plan
Safety Leadership Book	08:20-09:45	Bradley Curve Diagnostic Program Roadmap	08:15-09:45	Current Reality of Incident Learning Process Your Role in ILP - Best Practices Case Study Video	
Reflection Questions on book	15'	Break	15'	Break	
	10:00-10:45	Group discussion about Safety Leadership book	10:00-11:10	Employee Engagement - Harvesting Frustrations	
	10:45-12:00	Safety Survey Results Process Initial Reactions Contrast to Risk Assessments	10:00-12:00	Role in Change Management	
	12:00-01:00	Lunch	12:00-01:00	Lunch	
	01:00-02:45	General Management Model / Work on Culture using GMM Model	01:00-03:00	Introduction to HSE Strategic Plan / Creating HSE Strategic Plan	
	15'	Break	15'	Break	
	03:00-03:45	Sponsors Roles & Responsibilities	03:00-04:15	Introduction to SafeStart	
	03:45-05:00	Creating HSE Point of View, Presentations and Feedback	04:15-05:00	Next Steps Planning	

Figure 25 Module I for General Managers

The second day of the module harnesses the managers with tools to improve the safety performance and culture in their facility. Incident learning process guides the managers to focus on the priority areas of safety and to evaluate the performance of their OHSMS. The Harvesting frustrations process helps the managers to improve safety participation and engagement of employees, which is a crucial part in successful change. Introduction to the manager role in change management provides the basis for HSE strategic development and day 2 the tools that can be included in the HSE plan. For institutionalizing the change the module provides SafeStart program to be implemented in the facilities. This module for General Managers meets the requirements emphasized in the theory and case studies. After the training the managers have the knowledge on how to lead change, the tools to improve safety culture on their part and the support given by the sponsors.

The module for HSE managers includes the same processes and trainings as in the General Managers module. However, the HSE managers also need more training on concrete actions to improve safety in plant level and more understanding of their roles in managing

change. Therefore some key element on creating safety culture and driving chance is introduced. The HSE managers should redesign their role and concentrate more on introducing ideas and actions to improve safety rather than trying to execute everything by themselves. This shift in mindset is an important part of culture change thus it is also emphasized in safety culture theory. The tools introduced in this module are more detailed and focused on mastering the process and the data. This enables the HSE managers to monitor, plan and improve safety more efficiently. This also supports the HSE point of view in business and therefore facilitates more change.

Pre-Program	HSE Summit Program Module II - HSE Managers				Post-Program
Safety Leadership Book	**Day 1 - HSE Culture**	**Day 2 - Shift in Role & Mindset**	**Day 3 - HSE Toolbox**	**Day 4 - HSE Toolbox & Next Steps**	Plan Execution
Safety Leadership Book	Why the HSE Program	Reconnect	Reconnect	Reconnect	Plan Execution
Reflection Questions on book	Bradley Curve Program Roadmap	Understanding Our Challenges in Creating HSE Culture	Incident Learning Process	SafeStart	
Reflection Questions on book	Break	Break	Break	Break	
Establish & Bring 12 Month HSE Strategic Plan and Heat map with GM	Group discussion about Safety Leadership book	Best Practices in Driving Change	Incident Learning Process	Refine Strategic Plan	
Establish & Bring 12 Month HSE Strategic Plan and Heat map with GM	HSE = Driving Discipline in the Business	Best Practices in Driving Change	Incident Learning Process	Next Steps Planning	
Establish & Bring 12 Month HSE Strategic Plan and Heat map with GM	Lunch	Lunch	Lunch	Lunch	
Safety Survey	General Management Model	Taking on the role of a Consultant to the Business	Employee Engagement – Harvesting Frustrations		
Safety Survey	Break	Break	Break		
Safety Survey	Review and refine HSE Strategic Plan	Statistical Data Analysis	HSE Paperless System		
Safety Survey	Case study – Culture shift in action	Statistical Data Analysis	Creating HSE Point of View		

Figure 26 *Module II for HSE Managers*

4.4 Pilot results

The pilot of the concept was arranged in North America, since the Baldor and Phoenix cases and their success were already familiar to the other facilities. Four facilities took part in the pilot of the first module for General Managers. Attending was the Plant manager or General Manager from each facility but also some operations managers and HSE

directors. The feedback from 9 participating managers was collected via free interviews after training modules and with a questionnaire about the overall success of the concept after the last training module. The questionnaires were collected anonymously to secure the confidentiality of the participants.

Day one was started with team building and introductions. This was important to be able to create an environment where people could share their thoughts and concerns safely and without detraction. Group discussions about leadership were found to be very useful and eye-opening. Also the analysis of the safety performance of their own facilities was done in open discussion which enabled the exchange of ideas why the results were as they were and what could be done to improve them. Working on culture using the General management model was perceived as a very helpful approach to understand the connections between leadership, strategy, skills and culture. Starting with collecting the elements of a desired safety culture and constructing the needed OHSMS structure and leadership styles backwards to reach the desired culture was experienced as unparalleled and an effective new approach. The manager's feedback was excellent; the training provided them a new viewpoint on how to approach such an abstract matter as culture in a concrete way. It also enabled them to generate ideas and actions how they could start improving their facility's safety culture. They also perceived that this approach could also be useful in other areas like quality and operations, where improvement actions are needed. Day two provided the managers the tools to further enhance the safety performance in the facilities. Especially Harvesting employee frustrations-training was considered as an effective approach to enhance employee participation and engagement. The training also helped the managers to shift the mindset that hazards can only be concrete dangers to broader view that also includes mental states as possible hazards for employees.

HSE strategic plan drafting on day two was experienced to be too sudden. Even though the pre-work conducted in the facilities was guided and the pre-analysis of the results already made, the strategic planning was difficult to start. There was some deviation between the facilities on how profound analysis they have made on the results of Safety survey and Risk assessments. This was directly reflected to the perceived difficulty of starting the HSE strategic planning. Also the three hours' time slot was experienced too short. To be able to support the managers more on the HSE strategic planning, the pre-analysis of the results should be harmonized. Thus everyone should have the same amount of support in conducting the surveys and Risk assessments. Also the current state analysis should highlight e.g. top three hazards in the facility and top five departments where incidents happen, thus providing every facility a starting point for planning. The pre-work could be formed as a template with detailed questions to help the managers to concentrate on right topics. This would enable the managers to have a better overall view of their performance and areas where improvements should be made. The HSE plan could also be more effective to draft in pieces instead of in one timeslot. This could be executed by

providing some time after each training module for managers to write down ideas and actions that could be useful in their own strategic plan.

The final questionnaire about the overall success of the concept was performed after the last training module. The questionnaires were collected anonymously to secure the confidentiality of the participants. Following questions were stated:

- Based on my experience, what would I rate the value of this development opportunity?
- How likely are you to recommend the program to your colleagues?
- What worked well in this workshop and how did I contribute to that?
- What didn't work well in this workshop and how did I contribute to that?
- What have I learned about myself through this development experience?

The overall feedback collected via questionnaires and interviews was excellent. Below presented the questionnaire results. The numbers correspond to the amount of participants agreeing on certain scale grade.

Table 13 Pilot questionnaire results

Question	*Results*						
Based on my experience, what would I rate the value of this development opportunity?	1 Not useful, Little value	2	3	4	5	6	7 Very useful, Great value
						3	5

	1 Not at all	2	3	4	5	6	7	8	9	10 Very likely
How likely you are to recommend the program to your colleagues?									4	4

What worked well in the workshop and how did I contribute that?	"The workshop was well planned with good vision of the objectives of this workshop" "The interactions and information sharing among the plants and core members" "Brainstorming the attributes of a strong safety culture and how leadership behavior fits in" "Getting a start on a strong plan" "Defining desired culture, then backing into structure, management and strategy to create it" "Participating with the group to really analyze the difference between culture and structure" "Small group, better involvement, structured very well, good presentation" "Input was required from everyone" "I was able to share experiences"

What didn't work well in this workshop and how did I contribute that?	"Info on what it was about before starting" "Felt that there was not enough time/material/preparation for the strategy part" "First steps in developing strategy. It was difficult to follow the provided tool; time was cut short due to schedule. Walk through the example would have helped" "We could have gotten a little further with our plan" "Everything went well" "Some plants had different survey feedback which allows more insight into employee feedback"
What have I learned about myself through this development experience?	"Need to ensure that the perception of my leadership matches what I believe, I am doing" "I have the right mind set but need to force myself to keep safety fresh and evolving" "I am more passionate about safety, more than I thought" "I am looking forward to getting back into plant level initiatives" "We have some good tools to explain; teach things that come naturally" "To be more vocal to my directs about safety" "I learned about frustration can lead to accidents" "I need continue carrying the passion and work harder to improve safety, employee involvement is critical" "Reaffirmed the value of plant collaboration to share ideas and best practices"

Every participant found the training concept very useful. The concept also met the expectations the participants had. All of the participants would also recommend this program to their colleagues. This underlines the success of the training modules and good practical contribution of the concept. With minor changes in pre-work activities and strategic planning this concept could be further improved to meet the excellence also in the future. However, since a cultural change is an evolutionary process that can last years, the overall success of the concept in improving safety performance and culture in the facilities cannot be yet stated. Further evaluation of the progress of the facilities should be investigated in long-term. Even though the safety culture would improve it is still difficult to show scientifically that it is only improved because of this transformation concept. However, taking into account the feedback the managers provided this concept can be a very potential way to improve the safety leadership competencies of managers. And since safety leadership is the key to true safety culture transformation in the organization, the concept can provide the solution for sustainable Health, Safety and Environmental cultural change.

5. DISCUSSION

The objective of this chapter is to discuss and evaluate the validity of the work tasks and the validity of the resulting concept as well as evaluate the scientific and practical contributions of this thesis. The concept was designed via three work tasks that would enable a reliable and successful concept for safety culture transformation. The work tasks considered both theoretical knowledge and practical inputs. Theoretical framework benchmarked the field of scientific research and evaluated what should be taken into consideration when talking about safety performance, safety culture and managing change. The theoretical framework built the base for the concept development but was not sufficient alone to validate the needed actions to create safety culture change. Therefore the practical knowledge of change initiatives and safety performance improvement was gathered from the previous safety improvement projects in ABB via interviews and database analysis.

The DM division HSE manager and the Director of HSE, DM Division North Americas were interviewed about the safety improvement projects and information about the used procedures and executed actions in these projects was gathered. All the collected information and final transcript was later reviewed and validated by the Director of HSE, Baldor NAM. It can be argued that the persons interviewed about the previous safety improvement projects might not be the most objective ones since they were also participating in the execution. However, the validation by Director of HSE, Baldor NAM ensures that the described actions taken and feedback from employees participating in these projects were correct. These work tasks could have also included some more interviews from the shop floor level as well as from the executing management team but since the projects were performed in the US a couple of years ago, the identification of single procedures and their effect on safety culture would still have been hard to validate.

The analysis of the safety performance improvements were done with database analysis. Long-term past performance of these facilities was not possible to analyze since there was no safety data available prior the acquisition by ABB. Past performance and the development of e.g. TRIFR performance would have provided more solid arguments for the success of the safety improvement projects. However, since a cultural change is an evolutionary process that can last years, the overall success of the projects in improving safety performance and safety culture in the facilities cannot be stated. Further evaluation of the progress of the facilities should be investigated in long-term. However, even though the safety culture would improve it is still difficult to show scientifically that it is only improved because of certain actions taken in the projects. Nonetheless, the analysis of the previous safety improvement projects provided good practices and procedures to be in-

cluded in the concept. Together with the theoretical framework the good practices under-lined some key issues that formed the requirements of the concept. Since the content of the concept was designed according to the requirements of the concept the method for concept design is validated.

The scientific contribution of this thesis is most emphasized to the concrete concept that can be used to improve the safety culture. Until today, the research field does not provide a concrete concept for safety culture transformation but many theories and concepts concerning different fields. There are many validated approaches for e.g. successful change but not one approach that combines the change initiative to safety performance or safety culture. However, to be able to validate the scientific contributions of this concept, more detailed analysis of the content of the concept and the success of the concept should be evaluated and tested also in other industries and scientific studies.

The practical contribution of this thesis is easier to present and evaluate. ABB already had many procedures to improve safety performance but these procedures were discon-nected and the overall picture on how to actually improve safety culture was missing. Analysis of the case studies not only provided ABB the information of the success of these projects but also a way to transfer the learning from these projects to a new, im-proved concept. The new concept provides ABB the tool to enhance leadership compe-tencies and harnesses the managers with concrete tools to improve safety performance and culture in their facilities. Taking into account the feedback managers provided in the first pilot this concept is showed to be a very potential way to improve the Safety leader-ship competencies of managers. Since the management commitment and leadership plays the key role in managing change this concept can act as a successful way to institutional-ize safe working practices to the facilities.

For now the concept is divided to two modules, one for General managers and the other for HSE managers but can be later adapted e.g. according to Bradley curve if this con-struct is found to be too heavy. With the Bradley curve- construct ABB could provide more allocated tools to facilities according to their current state of safety culture. For facilities that still have highly dependent culture, the concept could provide more concrete tools to improve safety while for interdependent cultures the concept could focus more on leadership competencies and employee engagement. The content of the concept can be further developed after the first facilities have participated in this concept. It is essen-tial to collect more good practices and feedback from the participants since then ABB can transfer the learnings into continuous improvement. Next steps for ABB would be to val-idate the success of this concept in safety culture transformation by analyzing the safety performance in long-term. Also the global adaptation and the challenges in modifying the concept to meet the cultural differences around the world should be further investigated.

6. CONCLUSION

The aim of this thesis was to provide a training concept for future Safety leaders and help them to enable a sustainable Health, Safety and Environmental cultural transformation of safety by choice and not by chance. The main goal of the concept was to develop Safety leadership competencies of line managers and create commitment, ownership and accountability across the organization. ABB already had many procedures to improve safety performance but these procedures were disconnected and the overall picture on how to actually improve safety culture was missing. The new concept harnesses the managers with tools to improve the safety performance and safety culture of their facilities and provides information and support for leading successful change.

The concept was built on theoretical framework and case studies. The theoretical framework introduced theories of Safety culture, Safety Leadership and Management of Change but also tools to measure and analyze safety performance. Analysis of the case studies not only provided ABB the information of the success of the previous safety improvement projects but also a way to transfer the learning from these projects to a new, improved concept. The concept was constructed to two modules for General Managers and HSE managers. The first module for General Managers included training on leadership and culture change, provided tools to improve safety and supported drafting of the HSE strategic plan. The second module for HSE managers included training on HSE culture and tools to improve it, introduced the challenges managers might face in the culture change and discussed the roles and responsibilities of HSE managers in the change.

The overall feedback collected from the participants of first pilot was excellent. Every participant found the training concept very useful. The concept also met the expectations the participants had. All of the participants would also recommend the program to their colleagues. This underlines the success of the training modules and good practical contribution of the concept. With minor improvements in pre-work activities and strategic planning-module this concept could be further improved to meet the excellence also in the future. However, since a cultural change is an evolutionary process that can last years, the overall success of the concept in improving safety performance and safety culture in the facilities cannot be yet stated. Further evaluation of the progress of the facilities should be investigated in long-term. However, even though the safety culture would improve it is still difficult to show scientifically that it is only improved because of this transformation concept. Nonetheless, taking into account the feedback the managers provided this concept can be a very potential way to improve the Safety leadership competencies of managers. And since Safety leadership is the key to true safety culture transformation in the organization, the concept can provide the solution for sustainable Health, Safety and Environmental cultural change in the organization.

In the future the construct of this concept could be adapted e.g. according to Bradley curve if this construct is found to be too heavy. With the Bradley curve- construct ABB could provide more allocated tools to facilities according to their current state of safety culture. For facilities that still have highly dependent culture, the concept could provide more concrete tools to improve safety while for interdependent cultures the concept could focus more on leadership competencies and employee engagement. The content of the concept can be further developed after the first facilities have participated in this concept. It is essential to collect more good practices and feedback from the participants since then ABB can transfer the learnings into continuous improvement. Next steps for ABB would be to validate the success of this concept in safety culture transformation by analyzing the safety performance in long-term. Also the global adaptation and the challenges in modifying the concept to meet the cultural differences around the world should be further investigated.

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