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Author: Olga Kvalheim

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……Olga Kvalheim………

(signature author)

Course coordinator: Marja Katariina Ylönen

Supervisor: Marja Katariina Ylönen

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Olga Kvalheim,

Stavanger, June 13, 2022

Summary

After Chernobyl accident in 1986 it was concluded that a bad safety culture contributed to it. Development of a good safety culture became a regulation requirement in many countries, and a necessity in many industries including dredging and marine operations.

The thesis is carried out as a multiple case study applying qualitative methods. Three cases are represented by the leading dredging and marine contractor companies, being three out of four biggest in the world. Data was collected by means of nine semi-structured interviews and from documents related to safety culture and safety programs. The aim of the thesis is to better understand companies' view on safety culture and its development; the influence of safety programs on safety culture and its measurement; related problems and challenges.

The theoretical framework grounds in intertwined concepts of safety culture and safety, model of organizational culture of Schein, and means to measure quality and maturity of safety culture.

Safety culture is being developed in the companies during the last 7-12 years within the framework of safety programs, which revealed great similarity. The results of the thesis demonstrate that the companies consider that safety culture can be engineered, changed, measured, and maintained. Safety culture is a part of companies' organizational culture and helps to take care of safety, provides market advantages to the companies. Safety culture improvement leads to organizational culture improvement, namely communication, increase of trust, democratic management style, and highlights the aspect of care for all employees.

Safety culture is being developed within three core elements: mindset and understanding, structures and functions, and practices. According to the model of Schein (2017) safety culture is created within three cultural levels: artifacts (observable behaviour, structures, and processes), espoused beliefs and values (ideals, goals, rationalizations), and basic underlaying assumptions (taken for granted beliefs, values, which determine thought, perception, and behaviour). The mindset of the companies is based on the espoused values of Vision Zero and that proper safety behaviour improves safety; the underlaying assumptions that all incidents and accidents are preventable, and that safety behaviour will provide long-lasting safe performance. Management sincere commitment and involvement, employees' empowerment, incentive structures, and reporting play important roles in a strong culture development. The study results show much focus on engineering risk assessment approach and less on sociotechnical perspective. The development is driven by industrial experience, market developments, and influence of ISO standards for risk.

The influence of safety programs on safety culture is measured by safety statistics, interviews, group dialogs, feedback, behaviour during trainings, and safety climate surveys. The quality of safety communication, employees' care for safety, involvement, and management commitment are assessed. Safety culture maturity is evaluated and certified by external Safety Culture Ladder audits mostly upon tender necessity. Some companies' units possess certificates of third (calculating) and fourth (proactive) maturity steps.

Development of safety culture is a gradual, continuous, and complex process demanding constant effort, monitoring, and financing. The cases demonstrate a reasonable progress. Safety culture evolutionized from compliance to rules and procedures to more proactive behaviour of all employees, nevertheless espoused values need to be extended by the ones reflecting dynamic and complex sociotechnical nature of safety. Combination of several safety perspectives, including sociotechnical perspective, Safety II and resilience can further improve existing safety cultures. Risk science can contribute to better understanding, assessment, and prevention of risks.

Certain problems and challenges were detected. Disrupted investments into the safety programs, insincere management commitment led occasionally to formal attitudes of employees. Companies' growth, temporary employment, subcontractors' involvement, and external influences create challenges for the safety programs and safety culture development. Learning, communication, and cooperation suffered during Covid-19 pandemic. Personal physical participation in learning was substituted by online participation and e-learning and undermined its quality.

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List of Acronyms and explanations

CHILD	Colleagues Help Incidents Leave Deme
HRO	High Reliability Organizations
HSE	Health Safety and Environment
IAOGP	International Association of Oil and Gas Producers
INSAG	International Nuclear Safety Advisory Group
JHA	Job Hazard Analysis
KPI	Key Performance Indicator
	Variables that indicate whether an organisation is on track to achieve its targets
LTIF	Lost Time Injury Frequency per XX of manhours
LTIFR	Lost Time Injury Frequency Rate
	Number of recordable injuries with absence (more than 24hrs) per XX hours worked by workers on payroll or hired in from other companies; based on compulsory notifications by projects, fleet, offices, and yards to the QHSE department. LTIFR includes all reported cases (with absence more than 24 hrs).
NINA	No Incidents No Accidents
NPRA	Norwegian Public Roads Administration
OHS	Occupational Health and Safety
PPE	Personal Protective Equipment
QHSE	Health Safety and Environment
SC	Safety Culture
SCL	Safety Culture Ladder
SMS	Safety Management Systems
SP	Safety Program
TRIR	Total Recordable Injury Rate
	Number of recordable work-related injuries per XX hours worked by workers on payroll or hired in from other companies; based on compulsory notifications by projects, fleet, offices, and yards to the QHSE department. Recordable injury includes fatalities, lost time injury cases (absence more than 24hrs.), Medical treatment cases and Restricted work cases. This excludes First aid cases. TRIR includes all reported cases.

1. Introduction

The idea for the thesis fostered of personal experience gained by the thesis author in one of the companies for over a dozen years ago. The safety program was just enrolled back then. The author found it fascinating to investigate how it developed after and formed the safety culture. Further, it seemed reasonable to explore and compare it with several companies within the industry. General interest in HSE and probable future work within the area motivated and inspired the researcher.

Safety culture (SC) is a very fascinating concept to study. It is grounded in theories from different fields, such as individual and organizational psychology, sociology and anthropology (Aven & Ylönen, 2021; Guldenmund, 2000; Schein, 1996, 2009, 2017). Depending on the point of departure researchers continuously contribute with its numerous facets.

No wonder, that the concept raises debates for over thirty years. Some consider it a "fuzzy concept" others call it the "motor" of safety performance (Reason, 1997) . Many believe it to be a proactive tool helping organizations to improve its general performance, safety, evaluate their "safety health".

The SC concept focuses on organizational issues, which can either lead to or prevent accidents. SC has a close relation to risk management. Safety risks are many, not only they are related to production and profit, but also to natural catastrophes and global risks companies must be prepared for. SC can help organizations to be better prepared. Covid-19 pandemic risk can be one of such examples. SC is often considered to compliment "technical safety barriers, whereas SC provides human and organizational barriers" (Aven & Ylönen, 2021, p. 1353). The focus in SC is on how things are done in practice and "on 'hot' variables of shared beliefs, attitudes, and norms within the industrial organisation" (Kjellén & Albrechtsen, 2017, p. 47).

Safety culture is often associated with a common framework for development and maintenance of organizational values, norms, processes and practices often initiated and reflected in organizational safety programs (Reiman & Oedewald, 2009). They are aimed to improve personal safety behaviour and create an overall organizational safety culture.

The concept of SC is studied in the thesis in a context of three world biggest dredging and marine contractor companies, within private high-risk industry in relation to safety processes, namely safety programs. The cases and programs are presented in the item 1.3. A safety program formulates main safety principals and seeks to improve companies' safety

culture and reach the safety goals. It sets the safety standards, including core values and rules, as well as describes expected employees and management behaviour.

SC helps organizations not only to improve safety, but also to strengthen themselves. It improves social relations between different levels in companies and to helps to overcome hierarchical and cultural differences. A good or strong SC reduces the necessity of compliance control procedures. It encourages people to proactively participate in safety, detect risks, and suggest improvements. SC improves the psychological climate and job satisfaction. It allows organizations to raise the level of trust and communication between the levels and makes organizations more profitable in the long run. SC improvement correlates with productivity and efficiency of an organization. It is well-documented, that safe companies are among the most lucrative (Hollnagel, 2014; Hudson, 2001). Additionally, good SC serves as a safety quality mark for companies within industries confirming their competitiveness and high quality of production and services.

1.1 Background

Big scale recurring accidents in high-risk industries in the last 35 years led to fatalities and irreversible consequences for humanity and environment. They shifted focus in safety research from persuasion, that human failures alone cause most of the accidents, to paying closer attention to organizational factors (Reason, 1997; Hollnagel, 2004; Dekker, 2014).

The present study focuses on the SC within dredging and marine business, related to high-risk industry, and defined as having high risks, hazards, likelihood of an accident with a high harmful potential in the form producing unvoluntary risks to the third parties and even generations. Reason includes the following types of companies into the high-risk industries: nuclear, chemical, aviation, oil exploration and production, transportation, marine, construction and medicine (Reason, 1997).

SC term was originally introduced not by science, but by accident investigation report and meeting reviewing the causes of Chernobyl nuclear accident in 1986, namely by International Nuclear Safety Advisory Group (INSAG-1, 1986). Poor safety culture together with various safety procedure violations concluded to be contributing factors to the accident. Regretfully, Chernobyl was followed by a series of major accidents like Piper Alpha, Alexander Kielland, and many other.

Different reasons can be distinguished as the root causes leading to accidents. Detection and explanation of the root causes among other are partly related to the safety science development. Hovden and Hale (1998) recognise three ages within the safety research: first

focused on technical measures and failures, second was preoccupied with human factors and individual performance, and the third is represented by organizational factors (Figure 1; Hollnagel, 2014, p. 25; after Hovden & Hale, 1998).

Figure 1

Three ages of safety
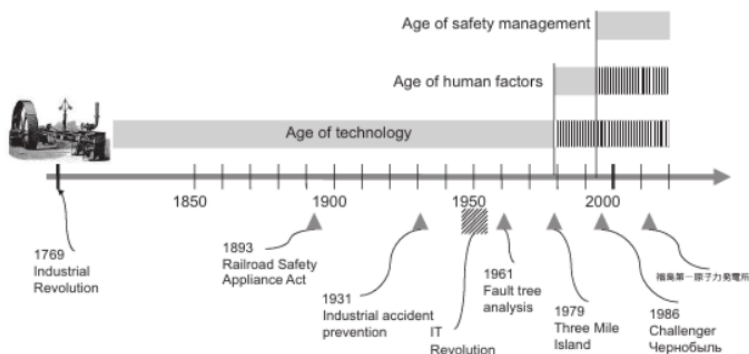
A systematic approach to safety was urgently needed. By presence and development of safety rules and Safety Management Systems alone companies could not tackle such complex problems and challenges. An evolution was required to take safety to a further step. The solution for such challenges was an introduction of the SC concept. It changed the traditional rational way of safety management interferences into the one, when "aims and intensions can be allowed to flourish, even if there are gaps. This is a situation in which formally undefinable characteristics such as enthusiasm, care and belief are to be found. The kind of organization that provides this support is a safety culture" (Hudson, 2001, p. 14). Major events stimulated further publications and SC research. The number of publications increased after each accident as shown in Figure 2 (Fleming et al., 2018, p. 11).

Figure 2

Industry publications by year with significant accidents and publications
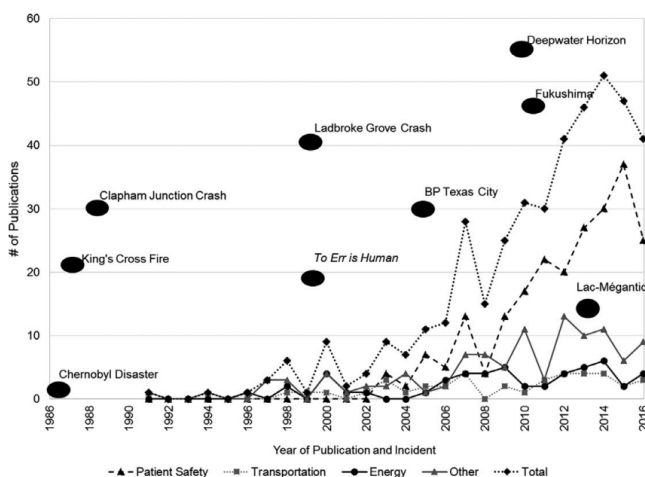
The concept spread into different industries and health sector. Moreover, good safety culture requirement in an organization is included in several laws in Norway and HSE regulations. For example, new HSE regulations of 2001 in petroleum companies are required to comprise the knowledge of research on safety culture. Emphasis was put among other factors on "the provision on good health, environment and safety culture, the provision on employee participation which has also been extended to apply to all matters of importance to health, environment and safety in petroleum activities, also in the design phase." (St. Meld. nr. 7 (2001-2002), p. 26). UK Health and Safety Commission encouraged companies "to improve their safety performance through the development of a "positive safety culture" (Clarke, 2000, p. 65). The Norwegian Maritime Authority sets safety culture and risk understanding among the highest priorities in the last two years (The Norwegian Maritime Authority, 2022).

Safety culture, according to the instrumental understanding and organizational perspective is seen as something, which can be designed, tuned, and upgraded producing safe behaviour. Focus on safety culture is a proactive approach to safety management (Antonsen, 2009). Good safety culture aims to contribute to overall safety in an organization. Though created on organizational level it is sought to motivate to a safe behaviour on the individual level perceived and acted upon as it "goes without saying". "An ideal safety culture is the engine that continues to propel the system towards the goal of maximum safety health" (Reason, 1997, p. 195).

Different measurement tools were designed to measure safety culture matureness. For example, companies can be certified in accordance with a safety culture maturity level by means of Safety Culture Ladder (SCL) (NEN, 2016). SCL became an industrial standard accepted by the International Association of Oil and Gas Producers (IAOGP) (Hudson, 2007). It allows companies to be certified within five steps of maturity. Such benchmarking proves competitiveness within a certain industrial sector (Clarke, 2000). More detailed description is provided in the subchapter 2.4.

Safety programs are part of the safety management tools which aim to reduce risks, prevent, or minimise the number incidents and accidents, improve safety, and enhance safety culture. They seek to raise awareness among employees and develop a safety culture, though demanding a lot of effort and time.

1.2 Purpose of research and research questions

The thesis explores how the concept of SC is implemented and developed in private business in three dredging and marine contractor companies. The author aims to understand the companies' view on SC, describe how the concept is implemented in practice, and what challenges, pros, and cons can be detected. The purpose of the thesis is to:

✓ To understand the current view on SC in the companies

✓ To explore how safety culture is being developed in the companies

✓ To consider which contribution does safety programs bring to companies' safety culture and overall safety

✓ To contribute to safety culture research by obtaining empirical data

Subsequently the research questions are formulated as follows:

RQ1 What are the companies' views on safety culture?

RQ2 How is safety culture implemented and developed in the companies within the safety programs?

RQ3 How is the influence of safety programs on safety culture measured by the companies?

RQ4 What are the deficiencies, problems, and challenges of the safety programs in the companies?

1.3 Presentation of cases

There are only few dredging and marine service provider companies in the world and the three ones chosen as cases are among the biggest four in the world (Reuters, 2010; Statista, 2019). Cases represent the companies, varying by the country of origin, size, and subsequently available budget. They can illustrate the state of SC understanding within this type of business. Cases will be presented throughout the thesis in an alphabetical order.

Dredging is "the subaqueous or underwater excavation of soils and rock" and includes four stages: excavation, vertical and horizontal transportation, use or placement of the dredged material (Bray & Cohen, 2010, p. 8). Dredging is vital for construction and maintenance of ports, navigation ways, for offshore energy activities, including exploration of oil and gas, installation of offshore windmills, rehabilitation of polluted areas, towage and salvage operations, flood control, and reclamation of new areas (Bray & Cohen, 2010). Works bear risky activities related to underwater work, use of big, complex equipment and technology, general high-hazard risks related on onshore and marine construction, work with toxic material, operating worldwide in unknown locations.

1.3.1 Case Boskalis

The first case is represented by Boskalis, being a Dutch company and operating within high-risk industry (Boskalis, 2022a). It has a Royal designation since 1978. It provides a wide range of services, which include marine construction, land reclamation, marine transportation, services for oil & gas clients constructing, maintaining, and decommissioning oil platforms, waterways, offshore wind farms, emergency response and engineering. It has over 100 years of experience, operates in 90 countries and six continents, has over 10 000 experts employed.

The Safety Program (SP) is named NINA (No Incidents No Accidents) and was launched in 2010 (Boskalis, 2021b). The name is visualized by the image in Figure 3 (Boskalis, 2021a).

Figure 3

NINA figure

"NINA embeds the desired safety culture in our organization and makes safety a fully integrated part of working behaviour." "This emphasis on behavior helps implementation to be long-lasting and not just rule-driven" (Boskalis, 2020b, p. 44)

"Since the implementation of NINA in 2010 safety awareness at Boskalis has increased significantly and, more importantly, has resulted in a major decline of the Lost Time Injury Frequency (LTIF). NINA has become an inextricable *part of our culture*. It has stimulated the way in which we work with each other: in *open dialogue* and *collaboration* to achieve operational excellence. Our clients too are increasingly embracing NINA as best practice and are enthusiastic to participate in our interactive NINA training program.

NINA makes employees aware of *their own responsibility* towards their safety. It stimulates a working environment in which safety, responsibilities and potentially hazardous situations are *openly discussed* and *reported*. The NINA *values and rules* are not only about procedures, but mostly *promote ownership* and *a safety-driven mindset*. Five short and clearly worded values with five supporting rules provide the framework and help us achieve our objective: No Injuries and No Accidents" (Boskalis, 2022b)

The program is based on five core values and rules (Boskalis, 2021c). Values are defined as "what an organization regards as important or even sacrosanct" (Hudson, 2001, p. 17).

Values

- I am responsible my own safety
- I approach others about working safely
- I take action in case of unsafe operations, if necessary, I will stop the work
- I accept feedback about my safety behaviour regardless of rank and position
- I report all incidents, including near misses, to inform others and build on lessons learned

Rules

- Prepare a risk assessment for each project, vessel, or location
- Obtain a permit to work for defined high-risk activities
- Make a job hazard analysis for hazardous non-routine activities
- Be informed about risk & control measures
- Be fit for duty and wear the PPE required

The rules are described in more detail for practical application in Table 1 (Boskalis, 2021c).

Table 1

NINA rules in practice

Prepare a risk assessment for each project, vessel or location	Be informed about risk & control measures
Responsible Manager/Captain coordinates the Risk Assessment and must involve supervisors The Risk assessment is viewed periodically and updated when necessary, such as change in work, scope or method or following an incident The measure defined in the risk assessment must be implemented	Everyone on projects, vessels and offices is informed about the relevant risk and control measures Before starting the work a toolbox meeting is held: In case of Job Hazard Analysis or Permit to Work As a result of the Risk Assessment Updates in the Risk Assessment will be communicated with relevant person on-site
Obtain a Permit to Work for defined high-risk activities	Be fit for duty and wear the PPE required
Identified high-risk activities e.g.: entering closed/confined spaces working with energized systems (including "Lock Out/Tag Out") Based on risk assessment other high-risk can be defined Defined control measures must be implemented Responsible supervisor issues a Permit to Work	"Fit for Duty" means not under influence of alcohol and/or drugs PPE on site: safety shoes and hard hat high-visibility clothing life vest during embanking/disembarking or if floating equipment lacks a railing Additional PPE are job-specific and based on the Risk Assessment, Job hazard Analysis or Permit to Work
Make a Job Hazard Analysis for hazardous non-routine activities	
In case of hazardous and non-routine jobs, the supervisor should do JHA (Job Hazard Analysis)	

Different roles of employees are personalized according to position occupied in the company, shown in Figure 4 (Boskalis, 2021c).

Figure 4

Roles according to NINA

MY ROLE ACCORDING TO NINA

AS AN EMPLOYEE
- Always check the safety of Yourself, Equipment and Surroundings (YES)
- Ensure that you are informed about risks and control measures for the job and work environment
- Inform your supervisor of hazardous situations
- Always follow the values and rules

AS A MANAGER/SUPERVISOR
- Lead by example by demonstrating safety leadership
- Create an atmosphere and conditions within the organization where employees are encouraged to work safely and to address safety issues
- Ensure compliance with the values and rules for the area of control

1.3.2 Case Deme Group (Deme)

The second case is the company Deme Group which is established in Belgium and operates world-wide within the same high-risk industry of marine environmental and construction operations, land reclamation and engineering services provision for gas and oil companies (Deme, 2022). Operations are performed with over 100 vessels excluding auxiliary equipment. The company has over 140 years' experience and over 5 000 skilled personnel employed. Safety same as in the first case has the highest priority.

The safety awareness programme CHILD (Colleagues Help Injuries to Leave DEME) was introduced in 2010. Later the program was modified to CHILD5. The message of CEO presented the new CHILD initiative and focussed on three points:

1. CHILD aims to make safety a personal issue. We take safety in our own hands, as a matter of priority. First, we think about our own and others' risks; then we start working safely. This must become a personal, spontaneous drill and not the result of enforcement.

2. CHILD wants to point out that poor safety statistics reflect badly on the reputation of the company and will eventually jeopardise the future of our organisation.

3. CHILD wants to confirm the fact that safety goes hand in hand with efficiency; a well-prepared and thought-out project is a safe project and will generate a profitable outcome.

As the CHILD action programme was fine-tuned, the focus was narrowed on six priority issues:

1. Safety will always and everywhere come in the first place. Applications of this principle were identified during work execution; work preparation; meetings; internal and external communications; and in the incorporation of risk assessment in the method statements.

2. More focus is put on safe work preparation and safe work planning. This was made concrete by stressing "Take-5"; Risk Inventory and Evaluation (RI&E) and Job Safety Analysis (JSA); complementing Standard Operating Procedures (SOPs); and by organising an increasing number of toolboxes.

3. Safety is everyone's concern. Every employee has the task to report and to correct unsafe behaviour and situations. Everyone gets the opportunity to propose improvements and new

ideas. "Stop-work" authority was explained and promoted by no one less than the CEO. A new Incident Notification and Analysis Form was introduced; Safety Hazard Observation and Suggestion Cards (SHOC) were distributed; and safety was emphasised during the annual feedback talk with crew and staff.

4. A more supportive, documented approach towards safety issues was set up in the company. This includes an overview of the DEME "Hazard Top-10" more profound safety education; site instruction with regard to health, travel, local legislation, and so forth.

5. DEME management staff is giving the correct example. Seminars for top management, area managers and project managers will be organised; the Project Management Manual (PMM) will be reviewed; safety-related training sessions for staff are to be improved.

6. Clear definition and communication of DEME standards with regard to personal protective equipment (PPE); point of interests during execution of heavy lifts; how to construct a proper jetty; correct handling and storage of compressed gas cylinders; correct transport and storage of fuel, oil, chemicals, paint and other things; alcohol and drugs policy; towing; explanation about Permit-To-Work (PTW) and Lock-Out-Tag-Out (LOTO) systems; the use of Material Safety Data Sheets (MSDS); minimum requirements for oil spill equipment, and so on."(Durt, 2012, p. 11)

Logo "A telling logo (Figure 5) was designed: the blue, falling dominoes at the right side represent dangerous situations and behaviour. Or they can be interpreted as someone in danger, losing control, unsteady, in need of support. They may also be seen as one unsteady person making others become unstable. CHILD seeks to be a dam: The dominoes lean against it, but do not fall. The bold letters underscore the idea of strength. The dam will get stronger if each and every one sticks closely together for the same objective" (Durt, 2012, p. 11)

Figure 5

The logo of CHILD and CHILD5 programs

"In 2017 DEME's safety awareness programme CHILD reached its 5-year milestone. Great progress has been achieved in addressing safety. Yet a strong safety culture has to be further promoted. Therefore, DEME launched CHILD5, its rejuvenated programme with the objective to make a transition *from safety awareness to a DNA Safety Culture*. CHILD5 fosters a culture where safety awareness becomes *second nature*" (Deme, 2018, p. 23). The logo is presented in Figure 5 (Deme, 2018, p. 23) and Figure 6 (Durt & Quirynen, 2016, p. 30).

"DEME has ambitious safety targets and wants everyone on board. Ultimately, it is aiming for zero incidents and that safety awareness becomes part of the company's DNA. The safety strategy is based on four pillars: *engagement/buy-in, collaboration, communication, and leadership*. These are the foundations for a better safety performance, for better quality and for more efficiency. And these are all crucial ingredients for sustainable business excellence." (Deme, 2016, p. 26)

"CHILD5 Campaign DEME's safety awareness programme CHILD (Colleagues Help Injuries to Leave DEME) was introduced in **2010**. While figures have improved eight-fold since CHILD's introduction, and although DEME has a very good track record compared to its peers,

DEME still wants to do more. For *safety to be embedded in the company's DNA*, **CHILD5** was initiated. Two seminars took place in 2016 for senior and middle management under CHILD5 and 12 more sessions will follow. The first two addressed the manager's attitude towards safety issues and how as an individual they can change their behaviour - and make the difference. In 2016 DEME focused on the further development of its Integrated Management System. Unlike many other systems this integrates purchase and logistics, tendering etc. but also QHSE-S. So again, safety is fully embedded in the company's culture. DEME believes that this integrated management approach is the true foundation for business excellence" (Deme, 2016, p. 27)

Figure 6

The logo of CHILD 5 initiative
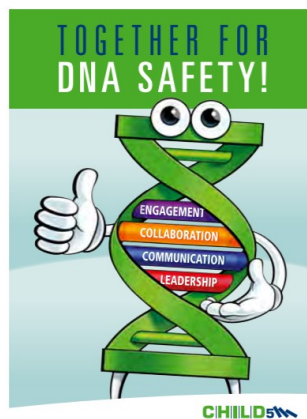
Figure 3: The "CHILD5" initiative aims to implement a "safety DNA culture" in DEME employees.

The reasons behind launching of CHILD program was a fatal accident in Angola in 2009 and further gap analysis performed by external party that revealed deficiencies in company's leadership (Durt, 2012).

"A fatal accident of an employee in Angola in 2009 was a rude awakening for DEME. Since then, safety is considered number one in the organisation's core values, and the prevention of all incidents is a top priority. From this tragedy, the "CHILD" (Colleagues Help Injuries Leave DEME) initiative was born and it has been the driving force behind bringing *safety behaviour* to a new and unprecedented level in the company. It resulted in a shift from *reactive to proactive behaviour* among employees. Procedures, risk analyses, work preparation and safety awareness were developed in parallel among all DEME employees. Meanwhile, each DEME employee knows that safety is a shared responsibility. It has been five years since "CHILD" was first implemented and the goal remains to have *zero incidents*, but the struggle to achieve this continues. Therefore, to maintain this strict focus on safety, DEME has recently launched its new "CHILD5" campaign. "CHILD5" goes further than the basic concept of "CHILD" and does more than just improve safety alertness. By launching the "CHILD5" campaign, DEME aims to make the switch from "*alertness to safety*" to a system where *safety is a part of DEME's DNA* (Figure 6). Safety is a part of the core values of the DEME and prevention of any incidents is a top priority for the company… The company continues to invest heavily in other innovative safety ideas and initiatives including the launching of the new "CHILD5" safety campaign. "CHILD5" aims to transform employees' *safety behaviour from reactive to proactive*. DEME's innovation contest in the safety category will continue to be on the company's agenda in the future. The hope is that such ideas will contribute to the well-being of others in the dredging industry and will enhance the reputation and sustainable future of the entire industry." (Durt & Quirynen, 2016, pp. 30–31)

1.3.3 Case Van Oord

The third case is the company Van Oord (Van Oord, 2022c). It is a Dutch family-owned company having over 150 years of experience as an international dredging marine contractor. It has received the right for using Royal designation in 2018. It has 4700 employees representing 83 nationalities. Main equipment consists of 60 vessels. The company includes four business units: Dredging, Offshore Wind, Offshore and Netherlands (Van Oord, 2020, p. 9). Van Oord operates worldwide.

The safety program is called Say Yes to Safety and was enrolled in 2016 (Van Oord, 2022b).

> A simple, but powerful and positive message that indicates Van Oord is embracing safety: Say Yes to Safety. At the heart of the programme are *five behaviour-based safety principles* express the *proactive safety culture* within our company. These principles are strong personal statements that encourage everyone to be *aware of safety* and *take responsibility*.
>
> Van Oord's values *'we care'* and *'we work together'* are fundamental to eliminating all incidents and personal injuries. Everyone working at, with or on behalf of Van Oord is expected *to take responsibility* for safety and *deal proactively* with safety matters. This includes clients, partners, subcontractors, and suppliers.
> At Van Oord, safety is about more than knowing the rules and procedures. It is about proactive safety leadership. This message is the core of our safety programme Say Yes to Safety as shown in Figure 7 (Van Oord, 2017, p. 40). Van Oord offers a wide range of safety items to make sure everyone working on a project location or on board a vessel is equipped with the right safety tools.

The statement and principles are as follows (Van Oord, 2022b):

- I take responsibility for my own health & safety and that of others

  Be fit, alert, and take care of each other

- I am a role model and demonstrate safety leadership

  Act as a professional and set an example to others

- I am open to feedback and challenge others

  Giving and receiving feedback provides you the opportunity to learn

- I adhere to the procedures, instructions, and lifesaving rules

  Make sure you are familiar with the rules

- I report incidents, near misses and ideas for improvement

  Share your observations and lessons learned to strengthen the organization

  YES, commit to the safety principles and inspire others to do the same

Figure 7

Say Yes to Safety logo and description
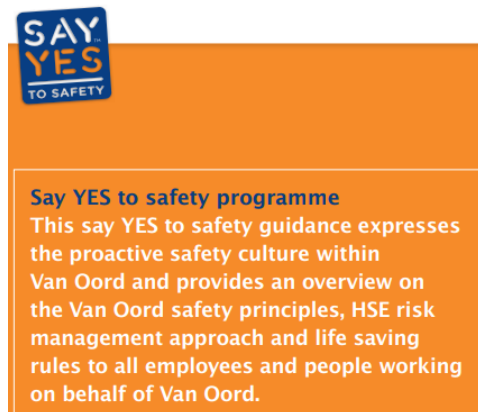
*"*Van Oord's new safety programme, "Say Yes to Safety" was started in January 2016. It is a sustainable safety programme and is designed to *encourage accountability* for *safety behaviour, leadership, and commitment.* It not only focuses on *safe working practices*, but also very strongly on *leadership and commitment* throughout the company processes. Some of the innovative features of the programme include practical measures to safeguard the people on site in their day-to-day work, new and appealing design that inspires everyone to say "YES" and a focus on personal commitment and behaviour for all people working for and on behalf of Van Oord." (Durt & Quirynen, 2016, p. 25).

2. Theoretical Framework

The chapter presents the concept of SC and various conceptualizations; the concept and model of organizational culture, developed by Schein; HSE culture; the concept of safety and safety climate; ways to design a strong SC; and means to measure quality and maturity of SC. Thereafter, theories related to safety programs, Vision Zero, and Safety I and Safety II concepts are described. These concepts, theories and models should not be underestimated. They provide guidance and refine further analysis. Selection of concepts "partly defines a case" (Lund, 2014). The theories included provide a certain lens or glasses the author used in this thesis to look at and explore the concept of safety culture.

2.1 Safety culture concept and its background

There exist totally different views in science on the SC concept from optimistic acceptance till total denial. Some consider it fuzzy due to the fact, that almost all safety failures could have been wrapped in it. The first report of INSAG did not comprise definitions of SC (INSAG-1, 1986). Reiman and Rollenhagen (2014) suggest that (bad) safety culture, same as human error, should not be considered as a fast and easy explanation

of the cause of accidents, rather than a starting point. The researchers call for a more systemic conceptualization of both safety and safety culture.

The first SC peer article appeared only in 1991 (Pidgeon, 1991). The SC concept is still developing and lacks unity or consensus on definitions, models and frameworks. It happens due to different perspectives applied, industry specific conditions, or even waves of SC concept development.

There are many definitions of SC, but only few examples will be provided. Guldenmund (2000) defines safety culture as "those aspects of the organisational culture which will impact on attitudes and behaviour related to increasing or decreasing risk" (p.251) and "strong convictions or dogmas underlying safety attitudes" (Guldenmund, 2000, p. 222). Lee defines safety culture of an organisation as "the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, and organisation's health and safety management" (Lee, 1996 cited in Guldenmund, 2000, p. 228).

Hudson (2001) adds to values, beliefs and practices "common problem solving methods" which include "risk assessment, cost-benefit analyses, accident analysis as well as investigation, proactive search for problems in advance of incidents" (2001, p. 18). Dekker (2014) criticises a definition of culture as "the way we do things around here" because in such a case it covers everything leaving us with no idea how to control it. "Say "safety culture," and you've probably covered whatever it was that "caused" the accident" (Dekker, 2014, p. 161). A SC he writes "is a culture that allows the boss to hear bad news" (Dekker, 2006, p. 171).

Aven & Ylönen define SC as "shared beliefs, norms, values and practices, as well as structures (including functions and related social relationships) with respect to safety in an organization" (2021, p. 1351).The thesis is based on this definition.

Two main perspectives are demarcated: socio-anthropological and organizational psychology. The former deals with understanding of meaning and social processes, the latter is focused on cognitive components and ideas formation (Aven & Ylönen, 2021). Since safety culture is related to behavioural results Edwards et al. (2013) see psychology useful to start with when trying to conceptualize SC since it is more oriented on behaviour prediction than anthropology.

Edwards et al. (2013) with reference to Brinkmann (2007) differentiates between anthropological, normative, and pragmatist conceptualizations of culture applied to safety culture.

Anthropological conception views culture as "possessed by all" consisting of several shared factors, beliefs, and attitudes which guarantee that behaviour recurs (Brinkmann, 2007, p. 72). According to this view, culture is naturally composed of "socially established structures of meaning" (Geertz, 1973, p.13 in Brinkmann (2007, p. 194). Culture is understood as a process of interaction between members and it cannot be managed (Aven & Ylönen, 2021).

The conceptualization aims for understanding and exploration of SC within an organization, where other organizational factors must be considered in addition to psychological factors. It helps in understanding whether some safety campaigns will be successful or not and what can be implemented into the existing organizational culture (Edwards et al., 2013). Whereas behaviour is not purely the product of culture and is influenced by other factors (Schein, 2017). "Only after we have discovered the deeper layers…DNA of culture, we can specify what is and what not an "artifact" that reflects the culture" (Schein, 2017, p. 13). In contrast to the normative view, (described below) the anthropological conceptualization explores both negative and positive influences of shared values, beliefs and attitudes on SC. Differences and peculiarities of subcultures, national and religious cultures, as well as influences of power are studied within this conceptualization. Qualitative methods are applied within this approach.

In normative conception, which Edwards et al.(2013) consider prevailing in SC field, culture can be cultivated in individuals and in a group. It can be strengthened and maintained, the current development level and its type can be evaluated. It is both a mechanism and a remedy for safety achievement. SC is an instrument to measure policies and procedures in an organization in relation to the best needed at a certain time point (Edwards et al., 2013). The normative view is also called an instrumental approach used often in management area (Haukelid, 2008 cited in Edwards et al., 2013). While recognizing that some cultural aspects cannot be changed, those which are changeable like structures, policies, and procedures in organizations are focused upon. SC is blended within safety management studies and often used as a measurement scale. Cultural differences, subcultures and the issue of power are not reflected in normative (instrumental) approach. The view is useful for benchmarking safety in a company and detecting deficiencies in SC which are to be changed (Edwards et al., 2013).

Pragmatist conception is about shared practices and considers safety culture as safe behaviours focused on results. Behaviours are based on intrinsic beliefs and values. This conceptualization is linked indissolubly to anthropological conception, which has a focus on studying underlaying beliefs and values (Edwards et al., 2013). The concept is widely used by

managers and practical specialists and thus tends to be closer related to safety management
rather than safety culture (Edwards et al., 2013). The issue of power and differences of
subgroups are studied within the conception as influencing factors.

Edwards et al. (2013) suggest combining all three conceptions in order to get a
"synthesised" conceptualization achieving a better, deeper understanding and practical
application for safety improvement as shown in Figure 8 (Edwards et al., 2013, p. 78).

Figure 8

A synthesised conceptualization of safety culture
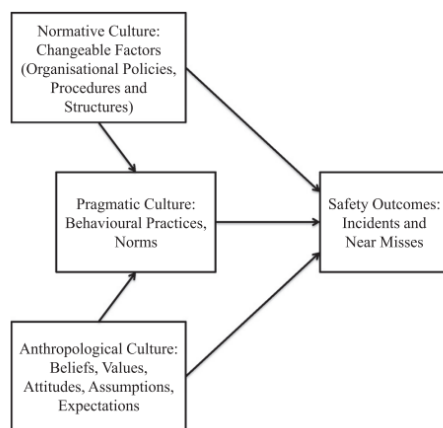
Le Coze (2019) describes evolution of the SC concept via two major "waves" of
development: first until mid-2000 and second from then till nowadays. First wave
distinguished between interpretive and functionalist views. The second wave brought
complementary and alternative views.

Culture in line with interpretivist view often grounds on anthropological views and
means that shared meanings of its members are created in a group naturally through
discussions about them and interactions with each other (Nævestad, 2009). Culture cannot be
engineered, managed, or modified from the top. "It cannot be measured it emerges" (Martin,
1985, p.95 in Nævestad, 2009, p.130). Safety measures can be successful if they are considered
meaningful by addressees and if these meanings are identity related (Richter, 2003; Haukelid,
2008 in Nævestad, 2009). Such contribution can be of a great value to practitioners (Nævestad,
2009).

The functionalist approach dominates in the SC research (Guldenmund, 2007). The
approach is popular among numerous governmental organizations, for example in the
International Atomic Energy Agency and the Advisory Committee on the Safety of Nuclear
Installations (Antonsen, 2009), practitioners and managers (Nævestad, 2009). It is similar to
pragmatist view but differs in focus on shared behaviour. It can be explained by analysis

reflecting attitudes to safety in an organization by means of questionaries (Guldenmund, 2000; Nævestad, 2009). According to the functionalist approach culture is seen as "a critical variable" influencing different outcomes including safety (Nævestad, 2009, p. 127). It is defined by researchers following this view as "the way we do things around here" (Reason, 1997; Hofstede, 1994; Furnham, 1997; Cooper, 2000 cited in Nævestad, 2009).

The followers of the functionalist view believe that SC can be engineered and governed by managers. It presumes that views on culture and attitudes are homogeneous. Dekker (2014) provides examples with focus on Vision Zero (described in subchapter 2.6) and "safety first". He notes that safety and behaviour modification campaigns, posters are typical for this view. It is often criticised for being over pragmatic and creating a myth of control (Dekker, 2014). The summary of the SC conceptualizations described above is provided in Table 2.

Table 2

Main conceptualizations of safety culture

	Anthropological	Interpretivist	Functionalist	Pragmatist/Pragmatic	Normative/ Instrumental
View on Safety Culture	-a process of interaction between members -naturally formed by meanings -shared beliefs and attitudes -cannot be managed -no control over culture	-culture is a metaphor for organization, what it does -cannot be changed, engineered -emerges from shared patterns of meanings (thought precedes and legitimatise action) - grounds on anthropological views -at home in culture studies, sociology, anthropology	-SC is "a critical variable" influence outcomes -can be engineered, strengthened, governed by managers - culture can be reduced to individual attitudes and behaviours -grounds in social and organizational psychology, management, engineering -"the way we do things around here" -shared patterns of behaviours --popular in management -myth of control	-equals to safe individual and group behaviours -related more to safety management -practices are outcomes of SC -practices must be based in underlaying beliefs and values (indissolubly related to anthropological)	- as a substance -mechanism, remedy for safety -a scale to measure company's policies, procedures - can be cultivated, maintained, strengthened -in relation to company's systems and structures -blended with safety management - prevailing in SC field
Studies/Focuses	-negative, positive influences of shared values, beliefs and attitudes on SC. peculiarities of subcultures, national, religious cultures, influences of power	-numerous ideas and perspectives on safety	-focus on safety climate, attitudes -homogeneity of views and attitudes (Vision Zero, safety first) -behaviour modification programs, posters, campaigns	-focus on results -power - subgroups differences as influencing factors	-changeable factors in focus
Method	Qualitative	Qualitative methods (observations, interviews, discussions)	Quantitative methods Climate questionaries	Questionaries	Benchmarking, measuring strength of SC

Le Coze (2019) defines four views within the second wave: neutral (interest), enthusiastic (open-minded), promoting, critical and radical (rejection).

Rejection and critical view

Le Coze (2019) considers Hopkins (2016) as having the most radical view, assuming that "safety" and "culture" should not be combined. The latter finds it more appropriate to talk about organizational culture, which impacts safety. According to his view, culture is a group and not an individual notion, it is formed by top leaders, it describes rather than explains things and can trample national cultures.

Neutral view

It recognises the worthiness of academic research of the concept and its diversity. Le Coze refers to the works of Silbey (2009), Guldenmund (2000, 2010), and Edwards et al.(2013) following this view. The last two scientists agree on the necessity of combining three perspectives on SC: academic, analytical, and pragmatic. Academic approach is examining the past, follows research traditions, and involves thick descriptions (Guldenmund, 2010). Analytical focuses on the present, provides descriptions, and surveys. And pragmatic aims on maintaining and making developments for the future.

Enthusiastic view recognises the practical view of the concept under certain conditions. Authors following this view promote the discussion on influence of power on SC and existence of subcultures (Antonsen, 2009).

Promoting view fully accepts safety culture idea and creates models and tools for its application in different spheres. Le Coze refers to Reason (1997), Cooper (2000) and Hudson (2007) sharing the view. It entertains enthusiastic attitude in terms of SC practical implementation in industry, does not discuss its relation to social sciences, and limitations. Safety culture maturity evaluation is an example of this view. Works of Hudson (2001, 2007), Westrum (1993, 2004), and Parker et al (2006) shares the view. It does not consider social construction of the concept and main considerations of the other three views.

Fifth view or third wave of SC development

Le Coze (2019) describes recent developments and suggests a fifth view or alternatively a third wave, that recognizes safety as being socially constructed with different competing interests. SC can be such an example too. Le Coze connects it with the developments in high-risk systems. Three waves and views are summarized in Table 3 (modified after Le Coze, 2019, p. 223).

Table 3

Three waves of safety culture studies and debates

Safety culture studies, controversies, positions, and debates		
1st wave 1990-2005	2nd wave 2005-2020	3rd wave
Interpretive and functionalist view	Rejection or critical view More neutral, detached scientific interest for safety culture as an object Open-minded about safety culture practical value, under certain conditions Promoting safety culture methods, programs, and models	Safety culture as a product of safety field Safety as a socially constructed field Contracting safety expertise to consultants Formed by different competing interests Safety is shaped by interaction and influence of different actors (particularly in high-risk industries): regulators, industry, consultants, academics, publishers Examples: safety culture, Vision Zero, Safety Culture Maturity Ladder, HRO*

*Note The concepts are explained in following subchapters

2.2 Definitions of culture, organizational culture, safety, risk, and safety climate

SC is intertwined with several concepts. Therefore, it is necessary to define and explain what organizational culture, HSE culture, safety, and safety climate mean and how they are related. Edgar Schein being an expert on organizational culture and leadership defines culture of a group as

"the accumulated learning of that group as it solves its problems of external adaptation and internal integration; which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, feel, and behave in relation to those problems. This accumulated learning is a pattern of systems of beliefs, values, and behavioural norms that come to be taken for granted as basic assumptions and eventually drop out of awareness" (Schein, 2017, p. 6).

He calls these values, beliefs and wished behaviour "the cultural DNA" (p.7). It provides stability to the group and programs aimed to change culture can succeed, if they conform to this DNA. Schein (2017) suggests analysing culture within a three-level model in Table 4 (Schein, 2017, p. 18). The levels are artifacts, espoused values and beliefs, and basic underlying assumptions.

Table 4

Three levels of culture

Levels of culture

1. Artifacts
- Visible and feelable structures and processes
- Observable behaviour
  - Difficult to decipher

2. Espoused beliefs and values
- Ideals, goals, values, aspirations
- Ideologies
- Rationalizations
  - May or may not be congruent with behaviour and other artifacts

3. Basic underlaying assumptions
- Unconscious, taken-for-granted beliefs, and values
  - Determine behaviour, perception, thought and feeling

Artifacts are the visible practices and processes by which culture manifests. For example, safety programs and campaigns. Espoused values as "the articulated, publicly announced principals, and values that the group claims to be trying to achieve" (Schein, 2017, p. 4). Plenty of companies, Schein states, declare their culture in the parlance of these values. For instance, safety first or Vision Zero (described in chapter 2.6).

At the level of basic underlaying assumptions culture allocates to its members "a basic sense of identity and defines the values, that provide self-esteem" (Hatch & Schulz, 2004, cited in Schein, 2017, p. 23). As a group of these assumptions culture determine for people what to focus on, meaning of things, how to behave and react in certain situations (Schein, 2017).

Schein (2009) claims that the solidity and depth of a culture in an organization revolve the following: "1. The strength and clarity of the founder of an organization; 2. The amount and intensity of shared experiences that organization members have had; and 3. The degree of success the organization has had" (Schein, 2009, p. 217).

Organizational culture is characterised by Guldenmund by seven features: "it is a construct, relatively stable, has multiple dimensionality, is shared by (groups of) people, consists of various aspects, practices, and is functional" (2000, pp. 222–225). The researcher refers to Ludborzs (1995) who notes that SC is part of corporate culture, the latter being a part of an industrial culture and a national culture.

HSE culture is closely connected to management. "Knowledge about the development of an organisational culture builds on the recognition that whatever is given systematic attention

and priority by management becomes culture. Management responsibility and behaviour are central elements in the work of building an HSE culture" (St. Meld. nr. 7 (2001-2002), p. 22)

Safety culture is a part of organizational and HSE culture, consisting of two concepts: culture, described above, and safety. Safe and safety can be defined as "without unacceptable risk" (SRA, 2018). It is "the antonym of risk (the safety level is linked to the risk level; a high safety means a low risk and vice versa). It is sometimes limited to risk related to non-intentional events (including accidents and continuous exposures)" (SRA, 2018). Safety I and Safety II concepts are discussed in item 2.8.

Aven and Ylönen (2019) raise concern that standards, related to safety and risk in particular, may promote inappropriate methods and principals. On the one hand, they provide orientation, achieved by global expertise and consensus, but on the other, lack "scientific quality" (2019, p. 280). Researchers argue that standardization poses a threat to risk and safety development.

Risk in ISO 31000 is defined as "the effect of uncertainties on objectives" (Aven & Ylönen, 2019, p. 282). Tight connection to objectives is unfortunate, cause risk can exit autonomously from objectives. Uncertainty is not in line with the current scientific knowledge. Authors argue that ISO approach reflects the one from 1970s and 1980s and is grounded in "traditional likelihood perspective" (Aven & Ylönen, 2019, p. 283). Risk assessments performed with inadequate quality will provide poor grounds for decision-makers, therefore wrong choices can be made. Standards are primarily "market-based rather than science-based"(Aven & Ylönen, 2019, p. 284). Risk experts do not consider the standard acceptable from scientific perspective.

Safety climate can be defined differently, Cabrera et al. define it as "the shared perceptions of organizational members about their work environment and, more precisely, about their organizational safety policies" (1997, pp. 256–257). It is related to employees' individual perceptions. Organizational culture manifests itself via organizational climate, which is one of the causal factors affecting job satisfaction and performance (Guldenmund, 2000).

Organizational climate precedes the formation of culture according to Schein (1992). Climate corresponds to the espoused values in Schein's model (Table 4) and safety culture is their cause (Guldenmund, 2000). The consequences of safety climate will result in evaluating responses expressed in behaviour, cognitive processes or behavioural, cognitive, or emotional. They are the artefacts according to Schein's model (Guldenmund, 2010). Interrelations of the concepts and influence on safe performance can by visualized by the model in Figure 9.

Figure 9

Concepts interrelation and influence on safe performance

2.3 How to design a good/ strong safety culture

Defining a SC as good or strong rests on instrumental and normative views on SC (Aven & Ylönen, 2021). The goodness is defined differently in SC research. Turner considers SC good if it "encourages people to care about adverse outcomes" (2018, p. 397). Aven and Ylönen consider SC good if "shared beliefs, norms, values, practices and structures are "good" with respect to safety" (p.1352). Whereas risks need to be conceived, evaluated, managed, and communicated based on the best existing conceptual knowledge, assessing the main component of risk -uncertainty, and what might happen in the future. Risk cannot be described properly by numbers alone and SC based on quantitative methods alone can be defined as poor (Aven & Ylönen, 2021). Aven and Ylönen argue that risk needs to be governed by a mix of three main strategies: risk-informed, resilience, and discursive.

In planning for safety culture the focus should be made not on "resident pathogens" detected empirically within the system, but rather developing risk management plans "to match the control requirements of particular hazard sources and the influence of the structure of the systems within which the hazard sources are found" (Rasmussen & Svedung, 2000, p. 46).

Unfortunately, there are little studies linking safety culture and risk science (Aven & Ylönen, 2021). The researchers argue that risk science can assist in creating a good safety culture. A new framework, integrating risk and safety science was developed to help companies in elaboration of a good safety culture. They distinguish three core elements of SC: "mindset and understanding, structures, and practices" (see Figure 10; Aven & Ylönen, 2021, p. 1357). Risk and safety sciences and their features are the key contributors to SC. Illustrations in the middle column reflect the ways to develop a good SC. Further research is required to understand how the mechanisms between the three components work, social and power relations affecting the formation of norms, values, beliefs and how "safety related instruments are implemented in an organization." (2021, p. 1364).

Figure 10

Building safety culture on safety and risk science

Safety culture	Illustrations	Key contributors
MINDSET AND UNDERSTANDING	-Identify what are the core and the key principles of these sciences, reflecting in particular the sociotechnical view -Management commitment to these -Learning, competence building and training - Organization's self-reflections regarding risk related knowledge and methods -Acknowledging different perspectives on risk - Willingness to take into account external factors (economic, political) and organization's responses to these - Monitoring mindset and safety culture	Risk and safety sciences Sociotechnical systems view Management's values, priorities and attitudes External factors (societal, technological, economic and political changes at the global and national levels)
STRUCTURES AND FUNCTIONS	-Adequate resources & competences for risk and safety management - Organizational structures facilitate knowledge transfer between the functions of the organization -Organizational structures support coordination of different risk and safety related activities - Risk and safety management as a distinct function in the organization - Integrated management of safety and security	Organizational arrangements and structural preconditions Risk and safety management systems
PRACTICES	-Competence building and training of risk and safety concepts, principles and methods - Integrating safety into all activities - Integrated management of safety and security -Coordination of all risk, safety and security related activities (risk analysis integrated into all activities) -Learning from incidents and daily operation - Transfer of generic risk and safety science concepts and principles to practice	Organizational strategies and policies Operational activities and measures

"Positive safety culture" can be achieved only in connection with other management processes, namely risk management (Clarke, 2000). Risks related to SC are sociotechnical existing in the whole organization and should involve all employees, not only those at the "sharp end". She stresses that "further research is required to develop a new generation of intervention programmes within a safety culture approach that produces a long-term, effective reduction of risks; especially those that are not easily identified and assessed using traditional risk management methods" (Clarke, 2000, p. 86).

A strong SC help organizations to become more resilient and not to drift into failure. (Dekker, 2006). The main elements of strong safety culture according to Dekker are:

1. Management commitment
2. Management involvement
3. Employee empowerment
4. Incentive structures
5. Reporting system

The following challenges are addressed by Clarke (2000), which require more research: different employment relations of employees (short-term, part-time), focus on teamwork which needs more attention to group level safety outcomes. Outsourcing and cooperation with other companies withing one industry, work with subcontractors degrade safety control possibilities and erode responsibility boundaries between parties. Globalization leads to multinational work within different cultures posing sub/ and cross-cultural challenges.

2.4 Maturity measurement of safety culture

Elaboration of different models for measuring SC maturity is in line with the promoting, normative and pragmatic views. SC of a company is evaluated according to several criteria, based on which a certain type of SC or maturity development step is assigned. Maturity models can be called descriptive as they describe key characteristics typical to each step or type (Filho & Waterson, 2018). SC evolutionizes from bad to good, following the steps (ladder) up. Maturity certification is performed against the Safety Culture Ladder (SCL) by accredited and independent Ladder Certification Authorities (NEN, 2022a). The system was initially developed by ProRail, and since July,1, 2016 is owned by the Royal Netherlands Standardization Institute (NEN, 2022d).

The questionnaire for the SCL self-declaration (SAQ) is prepared according to the SCL certification scheme (see Figure 11; NEN, 2016, pp. 8–9). The main criteria for evaluation originate from six main aspects defined in the questionnaire and presented in Figure 11.

Figure 11

Main subjects of SCL questionary

Leadership and involvement are evaluated based on the attention given to safety. It includes provision of clear rules and monitoring if employees comply with them. Good behaviour needs to be stimulated and rewarded; employees need to positively confront each

other about undesired behaviour. Additionally, it is evaluated how incidents communication is performed, as well as which structures and who is responsible for (un)safe work.

Policy and strategy are assessed in connection with the importance of safety on the strategic agenda, in company's vision, to the degree safety is integrated into management and safety, and investments are considered as "profit-enhancing factor" (NEN, 2016, p. 8)

Organisation and contractors include evaluation of contractors' choice, whether their safety behaviour and performance are focused upon. It includes the ways new employees are selected and instructed in relation to safety. Employees of safety departments need to have high competence and short communication lines with company's directors.

Workplace and procedures are rated in accordance with company's attention to risk awareness and which efforts are taken for its optimization. They include planning of work, safety at workplaces, and procedures.

Deviations and communication have focus on reporting and ways it is performed, regularity of inspections, whether lessons from incidents are learned, and how improvements are implemented in practice. Safety communication and evaluation need to be sufficient.

Audits and statistics should include safety behaviour audits, based on the health and safety statistics, and their trends analysis improvements need to be implemented.

The model of HSE culture ladder in Figure 12 (Hudson, 2007, p. 704) became the industry standard, which is approved by International Association of Oil and Gas Producers.

Figure 12

The HSE safety culture ladder
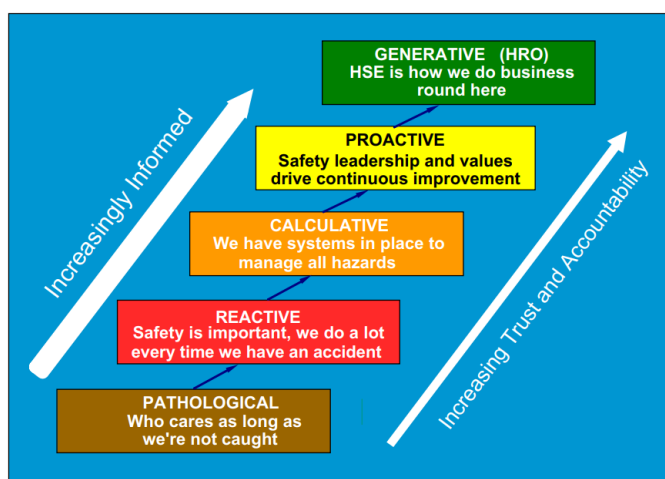
The model differs only slightly in wording from the model applied by NEN and shown in Figure 13 (NEN, 2022c). Each step is numbered and corresponds to the description below, provided on the SCL site.

Figure 13

Safety Culture Ladder Steps
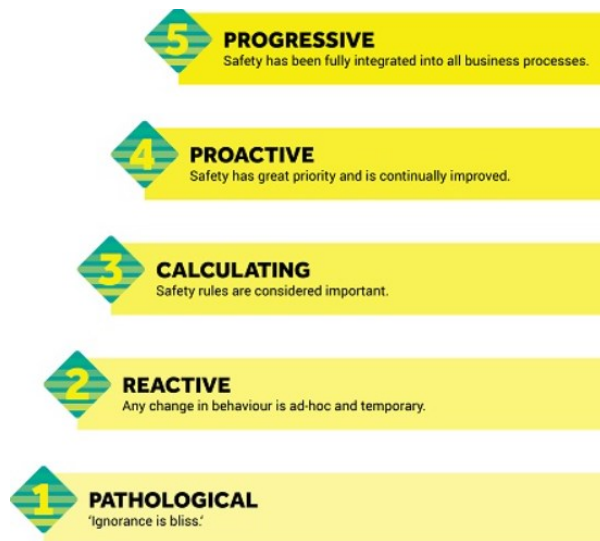
Step 1 Pathological

The company's attitude is: 'we have no mishaps, we deliver good quality, so why should we waste time on preventive activities' and 'what you don't know won't harm you'. The company makes little to no investment in improving safety behaviour. This is not the desired attitude and will therefore not be rewarded.

Step 2 Reactive

The company tends to make changes after things have gone wrong. The response is based on deeply ingrained patterns. Employees are inclined to feel themselves the victim of a situation, rather than personally responsible. 'But that is not my fault?' Change behaviour is often ad hoc and short lasting. This behaviour is moderately valued.

Step 3 Calculating

The company has determined which safety rules are important. It adopts a vulnerable approach, assumes responsibility, but is often driven by self-interest. 'What's in it for me?' Involvement in safety and compliance with rules and laws is mainly the task of (senior) management. Attention is given to health and safety, which is valued.

Step 4 Proactive

Safety has a high priority, is deeply ingrained in the company's operations. Continuous investments are made in raising safety awareness and employees are encouraged to confront one another with unsafe behaviour. Improvements are structurally implemented and evaluated. The approach is characterised by proactivity and initiative. Safety awareness is regarded as an own responsibility: 'how can I contribute?'. This form of behaviour is highly valued.

Step 5 Progressive

Safety is fully integrated in the operational processes. It is a fixed item on the agenda during reflection and evaluation within the own organisation and with sector parties. Safety is

ingrained in the thinking and behaviour of all employees; it is part and parcel of their work. This is very highly valued.

Hudson extended his model in Figure 12 into more detailed stages as shown in Figure 14 (Hudson, 2007, p. 706) based on motivation literature in order to help companies to "define where an organisation might go and how it might go there" (p.705).

Figure 14

The detailed change model with 14 stages

The detailed change model with 14 stages

Pre-contemplation to contemplation – AWARENESS
1. *Awareness* – simple knowledge of a 'better' alternative than the current state
2. *Creation of need* – active personal desire to achieve the new state
3. *Making the outcome believable* – believing that the state is sensible for those involved
4. *Making the outcome achievable* – making the process of achieving the new state credible for those involved
5. *Personal vision* – definition by those involved of what *they* expect the new situation to be
6. *Information about successes* – provision of information about others who have succeeded

Contemplation to preparation – PLANNING
7. *Plan construction* – creation by those involved of their *own* action plan
8. *Measurement points* – definition of indicators of success in process
9. *Commitment* – signing-up to the plan of all involved

Preparation to action – ACTION
10. *Do* – start implementing action plan
11. *Review* – review progress with concentration upon successful outcomes
12. *Correct* – reworking of plan where necessary

Maintenance – MAINTENANCE
13. *Review* – management review of process at regular (and defined in advance) intervals
14. *Outcome* – checks on internalisation of values and beliefs in outcome state

The true SC according to Hudson (2001) is the one revolutionized to the steps four and five. From step one until three (including) SC can rather be described as "formal and superficial structures rather than an integral part of the overall culture" (Hudson, 2001, p. 19). There are two main threats for evolution between the ladder steps, which are failure and success (Hudson, 2001). Failure is when a company returns to the old approaches proved to be effective before. Success becomes a threat when a company sees no reason develop further due to achieved improvements. Commitment of management is crucial in the safety culture development process. He argues that the last two steps are easier to achieve for smaller companies, as they are normally less bureaucratic, open for changes, more adaptive and focused.

Despite of the fact that maturity models are popular tools for SC assessment in different industries, they are criticised in research, as they do not consider fine ethnographic distinctions and recognition of SC as a construct (Le Coze, 2019). Filho and Waterson (2018) studied 41 publications with studies either reporting data from maturity model application or case studies using the models. The results showed that little studies could prove the validity and reliability.

Maturity models might give a wrong picture how SC functions in companies (Filho & Waterson, 2018). Its development is visualized going from the bottom to the top and SC is seen as being static. By this it neglects the fact, that in practice beliefs and values may change during short time periods (Turner, 1978). They argue that 44% of their sample did not provide any reliability or validity of the obtained results. Filho and Waterson (2018) recommend that if used, their pragmatic purpose is to be acknowledged, and it is better to combine them with other assessment methods.

2.5 Safety programs

Companies face daily with different types of safety risks connected to their operations. Production and provision of services especially in the high-risk industries are always connected with dangerous hazards and high risks. One of the primary tasks of a company is to manage them.

Safety management in a company requires establishment of safety philosophy with safety policies, goals, and programs (Aven, 1992). Aven explains that a policy is a principal statement of a company applied for guiding and limiting management action. A goal is a statement of company's objective. A safety program describes "safety policies, goals and acceptance criteria, and the measures" to guarantee that safety management is performed (Aven, 1992, p. 163). Acceptance criteria are "verbal or numerical statements/quantities, which express the level of risk or reliability deemed acceptable or desired" (Aven, 1992, p.10).

To establish a SC means to specify demands at several levels in an organization (Guldenmund, 2000). Guldenmund explains, that the process includes description of requirements at policy level, demands to managers and employees. These requirements include knowledge, commitment, involvement, responsibility, and awareness.

Companies aim to reduce the number of incidents and accidents. Hollnagel (2004) defines accident as an event with an unexpected and unwanted outcome. Incident differs from accident by outcomes severity. One of the means for such a reduction can be changing employees' behaviour.
Antonsen (2009) argues that management often tries to change safety behaviour with the help of improvement programs, quite typical for petroleum sector. Where safety culture means mostly compliance with procedures and rules.

The programs intend to "change culture through attitude modification and the principals of behaviour-based safety, achieved by learning, training, rewards and penalties, attitude campaigns. Safety culture implemented by a top-down approach broadens the scope from

intending initially to control employees' acts to controlling "hearts and minds" (Antonsen, 2009, p. 190). "Hearts and minds" is a brand under which several tools for SC development were elaborated (Energy Institute, 2022). Antonsen considers this being a good example of "prison-like surveillance" defined by Foucault (1977) aiming to disperse "control and discipline into more and more areas of human activity" (Antonsen, 2009, p.189).

Schein (2017) argues that before one decides to change a culture in an organization, one needs to understand what precisely has to be changed omitting the word culture. "Because culture is just an abstraction that refers to a lot of concrete things such as structure, process, beliefs, values and behaviour" (Schein, 2017, p. 319). Normally changes are triggered by some dissatisfaction or pain.

Schein (2017) points to a debate which change is first required and possible when initiation of change programs takes place: first values and beliefs and then behaviour, or vice versa, when values and beliefs will succeed, the changed behaviour follows as a justification. If one wants to change values and beliefs first, then the connection between beliefs and behaviour must be clearly specified. If one wants to change behaviour first, it is required to explain and describe which behaviour is expected in the future. To do so, one needs to identify a problem and what needs to be done to solve it.

Behaviour change cannot be implanted by force. It will result in culture change only, if the new behaviour is conceived to improve things (Schein, 2017). Schein explains that the backbone of a new cultural learning, meaning the learning of new values and beliefs, will require "cognitive redefinition" of certain concepts of the learners' assumptions. "Such process is more than rationalization..it is when a publically espoused value is subordinated to other values.." (Schein, 2017, p. 334).

Further step will require new evaluation methods and standards, where criteria and goals are to be thoroughly elaborated and stated. Change programs in high-hazard industries aimed for safety improvement "take hold only when CEO becomes personally involved, and provides a role model through his or her own behaviour, and defines the standards to be met" (Schein, 2017, p. 337). Learning of new values and new behaviour must be confirmed by better results. The success of the change program and subsequent cultural change can be verified by the culture assessment process. The process of change is divided by Schein (2017) into three stages in Figure 15 (Schein, 2017, p. 323).

Figure 15

The stages and cycle of learning/change

Stage 1 Creating the Motivation to Change (Unfreezing)
- Disconfirmation
- Creation of survival anxiety or guilt
- Learning anxiety produces resistance to change
- Creation of psychological safety to overcome learning anxiety

Stage 2 Learning New Concepts, New Meanings for Old Concepts, and New Standards for Judgment
- Imitation of and identification with role models
- Scanning for solutions and trial-and-error learning

Stage 3 Internalizing New Concepts, Meanings, and Standards
- Incorporation into self-concept and identity
- Incorporation into ongoing relationships

Cabrera et al. studied the relationship between safety climate, safety management, and safety performance (1997 cited in Chen & Jin, 2013). Zohar argued that safety climate correlates with safety programs effectiveness (1980 cited in Chen Qian & Jin, 2013). Additionally researchers detected several safety culture and climate dimensions which demonstrate the success of safety programs (Zohar 1980; Loushine et al. 2006; Aksorn and Hadikusumo 2008 cited in Chen Qian & Jin, 2013).

For example, Loushine et al. (2006) specified that management commitment and communication are the most often success factors, which are studied. Other factors were unsafe acts and hazards authentication, involvement of employees, and safety culture. Aksorn and Hadikusumo (2008) discovered four main categories of success factors: employees involvement, control system and safety prevention, arrangement of safety, and management commitment (Chen Qian & Jin, 2013).

Authors continue that management commitment and employees' involvement are the main factors in safety programs success. Continuity in safety work is a must and employees must be equally treated. They consider, that effective communication have to be established between site management and workers making safety rules easier to understand and comply with (Chen Qian & Jin, 2013).

2.6 Vision Zero

Vision Zero is an example of the safety policy applied in the companies' safety programs and management. Vision Zero policy was adopted by the Swedish parliament in 1997 as both a long-term goal and a strategy in order to achieve road safety (Trafikverket, 2019). The sense of it is that it is human to make mistakes, but human mistakes should not lead to fatalities on the roads. The responsibility of road users was extended on all the agencies, who have

responsibility for safety provision on the roads: designers, maintenance, legislators, police, auto producers etc.

In the beginning the fatalities on the roads halved, but later the figure levelled off. The target to halve the number set in 1996, namely, not to exceed 270 people was not achieved by 2007 (Trafikverket, 2020). An evaluation was made by an independent party. It concluded that: not all the stakeholders were involved, setting an objective by the fatalities numbers does not provide a sufficient direction to effective measures, management was neither clear nor sufficient, and work evaluation and monitoring was unsatisfactory.

Therefore, a "management by objectives model" was suggested in 2008 for more systematic work. It would require stakeholders' involvement and setting intermediate goals. Safety performance indicators are used for such measurement and intermediate safety goals reflecting the maximum number of injuries, fatalities, and indicators. Further, situations which can have a verified potential of influencing fatalities and injuries numbers must be measured and monitored. Annual evaluations had to be made.

The Norwegian Public Roads Administration (NPRA) also adopted the Vision Zero policy in the National Transport plan 2022-2033 (Meld. St. 20 (2020–2021).

> "The Government's ambition is that the number of fatalities and serious injuries in road traffic shall be reduced to a maximum of 350 y 2030, which maximum 50 shall be fatalities. This means a reduction of 50 per cent compared with the current numbers. The long-term ambition is that there shall be zero fatalities in road traffic in 2050." (Meld. St. 20 (2020–2021), p. 27)

Njå et al. stress that measures must not only be based on historical studies of the previous accidents, but NPRA will perform risk analyses and "active systematic audits in the entire road traffic system to map risk factors and conditions that affect safety in the negative direction." (Njå et al., 2020, p. 169).

Similar to the dissemination of the safety culture concept into different countries (Scandinavia, USA), industries and spheres, Zero Vision migrated from road safety to industry, and oil & gas business, more known as Zero Harm. The idea is that all accidents are preventable not in the future but in a current perspective (Society of Petroleum Engineers, 2018). Zero Philosophy (Nullfilosofi in the Norwegian language) is explained in the Norwegian Report №7 (2001-2002) to the Storting like this:

> *"Innføring av «Nullfilosofien» er en milepæl rent holdningsmessig. «Nullfilosofien» kan oppsummeres som at ulykker ikke skjer, men forårsakes. Alle ulykker kan derfor forebygges, slik at målet vil være null skader og ulykker. Dette forutsetter ansvarliggjøring i alle ledd og et kontinuerlig fokus på risikostyring, forebygging og læring.»* (St. Meld. nr. 7 (2001-2002), p. 22)

«Introduction of Zero Philosophy is a purely attitudinal milestone. Zero Philosophy can be summarised as follows, accidents do not happen, but they are caused. All accidents can therefore be prevented, so that the goal will be zero incidents and accidents. This requires accountability at all levels and a continuous focus on risk management, risk prevention, and learning."

It is acknowledged further that underreporting can be a direct consequence of the philosophy's practical application and subsequently requires its follow-up and prevention.

Petroleum Safety Authority explains that Zero philosophy is a mindset (Petroleum Safety Authority, 2022). Another report of the authority suggests shifting from a goal of zero achievement to a zero-harm expectation, therefore focus should shift from the future to the present moment. "This shift in mindset is imperative to eliminate catastrophic incidents" (Society of Petroleum Engineers, 2018, p. 23). Authors acknowledge that safety programs must be assessed by combining lagging indicators (events that have occurred) and leading indicators (risk-control measures).

Despite that safety is easy to measure by reduced numbers of incidents and accidents, such indicators are not reliable for safety program of the company. Reason (1997) explains that it is not a reliable indication of genuine system's safety. It neglects the aspect of uncertainty in risk and socio-technical nature of safety. According to Weick (1987) safety management is the management of a "dynamic non-event".

As a solution to the problem the Society of Petroleum Engineers suggest for individual companies is to develop HSE culture based on the modified model in Figure 16 (Society of Petroleum Engineers, 2018, p. 28) grounded in the model in Figure 17 (Long, 2014).

Figure 16

The DuPont Bradley HSE culture model modified to include Zero
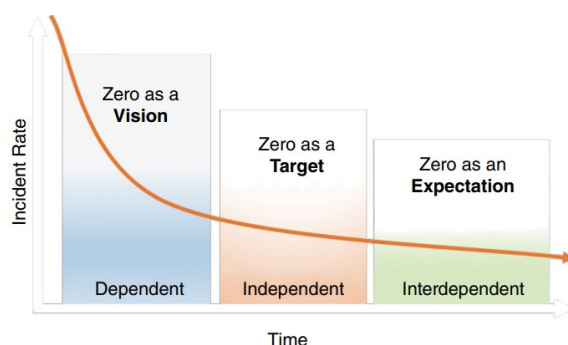
In dependent phase a company is driven by rules and procedures and rigid control. When culture matures to independent level employees take personal responsibility for safety. At the interdependent stage each employee is both concerned about personal safety as well as the

others. Their motive is not a pure compliance, but care and wish. This stage is characterized by close collaboration of management and employees.

Figure 17

The DuPont Bradley curve
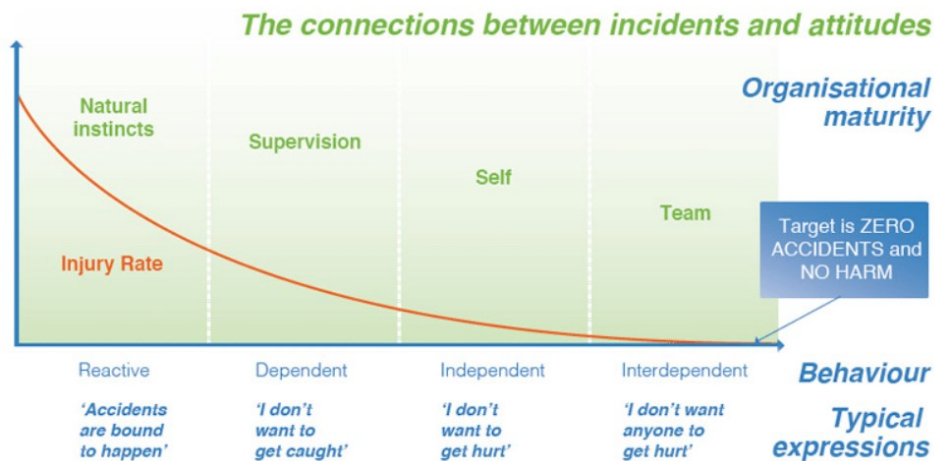
Zweitsloot et al. (2017; 2013) promote Vision Zero or Zero Accident Vision (ZAV). They summarize the common pitfalls when applying the vision in the Figure 18 (Zwetsloot, et al., 2017, p. 91).

Figure 18

Pitfalls when considering Vision Zero

Table 1. Pitfalls when considering Vision Zero.

Vision Zero used inappropriately	Vision Zero used appropriately
Applying Vision Zero as a **target** and making people accountable for realizing it (perhaps even strengthened by economic incentives)	It is a **process** that requires commitment from all leaders and workers in an organization
Focusing strongly on incident rates (and other **lagging** indicators)	Using **leading** indicators
Assuming that more safety rules, **management** systems and behavioural control will help to go from good to excellent safety performance	Focus on **leadership**, being innovative and promoting (collective and individual) learning
Assuming that **one** approach is able to improve different types of safety (e.g. process and personal safety)	Using a **variety** of approaches and adapting them where appropriate

Zweitsloot et al. (2013) claim that 280 companies, being the members of the Finnish "Zero Accident Forum", initiated in 2003, managed to reasonably improve safety. Therefore, authors argue that ZAV has a big potential in safety improvement. A similar forum followed in the Netherlands in 2012. Its members promote successful practices and achievements by sharing their experience and giving advice.

Vision Zero is continuously discussed at the International Strategy conferences for the Preventive Occupational Safety and Health culture (IAG, 2022). The members are: "110 experts from 34 countries... Participants came from 17 EU member states and Albania and

from the US, Australia, Brazil, South Korea, and Singapore as well as the Russian Federation, Ukraine, Azerbaijan and Kyrgyzstan". Five pillars of the safety and health culture were established to promote a preventive culture at the second conference. The first pillar is Vision Zero and the second is raising awareness. The last conference took place in 2016 and united "almost 230 participants from 36 countries" and the first topic remained to be Vision Zero (DGUV, 2016a).

"Zero accidents is not the principal goal of Vision Zero in itself, it is the conviction that the process and approach is correct and that the prevention of accidents and occupational diseases can be achieved!" explained Pete Kines from the Danish National Research Centre for the Working Environment. The contributors were also unanimous that Vision Zero is only possible if prevention is practised by everyone in the company from top management through to each individual employee. "Vision Zero isn't about technical competencies but rather leadership and people's commitment", said Steve Hails from Crossrail Ltd. in the UK" (DGUV, 2016b).

However, the Vision being originated by industry is little researched in academia.

2.7 Criticism of Vision Zero and safety programs, suggestions for improvements

Safety programs have received much criticism as they base on the understanding that human error and unsafe behaviour are the course of 85 percent of incidents and accidents. Subsequently, by changing human behaviour and assigning more responsibility to each employee will prevent most of the incidents and accidents to happen. However, this not in line with socio-technical approach in safety, which is explained on page 32. Such programs focus on "responsibilization" of employees, which became a popular tendency in many countries (Dekker, 2014, p. 164).

Gray (2009) argues that instead of employers and employees being "equal partners" with a common and shared safety responsibility, the latter is often not equally distributed in practice. As a result, employees are blamed and sanctioned for not fulfilling their safety responsibility. Employer's individual responsibility though is shifted to corporate. Subsequently, responsibility for "workplace risk" becomes indistinct. Under new increased individual responsibility workers need "to adopt a rights-defined identity" (2009, p. 327).

Frameworks for increased individual responsibility are based on so called "government-at-a-distance" (Gray, 2009, p. 328 with reference to many). It reflects a shift from a "demand and control management" to neo-liberal regulation ruled by decentralized features of "at-a-distance regulation" (Braithwaite, 2000, cited in Gray, 2009, p. 328). Main element of such framework is to make all responsible via informal mechanisms of social control. Traditional blame for being a "careless worker" shift to being the one not being able to take personal responsibility. Gray defines a neo-liberal worker as "an ideal-type rational actor that is

autonomous, has free choice and is unaffected by power/social/cultural relations in the workplace" (2009, p. 330). Main conclusion and controversialities of such approach Gray summarizes as follows:

- ✓ They do not explain unsafe work performance
- ✓ Neglect the social context of safety violations
- ✓ Focus on individual decisions blurs responsibility over safety risks at workplace
- ✓ Workers are blamed and punished
- ✓ Ignore power relations and workers legal understanding
- ✓ Ignore organizational causes of accidents, incidents, and unsafe acts
- ✓ In practice responsibilities are not equally distributed
- ✓ It is doubtful that workers can ever be "fully responsible" for exposed risks
- ✓ Complex relationships (social, institutional, workplace) are not accounted for
- ✓ Risk assessments may add to detecting the violators and contribute to responsibility blurring and compliance

Dekker (2014) sees the roots of such philosophy in behaviourism psychology which dominated in the 1930s. The essence of its meaning is that those who are working safe do not cause incidents and accidents and can be rewarded. Whereas those who cause incidents and accidents must be punished. This school in psychology had no interest to investigate what happens in peoples' minds. Dekker warns against the following:

- ✓ Such programs do not investigate *why* people perform unsafely

- ✓ Instead of asking *what* if responsible for risk formation they ask *who*
- ✓ Create an atmosphere of fear, irritation, underreporting and stigmatization
- ✓ Can ruin solidarity at workplace
- ✓ Learning and honesty are compromised

Dekker opposes to mixing statistical probability with individual commitment and suggest to constructively revise the following:

- ✓ Safety is defined as absence of negative events
- ✓ Zero is defined by the result and not by "control variables"
- ✓ If zero is achievable then all misses must be investigated
- ✓ There is no support in safety research that Vision Zero is achievable
- ✓ Real risk is not paid due attention

Despite of optimistic number of incidents and accidents disasters can happen due to other various reasons. Mindset based on the simplified ideas why accidents happen might ignore data, which can be relevant for accidents prevention and limit the precautions taken by employees (Turner, 1978; Weick et al., 1999).

Dekker concludes, that "A zero vision does not come out of safety research. It is neither a research result, nor a scientific prediction. There is no accident theory underpinning it" (2014, p. 173).

Focus on counting and comparing the numbers of reduced incidents and accidents after certain intervention can be seen as a quick and effective, but it only decreases uncertainty feeling temporarily and it is not a comprehensive solution on the long term basis (Hollnagel, 2014).

Reason claims that "both individual and organisational accidents have their roots in upstream organizational and managerial factors" (1997, p. 232). He distinguishes between three approaches to safety management:

- Person model – focuses on personal injuries reduction

- Engineering model – focuses on human-machine interface and reliability of a system

- Organizational model – "deals with integrity of defences and broader systemic factors" (p.239)

Focusing on personal model he considers to be counterproductive. The number of injuries cannot serve as an indication of organizational system health or proneness to accident. It has little value for possible potential of an organizational accident.

Socio-technical approach can be complimentary to the traditional engineering risk assessment approach (Aven & Ylönen, 2018). Whereas in the latter linear models are used for system understanding (see pp.35-36) and risks are quantified (Aven & Ylönen, 2018). The former on the contrary puts focus in safety on both dynamics within an organization, as well as external influences of the environment (Reiman & Oedewald, 2009). Both organizational safety and disasters are produced in the interplay of social, technical, and organizational processes (Turner & Pidgeon, 1997). Applied to SC in the high-risk organizations it requires conjoint optimization of culture, technology, and structure for achievement of safety (Nævestad, 2009).

Such an approach is based on the model of socio-technical system in Figure 19 with multiple levels of decision-making and controls developed by Rasmussen (1997, p. 185). He divides a system into six decision-making levels: political authority, regulatory authorities, business, management, staff, and operators. The socio-technical systems are dynamic, therefore understanding of parts interaction also changes within time. Systems often aim for different simultaneous and competing goals: efficiency, economic gain, utilization of employees. It is not easy to prioritize between these goals. "This system is presently stressed by a fast pace of technological change, by an increasingly aggressive, competitive

environment, and by changing regulatory practices and public pressure" (Rasmussen, 1997, p. 185).

Figure 19

The socio-technical system involved in risk management
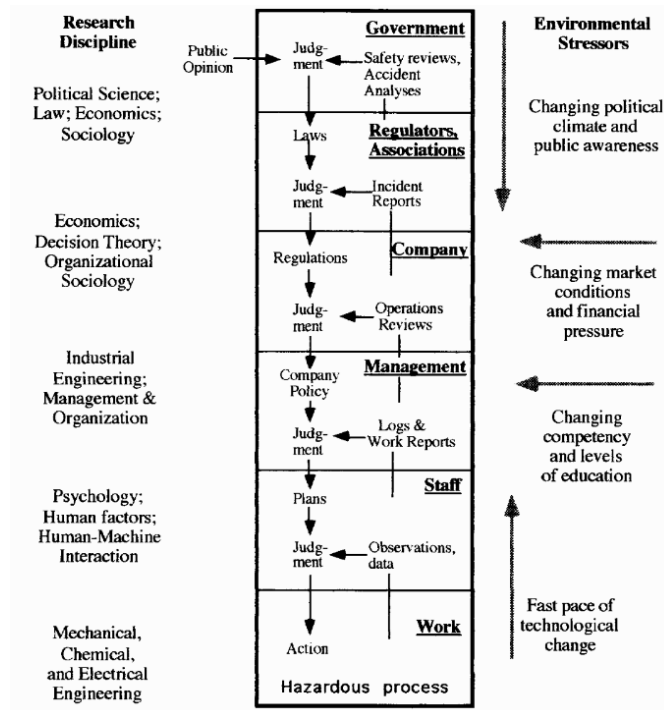
For achieving safety Dekker suggests focusing on High Reliability Organizations (HRO). These were few organizations within the high-risk industry, which demonstrated extraordinary safety results while operating in complex systems under demanding circumstances. They were analysed within HRO project (La Porte, 1996). Dekker summarized the organizations' properties (Dekker, 2014, pp. 186–187):

- ✓ "Meta-monitoring"
- ✓ Past success does not guarantee future safety
- ✓ Oppose to "fragmented" problem solving
- ✓ Pay attention to "drift towards hazard"
- ✓ Analyse the "gap between work-as-imagined and work-as-done"
- ✓ Keep risk discussions alive
- ✓ Support "whistleblowing" and other interpretation of risk and safety
- ✓ Be open to debate and fresh perspectives

Dekker (2014) explains that it is quite complicated to increase the safety progress further within time. Nevertheless, many organizations, for example nuclear and airline companies, studied by HRO, managed to become ultra-safe or near-zero, living at the thin edge of the wedge (Figure 20; after Amalberti, 2013; modified in Dekker, 2014, p. 179). Performing the similar things does not bring much difference. "It will maintain the status quo.. emphasizing

standardization and compliance, and investing in incident reporting, will help the organization maintain its safety level. It will do little, however, to improve safety even further" (Dekker, 2014, p. 180).

Figure 20

Building a safety culture
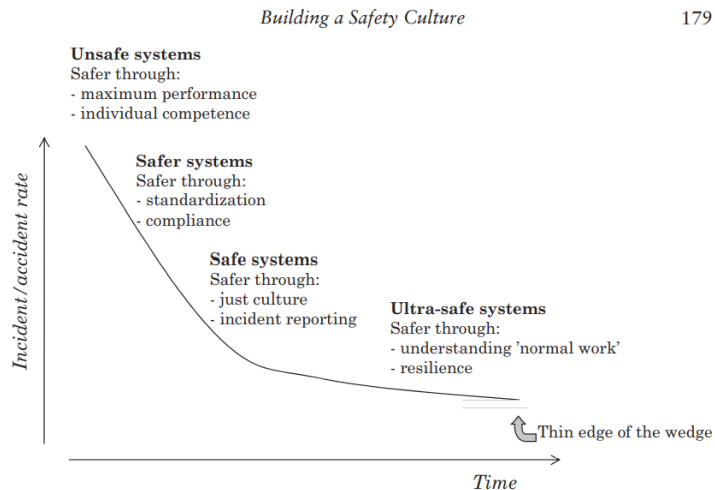
How the consensus on safety understanding is formed is of importance, as view on safety at the "sharp end" and "blunt end" differ. "Sharp end" means the place during work performance where people are directly involved in a "safety-critical process" (Dekker, 2006, p. 59) and when actions' consequences demonstrate themselves instantly (Hollnagel, 2014). "Blunt end" means organization/s that "supports and drives and shapes activities at the sharp end" (Dekker, 2006, p. 59). These differences and opinions are the basis for learning and improvement of safety culture, which presumes a democratic approach. This is in line with Rasmussen model stressing different goals and as a result possible conflict between them, and with Dekker's "New View".

Dekker (2006) distinguishes between two opposite views on understanding the causes of accidents the "Old View" and the "New View". The Old View sees the cause of problems mostly in human failures and extensively preoccupies with them. The essence of it is that unsafe human behaviour is seen as the root cause of accidents, and by changing human behaviour to safer, one can eliminate accidents and occupational injuries. Corrective measures are necessary to change human behaviour. The New View understands human error as a symptom of broader, underlying problems and subsequently focuses not on individuals, but on the system.

Vision Zero programs have some challenges with underreporting and subsequently incorporation of new knowledge and learning. Oltedal and McArthur (2011) conducted a

survey with 1262 questionaries from 76 merchant shipping vessels, which resulted in establishing factors that enhance and undermine reporting. They are "enhanced safety related training, a trusting and open relationship among the crew, safety-oriented ship management, performance of pro-active risk identification activities and feedback on reported events" (2011, p. 331). Productivity demands and lack of care for safety from shore employees resulted negatively.

Hollnagel (2014) calls the idea that all accidents are preventable a myth. If safety management is driven by safety myths, then it sets unrealistic goals, policies, and attitudes of management. He appeals to consider a formula N/M where N is the number of events (accidents, incidents) and M is the number of "complimentary events" (Hollnagel, 2014, p. 172). Safety I focus is to minimize negative outcomes and Safety II aims to increase the M value.

Despite thorough risk analyses not all risks and hazards can be detected and eliminated, same as not all the way when things go right can be found. He refers to an example with a saying "the devil is in the details" which can be a logic in Safety I approach, whereas in Safety II "the devil is whole" (Hollnagel, 2014, p. 173). The devil is where we normally do not look, "in the ways in which systems, organizations and socio-technical habitats usually work" (2014, p. 173). He concludes that, to manage complex socio-technical systems safety myths and their ideals need to be rejected. "Safety synthesis is the constant creation and maintenance of conditions that allow work to succeed on the basis of all criteria taken together" (Hollnagel, 2014, p. 180).

Clarke (2000) with reference to Horlick-Jones (1996) warns that having an objective of zero accidents underrates the complicacy of safety culture. Serious latent failures can remain unnoticed. She considers benchmarking based on safety culture within an industry to be a valuable process in "safety health" assessment as it will provide a more "sensitive indication" than statistic numbers. (Clarke, 2000, p. 85).

Accident models

Hovden et al. (2010) continue this discussion on the changes in working life environment and their influence on safety. While arguing on the increasing complexity of working life they wonder that "most experts and practitioners still believe in the domino model and the iceberg metaphor" (2010, p. 953). An accident model is "a mutually agreed and often unspoken understanding of how accidents happen" (Hollnagel, 2014, p. 27).

The models offer ideas of what risk is, how to contain, and manage it (Dekker, 2014). Four families of accident models are distinguished in Figure 21 (Dekker, 2014, p. 124). The

models are relevant for understanding the focus in safety and learning within the safety culture concept.

Figure 21

Accident models

Table 5.1	These four different accident models provide different explanations of risk, what it is and how it can best be contained		
Accident Model	**Risk Defined as**	**Major Threat to Safety**	**Manage Safety by**
Chain of events	Weakest link in the chain	Unreliable humans	Getting rid of weakest link
Barriers (Swiss Cheese)	Accident trajectory not stopped	Weak defenses	Plugging holes
Systems theory	A control problem	Complexity and goal conflicts	Making goals and erosion visible
Drift	Gradual acceptance of lower margins	Being successful	Staying chronically uneasy

Chain of events is the same as domino model and illustrates events which interact and cause an accident. The sequence of events is linear, has a direct cause, and effect relation. The model in Figure 22 visualises how the accident happen but does not explain why (Hollnagel, 2004, p. 49). The main cause of accident are unreliable humans. To be more exact safety attitudes are the primary causes of incidents (Guldenmund, 2000).

Figure 22

The Domino theory (after Heinrich, 1931)
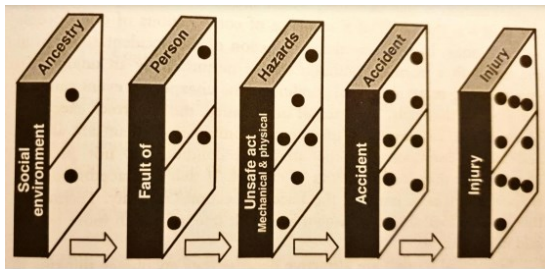
Hovden et al. (2010) admit that though energy-barrier model (Gibson, 1961) and Haddon's (1968) 10 strategies for prevention of loss will always be actual for understanding and prevention of occupational accidents at the "sharp end". Concepts of HRO and Resilience safety, Safety I and Safety II can complement and improve the management in occupational safety, namely learning from accidents, planning, and analysing. These theories were also elaborated and applied within high-risk socio-technical systems context.

2.8 Safety I and Safety II

Safety I and Safety II concepts in combination contribute to safety, help to understand the work as it is performed, and have a direct effect on learning in SC.

Safety is defined according to Safety I perspective as a "condition where the number of adverse outcomes (accidents/incidents/near misses) is as low as possible" (Hollnagel, 2014, p. 49). Where possible means "affordable" in terms of "costs, ethics, public opinion, etc" (Hollnagel, 2014, p. 49). Safety management goal therefore is to reduce these numbers to affordable level, detect what goes wrong, fix it, and prevent that something drifts to a non-normal state. Different barriers assist in prevention. Such view on safety developed during many years in history.

Safety II is a condition where as much as possible or everything goes right, it is "an ability to succeed under expected and unexpected conditions alike, so that the number of intended and acceptable outcomes (in other words, everyday activities) is as high as possible"(Hollnagel, 2014, p. 134). In Safety II most important is understanding of success and active involvement of people. Safety then needs to be defined as "ensuring that everything goes right" (Hollnagel, 2014, p. 137). Safety management and safety then focus on things that go right in daily work. People can discover what goes the way it should not, are able to correct, and adjust it. Safety II management can be described as proactive, since changes are introduced before the unwanted outcome, preventing it from realization.

It is important to understand Work-as-Done. Work-as-done is the actual work performed by employees at the sharp end including possible changes and adaptations from the Work-as-Imagined, which is the way it should be done according to stipulated procedures prepared by the blunt end, based on the assumptions of the blunt end (Hollnagel, 2014).

Hollnagel highlights an imbalance between things going right and things going wrong in Figure 23 (Hollnagel, 2014, p. 47).

Figure 23

The imbalance between things that go right and things that go wrong
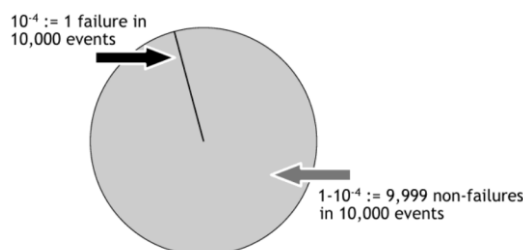
Hollnagel provides a comparative summary of two perspectives as shown in Figure 24 (Hollnagel, 2014, p. 147)

Figure 24

A comparison between Safety I and Safety II

	Safety–I	Safety–II
Definition of safety	As few things as possible go wrong.	As many things as possible go right.
Safety management principle	Reactive, respond when something happens, or is categorised as an unacceptable risk.	Proactive, continuously trying to anticipate developments and events.
Explanations of accidents	Accidents are caused by failures and malfunctions. The purpose of an investigation is to identify causes and contributory factors.	Things basically happen in the same way, regardless of the outcome. The purpose of an investigation is to understand how things usually go right as a basis for explaining how things occasionally go wrong.
Attitude to the human factor	Humans are predominantly seen as a liability or a hazard.	Humans are seen as a resource necessary for system flexibility and resilience.
Role of performance variability	Harmful, should be prevented as far as possible.	Inevitable but also useful. Should be monitored and managed.

Focus on Safety I or what goes wrong Hollnagel (2014) explains by the influence of the following actors:

- ✓ Regulators (demand reporting of incidents, accidents, unintended events)
- ✓ International organizations (investigating adverse events applying different models for assessment of causes)
- ✓ Abundant literature (describing, explaining accidents and incidents)
- ✓ International conferences
- ✓ International research projects
- ✓ Experts and consultants (explaining and training how to avoid and prevent risks, accidents, and incidents)

They ground in stereotypical principal of safety and its motto "find and fix". The actions then limit to looking for problems, finding causes of incidents and accidents, removal of threats, and barriers improvement.

The opposite tendency or unpopularity of Safety II focus can be due to

- ✓ Absence of regulators or authorities demands
- ✓ No agencies are supervising it
- ✓ Unclear how to evaluate it
- ✓ Lack of theories, methods, or models
- ✓ Hardly any theories on human successful performance
- ✓ Lack of promoting expertise, publications, books, or magazines
- ✓ Few examples of organizations promoting it (HRO is most known)

Hollnagel calls management according to Safety I reactive and describes it with the help of a model in Figure 25 (2014, p. 55). Harm can be measures by the number of accidents and incidents. Safety I approach can be detected also in risk analysis, management, and accident investigations. Investments in safety as a result are a burden, thus safety and productivity

conflict becomes strained. He argues that Safety I flourish on "monolithic explanations" of causes, lack of something, for example safety culture or human error (Hollnagel, 2014, p. 140).

Figure 25

Reactive management cycle
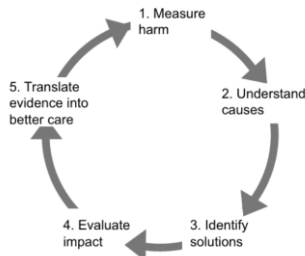
In industry work is to be performed as imagined. Safety II ontology is based on comprehension of the fact that socio-technical systems and work environment changed dramatically and became complex and hardly predictable. Therefore, performance needs to be adjusted by people and organization. Aetiology are suppositions on how something happen, it is "the way of explaining phenomenology in terms of ontology" (Hollnagel, 2014, p. 128). Certain events cannot be explained by liner causality and the result cannot be easily explained due to "emergent" properties. Hollnagel refers to G.H. Lewes describing emergent effects as "not being additive and neither predictable from knowledge of their components nor decomposable into those components." (Hollnagel, 2014, p. 129).

Applying Safety II perspective does not imply to analyse risks and what went wrong. Acting proactively pays off in the long run. Both Safety I and Safety II are complimentary perspectives. Work-as-Done consists normally of a mix of two. Socio-technical systems become more and more complex and Hollnagel (2014) argues that sticking to Safety I perspective only is inappropriate, and this tendency will even be more evident in the future. The relationship between Safety-I and Safety-II is shown by the model in Figure 26 (Hollnagel, 2014, p. 148).

Figure 26

Relationship between Safety-I and Safety-II

System is resilient if "it can adjust its functioning prior to, during, or following changes and disturbances, and thereby sustain required operations under both expected and unexpected conditions" (Hollnagel, 2014, p. 183). The recipe for safety is to combine both Safety I and Safety II approaches.

3. Data and Methods

3.1 Research design and strategy

Research design was prepared in the start of the thesis project work, used as a guidance, and management tool within the process. The design is based on Blaikie & Priest (2019) and is represented by a model in Figure 27. The process is cyclic consisting of key elements, that are intertwined and justified the main decisions the author had to take to fulfil the research. The elements related to the method, logic, and data are explained below.

Figure 27

Model of research strategy in the thesis work
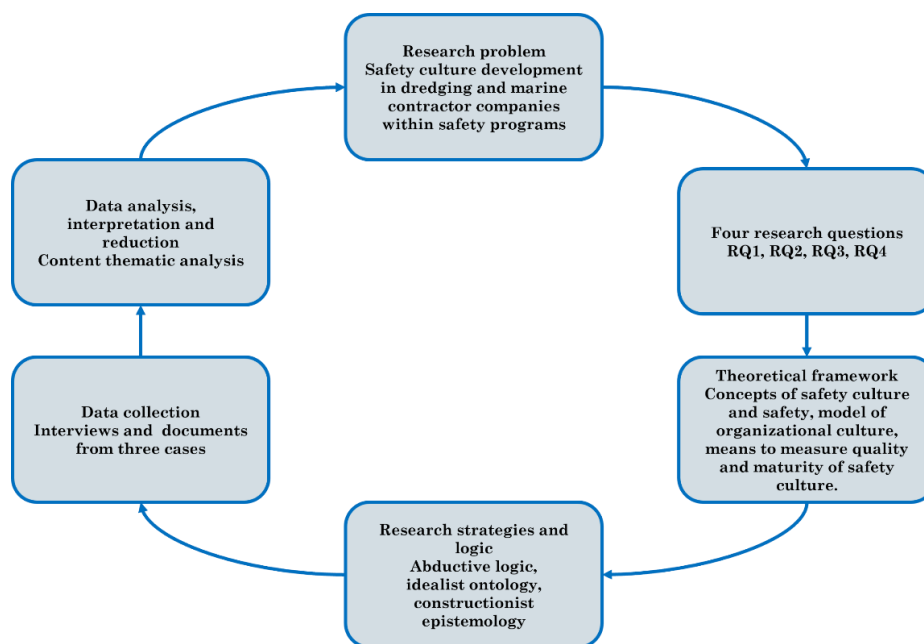
Abductive logic is applied in the thesis. Abduction "often involves the interpretation of phenomena in relations to structures and mechanisms." (Danermark et al., 2019, p. 112). Questions "What" and "Why" are common for the abductive logic of enquiry. Several concepts are chosen in the thesis as the point of departure. Empirical data is collected and further analysed based on the theories, with an intension to find some new ways of observation or interpretation.

Results of the abductive research provide new interpretations of the rules and new insights. The core of abductive inference is recontextualization. Its essence is "..to observe, describe, interpret and explain something within the frame of a new context" (Jensen, 1995, p.148 cited in Danermark et al., 2019, p. 113). Abduction rarely (if ever) leads to clear truths (Danermark et al., 2019). Abductive strategy can be split into the two stages: first is describing activities and their meaning, second applying concepts and categories, which provide a foundation for understanding of a problem or a phenomenon (Blaikie, 2000). Abduction is commonly about providing a different meaning to events or descriptions applying theories as points of departure (Danermark et al., 2019).

Two types of assumptions are used with any of the logics of enquiry ontological and epistemological. Whereas ontology is concerned with nature of social reality, epistemology deals with the ways knowledge is obtained (Blaikie, 2007). Commonly abductive logic is used combining idealist ontological assumptions and constructionist epistemology. It is grounded both on the constructionist understanding of reality and explanatory source, which lies within (Blaikie, 2000). Idealist ontological assumptions are based on peoples' shared interpretations of social reality (Blaikie, & Priest, 2019). Constructionist epistemology is provided by the author investigating the problem from inside. The result is researchers' contemplations about social realities, which can never be considered as true or false. Thus, the objective of the thesis aims for exploration, understanding, and describing phenomena.

3.2 Case study

The thesis is based on case study methodology. Yin (2003) defines a case study as an empirical enquiry which investigates a contemporary phenomenon during its lifetime existence and particularly when the boarders between context and phenomenon are not explicit. A case study enquiry explores a situation, which is technically distinctive and comprises more points of interests than data points. Researcher needs multiple sources of evidence with data, which benefits from previously made theoretical assumptions guiding this data and its analysis (Yin, 2003).

Case studies type can vary based on the number of cases. A single case study explores in-depth one case, whereas several case studies are defined as comparative, have less depth, but more variety. The latter are confirmative and fit good for hypothesis testing or falsification of certain assumptions stemming from single case studies (Sovacool et al., 2018). In addition, they can well demonstrate causal effects beyond one case and therefore providing stronger evidence and broader generalizability as shown in Figure 28 (Sovacool et al., 2018, p. 32).

Figure 28

Hierarchy of evidence for qualitative case studies
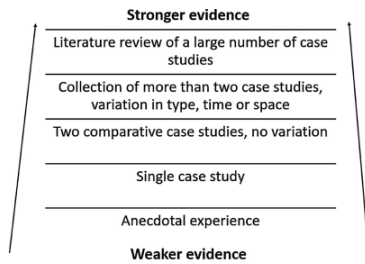
    Multiple case study with application of the qualitative method is applied in the thesis. The cases are presented in the item 1.3. Three cases help to discover some common trends in SC development within the dredging and marine services industry, but also highlight various aspects and differences. Different stages of the development process and differences between them will be explored and compared.

    There are various controversial views on case studies. Flybjerg (2004) explains and contests five misunderstanding about case-study research. They are described as followed: generalization is not possible, the general knowledge is more valuable than context dependent, single case study can only be useful in the first stage of research process for hypothesis generation, verification part is biased, and generalization together with summary are problematic.

3.3 Qualitative method

    To explore and understand a case, concept, or phenomenon one needs to collect different types of data. Qualitative data can be collected via observations, document analysis, and interviews.

    The thesis applies qualitative research methods. Qualitative method includes an interpretation and analysis of the collected data by the researcher. The method suits best for in-depth analysis of a restricted number of cases, has an inductive, and exploratory nature (Sovacool et al., 2018). Such methods "can better reveal how social actors "construct" different viewpoints (Johnson & Onwuegbuzie, 2004 in Sovacool et al., 2018, p. 32).

    Each method has its own strength and weaknesses of which researchers should be aware of. Volumetric empirical data posed both a strength and a challenge. On the one hand, it provides the empirical data to the reader in authentic form, makes the data transparent for readers and saturated, increasing its reliability. Descriptions of findings in the chapter 4 are quite spacious. On the other hand, exploring three cases led to time consuming procedures first collecting the data, transcribing, and then analysing it. The author faced one of the common

challenges to condense the amount of obtained data (Brinkmann, 2013). The method of analysis guided the process and is discussed separately in item 3.8.

3.4 Data collection

Generally, data used by a researcher can be distinguished between three types: primary, secondary, and tertiary. Primary is the data generated by a researcher, secondary is the type generated by another party and tertiary the one analysed by the other researcher (Blaikie, & Priest, 2019). Primary data is preferable for research due to the direct contact of researcher and the source/s. Use of secondary and tertiary data may lead to a risk of inconsistency or distortion.

Primary data consisted of nine interviews and constituted the main data in the thesis. These semi-structured interviews were conducted for getting a better and more detailed understanding of the SC development, its dimensions, and to achieve a reasonable saturation for each topic. Secondary data was obtained from the open public sources of the companies, such as descriptions of the SPs on the web sites, and publicly open documents from these sites, namely different types of company reports and articles, as well as regulatory and certification documents. It was not analysed in detail, rather provided as support for the cases presentation and illustration of the main points.

3.4.1 Preparations to interview process

A preparation process was required before conducting of the interviews. First, enquiries to the companies with a request to cooperate were sent by an e-mail. A detailed letter was attached explaining reasons and purpose of the planned research, informing about the topic and the method, deadlines, possible benefits for the companies, and rights of interviewees in case they choose to participate. Some additional discussions and explanations by phone took place before the answers were gained. To have an in-depth coverage of the topic, the goal was to approach people from three main job occupations: top management (equals to project management), middle management and workers/operators. The author sought advice from the companies or employees to find the volunteers. Most of them agreed, though some refused due to either current workload and plenty of similar requests from other parties, or other private reasons.

Main themes for discussion were sent to the contact persons based on which several candidates were advised, either having knowledge in the SC topic, or representing different levels of the company. The candidates were contacted and if the agreement was reached, the dates for interviews were appointed. A declaration of consent (Appendix A), signed by the

author was sent by e-mail in advance before an interview with a request to get acquainted with it, add, or change something upon necessity, and to send it back signed. It was sent back signed by the interviewees before the interviews.

An interview guide (Appendix B) was prepared beforehand after writing a literature review and acquainting with interview conduction methods. In parallel, the author obtained the information related to the research problem from the publicly open documents on the companies' web sites and other related web pages (provided in references).

The interview guide was used as a framework containing main questions and sub questions. It was not sent in advance, only the main topic. Two of the interviewees wished to know more about the nature of planned questions before interviews. In such case, the following themes were sent: general understanding of company' SC, history of the safety program and development of SC, influence of SPs on SC and indications of it; problems, challenges with SPs and SC.

3.4.2 Interviews

An interview is "an intersubjective enterprise of two persons talking about common themes of interest" (Kvale & Brinkmann, 2015, p. 218). Interviews are the most common methods of qualitative data collection (Sovacool et al., 2018). They reflect the constructionist view of reality. Interviewee and interviewer are creating the reality together.

Interviews can give access to the targeted audience perspectives, ideas, judgements, and beliefs (Sovacool et al., 2018). The goal in collection of data from interviews is to obtain a "purposive" sample, containing a range of experiences useful to the research (Sovacool et al., 2018, p. 29).

Semi-structured interviews called sometimes "conversation/discussion based" were chosen for being less rigid and allowing the researched a certain freedom (Andersen, 2006, p. 283)[1] . The goal of the semi-structured interview guide is to elaborate "broad themes" (Sandy & Dumay, 2011, p. 246). Semi-structured interviews are popular because they are "flexible, assessable and intelligible and, more important, capable of disclosing important and often hidden facets of human and organizational behaviour" (Sandy & Dumay, 2011, p. 246). The interviewees were given freedom to dwell upon topics which were considered relevant and related. "In journalistic jargon interview is as a dance in which the researcher leads, but the informant is the queen of ballet" (Østlyngen & Øvrebø, 1999, p. 301).

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[1] Citations being in other than English language are translated into English by the researcher

Active interviewing was applied, the purpose and meaning of which is not only to be active in interviewing, but that interviewer actively exploits the situation to develop and get answers to his/her research questions (Andersen, 2006). Active means "that the researcher continuously seeks to take advantage of the interview situation to try out own prerequisites, as well as prerequisites for informant observations, descriptions and assessments" (Andersen, 2006, p. 280).

3.4.3 Interview process

Since people were located in different countries, interviews were performed online via Teams and two via WhatsApp calls. Five of them were conducted with video option on and four without. Each interview was recorded with an MP3 voice recorder. Interviews lasted from one till two hours. One hour was enough in general to cover the interview questions. The calculated average arithmetical interviews length was 64 minutes.

Six of the interviews were conducted in the English and three in the Russian language. Citations provided from interviews conducted in Russian were translated into English by the researcher. Three persons from each company were interviewed, though some of them had experience of work in several companies or joint ventures, established for certain projects, and sometimes could compare the companies.

3.4.4 Interview situation

The atmosphere was open. Most of interviewees were curious, interested in discussion, eager to share their thoughts and knowledge, occasionally joking and smiling. Some of the first interviewees gave advise on whom else the author could contact later for another interview. With each subsequent interview the author felt becoming more "professional" as interviewer, comfortable and freer when the sequence of questions took another turn and adjustments, or clarifications were required. An overview of the interviewees is provided in Table 5.

Table 5

Overview of the interviewees

Characteristics	Company X			Company Y			Company Z		
Position	Middle Management	Top Management	Middle Management	Top Management	Top Management	Operator	Middle Management	Middle Management	Operator
Experience in a company, range in years	below 5	10-15	5-10	5-10	below 5	below 5	20-25	below 5	15-20
Professional experience, range in years	15-20	10-15	10-15	25-30	10-15	10-15	20-25	10-15	30-35
HSE related experience	10-15		10-15				15-20		

Note. Company names and interviewees exact years of experience are not mentioned due to privacy and ethical reasons

3.4.5 Challenges in interviews preparation, conducting, and transcribing

First and the major challenge was to find people eager to be interviewed within three company levels and to appoint a virtual meeting. It took quite a long time to wait for the approval. Some interviewees required few days before they could meet, some several weeks. The preliminary planning worsened by the political situation in the world and sanctions, leading to interviewees' extra stress and different pressures.

Interviews varied due to natural human character differences and interviewees' positions. Some were very talkative and discussed related topics, others on the contrary replied briefly. Some answered precisely to the question asked, some broadly covering few questions of the question guide. Therefore, the sequence of questions initially planned varied. If interviewees touched upon other related topics, additional questions were raised by the researcher. Since each person is a specialist in his/her area of responsibility, some could answer more to one question and less or nothing to the other. If the questions were not clear enough, they were explained or reformulated.

The interviewees' positions mattered in discussions. Operators talked less, interviewees from middle and top management were willing to talk more and discuss. Some interviewees dwelled upon other related issues and/or switched from one topic to the other. As an example, transcribed interview of an operator was on two and a half pages of A4 format, another two on six pages each, while middle and top management interviews were transcribed on 7-9,5 pages.

Upon completion of an interview each audio file was transcribed into a written form for further analysis. This procedure was time consuming and sometimes challenging to structure, despite of the interview questions serving as a frame. The total volume of transcribed data constituted 59 pages of A4 format in Times New Roman font of size 12.

It was better to talk with video option on, the contact felt closer. Without video discussion was more difficult. The parties could not see emotional reactions, only hear, some questions had to be repeated twice or explained. It can partly be explained by the fact, that most of the interviewees were not English native speakers and pronunciation of each person is different.

It was not always possible either to find and select people from each company having the equal knowledge in the topic and professional experience, or after finding them to obtain their willingness to participate.

3.5 Reliability and validity

The author studied the topic from the constructivist perspective. Therefore, the results can not represent an objective truth or facts, but rather an interpretation in a particular context. "No

study, irrespective of the method used, can provide findings which are universally transferrable" (Malterud, 2001, p. 485). Nevertheless, reliability and validity of a research assures proper quality of the research.

Internal validity refers to the issue if the research examines something it is supposed to.

External validity in qualitative research means a possibility to apply hypothesis or the results beyond the context of a research (Malterud, 2001). Malterud defines it by the term transferability, where the goal of a research is to obtain results which can be applied in other settings. External validity relates to "generalizability of the study's results to other groups, contexts or time periods." (Sovacool et al., 2018, p. 22).

Cases are studied in order to contribute with empirical knowledge, "enter into a dialogue where one's research resonates with other works. The work of others may serve as a basis for a form of triangulation, not in order to establish actual validity, but to suggest likelihood and probability" (Lund, 2014, p. 7). Triangulation is a research method combining several strategies.

The results of the thesis are not generalizable in a surveys-like sense. The findings cannot be generalized to the whole company or industry. The companies consist of many thousands of people, many vessels, offices across the globe, and several business units. The findings are rather a snapshot picture based on the analysis of the three cases, nine interviews, and data from secondary sources.

Nevertheless, the results of the analysis are indicative, as all three cases are represented by the biggest dredging and marine services provider companies. The material is saturated by the primary and secondary sources and can be used for forming an understanding (though limited) about the views on SC, its current SC status, features, and development and monitoring within this industry.

Reliability is related to the "appropriateness of the methods undertaken and the integrity of the final conclusions" (Noble & Smith, 2015, p. 34). It was ensured in the thesis by means of detailed method description, including sampling of the data (subchapter 3.4), its presentation (chapter 4) and analysis (subchapter 3.8). The study of multiple cases and comparison between them increase reliability of the research. It improves building a theory and understanding causality (Bryman, 2012).

3.6 Method of analysis, reduction, and limitations

Thematic content analysis was applied for analysis of the obtained data. Textual information is analysed and themes are explained (Forman et al., 2008 cited in Vaismoradi et al., 2013). It is a systematic process which includes coding, examination of meaning and

"provision of a description of the social reality through the creation of theme" (Berg and Latin, 2008; Zhang et al., 2009 cited in Vaismoradi et al., 2013, p. 101).

Data was grouped into categories. Categories are related to the explicit text content and descriptions of "participants accounts", whereas themes come out later at a more abstract level, when a researcher tries to conceptualize and looks for the meaning laying under (Brinkmann, 2013; Vaismoradi et al., 2013). The chapter with findings is grouped according to categories and subcategories.

The processes of categorization includes three components: "origination, verification and nomination" (Constas, 1992, p. 257). Categories may originate from participants of a research and be created by a researcher, based on his/her views with reference to the previous research related to the studied topic. Verification supports the creation of categories. Constas (1992) names six justification sources: external (by external experts), rational (by rational logic), referential (referring to existing research), empirical (formed internally by a researcher), technical (when procedures or language are borrowed) , and participative (when participants may review and change the study results). Referential, rational and empirical justifications were used for categories creation in the thesis. Nomination was applied for naming of categories.

Thematic analysis was used with to detect main themes and subthemes. A theme is "an implicit topic" which structures recurring ideas and allows researchers to answer the research question (G. W. Ryan & Bernard, 2003). Themes are repeated topics, concepts, points of views, etc. Lunenburg & Irby (2008) recommend using major themes. "Thematic distinctions are rich in information and potentially very productive and they would therefore be preferable to all kind of distinctions, if their use did not make it so difficult to achieve reasonable levels of reliability" (Krippendorff, 2004, p. 110).

Thematic analysis is most effective if a researcher search for themes, that aim at research questions, "frame themes conceptually and explore links among them" (Bailey, 2007, p. 155). Bailey argues that a researcher not only find these themes but also creates them from the data.

Subthemes are parts of the same concept as themes but determine some elements of the theme. Themes and subthemes should grasp important issues related to research questions (Vaismoradi et al., 2016). Occasionally labelling is used within themes development, meaning that phrases from interviewees are used to accurately and, in a nutshell, describe something. For example, safety was "a paper-word".

Discussion chapter 5 is structured according to themes and subthemes helping to answer the research questions. Main themes corresponded to the research questions, namely, to understand the companies view on their SC and its key features, themes reflecting development

of SC and how its maturity is measured, indications of effectiveness of SPs, and problems and challenges related to the SPs. Within each main theme subthemes were detected and conceptualized based on the works and models of Schein (Schein, 1996, 2009, 2017), Dekker (2006, 2014), Hollnagel (2004, 2014), Clarke (2000), Hudson (2001, 2007), Le Coze (2019), and the framework of Aven and Ylönen (2021) reflecting main constituents in SC: mindset, structures and practices in within the cases. Four core ingredients of a strong SC, distinguished by Dekker (2006) were analysed: management commitment and involvement, employees' empowerment, presence of incentive structures and reporting systems.

The themes and subthemes are presented by the researcher creating a "story line" (Vaismoradi et al., 2013). The storyline is recognized by the researchers rather "a strategy of "meaning" making, not "truth" making" (Bailey, Patrica Hill & Tilley, 2002; O'Reilly & Parker, 2013; Pratt, 2009; cited in Vaismoradi et al., 2016). The storyline in the thesis is created in the discussion by first presenting the companies views on the SC, with further description of its development and maintenance, proceeded by measurements of development degree and then highlighting the related problems and challenges. It provides a holistic picture of SC development process in the end.

Data reduction

Data is reduced (but not limited to) by coding. It is a method of data management allowing to reduce large amount of data into smaller ones, named codes. Several types of coding were used. "Conceptual coding" is applied distinguishing main elements and dimensions of the studied topic and concepts, as well as "participant perspective code", reflecting positively, negatively or indifferently about certain things and "participant characteristic code" reflecting characteristics made by participants (Vaismoradi et al., 2016).

Limitations

When studying several cases exploration and analysis of each case was done in a less in-depth degree than in a single case study. It should also be noted that the last two years (2020-2022) of work in the companies was performed under strict restrictions of Covid-19 regulations, which influenced the normal work in and operation of the companies. Besides, each company consists of different units and types of business. Interviewees represent only one or two units within a company and not all of them.

3.7 Ethics

General ethics rules were applied when using data or research made by third parties with proper reference. Collected data should not impose any harm to the informants, therefore people

are referred to as interviewees and job titles are not used. A distinction is made between top management, middle management, and workers/operators. Citations are not linked to a certain interviewee. Age and experience numbers are approximated. Information from interviews is summarized and anonymized. Personal permission for using quotations and interview data was obtained before each interview, rights of interviewees were additionally explained (see Appendix A).

4. Empirical Findings

Present chapter provides the results of the thematic data content analysis. The findings give a reader an opportunity to acquaint with the primary and secondary data, with the most important citations and to make his/her judgements. In addition, they increase the transparency and reliability of the analysis. Four research questions were used as the main categories and framework to structure the presentation of findings in each case. In addition, other subcategories were distinguished within these categories.

Each category is presented from each company's point of view, mainly based on the interviews and some illustrations from secondary sources. Direct criticism is not structured under a certain company (explained in subchapter 4.4). The findings and citations will be provided with brief relation to the theory. Summary of the results will be given at the end of the chapter in the form of a table. This chapter does not include interpretation of the data by the researcher. Discussion of the findings, their interpretation and relation to the theoretical foundations will follow in the subsequent chapter 5.

4.1 Companies' view on safety culture

A view on SC will reveal its purpose as seen by the companies, predetermine, and explain the strategies and methods used for its development.

Case Boskalis

SC is seen as something the organization has. "NINA safety culture is embedded throughout organization" (Boskalis, 2020a, p. 51). One interviewee described it as a part of a brand. SC can be controlled, maintained, and modified by means of campaigns, policies, examples from different project sites, and employees Over 17000 employees received training, 600 participated in open dialogs on safety "which confirmed that safety if first and foremost about behavior" (p.51). SC helps to achieve long-lasting safe performance.

The company aims for one homogeneous safety culture in the company, which unites all the divisions and business units. *"There is one safety culture, one NINA, and it is transmitted everywhere".* The core values and rules need to be shared by all members of the organization.

Employees are assigned safety responsibility for themselves and colleagues. Atmosphere of open communication, trust and feedback reporting is encouraged. SC is seen as a tool for communication improvement and increase of trust along with reducing the necessity of compliance control. Findings from secondary sources stress that internal culture is highly transparent, where risks are timely identified, reported, and analysed (Appendix D, Boskalis, 2020a).

SC is also the way the employees work together, communicate, and have the same rituals. SC is related to occupational health and safety, but is recognised as having a broader dimension, covering as an example mental health. Different tools are developed to make communication and reporting between the stakeholders easier and more efficient, assuring that information can reach fast different company levels. The scope of NINA program is extended to include subcontractors.

Some differences in development level in various units were detected. Several interviewees related a higher level of SC to the oil and gas divisions. Reasons for this can be among others, that these disciplines were client driven and had more stringent requirements, some initiated after big scale accidents.

"I think it applies for the big four[2]. They all have their dredging operations, offshore wind operations and/or offshore. There is still difference within safety culture within dredging and offshore wind." The latter was two decades ago a *""cowboy business", things are overengineered and overrated when it comes to safety, whereas oil and gas reached some common sense".*

Due to the different working environment and type of work there is a difference in SC application. People working in the office have different problems than those in operations. For the office fatigue, overload and mental problems are typical, in operations industrial injuries, time pressure and stress. One interviewee suggests the solution laying in uniting the levels of CS *"by common involvement".* *"It would've been best if people realized the differences in subdivisions and keep the SC on a similar level, which it is common, it's something that unites them all".*

Interviewees considered that SC is good or strong if everyone is aware of personal responsibility and the consequences of personal actions. SC should be based on respect of all individuals and nationalities, who need to accept the values, and follow these rules. It needs to be based on everyone's intrinsic motivation to work safely, keeping an eye on the others, and discussing safety issues. *"See what the others are doing, do they work in safe way, or are*

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[2] The biggest four dredging companies in the world (Boskalis, Deme Group, Van Oord and Jan de Nul (Statista, 2019)

they taking shortcuts, discussing with crew members should we do it like this or like that- in a safer way, despite that it will take more time."

The safety program is seen as the ultimate view on safety, though admitting its internal boundaries. The SP aims for the goal of zero accidents. This goal is embedded in the SP name.

"Even if we ideally follow the SP, there are always some factors, which are not considered, or something cannot be seen by somebody when something may happen anyway. But the SP is almost an ideal guidance how to think, to work and in which direction to move."

"Of course, it is an ultimate view, we are always trying to achieve Zero incidents and accidents".

Case Deme

The company sees SC as a way to increase safety awareness and improve behaviour. Focus is made on personal acceptance and understanding of safety importance, and values acceptance and support. SC is not seen by interviewees as a control instrument rather as a management tool.

"SC is first of all the attitude of personnel to safety, it is an inner perception, these are not instruments of control or intimidation, a person should realize and understand it himself/herself."

SC is seen as uniform for the whole company but reflecting different aspects, depending on the type of work.

"One has different aspects of safety which should be more or less important depending on your job."
"The safety program is about safety behaviour, and SC is an element of management."

The goodness and strength of SC is in personal faith, sharing the SC by all the members, by looking both after own safety and safety of the colleagues. The SC is considered to be strong when employees raise the safety issues, discuss them, and suggest improvements, when HSE is included in all the processes of the company, and mirrored in the contracts with subcontractors. The aspect of care is stressed. *"What I am inspired about that care about people has the first priority. For example, when somebody gets evacuated from the ship, captains and project managers asked to inform them frequently about the person's condition."*

SC improvement and development is a typical tendency not only in Deme, but in most of the big companies. SC in Deme improves fast due to the wish of expanding the business from purely dredging to offshore, where SC has a long development history. The mentality in dredging was different as accidents were considered to be "normal" for the type of business.

A parallel can be made to Ludborzs (1995) distinguishing between industrial cultures, where gas and oil SC is described as more developed in comparison to dredging SC.

"The tendency of improvement and development of SC is typical not only for DEME, but in general with big contracting companies. It is expected in general in the whole industry, that the SC grows and gets more and more important. In Deme I think why it grows fast, because we moved from merely dredging contractor to also offshore contractor. In offshore you have already a longer history of SC and safety initiatives, compared to purely construction. The offshore industry had in the 60-70ies very bad accidents, where a lot of people lost their lives. That is when they started the SC. Whereas in construction and dredging industry accidents and also severe were considered to be ok, so the mentality was different."

"Gas and oil companies are far ahead in development of SC, they have invested a lot of resources into it. It works well, you can see it, when you visit their projects."

A high level of SC is also noted by interviews in oil and gas units, judging by personal experience, and witnessing how personnel on work level acts. It was noted that the SP's scope broadens and develops each year, as an example focus on mental health and environmental issues was noted.

"What we see now more and more that environmental focus becomes more and more important. So, it gets broader than only safety, than well-being of people. Now mental health came also into the picture. I think a safety plan of 10 years ago is not an ideal any more for now. And it also changes, there is no stand still, I would say".

Case Van Oord

Safety culture is seen as a way to deal with safety, when employees genuinely understand its importance and proactively participate and contribute to it.

"It's the way how people genuinely without any force from their bosses look at safety and genuinely seek to take care of each other. It is not mere adhering to rules and regulations. It is what people feel and intrinsically motivated to make the workspace a better place. The rules are needed to make it happen and everybody need to adhere to the rules, but it is an intrinsic motivation of people to get that done."

SC needs to be understandable for everyone, shared and adhered to by all.

"It is a culture that everybody understands, believes in, and adheres too. It is not just a tick in the box, it is something you actively take part in, and actively contribute to. I think that is the culture rather than different procedures, it is when everyone is involved. The procedure you have to do as you are told, whereas in the culture you do because everyone joins in."

It is described by one interviewee as "the way we do things", definition Dekker (2014) opposed to due to its broadness. SC is based on values, is intertwined with company's systems and local legislation.

"Depends how you define culture. Culture is the normally how we do things. We do things in such a way that everyone can get home safely. What do we need for that? Of course, we have the values, and we have all kind of systems, local legislation, and that all together are all kind of parameters in the culture, defining why we are doing things like we do."

Safety culture is seen as tool to make safety an intrinsic part of the organization, embedded in all structures and ways to work. Whereas the maturity of SC is measured by the SCL.

"SC is a key to reach a sufficient level on the safety culture ladder. SC helps to make safety become an intrinsic part of the organization, that people do not see it as a burden, or as something that comes along, but that safety is fully embedded in the whole way of working".

According to the interviewees company aims for a uniform SC in the company, admitting different roles employees play in it, and a necessity to comply with specific rules.

"The safety culture is the same, it is just the way we adhere and apply it is different, because we have different roles. Some do not perform work physically, which would require a PPE or safety involved, but they definitely consider it in their daily job. For example, engineers consider it in their design suggesting solutions and contributing to a higher safety level".

Schein provides an example of engineering when explaining "the basic underlying assumptions". It becomes unthinkable to design something unsafe, "it is a taken-for-granted assumption, that things should be safe" (2017, p. 22).

Some interviewees admit that there is a different focus on safety in various business units, which results in unlike level of SC development. SC in Offshore wind is considered higher than in dredging. It was partly explained by the lower HSE standards existing in dredging.

"In offshore wind (OW), there is absolutely more focus on safety compared to dredging. I think SC with offshore wind is the highest, despite that it is quite high in all the departments. Because clients in OW also have a very strong mindset on safety, and that cascades down to the contractors (us). Not only strong demands, not regulations, but also presence, mindset, and continuous focus, and that is a good thing."

"Dredging does not have such high HSE standards, except for offshore works and windmills, that is different".

Safety culture was considered good or strong, when people are willing to proactively participate in safety, care for each other, and act in unsafe situations.

"When people are proactive, do they want to take care of each other, if they see something they act, not because they have to, but because they want to."

4.1.1 Zero Vision as a key feature of the companies SC

All three companies have a Vision Zero policy. The success of SC development was also associated with the achievement of zero incidents and accidents. Following homogeneous views like Vision Zero is typical for the functionalist view on SC (Dekker, 2014).

Case Boskalis

"The ultimate goal should always be ZERO, because even one person hurt is too much. It is not so much about being realistic or not. It should always be the goal, the focus we keep in our head. For me there is no doubt about it."

"I think ZERO goal is achievable. Everybody has to think about that, and we have to work in a safe way. If everybody thinks like that, you can achieve this ZERO."

"I think a goal should be ideal, though we realize that we hardly can reach that ideal, but we need to aim for it…It would have been funny if one accident were allowed."

Case Deme

The interviewees fully support and promote Vision Zero, seeing it as ultimate goal of any safety policy. One interviewee suggested that the Vision Zero is necessary according to some of the ISO standards, where it is described allegorically. KPI goals are used as yearly goals.

"I think it is an ideal goal, which is required for certification in accordance with ISO standards, where one needs to claim the goals and values. In reality, we have goals according to KPI, which are not 0. We analyse annually LTI and try to reduce them. In the past we (all employees) received bonuses if we managed to reach KPIs."

"An ultimate goal of any safety policy is to have zero accidents. KPIs should be set as realistic targets. I support ZERO accident goal because it is a correct goal. If you say it is ok, as long as we can make so many millions of profit, we can have so many accidents, that is not really the idea of the SC. It should be ZERO. Can you always achieve it or not? But should you do everything to be able to achieve it? Yes. It is realistic but may be not this year and not the next. You have to check why and to take lessons from it."

Finding from secondary source

"The principle behind the slogan 'Zero accidents and zero environmental incidents' is the target of our organization. All possible must be done and all necessary resources provided in order to achieve this target" (Deme, 2020, p. 11).

Case Van Oord

Vision Zero is seen as a global and realistic goal, and LTIR as current planned objectives.

"It is a global goal. Even morally it is not possible to accept one accident or ten. If something happens of course no one is punished."

"Every project has a Zero Vision, no accidents, no harm. However, we also need to be realistic on the company level. The goal is Zero, but the target of LTIR of the TIR should be below the planned level."

"In the end everyone wants to have that. No one says, "I can live with one fatality a year". Considering the level, we are right now, it is not very difficult to get the rates lower, but there is still some room for improvement. If you see where we are coming from in the industry, we have already done quite a lot."

4.2 Development of safety culture in the companies

Safety culture development started with the enrolment of safety programs in the companies. In both Boskalis and Deme programs were introduced in year 2010 and in Van Oord in 2016. DEME introduces a second modification of the program CHILD 5 in 2016.

4.2.1 Historical background

A reasonable question arises if any SC existed before the enrolment of these programs. Opinions about it were different: some did not know, some think some sort of SC existed, which was encouraged by some slogans, though which could not be reproduced by interviewees from memory. The interviewees from Van Oord did not have this information.

Case Boskalis

SC existed but with different characteristics that it has now. There were man-safe trainings, which were already focusing on behavior.

"But it was a one small training given to everyone, was not really a program. It was an extended version of an induction training. But that was all we had then".

"There were some kind of safety rules."

"Hierarchy had a more important role in safety than it is right now. I think it was unbalanced/not well balanced between production and safety. Production goals were prevailing."

But with NINA enrolment a whole NINA world was created.

"You have a name and the whole NINA world, which came along with all the courses, attention, trainings, and events etc."

Case Deme

One interviewee suggested that the SC before was about adherence to the rules, which if not followed led to consequences. With the development of SC to higher maturity steps, safety standards are raised.

"It was more about the rules, which you have to follow. If you do not follow them, there will be consequences. There are different levels of SC. You raise your standards, as you culture develops and gets more mature".

4.2.2 Reasons behind programs initiation

As Aven (1992) stated safety management in a company requires an elaboration of policies and safety programs. New programs were also related to the development in the companies' management systems. Additionally the reason for initiation of a new change program or its modification is some pain or dissatisfaction (Schein, 2017).

Case Boskalis

Before the program initiation the company performed interviews with over 1500 people from different levels of the company, including clients and subcontractors on the matter of current safety status and what had to be achieved. Obviously, consultants' companies developing the programs followed Schein's (2017) advice - first to ask a client what they want to achieve and get a clear picture of the problems to be solved. The survey had four major outcomes:

1. Rational identity to safety was missing

    "It was just a paper-word, and people did not relate to it".

2. It was not cool to talk about safety, because production was topic number one

3. To address superiors was tabu

"It was a hierarchy thing, which blocked people from speaking about safety. Because of different backgrounds, also natural hierarchy on board the vessel, addressing superior was not done".

These were the barriers and patterns, which they had to break through and what was taken to SP design.

The hierarchy can be even stronger due to the cultural differences. One of the aims of SC in the company is to unite all employees from different cultures to have a one common SC. Problems of mindset in the national cultures exist and requires different effort in SC development.

"I witnessed this with the Asian Colleagues. When we told to Thai and Philippine people to speak out if they see something going wrong or if they have a better idea, they almost fell out. "Can I really do it, is it allowed?" It was a real eye opener for them and its perfect for organization. If you only have people who say, "Yes boss". We consider it stupid. We can do it way more efficient".

Another interviewee explained that the company had an ambition to develop. In 2010 it was mainly a dredging company.

"Doing a bit of offshore work, we wanted to grow into high-end /other markets, more into the oil and gas industry, so that meant we had to look at our safety standard."

"Time has proven that with only PPE, procedures, and systems you do not get any further."

"We had so many accidents before NINA, some works were not that safe as they are now…It costs so much money for the company if something happens, insurance payments, and to have a replacement for an employee if he/she is on sick leave."

"Developing a good safety culture overlaps with what they are trying to achieve on human wellbeing from HR perspective. It goes hand in hand. We focus on SC because it is wanted in company itself."

Case Deme

A gap analysis was performed by a third HSE consulting company, based on interviewing employees from different levels. The root causes of the current safety situation

were identified: management did not have and show commitment to safety, there was lack of communication, cooperation, reporting, and employees were indifferent.

Some of the reasons mentioned were high accidents and incidents rates, one fatality in Angola in 2009 in Deme, and the major changes in the world. It was mostly the culture of compliance with strong hierarchy and bad communication between different levels of the companies.

One the interviewees in Deme pointed out the economic reasons. Having a lot of accidents is very costly for the company both financially and in terms of reputation.

"If you have accidents then suddenly your activity stops, you need to implement different things. It is all not planned and costs a lot of time and money".

The company aims to work for good clients, and it needs to have good safety records and reputation.

"We require a good safety record, so in the long term, if you have a good safety record, you will have a better reputation and more opportunities to work".

An interviewee described the evolution of CHILD program in four stages:

1. Historical safety or "cowboy safety"

   Times when employees worked as they themselves considered safe enough. These were the times in the beginning of dredging industry.

2. Paper safety or technical safety

   These were the years when a lot of rules, procedures and manuals were written. It was a long period with plenty of rules, which were hardly remembered or implemented in the actual work.

3. Safety awareness

   The focus shifted for raising personal awareness of employees and providing them with instruments for changing and improving safety situation

4. Safety as part of DNA

   When safety is embraced and acted upon unconsciously and naturally.

   "The same as people behave in their private life and cross the street on a green light".

Case Van Oord

SC development came along with the development of management systems. Managers in the company have responsibility for employees and care for them. Numerous accidents and incidents ruin reputation, reduce interest from clients, and endanger the license to operate.

"It was SC in relation to timing. First, we handed out helmets and boots, then we had management systems. I think it came along with the management system, we put more emphasis on the systems. Having a good SC is not the legal or insurance requirement. We as an employer have a moral obligation to take care of our people. And if a company has too many incidents, it will damage its reputation and clients will not contact it. The reason will be that the incident rate is too high, and it is also about your

license to operate with as low as possible level of incidents. If you are always in the news with incidents and accidents, then you are destroying your license to operate."

General to all cases was that having a good or strong safety culture, according to the interviewees is not a legal requirement neither in the Netherlands, nor in Belgium. But occasionally it is a requirement from potential Client side for participation in a tender for a certain project, especially in Oil and Gas projects.

4.2.3 Development of mindset and understanding

Mindset and understanding is one of three core elements in SC concept. It includes shared values, norms and beliefs in an organization and guide safe performance (Aven & Ylönen, 2021). Values are defined as "what an organization regards as important or even sacrosanct" (Hudson, 2001, p. 17). In two of the cases (Boskalis and Deme) references in descriptions were made to organizational DNA, called by Schein "the cultural DNA" comprised of values, beliefs and wished behaviour (2017, p. 7). The programs aimed to cultural change can succeed only "if they are consistent with the group's cultural DNA" (Schein, 2017, p. 7).

4.2.3.1 Main values, how and why they were chosen.

Case Boskalis

An interviewee told that in the beginning more than 200 values and rules were suggested. The main design principals for values and rules were Invite, Care and Speak up. Rules had to be as simple as possible and at the end they were reduced to the five main ones (see subchapter 1.3.1).

"These five contain everything to create a safe work environment no matter where you are. Whether you are in offshore project with a lot of rules and regulations, or on a small dredging project in the middle of nowhere. These are the five basics, that is why they all start with "I". It is really about taking own responsibility, but also having that right to create your own safe space within the environment, you are working in. It can be different for everyone of course. The focus is taking ownership from your own perspective, being aware of the risks, that are on you project or the vessel."

Another interviewee suggested that choosing only five main values and main rules was a way to avoid bureaucracy.

"It was a way to go away from the boring and tedious bureaucracy".

A good example was provided by one of the interviewees from the project in Nigeria. People embraced the program and liked it so much, that they made a song about it. Every Friday after day and night shifts people were singing it, smiling, and hugging:

The song is "about the lady called NINA, the lady I know so well, NINA, we love you so much…"

"The program helped to improve not only safety, but efficiency and communication in general, and that is what the strong point of NINA, it is short and strong. You can say to somebody: "Hei, it is not so

NINA". Everyone in the company will know what that means. And if you have subcontractors, who have done one or two NINA days, or are on a long duration project, they also start acting the same way".

It means that when a common culture is developed, its members develop a common language. People start to develop a common "jargon", shared and conveyed in the use of "acronyms, forms of humour, and expressions that symbolize some of the essence of the shared experience" (Schein, 2017, p. 7). He stresses that the culture is not only behavioural, but the shared learning makes members within time think, talk, and perceive things in a common similar way.

It is better to build a culture on the "existing cultural strengths" (Schein, 2009, p. 223). The DNA of the company was taken as a basis for development of the program. It constituted from strong characteristics of the company:

"We always get the job done no matter what, we like to be innovative, and proud of belonging to the company, and we added safety to it. Using that strength of the company, that's what makes it successful, then it is embraced by people. If you want to make it a push off in their way of doing, it will never work."

"No matter what" in this case referred not to compromising safety, but to solving different tasks in difficult and challenging conditions and environments.

Case Deme

Interviewees comment that the values (subchapter 1.3.2) are easy to remember and understand. They stress what was also important before, but just highlighted more in present. When the values are simple, they will be better accepted by employees. They are simple in a way that they are in line with normal human values.

"*They correspond to what people normally would think as a value, like everybody should have the most fundamental, that we all have in common. I think they are easy those values, but not always in the past used to be put forward so extensively. I think the plan was in the programs to put more attention, to stress out the values more. That it is indeed important and can come before production, or before the costs, and everything. I think that everybody has those values, but sometimes people might think it is not important, or not really supposed to work actively on these, and that's what the biggest purpose of such program is to bring it high on the priority list.*"

"The idea is to reach every individual. In order to improve SC one needs to start with changing of attitude of each person."

"Safety should be on the subconscious level. One should work safely instinctively."

To change something, one needs to start with herself/himself. That is why all values start with "*I*".

Case Van Oord

The values (see subchapter 1.3.3) are simple and some of them, for example about following the rules, goes without saying. *"It should be a given".*

"They are probably chosen because they are the most effective ways of getting engagement". Reporting value is important to learn the lessons and improve the future. When feedback is welcomed it "allows people not to be scared to give it."

Demonstrating commitment and being a role model is important, especially by top management. Having and adhering to the same values make people equal in terms of safety obligations and responsibility.

"If somebody in a senior role ignores the rules, it will make other people ignore the rules as well. I think if he can do it, I can do it, that is what people on the deck will say. I think it needs to be an example set from the top, whoever is onboard, whether its CEO or PM or captain of the ship or even Pieter Van Oord. If he is doing it, or he should do it, everyone else feels equal in it, because we have the same responsibility."

"You just understand how to think, prepare your work, and perform it without millions of rules and standards."

One of the interviewees, having experience in two of the companies, thinks that these programs are very similar. *"They just have different names, logos, only the brand is different like Pepsi and Coca-Cola".*

4.2.3.2 Transformation of individual values into organizational and vice versa.

SC is a group phenomenon, it is formed by the values, attitudes and perceptions and behavioural patterns of each individuum and a group (Lee, 1996 cited in Guldenmund, 2000). After a certain culture is established in a group, it will transfer these elements to the new group members and generations (Louis, 1980; Schein, 1968; Van Maanen, 1976; Van Maanen & Schein, 1979 cited in Schein, 2017).

Case Boskalis

If each individual acts in expected way, all the others will join and do the same.

"If each person will act this way, all the others will do, and it becomes common and shared."

"If each person develops, then all members will a priori end up constituting an organized structure, which cannot be a chaos."

Each value starts with "I", when each employees need to commit to the values, care about environment, and share them with others. Trainings help people to understand the rules and values, their role, and contribution.

"Although they all start with I, they have the purpose to also care about your environment. They start with I because everyone should take part in it. You cannot say we, then one is a bit more and the other a bit less. They all have the purpose of addressing safety with others, so we have to Invite, Care and Speak up. The values are supported by different training programs for different roles: operational floor, management, etc."

Management supports the values verbally and demonstrates it by personal example. Common success is celebrated. Formal celebrations of success and rituals Schein relates to the observable manifestation of culture or artifacts (2017).

"Values are supported by management example and commitment. All top managers recorded personal statements, with strong message what NINA was, and this is how we are going to do it. Trainings were accommodated. Each anniversary five, ten years are widely celebrated."

"The values are supported by management example, and trainings after."

Case Deme

Individual values become shared through the common culture. Each employee will appreciate, that company cares about them. All will contribute and work for the common goal.

"Individual values become organizational via the culture. Each employee will be proud to work in a good company, which cares for its employees. We all work for our common goal."

Case Van Oord

Personal commitment is important, if all commit and act in a similar way, aiming for common goals it forms a culture.

"If you say I am going to do it, it is not "You" or "We". "I" is there to make people own it; it is my job to do it. If everyone does it, it becomes a culture, doesn't it? If we all do the same thing, and we are all aiming for the same thing. I have to do it, but so do you, so we are doing it all together. That's how it happens, by making it individual, you make the group all believe the same thing and join them together."

4.2.3.3 Management commitment.

Management commitment is one the four main "ingredients" for development of a good safety culture according to Dekker (2006). Management commitment is crucial for the overall success and process of SC development both in the start and during its lifetime. Management by their own behavior example and messages describe and demonstrate what is expected from their employees. The commitment needs to be genuine (Turner, 2018).

Case Boskalis

SC development starts from the top down, when the top management demonstrate their commitment and explain what is expected from employees. Top management leads by own example.

"It starts with the highest level of the organization to show their commitment. They stress, that it is ok to talk about safety, that they fully support the program and the philosophy."

"People are led by management example. They have to take the values close to their hearts and get them across to their people. They have to be ambassadors."

Deme

"It goes from the top management to the lower positions".

Case Van Oord

"The actual SP is top-down. It was created as a set of rules from the top and cascaded down."

"Operational management should at least make clear to everyone in a team, to the vessels, how the safety culture should look like, it's a task of a safety leader. One needs to lead by example from his/her role. People from catering and facility have to lead differently, than a project manager, or captain on the vessel. You need to show to the others that you are acting safe."

4.2.3.4 Role of learning in safety culture.

Culture of a group is not inherited but learned (Guldenmund, 2010). Culture if formed by shared learning and experience (Schein, 2009). Learning is an important constituent in SC (Aven & Ylönen, 2021). First, the SPs need to be learned by employees.

Case Boskalis

Training programs are designed for employees from different levels. Trainings for operational level are very practical. *"We teach people how to give feedback by practicing role play".*

Management training sets focus on the role of a supervisor creating a safe and open environment. *"Supervisor is responsible to create a safe and open environment".* At present the company creates a new training program on safety leadership to strengthen this level. *"...to really strengthen the SC throughout our supervisory level."*

"All the divisions, units, departments have to be included in trainings".

Form of trainings

Trainings are conducted as group trainings because this form suits best for SC development. *"...instead of making it a tick in the box or an e-learning only, where you just do a knowledge test. In groups one can really work on SC".*

The goal is to *"raise awareness and ownership with people for their own working environment."*

E-training is an individual online training, provided both for own employees, subcontractors, or anyone else, who wish to do it.

Case Deme

Group trainings, QHSE seminars, safety workshops are arranged.

"We have group trainings, where the program is explained, questions are answered."

"QHSE seminars were arranged when specialists were coming from all over the world to exchange their experience."

Learning from mistakes and experience

Learning is performed not only by taking lessons from what happens within the company, but also from its subcontractors or external parties. In case of any accidents in

external companies, which occur on common projects, employees are informed, cases are discussed, problems and causes are explained.

Sharing experience by the end of each project is performed in the form of seminars. The summary of the project is presented, including all the challenges and risks uncounted during the project. These are explained, lessons are taken in what to pay attention to on the next project. End of work presentation report is prepared in a written form after and available for the employees.

"Many people were invited from different projects including the ones, which will work on the similar projects in the future. It is very important to compare what was planned with what had actually happened. It was also important for people from tender departments to see what was included, and what was not, and which effect it had on the project."

Case Van Oord

Safety events are organized in the company based on the certain incidents, which show a tendency of happening more often. For example, tripping and falling, lifting, and cuts during stripping of cables.

"They are mainly triggered by negative trends. After an incident or accident, a root and cause analysis is made, including findings and safety alert. They create a safety event based on a specific topic. Every project is asked to take time for it, group picture is taken after. It is arranged globally, everyone can dial in. There are two external chairmen, one external speaker. So, it does not limit to a regular thing, which is done on project with Say Yes to Safety induction etc."

Learning is performed not only by taking lessons from failures, but also from success.

4.2.3.5 Safety I/ Safety II.

There was not much clarity within interviewees on why the focus on positive aspects, things that go well (Safety II) is also important. Nobody mentioned the concept of Safety II in the interviews.

Case Boskalis

Success stories are published on the company's web site (Boskalis, 2022d)

Case DEME

However, DEME has a clearer focus in their documents on combination of both Safety-I and Safety-II perspectives. Deme started to approach QHSE from three sides since 2018. "What's going right" they call and visualize in Figure 29 as "a green initiative" (Deme, 2020, p. 18).

Figure 29

Approaching QHSE from three sides

The company started putting focus on success stories on a companywide level. Something similar was done before, but it was on a different scale. It was more like exchanging the experience at the end of the project and bringing it to the next if one worked there or heard about it.

"Of course, it's good to talk about things, that are done well, but it does not help much, because if it's done well and they continue to be well, there is no need. Of course, mostly the focus is on what is not going well."

Safety success stories is a global company initiative. All divisions were preparing their success stories and uploaded them in intranet (internal or restricted communications network of a company). All employees worldwide can read them, and successful experience can be shared, and implemented on the future projects. Examples were very different from funny ones till suggestions on risk reduction possibilities for typical operations. An interviewee commented that they need to be better categorized for the possibility of practical application.

"These stories can be categorized in a better way, so that other people can find easier what they can copy and apply for their projects."

Case Van Oord

Positive experience can be included into SHOC cards.

4.2.4 Incentive structures and functions.

These structures are elements of a strong SC (Dekker, 2006). Attitude to incentive structures and their application was different within the companies.

Case Boskalis

Bonusses are often paid out upon a successful completion of a project without accidents or if a vessel was operating certain amount of time without accidents, or a round number is achieved.

"For example, five million hours without accidents" is reached.

"Different projects can decide on their own about awards. It can be different: individual or team-based."

"People get small prises, like souvenirs for certain safety observations, SHOC (Safety Hazard Observation Card) cards."

Case Deme

Employees get remuneration for participation in projects which contribute to safety and for arranging certain campaigns.

"For success stories, vaccination campaigns and it is a great motivation!"

"Remunerations are possible on the projects. They were given for the best safety observations. It was a big event, when people were officially presented with letters of gratitude and prices given out by project managers themselves, hands were shacked, pictures taken. It was a big deal! The program worked magnificently! So many observations were submitted."

"I think some remuneration measures are necessary at least in the beginning to get people interested. Many people are venturous and want to be distinguished. I think it is a good motivation despite of what some consultants sometimes say. They say material remunerations are not good. They might know a lot of theory, but little practice."

Case Van Oord

Remunerations often take form of a good work appraisal. Rewards for absence of accidents and incidents may lead to underreporting. Proactive safety activities are rewarded.

"Within our industry it is a point of attention on your appraisal, but not so much related to bonuses. 0 incident is 5000 bonus, 1 incident is 2500 – it is not like that. Employees can be honoured for submitting a brilliant idea."

"If one remunerates if no accidents or incidents occur, it gets tricky, because some may get tempted not to report them, it may lead to putting stuff under the carpet. One can rather make rewards for proactive safety activities, giving good suggestions for improvement. That is cool."

4.2.5 Practices

Practices are the practical demonstrations of organizational safety culture and constitute its natural part (Aven & Ylönen, 2021). Authors explain that this is a process of abstract knowledge conversion into the real one.

New tools and applications are being constantly developed by the companies for reporting, making risk analysis easier etc. Before each job a JSA (Job Safety Analysis) is performed.

Case Boskalis

An interviewee pointed out to a ritual to evaluate most probable and catastrophic risks which might happen on the project and them discuss them with employees at a start-up meeting.

"The program works well. We have a ritual, for example, before the project start, we make evaluations of most probable and catastrophic risks that might happen. We make a start-up meeting, informing, and discussing them."

"The values are supported in daily work. We have daily meeting and discussions, where safety issues are raised."

During the project fulfilment safety issues are discussed at daily operational project meetings. *"Each employee can discuss and raise safety issues, even if it seems a small issue, one needs to tell."*

SHOC cards including negative and positive observations are written and submitted by employees. *"We had an idea box before, where one can drop ideas related to safety. Nowadays, every company has safety observation cards and a mobile application".*

This increases a motivation of people, because they participate in safety personally, and their ideas, if found useful, are incorporated in the whole company.

Meetings after projects completion are arranged to share the experience and compare what was planned to what actually happened.

Case DEME

Observation cards are submitted, safety meetings are conducted, joint seminars for HSE employees from different countries are held. The company arranges Safety Moment Days. Success stories are written and sent by employees.

"The success stories were great, there were a lot of positive experiences, which could be transferred from one project to another."

HSE issues are discussed daily at morning meetings.

"Each morning on the project a working meeting starts with the discussion of HSE issues."

Stop the work authority is considered very important and is occasionally applied.

"Anybody can use stop work authority, if they see or think smth is unsafe, even if you are not taking actively part in this job. You have a full right and the duty to stop it, if you see that it is unsafe. It's a very important one is that people have this mandate to stop the works, and that they will not have any negative consequences because of that."

Case Van Oord

Similar to the cases above, safety issues are discussed at meetings. Necessary risk analyses are performed before the work start. Feedback is provided by employees and observation cards are submitted. Mobile applications are used for feedback and observations.

"The moment I am on the vessel, and I see something, I can take a picture, upload, and write what it is, what I recommend. It should be addressed the other day. Every morning meeting these cards are discussed and immediate action is taken. One can also post them anonymously and they will always be

heard. Personal feedback always follows. For example, we did this with your SHOC card, and we are going to do so and so."

4.3 Monitoring of safety programs influence on safety culture

The companies are monitoring SP's success and its influence on companies' mindset and safety culture. Monitoring constitutes and important part in the SC development process. It shows the current state and the necessity of certain interventions. It corresponds to the stages Action and Maintenance of the detailed change model (Figure 12; Hudson, 2007) .

Case Boskalis

The company gets the required information mainly from trainings judging from what employees say and how they act. The needs are evaluated and required action is taken for improvements. Incidents rates are also considered.

"We mainly get this information from our trainings, based on what people say, how they act. That is how we see what's needed, because it is different everywhere. The starting point on which you can build SC is different. It depends if we work with locals, for example, on Manila project or we work with others, who are already within other teams, that are familiar, so we constantly adapt to what is needed. That is how we keep it close to the safety, organizational developments as well, by monitoring that. Because it is all about perception. And of course, we look at the incidents rates as well, but mostly on what is coming out is from the feedback given at the trainings."

The company conducts occasionally dialogs in groups of six-seven people with 10-12 questions. "*We measure how do they perceive the openness towards feedback, the safety leadership from their supervisors both in words and in ratings."*

The interviewee cited above was quite critical towards anonymous e-surveys because at the end *"one gets some data and having no clue what is the reason that people answer like that."*

Dialog helps to understand the reasons of employees' answers. The importance of dialog within the groups was stressed by Schein (2009) and it could be successful only, if the participants are interested and motivated. He argued that one cannot use a survey for culture evaluation, because there will be never enough questions to evaluate all, and one will not know what one can do with what one gets. Certain questions will not be understood. And since a culture is a "group phenomenon, it is shared tacit assumptions" (Schein, 2009, p. 221). It is better to be assessed in groups. He recommends first to detect the artifacts, related to enquiry, and observed behavior, compare them with organizational espoused values and in case of mismatches, search explanations in tacit assumptions, explaining such behavior.

"You have to understand where it comes from to be able to do something with those outcomes. It is really important. Many companies just send out a survey which is anonymous. And it is already my first question: "why do you need to make it anonymous if it is about SC?". In such case it means you still have certainly some work to do. Sometimes people give low or high score, and if you ask why, silence

follows. Then it becomes wrong. One cannot judge things you get only on paper. You really need to understand them. Dialog and storytelling are important tools within NINA program".

Another interviewee focused on own role *"I will give feedback if something is not right or not working".*

The third interviewee replied that daily reports on a project contain not only production information, but also HSE statistics. *"Accidents and incidents statistics is recorded and demonstrated. The values can demonstrate an effectiveness of SP".*

Success is demonstrated visually by statistic numbers, which are installed in offices or on sites. *"These are big numbers reflecting the amount of days without accidents".* The success of SP during the last 10 years in presented by the company in Figure 30, reflected in LTIF and TRIR (Boskalis, 2020b, p. 45)

Figure 30

Results during 10 years of NINA implementation
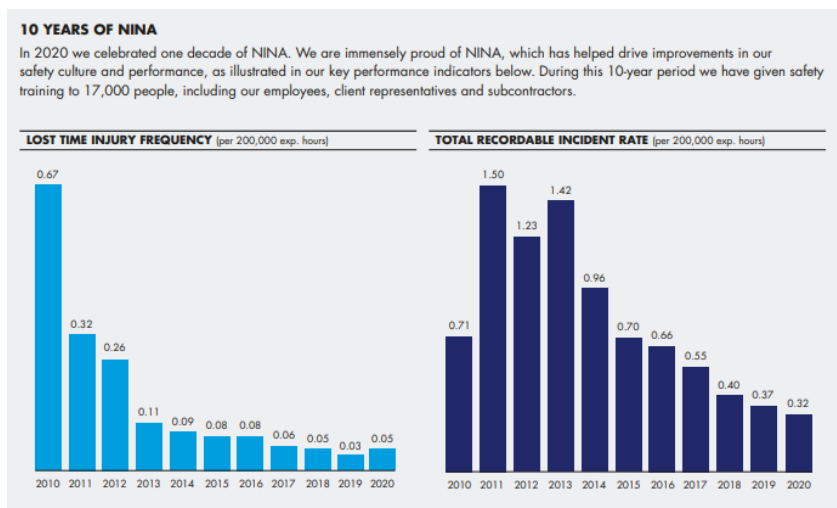
Case DEME

The interviewees considered that indications of SP influencing SC can be reflected by safety statistics, observations, and feedbacks. An example is provided in Figure 31 (Deme, 2020, p. 16). Types of accidents are analysed, and targeted improvement campaigns are initiated.

"If you have a good SP, you expect that numbers will show. I think, good indicators are low number of severe accidents with severe consequences, and probably a high number of reported incidents, and events. If you have typical incidents and bad indicators, it means it is not working well, and it is quite important to report and to monitor all that."

"Company understands that something is not working, unfortunately, as practice shows, from incidents probably."

"We look at the types of accidents we had, the things that went wrong. For example, few years back, we had a lot of lifting accidents, and we were specific and focusing on lifting and lifting procedures and campaigns to improve it. It is quite good as you tackle the most apparent problems."

Figure 31

QHSE Statistics

Safety level is discussed, and feedbacks are provided. Yearly surveys are conducted together with internal audits by means of dialogs with employees from different levels.

"Company conducts general yearly surveys, where safety is included as well."

"We discuss safety level within our teams."

"HSE statistics can be considered, but we should not base our analysis on it only. It is done better by means of internal audits by talking to people from different levels."

"We have no problems with reporting, when navigation starts, we get so many reports, but half of them cannot be classified as incidents."

Case Van Oord

Statistics LTIFR (Lost Time Injury Frequency Rate) and TRIR (Total Recordable Injury Rate) can serve as the SC development indicators, though only partly. The trends show if some changes or campaigns are required for improvements. An example is provided in Figure 32 (Maitlis & Sonenshein, 2010, p. 559).

"Our TRIR in 2020 was 0.48 vs 0.65 in 2019 (Annual report 2020, p.11)."

"At least statistics are the main driver to further attention to the program"

"We record LTIFR and TRIR, lagging indicators, by which you can measure the safety performance, but to grade a culture is very difficult, one can try to do it by means of anonymous surveys. Do it on an annual basis and check."

"We monitor the HSE statistics, it is presented on the weekly meetings: number of accidents, observation cards, the trends they have since the start of the project for the past year, quarterly."

Figure 32

HSE statistics
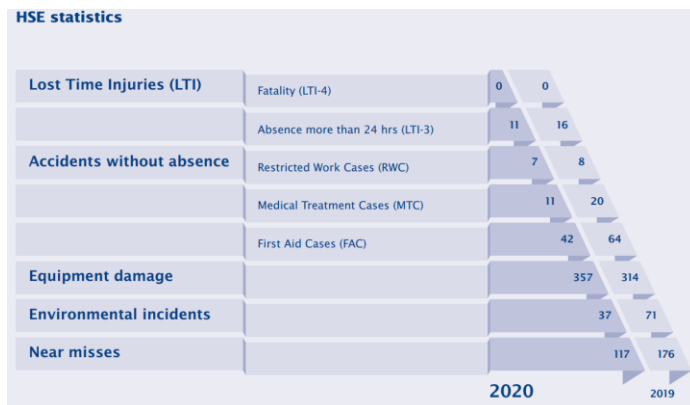
Checking employees' attitudes, the way they think, and interact is just as important, as statistic trends.

"There are things one can measure and others not. One can measure the number or incidents and accidents, draw a trend. Hopefully it goes down, trend for observations hopefully going up. These are measurable. But I don't think that's the only thing. It is about peoples' thoughts, how they buy into it, and interact. That is what one can check, but it is not measurable, it is only to get a feeling about that. There is an intangible part of it as well, it is probably just as important."

4.3.1 Measuring the safety culture maturity

Safety Culture Ladder (SCL) as described in detail in the subchapter 2.4. is a consultant's product for companies' safety culture maturity auditing and certification. Attitudes towards measuring the maturity of SC via SCL were different. All three companies use the certification and go through the auditing. Whereas not the whole company, but certain units or business divisions are being certified, and when required by particular Clients' tender terms for obtaining new projects. The SC maturity certificates of the companies are provided in Appendix C to the thesis.

Case Boskalis

One interviewee criticised it, as when one knows how the auditing is done and what the requirements are, it becomes easy "to fix" a higher level of SC maturity certificate by adjusting the programs, sites, and documents, so that they fit the higher levels of SC development. Intended initially to assist companies in safety culture development, according to the interviewee, it became more a formal tool often not reflecting the real maturity of a SC, the state of things with SC within a company. SCL does not assess the amount of programs' financing.

"It is not done for the whole company. They work with it in certain company parts. Because they are simply required to do so to get a project. In tendering process, it is already a requirement, so we have Boskalis Netherlands, for instance, they work with it, Offshore Cables, but it is not entirely on the whole

level of the organization. It's depending. We only have it when we need it to be certified to acquire a project. I think the SCL is still developing itself and you would see it. The original intension of the SCL was to encourage and support the SC, but it is not what it does in practice. I think they have a great lack of understanding, auditors that really understand the concept of safety behaviour. I would say they are trying to audit it in the authentic old way of auditing. But if you want to audit behaviour that is not working. It could be a good tool, but at the moment, it is not…. I would say our SC is on the highest level. But I have also seen small companies, which have nothing in place, but still received level 4 certificate. Because if you are really smart in doing some preparations on paper and in your systems, and you can still tick it. That's why I say, I think we have NINA and that is what we focus on. If they want to audit it throughout the SCL that's fine, but it is not the other way around. We are not focusing on the SCL, we are focusing on what is needed for our company. We fully trust, that it should be one-one match with the SCL, because it would be strange if it is not".

Case Deme

Interviewees were not oriented in SC development to SCL maturity steps but confirmed that on certain projects it is known and required.

"I have not heard about orientation to reach a certain level on SCL, but we have our own goals, split into steps."

"We have our yearly safety plans and targets and KPIs are inked to that".

"We don't have such an orientation, but those who work for SHELL, they talk a lot about this ladder".

Case Van Oord

SCL is used as a benchmark for SC evaluation. Having such a certificate provides the company with a market advantage. Despite that the certification is done in the Netherlands, it can still have a great value in other countries. The company aims for the highest step Progressive (see item 2.4, Figure 13).

"The indicator of SC development is the ladder of course. VO is aiming for the highest level. It is a final aim and also a selling point. Especially for the projects in the Netherlands your position on the SCL has an impact on your tender. Certification like that is only done in the Netherlands (NL). But of course, you can always try to sell it to foreign clients, write what it is in NL, and say we are almost there, level 4… I think everyone is trying to be at the same level as its competitor. One at 3 aims to 4, we aim to get from proactive to progressive."

Two of the interviewees, who had experience in more than one of the three studied companies, were genuinely surprised of the companies' certification to lower or higher steps. They mentioned that they cannot perceive and feel this difference.

4.4 Deficiencies, problems, and challenges of safety programs

The subchapter presents some challenges and problems related to the safety programs and SC development. Certain problems or challenges are not necessarily faced or named by all the companies; therefore, the findings are occasionally structured only under one or two cases. To comply with ethical principles, to protect interviewees, and appreciate their openness, citations containing criticism of the program or management will not be structed

under company name. The author chooses this stand as it can also be perceived as sensitive to a company. It is nevertheless important to reflect them in order to take lessons from it, and to further improve SCs.

To begin with, the interviewees noted that the program itself should be simple and understandable.

"The program should not be overloaded and be easy to understand for all levels. The use of overcomplicated words may cause rejection."

4.4.1 Sufficient funding and continuity in development

Funding of the programs and continuous investing are crucial for their success. The success is not possible without big investments. It is crucial to have enough funds to properly finance the program through its lifetime. It allows to appoint permanent personnel for working with the program, instead of just distributing these additional tasks to somebody on top of other daily responsibilities. Sufficient funding makes possible to employ professional trainers and conduct training in groups instead of only e-learning. One interviewee points out a problem of insufficient financing.

"The program was mainly funded well in the beginning, when it was rolled out, but then just left as its it. But people are changing, new ones are coming, permanent employees also start to forget within time. The program should be alive. Financing was cut down after and it tells on effectiveness of a program. If one has enough funds, they can hire professional trainers, instead of somebody just reading from a paper, people can be sent for group trainings instead of e-trainings or reminders by mail, when people are assigned for working only with a program instead of other employees having it as an extra task to their main daily tasks when work pressure is quite high."

"The program is not just a policy, which one can hang on the wall and that's it. One must work with it all the time. It is the main challenge. You cannot let it sink to the bottom, it should be on the surface, in front. I objectively see that two companies invest very differently into the program. The effect will be different if a company can:

hire professional trainers	*Appoint somebody to read a training from paper*
one can participate in a group training	*Read an e-mail or make a tick in the box training*
participate in an international knowledge exchange	*Be restricted in ones 'office or project*

The concept of the program can be brilliant, but how it is implemented and developed is crucial."

Case Boskalis

"If you see what amount of money this company puts into the effort of safety, I think it is quite impressive. We have trainers flying all over the world doing trainings. If that would have had a tension or been difficult, project manager would have said not to send a trainer, because it going to cost him/her money. Then it is never going work. So having that attitude that it is allowed to spend money on safety is an important one."

Another interviewee stressed the professionalism of Boskalis program trainers.

"Boskalis has the whole department dealing only with the program. They work continuously on it. Something happens always."

Continuous work is required to keep the SP active. "*Keeping the program alive is very important*".
Constant adaptation of the SP and development of SC are necessary. To keep the development
of SC and SP with the company growth is a challenge.

"*We need to keep it up with pace of the company growth.*"

"*The starting point on which you can build it is different. For example, it requires a different effort if
we work with locals, on Manila project or with others, who are already with other teams, that are
familiar. We constantly adapt to what is needed. That is how we keep it close to safety and
organizational developments as well.*"

"*It's never a moment when you say now, we are in full control, we will never be. Because it's a
continuous process, which we must monitor, and we must keep putting a lot of effort into it. Once you
stop this, the level of safety will immediately drop.*"

Case DEME

"*Good planning and budget are required for successful program implementation. First, one needs to
roll it out, but then to support. Somebody has to constantly analyse the development, talk to people*".

Case Van Oord

"*People should be regularly reminded on the use of the program. When all going well in the end, it
should not be necessary, because it should be in everyone's mind and behaviour*".

4.4.2 Differences of mindset in generations

The interviewees note that it is easier to develop a SC among employees of younger
generation and new employees. It does not require to change the mindset existed in older
generations, when SC was reactive.

Case DEME

"*I can say in general SC grows and gets more and more accepted every year. It gets better and
especially younger people, and new people understand, that this is what the company wants, and they
should work like that, then it gets better.*"

«*Sometimes program does not work, cause old guard people do not wish to change their mindset. They
have their safety complacency and know how to do their work, that's enough for them…I see in contrast
that young project managers are very interested in HSE, take it seriously and act. I see how SC is
changing new young are coming and even before mobilization they ask if we have all plans in place.
Before the main concern was to acquire a phone number of the doctor on the vessel and which hospital
will be used in case of incidents/accidents. The progress is happening, the new generation is coming*".

Case Van Oord

"*What will help in development is that the younger generations, at least the millennials are perhaps
more cautious when it comes to doing things quick and not well considered. This is what I see in offshore
wind. They have got a different attitude to safety, than people above forty plus. Because they are also
quite critical, typically well-educated, trained to speak out. By doing so, they also trigger may be the
right thing in other people. Being positively critical and constructive, that is also helping us to further
improve safety.*"

4.4.3 Management commitment and involvement

Management involvement needs to be realistic, sincere and continuous. For example, if a top manager on a video recorded for employees is dressed for the contraction site, but all see on the background that a manager is in the office it confuses employees.

"*People get confused why a person is wearing a helmet and a safety west*".

"*Formal attitude of management instead of sincere commitment, formal use of the program. How to promote it, if it is not promoted from the top?*

"*If management treats SC as a formal requirement, that it has just to be implemented somehow without believing and active participation, the program will not succeed. When SC is needed to demonstrate a certain level and certificate during a tender, then it becomes just a fake.*"

"*If it is pushed to the responsibility of HSE department only, and there is no commitment from management, it is impossible to implement none of the programs in a company.*"

4.4.4 Risk of safety program becoming a formality

The program should comprise and be implemented in all offices equally despite of their profitability for the company. If certain offices are excluded, working place is not safe enough then SP becomes for them just a formality.

"*If safety culture is only for the surface, developing around "the kitchen", main office and close to the management, but at the same time a company has some distant warehouses or not much profit bringing subdivisions or offices, where nobody cares about them. Working place is dangerous, nobody cleans the roads, equipment is old, and they only get some e-mails or messages about the safety culture.*"

4.4.5 Top down or bottom up?

A concern was raised by one interviewee, building the career from the work level till the top, that it is important to keep people doing the job involved in decisions on safety, rules, and risk analysis performance. It should be avoided that the program is driven too much from top-down and not from bottom-up as well. Employees proactive participation in SC is a key feature of the last two steps Proactive and Generative in the SC maturity model (see Figure 12; Hudson, 2007). By getting employees from the "sharp end" involved will limit the gap between Work-as-Imagined and Work-as-Done (Dekker, 2006, 2014; La Porte, 1996). Understanding the normal operations help systems to become ultra-safe (Figure 20; Dekker, 2014).

"*When communication chain from bottom-up is missing and only directives are coming from the top, then it is irreciprocal and causes resistance and irritation.*"

Case Boskalis

"*On the other hand, the development is also bottom-up, because we really focus on operational work floor and trying to empower employees to speak up to their superior, so it works both ways. That's how we focus on the program, we keep giving that message to the highest level withing the organization,*

they have to be visible in their leadership and be inviting and at the same time, asking people to speak up. Then it works both ways."

Case Van Oord

"Of course, one thing you need to avoid, that people in the office will write procedures and people in the field will just sign off on the procedure, but they do not do it like that in practice, and they don't think about how to do it. If it becomes more from top-down, from head-office, a lot of programs, and no safety initiated from the bottom level, then it is not good. It is important to keep the people doing the job really involved, and close to the safety. If they are very much involved on their level and don't participate, if it is only the high level which is involved, disconnected from the people doing the job, then it does not work. In fact, I want to highlight that with any programs make sure that people doing the job are reached, and they can understand it and they can take it in their daily job. A good concept is in a way that people doing the job need to look at what is now important for this task, or for the number of jobs they have to do, and they have to come up with how they think they can do it safely."

"The SC should probably be developed in both directions."

It corresponds to the claims, made by Zwetsloot et al. (2013), who stressed the importance of workers participation in the formation of safety. Importance of such participation can be explained by three reasons: workers are directly interested in safety, they work in close proximity to hazards, have unique and commonly tacit knowledge on the factors of risk, dangerous processes and practical experience of solving such tasks (Podgorski, 2010 cited in G. I. J. M. Zwetsloot et al., 2013).

Another interviewee reflected, that it should be a common effort of employees from different levels and employers. A cooperation in safety efforts is required between administrative office, site office, vessels, and main office. A certain scepticism of operators was noticed at the early stage of SC development towards people making the procedures.

"Though the company I worked in was one of the best examples in terms of safety in my experience, but even there we saw confrontation, not obvious, but it existed. When you communicate with a project, they think, that all the company's money comes from projects only. The vessel believes that it brings money to everyone, and some "fools" are sitting on the shore, who is in the office not clear at all, and the head office people are generally "inhabitants of heaven" and there's no point in trying to convey something to them. It is not some personal negativity, but purely bla bla talk. This opposition is always there. Confrontation in terms of safety. Though sometimes those who are on the vessel do not know their own procedures, but all the rest, the people who develop them, translate them, know the legal intricacies of the project, from which this or that requirement follows and should be reflected in this procedure, this is done only from the office. There is a complete ignore, you do not know, and do not understand anything, we will not do it like this. They comply in the end, but there is this rejection. How to unite all? By involvement, superintendants are a connection joint to the vessels, project managers both to the project and head office. Middle and Project management are the key links in this chain. Would be nice if people just realised the difference between these units of the company and that they have one safety culture, which is something bigger and more universal, which unites all."

The discourse above evokes an association with Schein (1996), who recognized minimum three subcultures in an organization: operators, engineers and executives. "The

three communities of executives, engineers, and operators do not really understand each other very well. A lack of alignment among the three groups can hinder learning in an organization" (Schein, 1996, p. 9).

Zweltsloot et al. acknowledge as well and important role of middle management in safety and a process of organizational change, calling them "a transmission belt" from operators to the management (2013, p. 44). He cites Maitlis and Sonenshein "organizational change gets enacted through middle managers who mediate the sensemaking between top managers and employees on the frontline to affect both cognitions and actions" (Maitlis & Sonenshein, 2010, p. 559). They also play a role of "emotional balancing and which they do partly by engaging in sense giving that manages subordinates' emotions and creates a sense of continuity and change" (Huy, 2002 cited in Maitlis & Sonenshein, 2010, p. 559).

Case Van Oord

SP development within a project should be a joint effort of project management, HSE, and operational personnel.

"Development, guidance and maintenance of the program should be a joint effort within a project and operational team. The program is HSE department driven, they are coordinating it, on the projects the HSE manager is the engine behind it, but operational management should also participate."

4.4.6 Whistleblowing

Attitude to whistleblowing depends a lot on the national culture of employees and political regimes in their countries. If reporting somebody/something can cause punishment or repressions to people within the country/nation, it stays long in the memory. It is difficult to change this mindset and assure, that it can only have positive consequences and serve a basis for future learning. The CS concept is a very western model, based on democracy and freedom of speech, blurred boundaries in hierarchy and absence of punishment. Some of the Russian employees of the older generation at working level were very negative about whistleblowing.

"I am not going to snitch on my colleagues, these are all western wretched policies."

Despite of the absence of punishment in the companies a kind of indirect "punishment" in the form of restructuration took place.

4.4.7 Restructuring

Cardinal changes might be required within a company if a SP does not work and serious problems are detected in SC. It might entail restructuring and new managers to be appointed in a company. Schein (2009) mentions a change of leadership as one of the mechanisms of

cultural change in case of company's non-success. He calls it a "painful process" during which identification of "dysfunctional elements, locating the carriers of those elements you do not want and replacing them" are required (Schein, 2009, p. 222). Such restructuring took place in one of the companies.

"A big restructuring took place, namely of HSE departments and its management including corporate levels. Things improved after that."

4.4.8 External influence challenges

Clarke (2000) pointed out to several challenges in SC development: temporary employment, outsourcing to subcontractors and multinational operation of the companies. The companies face these challenges and are trying to deal with them.

4.4.8.1 Different types of employees' employment, subcontractors.

The strength of a certain culture will depend on time of its development, stability of the group and "the emotional intensity of the actual historical learning experiences they have shared" (Schein, 2017, p. 15). The companies face the challenge of groups instability and try to increase it whenever possible. Additionally, on many project accidents and incidents statistics of subcontractors is included in the statistics of the companies. The latter being the main contractors for the jobs bear a general safety responsibility for their part of the project. Safety control possibilities worsen and responsibility boundaries between parties might erode (Clarke, 2000).

A big gap in safety level can occur in particular on the projects outside Europe and will require additional efforts.

Case Boskalis

An interviewee commented that SC development is easier with internal employees. Whereas the subcontractors' involvement may negatively affect the company's safety.

"With internal employees everything is clear, they are used to the SC, and it is easier."

"Changing mindset requires time, it requires years, but people are coming and going."

"We are having a company with sixteen thousand people working all over the world, coming and going, and external influences. Those are requirements that are changing. We must hire local stuff, even on our vessels, unexperienced crew on our vessels, because of local requirements make us do so. That affects our safety".

Case Van Oord

The company tries to use the same subcontractors when possible. Otherwise, if the company has no option but to involve subcontractors with a lower safety level, then a lot of effort is invested in improving it.

"The VO people tend to use the same people a lot, even if they are nor in staff, they might work for us three, six months, then don't for a while, then come back. There is constantly a big number of people returning."

"We try as much as possible to have subcontractors on board of SP as well. If there is a major gap in the safety level, one really needs to pay much attention to it. Also, in subcontractors' qualifications safety is very important. In Europe it is not so much the case, but if you go for example to Asia, you really have to put more effort in the selection of your subcontractors. Some of the subcontractors may be attractive from financial point of view, but safety is at a such a low level, that one should not award them a contract. If there is no other choice, than you have to involve them. But then one must pay a lot of attention to it."

3.4.8.2 Covid challenges.

Understanding the influence of internal factors on safety, uncertainty component of risk and considering them is one of the key contributing factor to development of mindset an understanding (Aven & Ylönen, 2021). Covid-19 pandemic presented a big challenge for the companies' operation in this period. On the one hand, the companies tested their abilities to adapt under extreme circumstances, which is a feature of resilience. On the other, communication, cooperation and learning suffered. Focus on employees' mental health became important in safety work.

Case Boskalis

"Mental health was not "on the first plate" of safety managers before. It highly effects the way we work and the way we work together."

Case Deme

"HSE department took the most heat during pandemic. Closed boarders, tests, vaccination, necessity of making planned crew changes… We were really knocked down heavily by it. We had to switch temporarily off our main HSE functions, and were working as doctors, psychologists, specialists for coordination and ordering of testing."

Case Van Oord

"COVID-19 had a lasting impact on our awareness of mental health as a key component of employee safety, resulting in improved monitoring of the well-being of employees"(Van Oord, 2021, p. 82).

"Thanks to the resilience of our people we have come through this uncertain time stronger" (Van Oord, 2020, p. 11). "It demonstrated that Van Oord is resilient and can make decisions rapidly under conditions of extreme uncertainty"(Van Oord, 2020, p. 85).

Criticism

"I feel that an issue of psychological state of employees is not covered enough or paid attention to."

"Communication and cooperation between units in different countries suffered a lot. Before we had common meetings and seminars, where people came from all over the world, sessions where we could discuss things, get personally acquainted. It was a kind of a teambuilding and it made easier afterwards to contact the colleagues and ask for advice".

3.4.8.3 Global changes after 24.02.2022

The changes after 24.02.2022 raised the acknowledgement. of risks and uncertainties even higher. The companies faced the needs for changing the common supply chains, restructuring, cancelling projects, and redirection to other markets.

Case Deme

"There were sanctions clauses in the contract before, now we probably have to include clauses about nuclear threats."

"Global threats, pandemic…, but considering what happens now anything might happen."

4.4.9 Definitions of risk applied

It is important to report in findings what interviewees did not talk about when asked (Brinkmann, 2013) or had problems to answer. The most interviewees had problems to define risk and safety and tell which definition is used in the company. There can be different reasons to it. Either they did not think much about it, or were afraid to make a mistake. Some promised to send an answer per e-mail, later, some did, some did not. Common replies were:

"Please check it on our site", "Most probably it is taken from ISO standards".

Case Boskalis

Annual report states that ISO 31000 standard is applied in risk management (Boskalis, 2020a). Where risk is defined as "the effect of uncertainties on objectives".

Case Deme

Risk is combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health, that can be caused by the event or exposure(s) (OHSAS, 2007, p. 4).

Case Van Oord

Risk is defined per ISO 31000 as the combination of both the likelihood of occurrence of an event and the impact the event might have on the achievement of the company objectives.

4.5 General observations

Operational personnel talked brief about SC. They commented as follows

"I don't know why I was chosen to talk about it, not sure I can tell a lot of useful information. My attitude to SC is quite simple. If a person itself is responsible, understands what he does, how and where, there should not be any problem to realize the consequences of his/her actions. But may be for some certain things are not obvious."

"I feel quite safe in Boskalis, the SC is quite good."

SC was understood by the interviewee above as a set of rules one must follow in certain situations: wear PPE, participate in safety meeting, comply with the rules. If stopping of the work will be required an interviewee relied *"I will tell the xxx(superior) and we can discuss it, take a toolbox or safety meeting"*. Which means that addressing a boss first instead of immediate action is preferred.

4.6 Summary of the key findings from the data

The key points from the findings are summarized in Table 6. The author's personal evaluation of SC maturity step in each case is not the goal and scope of the thesis. Problems and challenges are summarised in a common column not splitting between the companies.

Table 6

Summary of the data findings from interviews and documents

SC aspects	Case Boskalis NINA (2010)	Case Deme CHILD (2010), CHILD 5 (2016)	Case Van Oord Say Yes to Safety (SYTS) (2016)
View on Safety Culture Data from Interviews and reports	-common language, work, rituals -get safety an intrinsic part of org. -make safety imbedded in work -part of a brand -make safety a common sense - one SC, one NINA - tool to achieve long-lasing safe performance, communication improvement -way to take care of safety -focus on safety awareness, own responsibility, safety-driven mindset -inextricable part of culture - SC is embedded through organization	-tool to reach safety awareness of all, incite personal responsibility for him/her-self and colleagues -about inner perception and attitude - tool to achieve safe behaviour, better safety performance -tool to improve accidents, incidents statistics - is an element of management - tool to achieve progress in safety -to transit from safety awareness as second nature to DNA SC -part of integrated management approach -safety determines company's reputation and future -safety is fully embedded in company's culture	- means to make ppl genuinely behave safely - look and care for others - common belief and share of SC - means of proactive participation in safety - sharing and adhering because all join in -key to make safety an intrinsic part of the company - key to reach a sufficient step on the SCL -fully embedded in the working ways
Mindset **Values**	1. I am responsible for my own safety 2. I approach others about working safely 3. I take action in case of unsafe operations, if necessary, I will stop the work 4. I accept feedback about my safety behaviour regardless of rank and position 5. I report all incidents, including near misses, to inform others and build on lessons learned	CHILD: 1.Safety is everyone's concern, report and correct unsafe behaviour 2. Focus on safe work preparation and planning 3. Safety will always and everywhere come in the first place 4. Supportive safety issues overview 5. Management staff is giving a correct example 6. Clear definition and communication of safety standards CHILD5: Engagement, collaboration, communication, leadership	1. I take responsibility for my own health & safety and that of others 2. I am a role model and demonstrate safety leadership 3. I am open to feedback and challenge others 4. I adhere to the procedures, instructions, and lifesaving rules 5. I report incidents, near misses and ideas for improvement YES, commit to the safety principles and inspire others to do the same.

SC aspects	Case Boskalis NINA (2010)	Case Deme CHILD (2010), CHILD 5 (2016)	Case Van Oord Say Yes to Safety (SYTS) (2016)
Zero Vision **Monitoring of mindset and SC**	+ -info from trainings (how people talk, act, perceptions) -group interviews and dialogs, storytelling	+ - safety statistics -observations and feedback -reporting trends -internal audits	+ - incidents, accidents rates -anonymous surveys
Indicators of SP influence on SC	-incidents, accidents rates -feedback	- focus on problematic types of activities	-high rates of observations - feelings, thoughts, perceptions of people
SP as an ultimate view on safety	+ with recognition of external influences		+
Indications of strong/ good SC **Interviews**	- common understanding - all act intrinsically safely - Safety and responsibility ownership by all - respect of people and cultures - safe own behaviour and checking others - discussing safety and finding better solutions	-common adherence, belief, and involvement - care for each other - proactiveness - HSE penetrating all processes	-common understanding and active participation - care for each other - a key to make safety an intrinsic part of the company - safety embedded in working ways -genuine belief and adherence - motivated, feeling SC is necessary
Secondary sources	-safe behaviour is priority - tool to achieve safe performance, communication improvement - SC integrated in risk management -tool to increase safety awareness, Open dialog, collaboration for achievement of operational excellence - safety-driven mindset	-transformation from safety awareness to DNA safety culture -safety as second nature -integration in management systems -engagement, collaboration, communication, leadership -safety to be fully embedded in the DNA	-we care -we work together - personal responsibility for safety behaviour - proactiveness - leadership -commitment
Risk definition	ISO 31000 Risk is "the effect of uncertainties on objectives" "In designing this system, we observed the principles and guidelines of the ISO 31000 standard for risk management" (Annual report 2020, p.62)	Risk- combination of probability and severity of the consequences or impact of an event	Risks are uncertainties which, if they occur, would affect achievement of the objectives either negatively (threats) or positively (opportunities). Risk is defined as the combination of both the likelihood of occurrence of an event and the impact

SC aspects	Case Boskalis NINA (2010)	Case Deme CHILD (2010), CHILD 5 (2016)	Case Van Oord Say Yes to Safety (SYTS) (2016)
		3.21 Risk is combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health (3.18) that can be caused by the event or exposure(s) (Occupational Health and Safety Assessment Series (OHSAS) 18001, 2007, p.9)	the event might have on the achievement of the company objectives. – per ISO 31000
Development of SC From	From rules compliance to behaviour change, production goals prevailed, Hierarchical	Rules compliance and consequences in case of non-compliance	
Reasons for SP initiation	After extensive analysis, survey by external party Hierarchy, bad communication, safety is just "a paper-word" Means to unite different national cultures Development ambitions from being more than a dredging company competitiveness, access to markets high accidents rates, unsafe tool to achieve human well-being need to be more efficient	After gap analysis by external party High incidents, accidents rates, one fatality in 2009, leading to economic losses Hierarchy, bad communication, changes in the world, no management commitment, lack of reporting Need to improve reputation, competitiveness, access to markets	Timing, changes in the world, change focus on management systems To have a good reputation Reduce incidents, accidents rates Keep the license to operate Get more jobs
Management commitment, learning individual and organizational	+	4 pillars: engagement, collaboration, communication, leadership	+
SCL certificate for certain units within the company	Step 3	Step 3 and 4	Step 4
Practices	safety meetings, discussions, JSA analyses and evaluations, SHOC cards, feedback, seminars, stories stopping unsafe work celebration of success	meetings, seminars, discussions, JSA analyses, SHOC cards, feedback, safety moment days, success stories stopping unsafe work	meetings, discussions, JSA analyses, feedback, SHOC cards, observations, stopping unsafe work celebration of success

SC aspects	Case Boskalis NINA (2010)	Case Deme CHILD (2010), CHILD 5 (2016)	Case Van Oord Say Yes to Safety (SYTS) (2016)
Indications of problems, criticism, challenges	Keep up the development of SC with the pace of company growth Formal attitude to the program Lack of funds Lack of management involvement HSE can assist in the SC development and SP, but it should not be only their actual responsibility, but they are eager to help Differences in mindset in generations making changes in SC more problematic Financing and constant support Occasionally there are too many safety initiatives Sometimes it's a bit forced Important to keep people doing the job involved in decisions on safety, rules, analyses'* Avoid that the program is driven too much from top-down and not bottom-up Tension between subcultures or scepticism hindering learning SC has to be inclusive for all members		

5. Discussion

This chapter provides discussion of the key findings described in detail in the previous chapter four. The chapter is structured according to the main research questions, the findings are combined with the theories and concepts from the theoretical framework in chapter two. Theoretical foundations will help to conceptualize and understand the findings in the light of the previous research. Each subchapter provides an answer to the research question in numerical order. The title of each subchapter already party frames an answer to each question.

5.1 Companies' functionalist, normative and pragmatic views on safety culture

An answer to the RQ1 "What is the companies' view on SC?" is provided in this subchapter. It partly overlaps with SC development and RQ 2.

The safety programs and companies' understanding of SC contain elements of *functionalist*, *normative* and *pragmatic* conceptualizations (subchapter 2.1, Table 2).

Functionalist view

SC is seen as a critical variable influencing the outcomes. Good SC helps the companies to sustain long term safety performance. It starts its development from top-down and it can be controlled, maintained, and modified by means of the SPs, campaigns, policies, posters, and examples from different project sites and employees (demonstrated by three examples). Surveys are typically used to monitor the SC development in this approach. Such surveys are conducted by Deme and Van Oord to monitor the safety climate in the organizations. As Dekker described it, the conceptualization foresees that both the views and attitudes need to be homogeneous, following as an example "vision zero" and "safety first" (2014, p. 162). All three companies focus on Vision Zero (described further in more detail) and the program Say Yes to Safety reminds of the slogan "safety first".

Apart from climate questionaries qualitative methods are used by the companies to understand the values and beliefs in deeper layers of SCs existing in the companies. It is performed by means of individual and group dialogs with employees, discussions at trainings, feedbacks, and storytelling. These findings confirm the *pragmatic* conceptualization of SC within the companies when SC equals to individual and group behaviours. The concept is indissolubly related to *anthropological* conception (Edwards et al., 2013) when companies study underlaying beliefs and values as the basis for practices. These practices are the artifacts of safety culture, based on Schein's model (Table 4; 2017).

Pragmatic view

The primary goals of SPs are also in line with *pragmatic* conceptualization. SC is associated with safe individual and group behaviours aimed at safe outcomes. The behaviour-

based approach is borrowed from psychology and lays a foundation for the SPs and the SCs. According to several interviewees, safe behaviour is grounded in intrinsic beliefs and values. Two interviewees from Van Oord put focus on the word "intrinsically" and "intrinsic" which can be related to intrinsic motivation described by Ryan & Deci (2000). It is "the inherent tendency to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn" (p.70). Authors made an important finding that for motivation of others and raising commitment, endeavours and "high-quality performance" environments supporting "autonomy, competence and relatedness" proved to be conductive to higher "internalization and integration" (p.76). It facilitates the transition from "must" to "want" (Zwetsloot et al., 2017).

SC is intended to motivate employees to safe behaviour Antonsen (2009) and the companies' views confirm that. Being an engine of maximum safety system (Reason, 1997) SC needs to be learned and practiced individually and in teams. The core values and rules need to be shared by all members of the organization. SC develops and continues through processes of socialization, which are mostly unconscious, considered as social construction (Zwetsloot et al., 2013). With the development of SC safe behaviour should follow subconsciously on the level of DNA. This focus is most explicit in Deme CHILD program, described by the interviewee as the last stage of safety program evolution, namely when safety becomes a part of DNA, employees embrace it and act safely unconsciously (subchapter 4.2.2). As a result safety becomes an underlaying assumption according to the model of Schein (2017, Table 4).

The following features of SC confirmed by the empirical data can be added to the *functionalist* and *normative* views descriptions. SC is seen by the companies as an instrument of market competitiveness, a tool for safety performance improvement (reduction of incidents and accidents), as well as overall organizational culture, and encouragement of proactiveness in safety participation.

Occasionally, research on SC may also combine elements of both interpretivist and functionalist views (Nævestad, 2009). It can be even more common in practice. Why not combine beneficial practices for the sake of SC efficiency and safety in general? The findings confirm that an understanding, noted by the interpretivist researchers is reflected in the SPs, namely that safety measures can be successful if they are considered *meaningful* by addressees and if these meanings are *identity* related (Richter, 2003; Haukelid, 2008 in Nævestad, 2009). But nevertheless, in contrast to interpretive conceptualization, it is possible to change them, following the functionalist view, for the new ones, to be possessed by all. These efforts on understanding of the existing culture or cultural DNA (Schein, 2017) and the results of particular interventions are being regularly assessed by the companies (more distinctively Boskalis and Deme).

Synthetized conceptualization

In all three cases a synthetized conceptualization of safety culture, suggested by (Edwards et al., 2013) can be traced. It combines *normative, pragmatic* (described above), and *anthropological* views on SC aiming for good safety outcomes.

The companies views' are in line with *normative* or *instrumental* (in management) approach to safety culture, described by Brinkmann (2007) and Edwards et al. (2013), meaning that SC can be cultivated both in an individual and in a group. SC is seen as a mechanism to achieve safety awareness, safe behaviour, and improve organizational culture.

SC is seen as a complimentary approach to safety and risk management contributing to the common safety goal in the companies. SC is a part of management systems and used as measurement tool for companies' competitiveness and success. Determining a level of SC, maintaining, and improving it is typical for all three cases. While admitting cultural differences within the companies' employees which cannot be changed, a focus is put on changeable factors, achieving common safe behaviour, and SC development.

Espoused safety values are highlighted. Employees are assigned safety responsibility for themselves and colleagues. Everyone becomes an indirect safety supervisor, as everyone has an authority to stop the work considered as unsafe. All three companies have stop the work authority. This authority provides accountability for safety behaviour. Since one cannot be held responsible for something, if a person has no authority to control it (Dekker, 2006). Dekker suggests the following formular: Accountability= Responsibility + Requisite authority (2006, p. 196). Introduction of this espoused value corresponds to the regulatory requirement, obliging accountability achievement for safety at all company levels (St. Meld. nr. 7 (2001-2002). SC and the main values empower employees to stop an unsafe work or eliminate shortcuts. "The value I will stop the work if it is unsafe is used in practice actively. It is very important that people have this mandate" (Deme interviewee).

Several interviewees mentioned, that even if somebody hypothetically wanted to make shortcuts or perform unsafe activities, it will be almost impossible due to everyone's attention to safety. The employees' control over safety related behaviour of other colleagues finds both positive and negative reflections in research. Antonsen (2009) sees it as an example of an attempt to diffuse control into different spheres of human activity. He explains that SC with a top-down focus broadens the scope of safety management. Originally meant to control employees' performance it is willing to control "their hearts and minds" (2009, p. 190).

On the other hand, this control over safety by employees is not limited to the intension of control over the safety related behaviours of colleagues. Common attention to safety allows

better and faster detection of risks, suggestion of improvements, and minimization of the gap between Work-as-Imagined and Work-as-Done. Such individual behaviour has become the common shared behaviour within the companies. It can be considered as a "self-sustaining" quality of a strong work culture, when the formed practices of employees mould the new members (and not only) thinking and behaviour to the one prevailing (Turner, 2018, p. 397).

However, "responsibilization" of employees was also widely criticised by Dekker (2014) and Gray (2009). Gray objected against the subsequent punishment of employees with ticketing system and sanctions in Canada and United Kingdom. "A key component of the individual responsibility framework is to make everybody responsible through informal social control mechanisms" (Gray, 2009, p. 328). One of the espoused values in each of the cases studied in the thesis is personal responsibility and ownership for safety.

Undoubtedly, it is one of the control mechanisms in the companies, an informal one. Nevertheless, the empirical data showed, that it is perceived very positively. All the interviewees considered it not as an additional burden, but a fair necessity, and perhaps even a moral obligation, and took it for granted. Each interviewee regarded it only natural to behave safely and to watch out that work, performed by others, is done in a safe way. It was explained by the wish to care both for their own safety, safety of their colleagues, and good future of the company they work in. Such behaviour is typical for interdependent stage in the DuPont Bradley curve (Figure 17). The interviewees did not perceive themselves as safety supervisors, but rather as partners, and equal participants in the process of common safety goals achievement. The above can be interpreted as artifacts of the culture based on two espoused values developed in the companies' safety cultures. The espoused values were the values declared by the companies and set as goals for expected safety behaviour. Whereas artifacts are observable behaviours (Schein, 2017).

Opposing some criticism of Gray (2009), none of the cases revealed any occasions where employees were punished or sanctioned. Moreover, it was highlighted by the middle and top management that such an attitude contradicts to the safety programs, their values, and the SC in general. One citation can serve as a good example

> "*We deliberately do not have any punishment for mistakes in NINA, it simply does not fit into the culture we want to achieve. We can only learn from this and try to avoid it. That's the most important. We keep learning from it and not make it a blame. We have to learn from failures and be open about them.*"

When investigating incidents or accidents the companies in line with Dekker (2014) and the New View on safety are trying to find out "*Why*" accidents happen, "*What*" was responsible, rather than "*Who*". Nevertheless, occasionally commenting that sometimes the cause can be a pure human error.

Common safety culture, individual and organizational values contribute to general positive organizational culture (Zwetsloot et al., 2017). In all the cases SC is seen a tool to improve not only safety in the companies, but in general organizational culture. SC improves communication between different levels of employees, making managers well informed on actual state of things in safety, increases trust, and reduces the necessity of rigid compliance control (Hudson, 2001). Moreover, Hudson considers the discovery that SC pays off essential.

All three companies confirmed these positive changes, though in a different development degree (discussed in subchapter 5.2 and 5.3). Atmosphere of open communication, trust, feedback, and reporting is encouraged. Different tools are created for simplification and assuring that information can timely and easily reach different levels of the company, and subsequent actions can be taken. The scope of the program is extended for subcontractors and clients, subsequently improving their safety and common cooperation. It facilitates the expansion of SC into other companies and industries.

Risk science can further strengthen safety culture by raising attention to risks (Aven & Ylönen, 2021). Aven & Ylönen highlight that risk field and safety culture are interconnected both permitting and restraining performance. The programs pay great attention to risk management. Risk assessments and analyses are part of the daily routines in the companies intended to guide the employees' actions, reduce or eliminate safety risks. The necessity of risk analysis is stressed in the programs by the main rules as well as by the interviewees.

 Different tools are elaborated by the companies to simplify the process. For example, applications are developed available for download into mobile phone, for filling in and sending. Observation cards (SHOC cards) are used in all the three cases helping to detect the observed, or potential risks, improvements, and to report them digitally in real time, substantiating by photos. These proactive features correspond to the last two steps in SC maturity model *Proactive* and *Generative*, when participation of employees in safety becomes proactive, both employees, and managers become better and faster informed about safety (Figure 12, Hudson, 2007).

Culture with positive influence on safety is not obligatory homogeneous and without conflicts, it should rather be democratic and allow different opinions (Antonsen, 2009). Different safety views enhance the learning abilities of an organization (Westrum, 1993 in Antonsen 2009). The companies support these views, ideas, observations, success stories, and suggestions for improvements are sent regularly by the employees. Innovations are encouraged as well.

In line with the promoting view on SC recognizing its importance and stimulating the application of different models for SC development and measurement, as well as the normative and instrumental views, all the companies studied scale their SC maturity, though not within the whole company but in certain units. Hudson's SC ladder (Figure 12) and SCL (Figure 13) for SC

maturity evaluation are used. Certain companies' units possess certificates confirming the SC maturity equal to step 3 or 4 (see Appendix C). Companies' attitudes to it expressed in the interviews will be discussed in subchapter 5.3.

Moreover, SC needs to be customized to the types of risks which an organization has (Zwetsloot et al., 2013). Zwetsloot et al. note that two safety cultures coexist on site: one occupational, another related to large and severe hazards. Authors warn against not distinguishing between occupational hazards and other more complex hazards. Companies should not put all the stakes and investments on visible risks elimination and ignoring the invisible ones. A major focus on visible risks and SC for occupational accidents is noticed in all the cases.

Vision Zero

Safety culture in all three cases is characterized by orientation to the Vision ZERO goal. All interviewees were committed to it and found it to be the right goal. Applying the Schein's cultural model (2017), Vision Zero is the espoused value in all three cases, based on the underlaying assumption of preventability of all accidents and incidents. It characterises the ideology and, in the case of Boskalis NINA, the also forms a name of the SP.

Vision Zero raises a lot of debates in research and practice. Dekker (2014) takes a critical stand, while others seem neutral and curious (Sherrat and Dainty, 2017 cited in Le Coze, 2019) or engrossed (Zwetsloot, et al., 2017). Zwetsloot et al. call the implementation of Vision Zero more of "a process – rather than a target" (2017, p. 88). It reflects "the ambition and commitment to create and ensure safe work and prevent all accidents in order to achieve safety excellence" (Zwetsloot, et al., 2017, p. 89).

This approach is generally oriented towards elimination of accidents mainly caused by human error. It can be explained by rational logic when accidents can be prevented by risk analysis and compliance with procedures. Such an approach minimises the role of complexity of the modern and global risks and the socio-technical system complexity. It corresponds to what Dekker (2006) calls an Old View on safety, seeing the cause of problems mostly in human failures and extensive preoccupation with them. Vision Zero is focused on Safety I concept and reactive management (Hollnagel, 2014).

Additionally, it is based on the personal model (Reason, 1997) in safety management rather than organizational. Main message of Reason's book, as he considered himself, was to communicate the idea that "workplaces and organizations are easier to manage than minds of individual workers. You cannot change the human condition, but you can change the conditions under which people work" (Reason, 1997, p. 223).

On the other hand, it is hard to underestimate the practical popularity, application, and success of the Vision Zero. It is substantiated by the wide international consensus reached by

practitioners in different industries and showing good and documented safety improvements results. It is discussed at international conferences and is called one of the pillars of safety and health culture. Moreover, as mentioned earlier, it is promoted by regulatory documents and described as attitudinal milestone (St. Meld. nr. 7 (2001-2002). Instead of being the goal on the dependent stage of SC, it revolutionizes further to being the target at independent SC stage and finally to the expectation at the last interdependent stage of SC visualised by the DuPont Bradley modified model (Figure 16).

Nevertheless, Vision Zero contradicts the theories of HRO and resilience, Rasmussen model (Figure 19), which recognize complexity of the socio-technical systems and their interactions. The complexity is stressed by Safety II perspective (Hollnagel, 2014). Hollnagel calls the belief in total preventability of accidents a "myth".

In case of DEME, the CHILD SP logo visualizes a Domino model of accident causation (Figure 5). Orientation on Vision Zero and domino models represent rather a narrow view on safety. It can be related more to the second age of safety (Hollnagel, 2014) preoccupied with human failures and individual behaviour. Paradoxically enough, but the concept of SC was introduced after big scale accidents, which demonstrated systemic nature of phenomena influencing safety, and inadequacy of linear models and technological solutions to manage them (Aven & Ylönen, 2018; Reiman & Rollenhagen, 2014).

The way to build ultra-safe systems (Figure 20) within time is to make them safer through understanding of the "normal work" and resilience (Dekker, 2014). Safety-I and Safety II concepts have to be combined to achieve the goal of maximum safety (Hollnagel, 2014). Thus they will allow to adjust, correct the systems both before, after, and during adverse events, making normal operations of a company possible upon expected and unexpected terms (Hollnagel, 2014). Such a complimentary approach will facilitate safety improvement, further SC evolution and progression. Safety II focus will provide a more realistic sense of control and proactive involvement, bringing the companies' SC to step 4 and 5 on the SCL. A good SC should allow perspectives variety (Aven & Ylönen, 2021).

Good and strong safety culture

Building a good SC rests on the *instrumental or normative* understanding of SC (Aven & Ylönen, 2021). In research, different authors evaluate the goodness of SC differently. Aven and Ylönen consider SC as being good when "the shared beliefs, norms, values, practices and structures are "good" with respect to safety"(2021, p. 1352). Authors suggest that building a strong SC based on safety and risk science can be beneficial for the quality and strength of organizational SC. Such science-based approach can build a sound foundation for SC in the companies. Moreover, systemic understanding of safety is an important aspect of a strong SC.

Dekker (2006) sees management commitment and involvement, employees' empowerment, presence of incentive structures, and reporting systems as the four compulsory components of a good SC. These components are in the focus of the companies' attention.

The companies consider their SC good if all in the companies have a common understanding of SC and faith in it, if all have individual and shared responsibility for safety. People are encouraged to proactively participate in safety. Dialog, trust, care, motivation, cooperation, and commitment are distinguished by the companies as the key features of a good SC. Additionally, SC is considered good when it is fully integrated in management systems, structures, and practices. Dekker (2014) characterizes this SC development stage by creating safe systems through just culture and incidents reporting (Figure 20). The above descriptions of SC features match the steps 4 and 5 of Hudson's evolutionary model (Figure 12), the SCL model (Figure 13), and what Hudson (2001) calls the true SC.

The summary of the conceptualized companies views on SC and their mindsets are presented in Table 7.

Table 7

Conceptualised views of the companies on SC and their mindset

SC aspects	Case Boskalis NINA (2010)	Case Deme CHILD (2010), CHILD 5 (2016)	Case Van Oord Say Yes to Safety (2016)
View on SC	**Illustrations**		
	-SC can be engineered, modified by programs, campaigns, posters	-SC can be engineered, modified by programs, campaigns, posters	-SC can be engineered, modified by programs, campaigns, posters
Functionalist view	-SC influences performance outcomes ("a tool to achieve safe performance")	-SC influences performance outcomes (goal of "bringing *safety behaviour* to a new and unprecedented level", "improve HSE statistics")	"focus on personal *commitment* and *behaviour* and for all people working for and on behalf of Van Oord"
	-focus on views homogeneity (Vision Zero, "one SC-one NINA")	-focus on views homogeneity (Vision Zero) -Monitoring safety climate	-focus on views homogeneity (Vision Zero, Say Yes to Safety) -Monitoring safety climate
Normative/ Instrumental	-SC can be maintained, strengthened -SC blended with safety management -changeable factors in focus -measuring strength, benchmarking	-SC can be maintained, strengthened -SC blended with safety management -changeable factors in focus -measuring strength, benchmarking	-SC can be maintained, strengthened -SC blended with safety management -changeable factors in focus -measuring strength, benchmarking
Pragmatist perspective, related indissolubly to **anthropological** view in trying to understand the underlaying beliefs and values	-relates to safety management -practices are the outcomes of SC, based on beliefs and values -tries to understand existing SC, beliefs, and values by means of dialogs -focus on differences in SC development in different units, taken over companies, international units	-relates to safety management -practices are the outcomes of SC, based on beliefs and values -tries to understand existing SC, beliefs, and values by means of dialogs	relates to safety management -practices are the outcomes of SC, based on beliefs and values ("safe behaviour grounded in intrinsic beliefs and values")
Promoting and **enthusiastic** view	-SC is "a way to take care of safety" -improves organizational culture -use of maturity models (SCL) -has a practical value -promote NINA to subcontractors, Clients	-DNA safety culture -use of maturity models (SCL) -has a practical value	-use of maturity models (SCL) -has a practical value -promote Say Yes to Safety to subcontractors

SC aspects	Case Boskalis NINA (2010)	Case Deme CHILD (2010), CHILD 5 (2016)	Case Van Oord Say Yes to Safety (2016)
Mindset			
Artifacts	Safety Program NINA -Vision Zero -stopping unsafe activities -analysing risks -celebration of success -active participation in safety improvement (at meeting, seminars, stories, SHOC cards, reporting and feedback -PPE - rituals, heroes, symbols -technological modifications by innovations	Safety Program CHILD, CHILD5 -Vision Zero -stopping unsafe activities -analysing risks -celebration of success -active participation in safety improvement (at meeting, seminars, stories, safety moment days, SHOC cards, reporting and feedback) -PPE - rituals, heroes, symbols -technological modifications by innovations	Safety Program Say Yes to Safety Vision Zero -stopping unsafe activities -analysing risks -celebration of success -active participation in safety improvement (at meeting, seminars, stories, safety moment days, SHOC cards, reporting and feedback) -PPE - rituals, heroes, symbols -technological modifications by innovations
Espoused Values	Proper and proactive safety behaviour improves safety (assessing risks, following rules, reporting, observing, stopping unsafe activities, suggesting improvements, trust and respect) - Vision Zero (all incidents and accidents can and must be prevented) - SC and SP's success to be monitored (critical components to be evaluated) -HSE reports and statistics reflect behaviour trends, important to adjust safety behaviours by trainings and campaigns -external influences challenge SPs and safety	Proper and proactive safety behaviour improves safety (assessing risks, following rules, reporting, observing, stopping unsafe activities, suggesting improvements) - Vision Zero (all incidents and accidents can and must be prevented) - SC and SP's success to be monitored (critical components to be evaluated) - HSE reports and statistics reflect behaviour trends, important to adjust safety behaviours by trainings and campaigns -external influences challenge SPs and safety	Proper and proactive safety behaviour improves safety (assessing risks, following rules, reporting, observing, stopping unsafe activities, suggesting improvements) - Vision Zero (all incidents and accidents can and must be prevented) - SC and SP's success to be monitored (critical components to be evaluated) - HSE reports and statistics reflect behaviour trends, important to adjust safety behaviours by trainings and campaigns external influences challenge SPs and safety
Underlying assumptions	-all incidents and accidents are preventable -employees improved behaviour will eliminate incidents and accidents, improve safety, provide long-lasting safe performance	-all incidents and accidents are preventable -individual and shared safety behaviour will eliminate incidents and accidents, improve safety, provide long-lasting safe performance	-all incidents and accidents are preventable - individual and shared safety behaviour will eliminate incidents and accidents, improve safety, provide long-lasting safe performance

5.2 Gradual development of SC from compliance to proactive participation

An answer to the RQ2 "How is SC implemented and developed through the safety programs?" will be provided in the subchapter.

Development of SC in the organizations was initiated as the result of changes in the world and a new focus in safety management systems on safety behaviour. The companies enrolled the new SPs governed by the awareness, that such development is inevitable and effective for safety improvement, reduction of incidents and accidents rates. The need to become more efficient and competitive contributed to it. From being just the dredging contractors, the companies wanted to develop further into oil &gas business, improve their safety standards, and win good contracts. Moreover, a general organizational culture required improvements.

The cases show that by enrolment of the safety programs a transition was made from compliance to safety rules and policies to changing the behaviour of employees. Judging by the historical background of SC existed in the companies before (subchapter 4.2.1), it could have been reactive. The programs are solving the accumulated problems with formal attitude to safety, communication between different levels, high number of accidents, underreporting, and lack of management commitment. Instead of being just a "paper-word" safety had to become personal and the importance of its discussion and attention had to be raised.

Program names

Names of the programs alone are worth dwelling upon. They are quite important themselves. In two of the cases the name is an acronym, but also has a meaning as a word. *NINA* – is the name of Boskalis SP. It means No Incidents No Accidents, moreover, it is a woman's name in many cultures. It is visualised by a cartoon lady in PPE (Figure 3).
CHILD – is the name of the SP in Deme and means Colleagues Help Incidents Leave Deme, but child as a word is dear and important to most people in any nation across the globe.
Say Yes to Safety – resumes more of a slogan, which some interviewees mentioned were widely used in "the older days" of safety.

With NINA and CHILD even the name of the SP is personalised to make it dear and private, breaking the pattern associated with safety as bureaucracy and "a paper-word", with Say Yes to Safety it is inviting and invocatory. An indicative example was named when employees in Boskalis even composed songs about the lady called Nina, who everybody loves and knows so well. The employees are using it often as an adjective describing something unsafe as "it is not so NINA", which on the one hand makes employees smile, on the other, defines unsafe.

As noted by Schein (2017) cultural change programs are always initiated due to some dissatisfaction or pain. In Boskalis and Deme enrolment of the safety programs preceded by the extensive gap analysis performed by third parties. The development of the SPs was performed in close contact with consultant companies. The results pointed to a very hierarchical system of control and compliance resulting in consequences for employees for non-compliance. Absence of communication between different levels and attitude to safety as a required formality were evident. Thus, such SC could have been scaled by first two steps in terms of SC maturity, namely to *Pathological* and *Reactive* (Hudson, 2007; NEN, 2022c; Figure 12, 13). Therefore, SC had to be changed for better, deemed to improve safety and the general organizational culture. That state can be associated with the first stage in the change cycle (Figure 15, Schein, 2017) – *creation of survival anxiety* – a need for a company to change in order to survive on the market.

SC is being developed in the companies within the framework of new SPs. The petroleum sector widely uses such type of programs with the aim of changing safety behaviour (Antonsen, 2009). Companies from petroleum sector are often being the clients of the three companies under study and promote these changes further to their subcontractors. *What to start with changing values or behaviour?*

From the two options, suggested by Schein (2017) either to start with changing of values or behaviour, it seems, that companies started with both options in parallel. The development of SC began with clear definition of values and rules, explaining what type of behaviour was expected. The clear messages and expectations in all the cases were introduced by the top management.

According to the culture model of Schein (2017, Table 4) these are espoused values and beliefs promoted by the companies. The intension, according to the thesis researcher's view, is that the espoused values should transform into the artifacts (observable practices and behaviour) at a later stage. Boskalis and Van Oord safety values all start with I, stressing each persons' ownership for safety (Table 6). It is a personal acknowledgement and promise to the company, resembling a personal safety oath.

Not surprising, that occasionally same notions are shared with religious vocabulary like for example rituals and cult. The author noticed, that in the Russian translations of the SC term consultants' companies occasionally use the term safety cult together with safety culture (Тимофеева & Комаров, 2016). Parallel to religion may suggest that safety should become something very personal and sacred.

Everyone should behave safely, stop unsafe behaviour, and accept safety critique positively. In the face of safety all should be equal despite of the rank. All need to report incidents and near misses, learn the lessons, and follow the rules. Compliance with the rules together with obligation becomes after a while a wish instead of a must, reaching interdependent stage of SC development (Figure 16, 17, DuPont Bradley model). In case of Boskalis and Deme a reference to DNA is made, which causes an association with the works of Schein and cultural DNA.

As stressed by several interviewees each value should begin with "I" rather than "We". Thereby, all take a personal commitment in an equal degree, avoiding in case of "We" that somebody needs to take it more seriously than the other. If everybody joins in equally, behaves in such a common and expected by the company way, then it becomes a part of the culture. It corresponds to the third stage of change cycle, when a new concept is incorporated into identity and self-concept (Figure 15, Schein, 2017).

Employees reflected that the values are simple in a way, that they are understandable, and only underline what was expected from them before: that everyone should be responsible for safe performance and should comply with the rules. This is something which existed in the culture of compliance in the companies at an earlier stage. This simplicity can be interpreted by a core human idea SC builds on (Turner, 2018). This idea is inborn and safe ways of working are naturally strived for. One of the interviewees explained "aiming for safety is in our blood, it is an instinct same as need for sleep and eat". The idea of caring for others is related to moral implications (Turner, 2018). Nevertheless, however simple, and natural it might seem, numerous safety research described how safety can be compromised under different production pressures (Perrow, 1984; Reason, 1997; Turner & Pidgeon, 1997).

One of the changes in the new programs was that employees were assigned an authority to stop the work, had to watch out for colleagues, and unsafe operations. It is a manifestation of how SC allows or restrains safe execution, mentioned by Aven and Ylönen (2021, with reference to Bienefeld and Grote, 2012; Detert and Edmondson, 2011). These espoused values encourage personal contribution to safety by not only controlling safety, but also informing of possible improvements, which call for alignment of the Work-as-Imagined and Work-as-Done, and innovations.

Establishment of SC means to specify demands at several levels in an organization (Guldenmund, 2000). The companies described these requirements in their SPs. They cover demands to managers and employees' behaviour. The requirements include knowledge, commitment, involvement, responsibility, and awareness.

Management commitment and involvement

Management commitment and involvement are vital for SC development (Dekker, 2006). Programs' enrolments start from a top-down intervention with a demonstration of management commitment and expectation of the same from the others. The tone is different from ordinary directives, typical to the previous style of management. Now the CEOs explain the importance, lead by own example, and invite everyone to join in. It corresponds to the stage five of Hudson's change model (Figure 14, 2007) personal vision, defining what is expected and how.

The values are actively (with a different degree) promoted further by the top and middle management of the companies. Their attitudes are especially crucial for SP's success and in the efforts of a more advanced development of SC (Hudson, 2007, see item 4.3.4).

Communication improvement

Another new intervention was to improve communication, and stress that all are equal in the face of safety, no matter of the rank. It corresponds to just culture an important subcomponent of SC, according to Reason (1997). An atmosphere of open communication about safety contributes to learning and is one of the key elements in HRO (Turner, 2018) and the *Generative* highest step in SCL. It encourages reporting, detection of hazards, and timely or anticipating prevention. Focus is made on learning lessons, which is why everyone should report and discuss all related to safety. Reporting and learning cultures are critical subcomponents of SC, distinguished by Reason (1997).

Role of learning

Learning is a very important part in SC development. Culture is an organizational phenomenon and it not only behavioural, but is comprised by the shared learning and experience (Schein, 2009). "Culture is the accumulated learning of the group" (Schein, 2017, p. 6). Reason notes that to engineer a learning culture is probably the easiest task, "but the most difficult to make work" (1997, p. 218). He distinguishes between its main elements: observing, creating, and acting. The latter create the most problems. He cites Pieter Senge "Learning disabilities are tragic in children, but they are fatal in organizations. Because of them, few corporations live even half as long as the person – Most die before they reach the age of forty". (Senge, P. M., 1990, p. 219).

Schein calls leadership a "key to learning" (2017, p. 14). As learning, according to him, happens via leadership, when a leader or an owner with the help of his own power explains and claims a new expected behaviour in order to achieve a certain purpose. "Learning something new or stopping something inappropriate will be mediated by leadership behaviour" (Schein, 2017, p. 14). It puts a start for learning of the new concepts and corresponds to the second

stage of cycle of change (Figure 15, Schein, 2017). This step is related to identification with role models and imitation.

Learning is an important part in building the competence (Aven & Ylönen, 2021). Building of competence and training are the main tools for understanding of risk and safety concepts. Learning can be both individual and organizational (Argyris, 1982 in Aven & Ylönen, 2021). Safety training programs are organized by the companies both for individuals and groups to inform and train employees. In the beginning employees learn about the programs both individually by means of e-learning and in groups. During trainings within the SPs people get acquainted with the common values and rules and explained what behaviour is expected in the company. Trainings are focused on different roles employees play in the companies. Sessions are arranged for top, middle managers and operational personnel.

Organizational learning has an important role in building a common competence. Employees and companies in general accumulate the lessons learned from their experience and apply to the future operations. These lessons are taken from both mistakes and success. Different safety campaigns are arranged which a triggered by repeated or increased trends of accidents and incidents rates. At the end of the project seminars take place summarising all the positive and negative issues, what was foreseen and happened, what was unexpected. Subsequent reports are written. Daily meetings are conducted, workshops with participants from different countries are arranged.

Schein (2009) appeals to consider tacit assumptions of employees. According to him, culture is "the shared tacit assumptions of a group that have been learned through coping with external tasks and dealing with internal relationships" and though it expresses itself in observable "behaviour, rituals, climate, and espoused values" its core is "shared tacit assumptions that can be brought to consciousness- but that operate most of the time outside of our awareness. As a responsible leader, one must be aware of those assumptions and manage them- or they will manage you" (Schein, 2009, p. 217). They can be revealed in groups discussions and trainings, methods applied by the companies Boskalis and Deme.

The SC development is to a greater extent triggered by negative trends rather than positive, traditionally putting a greater focus on Safety I. Deme includes a necessity of learning from success (Safety II) in their documents more explicitly (Deme, 2020, p. 18). Orientation on Safety II could be detected by such initiatives as sharing success stories and positive observations in all three companies. Some of the interviewees did not see much use in success stories unless it had a direct practical implication for others or future work. For example, that the successful experience could be copied and replicated on the other projects or in business

units. In Deme these global initiatives started approximately in 2020-2021, according to the interviewees' judgements. Features of safety being dynamic and people being resilient are traced on the companies' web sites.

Development of SC is a complex and long-lasting process, a "never-ending story" same as development of safety, and requires continuous monitoring, and maintenance. Realizing that there is no "final terminal" is "the essence of maturation" (Dekker, 2006, p. 220). An organization has a strong culture, according to Dekker, if it constantly tries to understand how it learns about safety, reacts to dangers and opportunities at all levels "of practice" (2006, p. 220). Companies are monitoring their SC development progress by safety climate surveys, dialogues, feedback, and HSE statistic trends.

By the results of such assessments companies decide which actions are needed to change or optimise the level. The process corresponds to the sequence suggested by Hudson (2007) and his model of detailed change (Figure 14). Stage 11 *Review* of the ACTION part require a review of the progress, stage 12 *Correct* needs changing of whatever is necessary. Further stages 13 and 14 are related to MAINTENANCE and include *Review* by management at regular intervals concentrating on *Outcomes* – in the studied cases it involves checking the internalization of the values and beliefs. Stage 12 *Correct* involves corrective actions either in the form of new campaigns or trainings introduced by the companies. Safety issues commonly require immediate intervention (Guldenmund, 2010) and cultural changes need years to incorporate. For example, in Deme, a modification of the SP itself was required to change the SC.

Employees' involvement and empowerment

Employees involvement and empowerment is one of the core components of a strong SC (Dekker, 2006). Employees need to see and feel that they make a difference, contribute to changing, improving safety policies and processes, and to be proud of it. SCHOC cards, success stories, suggestions for improvements are practiced by employees in all three cases. After submission of SCHOC cards employees get personal feedback, including which safety measures were or will be taken regarding the observations. Thus, employees alter the knowledge, "technological artifacts and their identities" (Aven & Ylönen, 2018, p. 14). Additionally, employees get praised and rewarded for good safety related ideas.

Incentive structures

Different kind of incentive structures are used to motivate employees' involvement. Their regularity and types differ even within one company, its units, and projects. Employees

are sometimes rewarded when projects end without incidents or accidents, in other cases for valuable observations, safety suggestions, and being proactive.

SPs and SC extension to subcontractors

Boskalis and Van Oord do not restrict themselves to the development of internal SC only, but additionally expand it to their subcontractors, and even clients (Boskalis, 2022c; Van Oord, 2022a). Subcontractors receive trainings during which the SP is explained along with the main values and rules. One of the reasons to do so, is that they bear the main responsibility both for safety and operations fulfilment being main contractors within a certain project. Subcontractors' performance influences the common success of the project and companies' reputation. Statistics of subcontractors, when operating within a project area, is commonly (agreed upon separately on each project) included into the statistics of the main contractor.

Reflections of the third wave in SC development

The findings demonstrate the fifth view on SC development (or third wave) reflecting the social construction of safety under the influence of different competing influences (Le Coze, 2019). Many actors are involved in shaping SC. International regulators make the development of a good safety culture a necessity. It is most evident in the oil and gas industry, where these requirements are shaped in the form of regulation requirements, for example in Norway (St. Meld. nr. 7 (2001-2002). Despite of the fact that such a condition is not yet a part of regulations for dredging industry in the Netherlands and Belgium (according to the interviews), the dredging contractors participate in tenders and perform work for clients from oil and gas world-wide, which have such requirements. They provide jobs for other industries and require the presence of a developed good SC. The dredging contractors in their turn impose such obligations to their subcontractors. Analogically, two of the dredging companies studied, teach, and train their subcontractors according to their safety programs and rules, forming at the end a common or similar safety culture. SC development migrates from high-risk industries to the other businesses.

Moreover, clients from oil and gas demand a certain maturity level certificate, as a confirmation of proper SC level during tenders. Possession of a high-level safety culture maturity certificate becomes then a market advantage and increases company competitiveness. Benchmarking based on SC within an industry demonstrates companies' "safety health" assessment in a more sensitive way than statistic numbers (Clarke, 2000, p. 85).

Consultants provide different tools for development and assessment of SC. The level of maturity is assigned by consultants' companies, performing audits and certification. SCL

example in Netherlands was described in subchapters 2.4 and 4.3.1. Academics develop new approaches and models of safety culture contributing its further development. Publishes publish new books and articles.

SC becomes "a safety product as part of a market" (Laroche, 2018 cited in Le Coze, 2019, p. 227). Le Coze relates Vision Zero as a similar example, started by regulators – the Swedish road authority, migrating to industry and OHS, and raising debates by academics. Relationships and interactions between these actors are complex, unavoidably producing controversies (Le Coze, 2019). However, such a market-oriented approach might downplay the complexity of SC and its engineering abilities.

5.3 Measurements and indications of safety programs influence on SC

An answer to the RQ3 "How is the influence of safety programs on safety culture measured by the companies?" is provided in the subchapter.

The influence of the safety programs on the SC in the companies, namely on mindset, understanding and practices is monitored and measured by the companies. Assessment of SC is in line with the *pragmatic* and *normative* approaches to SC, pursues the objective to evaluate the current state in order to maintain, or develop SC to a further level (Edwards et al., 2013; Guldenmund, 2000, 2010).

The assessment is necessary, but not easy. It can be irritating for managers "that culture is not easily measured and controlled...if you cannot put numbers on it, it is "soft stuff" " (Schein, 2009, p. 215). Whereas culture is "a value-free concept,…safety is not" therefore evaluations are made how a culture has to improve in order to better strengthen safety (Guldenmund, 2010, p. 1475). Safety is about behaviour and culture is about understanding what behaviour means. This can partly explain a tendency of the top and middle management to measure SC by HSE statistics. Such measurement was mentioned by most of the interviewees as a commonly applied indicator.

Measurement of SC by HSE statistics

One of the biggest achievements of SPs in the companies is reflected in and measured by LTIF (lost time injury frequency) trends. Behaviour trends are the main focus in safety culture assessment in line with pragmatic approach (Guldenmund, 2010). If trends are increasing, sometimes prevailing in certain types of the accidents, they give signals to the management that something is wrong, and targeted campaigns must be introduced for improvements. This might lead to SPs' modifications or even restructuring. For example, internal reorganization was required in one of the companies.

Declining trends, on the contrary, serve as a partial confirmation of the programs successfulness and improved safety behaviour of employees as a result. Big achievements are commonly visually demonstrated in the companies' premises, on web sites, and in the documents. This corresponds to the stage six of the change model – *information about success* (Hudson, 2007; Figure 14).

Despite of such an optimism, orientation on the statistics alone as a safety barometer was criticized by many scientists (Aven & Ylönen, 2021; Dekker, 2014; Hollnagel, 2014; Reason, 1997; Reiman & Rollenhagen, 2014). Already in 1997 Reason reproved the assessment of safety in hazardous industries during ca.15 preceding years by LTI, due to its focus on individual accidents, instead of organizational, and engineering. He explained that it is not a reliable indication of genuine system's safety. Reiman and Rollenhagen consider it to be a typical feature of functionalist approach measuring "a bit of this (e.g. individual attitudes) and a bit of that (safety management systems, collective norms, practices)" (2014, p. 10). They note the trend to be especially prominent in quantitative measurements of negative outcomes (injuries, adverse events).

The trend corresponds to the focus on Safety I, when the number of accidents and incidents have to be as low as possible (Hollnagel, 2014). Hollnagel calls such management reactive and represents it by the reactive management cycle (Figure 25).
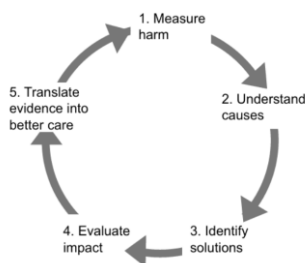
KPIs (Key Performance Indicators) predetermined by the company in the beginning of the year represent the affordable amount of risk, which companies can bear. Being governed by the statistics alone presumes, that all accidents can be rationally explained, and have a direct cause-effect relationship. By focusing on incidents and accidents rates complex and dynamic socio-technical nature of safety and uncertainty component in risk get neglected. Conversely, according to Weick (1987) safety management is the management of a "dynamic non-event".

These methods are common to the *Calculative* step 3 of SCL (Hudson, 2007; Figure 12). For this stage is typical to compare unsafe consequences to financial losses. A true SC is the one going beyond first three steps, including *Calculative* (Hudson, 2001).

Nevertheless, the companies recognize that statistics can measure their SC only partly. Internal audits in the form of dialogs with employees are conducted, observations during trainings are collected to check employees' understanding and mindset. The method is called by Guldenmund (2000) with reference to Ludborzs (1995) a SC audit, when main SC components and requirements are rated. During group trainings monitoring specialists check how people react and act in certain situations. Applying the cultural model of Schein (2017), they try to evaluate if companies' espoused beliefs and values are manifested by artifacts. Basic underlaying assumptions, determining perceptions and thought can be understood. In case of problems some interventions in the form of trainings are introduced.

As stressed by the interviewees, SC is being developed not only top-down, but also bottom-up. For achieving safety, in line with Dekker (2014), the companies tend to analyse gaps between work-as-imagined and work-as-done, support whistleblowing and reporting, and be open to risk and safety debates, which are the features characteristic of HRO (High Reliability Organizations) and the *Generative* highest maturity step in SCL.

Feedback and observations are generally practiced by the companies. Indications of SC improvement or status are judged by feedbacks, number, and quality of sent observations, and suggestions for improvement. High number of reported incidents or safety events and observations will prove that SC becomes a proactive tool corresponding to the *Proactive* SC maturity step (Hudson, 2007; NEN, 2022c; Figures 12, 13). The companies compare the progress in employees' perceptions, thoughts and behaviour against the main values and rules. They judge the SP's influence on SC by the level of engagement and collaboration, quality of communication and leadership and commitment.

The companies measure and try to understand the status of their SC by means of surveys, measuring the safety climate, being typical for the functionalist view. Surveys are performed by the companies to check the safety climate, namely perceptions of the employees about safety programs. Interviewees from Deme mentioned yearly surveys where safety agenda is included. Anonymous yearly surveys were named by Van Oord interviewees. An interviewee from Boskalis opposed to anonymous surveys, as the notion of anonymity according to the interviewee already manifests the existing problems with SC, contradicting with the value of open communication and welcomed feedback. The interviewee preferred storytelling tools and group dialogs with six-seven employees and ten-twelve questions. The power of storytelling was stressed by Dekker and characterized as a "powerful mechanism for others to learn vicariously from trouble" (2006, p. 203). Their

storytelling tool also include interesting and useful safety experience and ideas (Boskalis, 2022d).

Interviews, individual and group dialogues are conducted by the companies, being characteristic for interpretivist or anthropological view on SC. The importance of dialog within groups was stressed by Schein (2009). He claimed that it could be successful only if the participants are interested and motivated. He clarified that one cannot use a survey for culture evaluation, because there will never be enough questions to evaluate all, and one will not know what one can do with what one gets. Certain questions will not be understood. And since a culture is a "group phenomenon, it is shared tacit assumptions" it is better to be assessed in groups (Schein, 2009, p. 221). In line with Schein, the companies detect the artifacts, related to an enquiry, and observed behaviour, and compare them with organizational espoused values. In case of mismatches, they search for explanations in tacit assumptions, explaining such behaviour.

Following the promoting view on SC, different tools and models are used to improve SC and safety in general, where SC maturity evaluation is a successful example (Le Coze, 2019). Certain business units of the companies are measuring their SC maturity. Boskalis assess SC maturity by SCL mainly if it is required in a tender by a future client (noted by interviewee). Van Oord interviewee referred to it as a guidance and orientation in the SC development. The interviewees attitudes to SCL were different from full acceptance till criticism (subchapter 4.3.1). In the former case the aim is to reach the final step on the ladder *Progressive* (NEN, 2022c; Figure 13) and improve SC, though not without pragmatic financial interest. Such a certificate is used as a tool, confirming competitiveness, providing better chances to win tenders, and fulfil profitable projects.

When criticising SCL, it was pointed by an interviewee to the drawbacks of such certification, as it audits culture in a traditional auditing way. Instead of encouraging a qualitative development of SC, it leads to formal attitude. Companies might be tempted to try and "fix" their systems and documents so, that they are tuned to reach a higher maturity step assessment. This can be obtained if one knows the process of certification, and formally adjusts company's systems/programs to what is required for higher steps. Regretfully, as noted by an interviewee, SCL certification does not consider the financial side and evaluate the amount of funds invested in the development of SPs and SC. Thus, revealing the actual companies' efforts. This critical attitude might be a reflection of a tendency, noted by Guldenmund (2010), that SC maturity can be replaced by the development of SMS, namely

company's structures and processes to be effective and as being "alive and dynamic systems" (p.1478).

The SCL is also a consultants' tool for SC development and maturity measurement. Its application reflects the third wave in SC development or alternatively the fifth view described by Le Coze (2019). The wave is characterised by the socially constructed field of safety by different actors with competing interests. Certain criticism was raised by one of the interviewees to the consultants' lack of practical experience. Designing safety from outside of an organization is another feature of the wave in contrast to the previous developments. Such practice is not always beneficial for an organization. Some of the consultants' failures were analysed by researchers on the example of British Petroleum (Bergin, 2011 and Hopkins, 2012 cited in Le Coze, 2019) which even contributed to some disasters (Hopkins 2012 in Le Coze, 2019).

Practices

Practices or artifacts, according to the model of Schein (2017, Figure 8), reflect how abstract knowledge is converted into practical application. By comparing the espoused values with artifacts, the companies understand what is working and what requires additional attention. Safety related activities which the employees perform daily serve as indications of SPs success. The employees act proactively and contribute to safety. JSA, meeting discussing possible risks, SHOC cards, end of the project meetings for sharing experiences, joint seminars, safety moments days, success stories campaigns, occasional use of stop-the -work authority are the expected artifacts.

Some of the employees even write songs about the SP, demonstrated by Boskalis case, develop common jargon and jokes. Development of common culture is typically accompanied by the development of a common language and jargon Schein (2017). "Natural language, metaphors, and patterns that connect have more requisite variety than do notation, argumentative rationality, or models" (Daft and Wiginton (1979) cited in Weick, 1987, p. 125). This may indicate that the culture becomes both very personal and common.

Weick highlights the importance of stories. By means of symbolic instruments culture remotely directs actions (Weick, 1987). People get reminded of the common values, when the same stories are shared, they serve as the general guidelines for problem solutions. Additionally, stories allow to reconstruct and remember complex scenarios. Weick sees in them the strength of "narrative rationality" enriching traditional rationality (Weick, 1987, p. 125). Shared numerous and intensive experiences by the company members and degree of organizational achievements increase solidarity and cultural depth (Schein, 2009).

5.4 Deficiencies, problems, and challenges of the safety programs

The answer to the RQ4 "What are the deficiencies, problems, and challenges of safety programs in the companies" is provided below. Such issues as: SPs' financing, development responsibilities, insincere management commitment and involvement, restructuring in case of no success, necessity of both top-down and bottom-up approaches, companies' globalization and business growth, work with subcontractors, generations differences, and external influences are discussed.

SC same as safety development is a never-ending story, a complex, and continuous process. In two of the cases (Boskalis and Deme) it has been already 12 years since the enrolment of SPs and in Van Oord over seven years. Companies faced different problems, deficiencies, and challenges during such an extensive period of safety programs and safety culture development.

The first issue to start with, the SPs should be formulated in such a way, that employees from different levels can understand them. Too many complicated words do not contribute to this goal.

The most serious challenge is that safety in general, and safety programs in particular, require reasonable financial investments. Adequate financing is important throughout the whole lifetime of the program. Sufficient funding presents both a necessity and a challenge. Often big investments follow at the stage of SP enrolment and are being cut after, which leads to SP formalization undermining its effectiveness. Active participation is substituted by e-learning and professional trainers by somebody reading from a piece of paper. It creates a risk of regression in SC development. In such case, a SP exists mostly on paper and safety tends to become again "just a paper-word".

Tasks of SP development are delegated to employees, already overloaded with their main daily duties, leading to their multitasking and overburden. Development of the SP and SC is a task of both top and middle management. Pushing it mostly to HSE departments responsibility will lead to regression of the general quality of SC and levelling down the steps of the SCL. Though HSE departments drive it, the development should be a common top and operational management effort. The failure of returning back to the old approaches was noted by Hudson (2001) and considered as one of the two main threats in SC development.

Another challenge is that an efficient SC cannot be "tackled superficially" (Turner, 2018). Management involvement and commitment are the necessary ingredients in the recipe of a strong SC (Dekker, 2006). Management should sincerely believe in the concept of SC and transmit the message further, both verbally, and by personal example. Demonstrated

insincere concern will not evoke positive changes and "must be seen as using their authority to set a caring example" (Turner, 2018, p. 398).

Based on some negative experience, sincerity and being close to reality are stressed by several interviewees. If otherwise, it creates a contrary effect on employees resulting in disbelief and management being the source of jokes. The SC concept itself will not be taken seriously. In worst case, if the SP does not work, or SC cannot develop further, a cure in the form of restructuring and a leadership change might be required. This was one of the required mechanisms of cultural change and the "painful process" of inoperative elements detection, determination of their carriers, and substitution noted by Schein (2009).

Moreover, though the SPs are rolled out from the top, combination of top down and bottom-up approaches is the feature of more developed SC maturity (Hudson, 2001). One of the interviewees warned against pure top-down development and several interviewees highlighted the necessity of applying both. Thus, two tasks may be solved. On the one hand, is narrows or even eliminates the gap between Work-as-Imagined and Work-as-Done, supporting proactiveness of employees. On the other, it helps to improve communication between different levels in the company and bridge diversities, existing between different subcultures within a company. Superintendents for example are a connection joint to the vessels, project managers are to the head office, site office, and project office (see subchapter 4.4.5, p.80). Combining these two directions of SC will help to avoid that SC remains on the *Calculative* maturity stage (Figure 12; Hudson, 2007) and will encourage its further evolution. Everybody should be taken onboard and need to be proactive.

Another challenge is globalization of the companies' business and their continuous growth. Boskalis interviewees stressed, that continuity in SC development is crucial. It is challenged by the constant company's expansion. Subsequently, companies which are taken over often require development of SC from a lower level and therefore demand more efforts and investments into the SP. Whereas, constant analysis, maintenance and adaptation are necessary.

One of the new dimensions in SC is reflecting "inter-organizational aspects" and trying to create a common SC "across organizations" (Aven & Ylönen, 2021, p. 1353). Challenges described by Clarke (2000; subchapter 2.3, 4.4.8) are partly addressed by the companies, namely in work with subcontractors. The companies note, that cooperating with subcontractors with significantly lower safety level (occasionally unavoidable), mainly outside of Europe, is challenging. On the one hand, it creates additional safety risks for the companies, and on the other, require greater efforts to improve subcontractors' safety, and

make them a part of the companies' SPs and SC. Thus, being both demanding and rewarding if the companies succeed. One of the examples was named by an interviewee, when they managed to significantly improve SC of a subcontractor delivering rock mass in Indonesia. "*I feel that a made over there something really important in my life*".

Generations differences in the mindset create certain problems. Employees older in age or working during the times, when companies had a very low level of SC, sometimes raised certain scepticism. For example, a request on informing about unsafe actions of co-workers was treated negatively and interpreted as whistleblowing and squealing on colleagues. "Old guard" (described by an interviewee) mindset requires more time and effort to change. On the contrary, a younger generation (millennials) employees are described by Van Oord interviewee as being good educated, more positively critical to safety, and proactive. One of the solutions noted by Turner is to recruit "the right people" (2018, p. 398). And this is internalized by the companies. An interviewee from Boskalis expressed it like this *"people are in principle hired with an experience of work in similar companies and who already have this SC knowledge and safety awareness"*.

External influences during and after COVID-19 and 24.02.2022 had a great impact on the companies. They reminded and demonstrated the effect of uncertainty, dynamic nature, and complexity of risk. COVID-19 influenced both positively and negatively on the SC development. Many common activities, like seminars, meetings, group trainings were not possible to continue with in-person participation and were replaced by online participation in the best case. In the worst case, required development activities were drastically reduced. A new focus in HSE work and SC is directed to the employees' mental health. On the other hand, companies both tested their resilience and actively demonstrated their abilities to adapt and cope with such risks.

6. Conclusion and Implications

The main purpose of the study was to explore and understand companies' view on SC, how it is being developed within the SPs, what influence the SPs have on SC, and how it is measured in three dredging and marine contractor companies. The research presented a snapshot of their views; development and current SC state, its monitoring; related problems, and challenges during the period of the last 7-12 years. The study is relevant for SC understanding, its development within the dredging and marine industry.

The new empirical data obtained by nine semi-structured interviews, its analysis with interpretations based on the selected theoretical framework, and new context chosen contributed to SC empirical knowledge within the industry.

The results of thematic content analysis suggested that the companies take a functionalist, normative, and pragmatic view on SC, meaning that SC can be imposed, changed, and maintained by the companies. Safety culture, constituting a part of organizational culture is developed within three cultural levels according to the model of Schein (2017): artifacts (observable behaviour, structures, and processes), espoused beliefs and values (ideals, goals, rationalizations) and basic underlaying assumptions (taken for granted beliefs, values, determining thought, perception, and behaviour). The results confirm a high importance of SC for the companies, its continuous and gradual development.

The SC development in the companies reflected both a wish and a necessity. They are dictated by the modern developments in the safety field, safety and risk management, and the necessity to keep up with them. The companies wish to be more effective, competitive, and successful. The discovery that SC pays off and makes companies more lucrative in the long run Hudson considered essential (2001). Starting from the nuclear, aviation, gas and oil sector the SC concept spread to other industries including dredging and marine services as demonstrated by the three cases. Regulation requirements and expectations of gas and oil clients promote and stimulate SC development.

A strong SC contribute to the companies' market competitiveness. The thesis suggested that the development is partly market driven, industrial experiences are applied, including Vision Zero and ISO standards. The Safety cultures studied are preoccupied to a great degree with human errors, focus on behavioural change, and less with sociotechnical approach.

SC is being developed within the framework of SPs, which are the artifacts of SC and establishing the main values and rules, being the espoused values. All SPs demonstrated a great similarity in mindset, comprised of artifacts, espoused values, and basic underlaying assumptions. The mindset of the companies is based on the espoused values of Vision Zero and that proper safety behaviour improves safety; the underlaying assumptions that all incidents and accidents are preventable, and that improved safety behaviour will provide long-lasting safe performance.

The companies develop employees' mindset and understanding which lead to behavioural changes of employees. The safety programs provide guidance how to think and behave. Employees are assigned more responsibility and accountability for safety. Employee's involvement is encouraged by management and praised. The values are actively

promoted by the top and middle management. Communication is encouraged at all companies' levels. Thus, helping the managers to be well informed, minimising the gap between Work-as-Done and Work-as-Imagined, and enhancing learning. Learning plays an important part in building competence. It reflects mainly Safety I thinking, though in the few recent years Safety II concept started to be employed. SC development and SPs are extended to subcontractors and Clients (in Boskalis and Deme). Considering the safety culture existed earlier, the cases demonstrate a reasonable progress. SC evolutionized from compliance to rules and procedures to a more proactive behaviour of all employees.

The findings demonstrated little focus on systemic nature of SC. Thus, confirming the research outcomes of Reiman and Rollenhagen (2014), pointing out that factors related to human and organizational nature prevail over technological (safety). More focus on socio-technical systemic nature is required for further SC development. The results are consistent with criticism in the scientific research related to SPs (Dekker, 2006; Gray, 2009), as they base on the understanding that unsafe behaviour of employees and human errors cause most of incidents and accidents. The findings may contribute to the claim of Clarke (2000), that new interventions programs within SC are required, which could help to address the risk, being not easy identified by traditional risk methods. Risk science, combination of several safety approaches will improve SC.

To monitor the influence of SPs on SC, the companies analyse HSE statistics' trends and implement campaigns targeting the detected problems. Additionally, internal analyses are performed in the form of surveys, measuring the safety climate. Individual interviews and group dialogs are conducted to understand the current meanings of values and beliefs, behaviour, the quality of safety communication level, employees' involvement, and management commitment. These results are in line with research of Chen et.al (2013), and confirm that management commitment and involvement, communication, and continuity of work are among the main success factors of SPs. Continuous financing of the programs is important. The companies analyse practices (artefacts) as manifestations of SC, including feedback and reporting.

Additionally, SC maturity is evaluated in certain companies' units upon necessity by external companies and SCL audits. According to the valid certificates companies' particular units have SC maturity equal to the steps three and four out of five possible. However, certain doubts were detected by the findings and observations, that these levels correspond to the interviewees' perception of the actual internal status of SC and measurements of the companies. For example, Boskalis interviewee consider their SC more mature, than step 3

(though only few units were certified), cases of other companies were named evaluated by high maturity steps, which exist only on paper and not in reality (according to the interviewee). Few interviewees having experience in several of the three studied companies did not feel much difference in the companies SC maturity.

During this long and arduous journey of SC development, the companies were facing various problems and challenges. Investments into the SPs need to be sufficient and continuous. Disrupted investments, insincere management commitment led occasionally to formalization of SPs and formal attitudes of employees. Top-down and bottom-up approaches in safety formation need to be combined. Companies' growth, temporary employment, and subcontractors' involvement required additional effort within the SP's work. External influences challenged the SPs and SC development. Learning, communication, and cooperation was undermined during Covid-19 pandemic since personal physical participation was substituted by online one. The companies may benefit by putting their attention to these issues and making necessary improvements.

Abductive logic and constructionist understanding of reality was applied in the thesis. Therefore, the results do not provide clear truths. Whereas interviews reflect subjective perception of reality, and meanings are constructed by different interviewees, as well as the author. Nevertheless, the results are indicative and present a snapshot picture of SC views, development, SPs influence measurements on SC, reflect problems and challenges and suggest directions for further SC and SPs improvements.

Limitations and implications

The focus in SC development is largely based on practical industrial experience, market driven developments, consultants' involvement in safety management and audits. Employment of academic and scientific research can contribute and improve companies' SC. Risk science can help, if companies use the current scientific knowledge of the field (Aven&Ylönen, 2021). Risk according to ISO standards, comprise a narrower understanding, which is not science driven.

Vision Zero espoused value is underlaying complicacy of safety and its dynamic character, and therefore can be extended by other values focusing on these features. More integration of HRO, Safety II, Resilience concepts, socio-technical view will strengthen the companies' SCs.

Certification by the SCL can be improved. Improvements can include the assessment of financial investments into the SPs and SC development. It can reveal the cases of formal attitude to SC development, being matured rather on paper than in reality. Incorporation of further improvements will limit, or eliminate the formal attitude to certification, and intensions to formally "fix" it. Additionally, it will contribute to more fair market competition.

An attempt was made to apply the framework of Aven and Ylönen (2021) however to a limited depth degree, which is typical for multiple case studies. Each case can be studied in more detail and at a different angle, for example with focus on risk and safety management systems. Such analysis may enrich subsequent research. The element of SC *structures and functions* was studied in a very limited degree. Nevertheless, it constitutes one of the three core elements and is relevant for further research. Power relations can be included and studied.

The primary data was limited to nine interviews and one or two companies' business units. More data can enrich further research. The differences of SC development between main units and divisions (Dredging, Wind, Oil and Gas, marine construction and services) and reasons for that can be useful for further, and more detailed study, and might help in SC improvement. Additionally, challenges, related to multinational and subcultural differences, and how the companies manage to overcome them can be useful to study.

The thesis provides only few insights into the latest external challenges (Covid 19, 24.02.2022). Learning, communication, and cooperation suffered a lot during Covid. Mental health became a new focus in SC and employees' safety. These influences on SC can be examined more at a later stage.

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Appendix A

Declaration of consent

University of Stavanger

Declaration of consent

I would like to conduct some interviews related to my Master thesis in Societal Safety at the University of Stavanger, Faculty of Science and Technology.

The main topic is Safety Culture in the organization and Safety Program.

I will record a conversation to ensure that information is full and can be used later for further analysis. This information will only be accessible for me. All the information provided during the interview will be anonymized when used in the thesis, be treated confidentially, and shall be deleted by the completion of the Master thesis and it's grading. Final deadline for thesis submission is 15.06.2022.

Participation in the project is voluntary and you may withdraw your consent at any time without giving a reason.

If you have any questions about the study, please contact me by e-mail: olga.kvalheim@stud.uis.no

This consent allows me to use the information provided in my Master thesis.

_____   _____

Olga Kvalheim
Master student in Societal Safety

Appendix B

Interview guide

RQ1 What is the company's view on safety culture (and risk)?

What is safety culture, from your point of view? (safety, risk)

Do you see safety culture as homogeneous/uniform in your company?

Did any safety culture exist before the safety program?

How or why were specifically these values chosen?

How do these individual values transform into shared organizational common values?

How are the values supported?

What is a good or strong safety culture according to the program, company's point of view?

Is safety culture a legal or insurance requirement in Holland to have a good safety culture?

RQ2 How safety culture is developed in your organization?

Why was the program initiated?

What existed before program was adopted?

Was it inspired by some developments within the company, safety field, by similar programs in other companies, by market competition, legal requirements of regulators and supervision authorities?

Can any difference be traced in terms of safety after the safety program implementation?

On which basis is safety culture developed?

How SC is being developed?

RQ3 What are the measurements and indications of safety program's influence on safety culture (or on its certain components)?

Are there any milestones or indicators in/of development?

Do you have any milestones or steps in SC and program development?

What are the reference points?

Does the company apply safety culture ladder as a guide? Are you certified by SCL? Do you aim for the highest step?

How is the success measured?

Is subcontractors' safety statistic included into your company's statistics?

Do you monitor safety climate or job satisfaction?

Is the program your ultimate view on safety? Is it an ideal state of things?

What is the effect of the program on overall safety in the company?

Whose task is the elaboration, guidance, and maintenance of the program?

RQ4 What are the deficiencies, problems, and challenges of the safety program?

How does the company maintain the program?

Were there any changes done within these years?

How does the company monitor understanding, developments, and improvements?

How does the company find out when something is not working or goes wrong?

Does somebody get fines or vice versa remunerated when results are good?

If incidents or accidents happen does anyone get punished?

Is what is written in the program done in practice?

How do you measure a general safety improvement?

Is it measured by means of LTIF and TRIR numbers?

How do you explain the Vision ZERO goal?

Do you want to add or mention something relevant from your side, what I did not touch upon when talking about SC and SPs, or what you consider relevant and important?

Appendix C

SC maturity certificates possessed by the companies

Data is retrieved from SCL site (NEN, 2022b)

Case Boskalis

Company ‸	Certificate number ⇕	Product ⇕	Step ⇕	Status ⇕	Valid until ⇕	Follow-up audit due ⇕	HQ Location ⇕	Country ⇕	C. of C. No.
Boskalis Nederland B.V.	21222-4.3	SCL Original	3	Valid	05-11-2024	05-11-2022	Rotterdam	NL	24143025
Boskalis Subsea Cables B.V. - Boskalis Offshore Subops GmbH	0418SCL202	SCL	3	Valid	29-11-2022	29-11-2021	Papendrecht	NL	24387623

Case Deme

Company ‸	Certificate number ⇕	Product ⇕	Step ⇕	Status ⇕	Valid until ⇕	Follow-up audit due ⇕	HQ Location ⇕	Country ⇕	C. of C. No.
DEME Infra Marine Contractors B.V.	3743026.10	SCL	3	Valid	27-01-2024	28-01-2022	Dordrecht	NL	24277837
DEME Infra Marine Contractors B.V. (Dredging, Environmental & Marine Engineering)	RQA00002146/3743026	SCL	3	Valid	27-01-2024	28-01-2022	Dordrecht	NL	24277837
DEME Infra Marine Contractors N.V.	3743026.9	SCL	3	Valid	27-01-2024	28-01-2022	Zwijndrecht	BE	0642.655.682
DEME Infra Marine Contractors N.V. (Dredging, Environmental & Marine Engineering)	RQA00002146/3743026	SCL	3	Valid	27-01-2024	28-01-2022	Zwijndrecht	BE	0642.655.682
DEME Offshore BE NV(Dredging, Environmental & Marine Engineering)	RQA00002147/3730632	SCL	4	Valid	24-06-2024	24-06-2022	Zwijndrecht	BE	N.v.t.
DEME Offshore NL B.V. (Dredging, Environmental & Marine Engineering)	RQA00002147/3730632	SCL	4	Valid	24-06-2024	24-06-2022	Breda	NL	20064480

Case Van Oord

Van Oord Grondstoffen B.V.	RQA00001766/3455368.4	SCL	4	Valid	24-02-2023	24-02-2022	Rotterdam	NL	65018222
Van Oord Nederland B.V.	RQA00001766/3455368.2	SCL	4	Valid	24-02-2023	24-02-2022	Rotterdam	NL	18106742
Van Oord Offshore B.V.	RQA00001766/3455368.1	SCL	4	Valid	24-02-2023	24-02-2022	Gorinchem	NL	11052251
Van Oord Offshore Wind B.V.	RQA00001766/3455368	SCL	4	Valid	24-02-2023	24-02-2022	Gorinchem	NL	11052540

Appendix D

Citations from secondary documents

Company's view on safety culture (to subchapter 4.1 of Empirical Findings)

Case Boskalis

"*One of the main foundations for risk management is the internal culture of the company, which is characterized by a high degree of transparency regarding the timely identification, evaluation and reporting of risks and a remuneration system that is geared to avoiding potentially perverse incentives. In addition to the specific risk mitigation measures mentioned above, our internal risk management and control systems include the following main components: 1. In the daily operations, the operational risk management and control is largely supported by a comprehensive system of quality assurance rules, procedures and systems, particularly regarding the acquisition and execution of projects (the aforementioned Boskalis Way of Working). 2. In addition to audits by external certification bodies, Boskalis also performs regular internal audits under the auspices of the SHE-Q department to review the design and operational effectiveness of this system. SHE-Q is discussed at quarterly meetings between the Board of Management and the management of the business units, with the management of the SHE-Q department also participating. 3. The daily management of the organization is based on short lines of communication and command. Speed, know-how and decisiveness are of the essence, both in the tendering phase and in project execution. Daily management is hands-on. 4. The progress and development of the operating results and the financial position of individual projects and business units and the Company as a whole, as well as the operational and financial risks, are monitored by means of structured periodical reporting, analysis of the financial results and performance reviews at Board of Management and senior management levels*" (*Annual report, 2020, p.67-68*).

"*Through the safety behavior program NINA we take care of the safety, security and health of everyone involved in our activities, including the communities where we work*" (Sustainability report, 2020, p.70).

Case Deme

"*DEME has ambitious safety targets and wants everyone on board. Ultimately, it is aiming for zero incidents and that safety awareness becomes part of the company's DNA. The safety strategy is based on four pillars: engagement/buy-in, collaboration, communication, and leadership. These are the foundations for a better safety performance, for better quality and for more efficiency. And these are all crucial ingredients for sustainable business excellence.*"(Deme, 2016, p. 26)

See additionally subchapter 1.3.2.

Case Van Oord

Findings from secondary sources - See subchapter 1.3.3.