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The safety mind-set in the ammunition chain of the Dutch Armed Forces

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The safety mind-set in the ammunition chain of the Dutch Armed Forces

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Preface

Safety and ammunition are topics that have a lot of attention of the Dutch Ministry of Defence and the Dutch parliament. Ammunition is dangerous, so the safety should always be ensured. Yet, recent times have showed that this has not always been the main focus. The mere suggestion that serious accidents with ammunition may have been caused by human failures and choices made, already makes the topic very sensitive within the Dutch Armed Forces. I hope that this thesis can contribute to the discussions on safety within the Dutch Armed Forces.

As I made progress with my thesis, I learned to understand what safety is about. Safety is a very complex concept and is an integral part of all operations. This made writing my thesis a real challenge. The only reason I was able to do it, was because of all the help received. I like to thank all the people that helped me during my thesis and in particular my graduation committee and the respondents in the Q-study, focus group and interviews. I also want to thank my colleagues of program Obelix. It was a real pleasure to work with them.

People often ask to summarize what you have done or learned in a short one-liner. I learned and did a lot. I think I am able to summarise the findings in my thesis with the following quote:

"A vision without the means to realise it, is a hallucination"

General James L. Jones USMC (2005)

Summary

On 6 July 2016 a regular exercise with a mortar group during the MINUSMA mission in Mali went wrong: a mortar grenade exploded inside the mortar barrel, resulting in the death of the two gunners and a heavy injury of a third person nearby (Joustra et al., 2017a). Multiple investigations were conducted into the accident, the ammunition chain and into the functioning of the Ministry of Defence. A year after the accident, this lead to the resignation of the Minister of Defence and the Chief of Defence (Ministerie van Defensie, 2017a). The reports pointed out that something was wrong with the safety culture within the Ministry of Defence among other things (e.g. Van der Veer et al., 2018; Joustra et al, 2017a). The attention of the Ministry of Defence has now shifted to seeing the human factor as an important root cause for accidents.

The ammunition domain is very fragmented and people within the Ministry of Defence often make the assumption that people from the different branches of the Armed Forces think differently about safety and its priority in making decisions for military operations. So far however it is unknown how the people in the ammunition chain think about safety or what causes differences in their thinking.

This led to the research question:
"What are key characteristics of the mind-set regarding safety of the various key-players involved in the ammunition chain and how can they be explained?"

The following sub-questions were used to answer the research question:

1. What are the perspectives of the key-players in the ammunition chain on safety?
2. How can the perspectives of the key-players in the ammunition chain on safety be explained?

A literature review was used to gain understanding in safety theories that could be applied to the ammunition chain. The focus was on Normal Accident Theory and High Reliability Theory. Q methodology was then used to identify and explore perspectives about safety of the key-players involved in the ammunition chain. A focus group and interviews with experts have been used to confirm the perspectives that were derived from the Q-study and to further explore their implications.

The conducted Q-study found three perspectives:

1. "Safety first!"
2. "Know what you are doing"
3. "Just fulfil the requirements and we can sort it out ourselves"

Perspective 1 and 2 were found with people that are part of the ammunition chain. Perspective 1 has an absolute way of thinking about safety. Perspective 2 has a more pragmatic way of thinking and focusses more on managing the risks than perspective 1. Perspective 3 has been found with people at the top level of the Ministry of Defence (Central Staff). These are the people that set the objectives, boundary conditions and make policies for the ammunition chain. Their focus is mainly on managing the lack of resources and regulating safety with internal oversight (compliance).

In contrast to what was expected at the start of the research, no (organizational) fragmentation has been found in the mind-set on safety with the participants of the conducted Q-study. The findings seem to imply that the mind-set regarding safety is mainly shaped by the organisational position and roles of the people involved with ammunition.

The perspectives 1 and 2 seem to correspond with how High Reliability Organisations (HRO) think about and position themselves regarding safety. In perspective 3, there seems to be no clear lower limit for safety, meaning that this perspective allows for trade-offs on safety if resources are limited.

The occurrence of perspective 3 was difficult to understand, therefore an explanation was sought. Combining the theory on NAT and HRO from the literature, the focus group and interviews with experts, a possible explanation for this perspective has been proposed. In this possible explanation the complexity in the governance at the top level of the Ministry of Defence seems to result in the loss of accountability for the ammunition chain. Further analysis, points to the separation of the military execution (CDS) and the policy-making and resource allocation (BS) as possible root-cause for this complexity.

From the point of view of safety, this is a structural problem, implying that after some time accidents with ammunition will return regardless of the safety measures put in place. Two possible solutions are proposed to prevent this from happening:

1. The military top (CDS) should get control over the internal policy-making and resource allocation.
2. An Integral Ammunition Management program should be set up in order to make better connection between the ammunition chain, CDS and BS. The focus of this program should lie on quality control, management of the regulations and management of knowledge & training.

List of abbreviations

ADR	Audit Dienst Rijk
AGCDS	Aanwijzing Gereedstelling CDS
ALARA	As Low As Reasonable Acceptable
ALARP	As Low As Reasonable Practicable
BPB-process	Beleid Plan Begroting-proces
BR	Bestuursraad
BS	Bestuurstaf
CDS	Centrale Defensiestaf (Central Defence Staff)
CDS	Commandant der Strijdkrachten (Chief of Defence)
CFA	Centroid Factor Analysis
CLSK	Commando Luchtstrijdkrachten (Air Force)
CZSK	Commando Zeestrijdkrachten (Navy)
DGB	Directie Generaal Beleid
DMO	Defensie Materieel Organisatie (Defence Materiel Organisation)
DMunB	Defensie Munitiebedrijf (Defence Ammunition Organisation)
DWS&B	Directie Wapensystemen & Bedrijven
DV	Directie Veiligheid (Directorate Safety)
EODD	Explosieve Opruimingsdienst Defensie (Defence Explosive Ordnance Disposal Service)
HDBV	Hoofddirectie Bedrijfsvoering
HDFC	Hoofddirectie Finance & Control
HRO	High Reliability Organization
HRT	High Reliability Theory
ILT	Inspectie Leefomgeving & Transport
I-SZW	Inspectie Sociale Zaken & Werkgelegenheid
JHL	Joint Hoofdlocatie (Joint Main Location)
KMCGS	Korps Militaire Controleurs Gevaarlijke Stoffen
MinDef	Minister van Defensie (Minister of Defence)
MINUSMA	Multidimensional Integrated Stabilisation Mission in Mali
NAT	Normal Accident Theory
NATO	North Atlantic Treaty Organisation
OVV	Onderzoeksraad voor Veiligheid
PCA	Principal Component Analysis
SG	Secretaris-Generaal (Secretary-General)
SMS	Safety Management System
STAS	Staatssecretaris (State Secretary)
USL	Unique Significant Loading
VKAM	Veiligheid, Kwaliteit, Arbo & Milieu

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1. Introduction

At the request of the United Nations a military coalition, the Multidimensional Integrated Stabilisation Mission in Mali (MINUSMA) is active in Mali to restore the security and stability in the country. The Royal Netherlands Army was part of this coalition from April 2014 until May 2019 (Ministerie van Defensie, 2018). On 6 July 2016 a regular exercise with a mortar group in Mali went terribly wrong. During the exercise a 60 mm mortar grenade exploded inside the mortar barrel. This explosion killed the two gunners and seriously injured a third serviceman (Joustra et al., 2017a).

The 'Onderzoeksraad voor Veiligheid' (OVV) investigated the mortar incident and found that several safety and quality checks were not performed with the 60 mm mortar grenades. The OVV concluded that, within the Dutch Military, quality and safety are subordinate to operational urgency resulting in a structural and serious lack of safety culture (Joustra et al., 2017a). In response to the conclusions of the OVV the Minister of Defence and the Chief of Defence resigned (Ministerie van Defensie, 2017a).

Subsequent investigations were conducted by the 'Audit Dienst Rijk' (ADR), 'Inspectie Sociale Zaken en Werkgelegenheid' (I-SZW) and the 'Inspectie Leefomgeving en Transport' (ILT) which all identified defects in the so-called ammunition chain of the Dutch military (e.g. ADR, 2018), and also in several other aspects than only safety, like personnel capacity and knowledge & training (Snel, 2019). The ammunition chain is a logistical chain, which includes the whole path from design until the ammunition is delivered to the user.[1] In the past several years, the ammunition domain of the Dutch Ministry of Defence has been downsized, while at the same time the demands from missions (including the demand for ammunition) in remote and difficult areas, for example the missions in Afghanistan and Mali, did not decrease proportionally resulting in relatively higher demands. According to the OVV, this conflicting situation stressed the ammunition chain and the (fatal) incident with the 60 mm mortar grenade occurred (Joustra et al., 2017a).

Since these reports, several initiatives have been launched by the Ministry of Defence to improve the safety within and effectiveness of the ammunition chain. But one of the difficulties is the fragmentation of the ammunition domain. A lot of subdomains, players and layers are involved (Potter, 2019). The different branches and layers (Navy, Army, Air Force, Military Police, the DMO, the CDS, etc.) all come together in the ammunition domain, but all have different cultures, characteristics and viewpoints. These differences can impede the growth of a safety culture through the whole ammunition domain like the 'Visistatiecommissie Defensie en Veiligheid' observed with the acceptance of the general action plan for safety (Verbeet et al., 2019).

Program 'Obelix' was launched[2] with the task to study the integral ammunition chain, initiate (structural) improvements and to take charge in the delivery of improvement projects (Snel, 2019). The goal of program Obelix is to improve the effectiveness of the ammunition chain in such way that in the future ammunition will be in sufficient amount on the right time in the right place whilst improving the safety (Snel, 2019). The focus of Obelix is on safety but the effectiveness is an important issue as well. The last few years the ammunition stock fell below minimum level with the consequence that not every unit could be supplied with sufficient and adequate ammunition (NOS, 2015).

[1] Source (2016) only available on intranet: link.
[2] Source (2018) only available on intranet: link.

The poor safety performances of the Dutch military can be blamed on thirty years of austerity according to the 'Visitatiecommissie Defensie en Veiligheid' (Verbeet et al., 2019). This is used by some people to explain the safety performances of the Dutch Armed Forces, because if a unit has to work on or beyond its operational limits it will find ways to make shortcuts in procedures in order to be able to solve the encountered problems (Moorkamp et al., 2014).

The reports show a picture where the Ministry of Defence does not have an adequate safety culture, i.e. does not prioritize for safety (e.g. Van der Veer et al., 2018; Joustra et al., 2017a). The reports task the Ministry of Defence to develop and improve a safety culture.

Safety culture is the part of the organisational culture which affects the members' attitudes and behaviour in relation to the organisation's ongoing safety performance (Cooper, 2000, p111). The desired effect of pursuing a high level of safety is that people remain constantly aware of the risks of working with ammunition are able to recognize risks and can make sensible decisions on how to act. Not only to prevent accidents, but also to protect the surrounding population. This thesis focusses on this task, by looking into the current mind-set on safety in the ammunition chain.

The topic of this thesis has a clear link to the master Complex Systems Engineering and Management, which focusses on complex social-technical environments. Safety is never isolated, but has a context in society and is all about decision-making, methods and tools (Ale, 2009). It is studied in the system consisting of man, technology and environment (Ale, 2009).

1.1. Research question

A lot has been researched and written on the safety culture topic. On how to develop or improve a safety culture, the literature is general.

Safety culture is a set of beliefs, perceptions and attitudes that reflect the importance that people in the organization put on safety, it is often regarded as a social construction (Zwetsloot et al., 2013, p43). Another definition is that safety culture is about the particular patterns of attitude of people towards safety practice (Ostrom, Wilhelmsen & Kaplan, 1993, p163). The concept of what a safety culture is, is broad, vague and hard to define exactly (Guldenmund, 2000). Safety culture is descriptive rather than active, meaning that the concept does not actively interfere in the organisation (Kines et al., 2011). Studying safety culture can be perceived as an attempt to grasp behaviour patterns of people in an organization.

In the past accidents were explained by looking for a root cause: a technical or individual failure. This way of thinking was, among other things translated into the 'zero accidents' discourse, aiming to do everything possible to have no accidents. Since then, other approaches emerged (Harvey, Waterson & Dainty, 2019). The concept of culture is sometimes used as a safety barrier against accidents caused by the human factor (Harvey, Waterson & Dainty, 2019). But as the attempt to define the concept safety culture shows, the concept is limited. Nevertheless, theories on accidents in complex systems and the role of the human factor do exist, for example the Normal Accident Theory and High Reliability Organisations (Harvey, Waterson & Dainty, 2019). These concepts can be used to study the ammunition chain of the Dutch Ministry of Defence.

The growing complexity of systems and organizations increasingly requires a safety approach which goes beyond the simple rational analysis of technical systems, organizational patterns and procedures in order to account for the system dynamics (Zwetsloot et al., 2013). The Normal Accident Theory (NAT) is a safety theory which tries to explain accidents within the context of system complexity. It focusses particularly on sociotechnical structures (Haavik et al., 2019). High Reliability Theory (HRT) studies High Reliability Organisations (HRO's). HRT does not emphasize how accidents happen, but what successful companies do to ensure and promote safety in complex systems. HRT focusses on the engineering concepts 'survivability' and 'resiliency' (Saleh et al., 2010), i.e. how an organization is able to prevent and resolve disruptions that affect the (production) processes.

The Dutch ammunition domain is fragmented because of the different branches (Navy, Army, Air Force and Military Police) and other organizational entities involved (Potter, 2019). It is unknown if this affects the safety in the ammunition chain. People within the Dutch Ministry of Defence make the assumption that people from the different branches think differently about safety. But is unknown how people working in the ammunition chain think about safety or what causes differences in thinking, i.e. what their mind-set[3] on safety is. The mind-set on safety of the key-players are relevant in particular, because the safety awareness behaviour of individuals is directly influenced by the group and depends mainly on the involvement of the management (Swuste, Frijters & Guldenmund, 2012). A lot has been said on this topic recently (e.g. Van der Veer et al., 2018), but no-one has researched what the people really think about safety. This is a knowledge gap. Knowing the varieties of the mind-set on safety in the ammunition chain will increase the understanding of incidents and help to make (safety) policies more effective.

The following main research question can be formulated to cover this topic and fill the knowledge gap:

"What are key characteristics of the mind-set regarding safety of the various key-players involved in the ammunition chain and how can they be explained?"

The empirical research focusses on the mind-set regarding safety of people in the ammunition chain. The focus is not on improving the systems, but to reveal the mind-set in order to start a discussion on decision-making about safety issues. The first step in exploring the mind-set, is to identify current perspectives on safety that people in the ammunition domain have. Then the implications for the safety in the ammunition chain and possible explanations can be explored.

According to Cools et al. (2009) Q methodology is able to show the segmentation on approaches and determinants regarding safety that matter for people. Showing the segmentation within the ammunition chain is important, because policies will be more efficient and effective if they are fine-tuned on specific target groups (Cools et al., 2009). Exploring the segmentation seems to be a crucial boundary condition for safety policies (Adamshick, 2007). In general the main advantage of Q methodology is the ability to distinguish groupings with similar attitudes within the population, while the common (attitude) questionnaires only show an overall impression (Ten Klooster, Visser & De Jong, 2008). This is useful, for example when exploring (dis)similarities between people from different branches. Q methodology is also a clear and captivating tool for communicating the aspects of safety to a broad range of stakeholders (Armatas, Venn & Watson, 2016).

[3] Mindset is a person's way of thinking and their opinions (Cambridge Dictionary, 2019).

Therefore, the main research question will be answered by answering the following sub-questions:

1. *What are the perspectives of the key-players in the ammunition chain on safety?*
   This thesis will use these perspectives from the Q methodology as an expression of the present mind-set and how groups have (dis)similar views regarding safety.
2. *How can the perspectives of the key-players in the ammunition chain on safety be explained?*
   Serious accidents with ammunition have occurred (e.g. Joustra et al., 2017a). Reports point to human (culture) and organizational (design) factors (e.g. Van der Veer et al., 2018). The perspectives and concepts like NAT and HRO will be used to explore (root) causes and design flaws within the ammunition chain that can explain the occurrence of ammunition related accidents.

1.2. Research approach

To find the answers to the research question and sub-questions, literature review, Q methodology and a focus group and expert interviews will be used as research approaches. Figure 1 visualizes the research approach and how they are linked to each other.

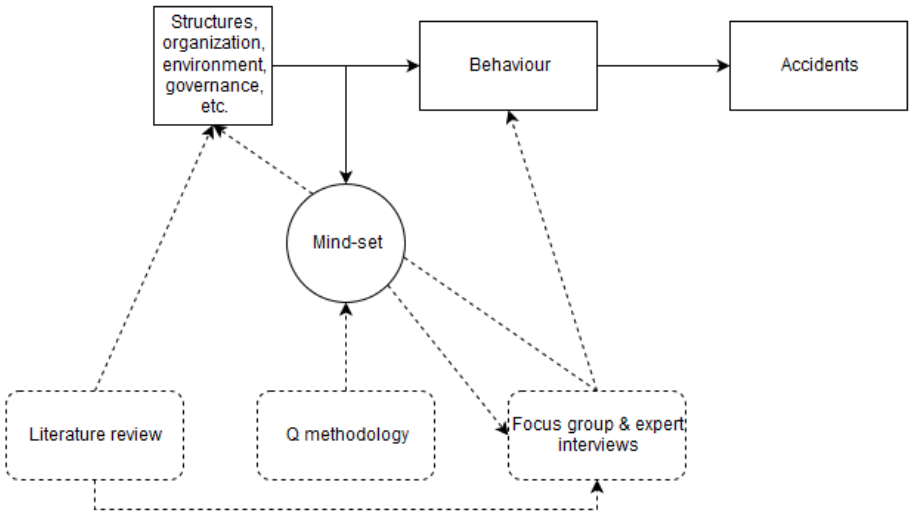

Figure 1: the research approach (dotted lines) and subject of the research

As a first step, a literature research is conducted. The aim of the literature research is to explore safety theories and concepts. This is done by using the search engines 'Google Scholar' and 'Scopus'. Search key-words are risk management, safety, safety culture, safety management, Normal Accident Theory and High Reliability Theory. Key-words like risk management and safety management were used to read more than only the specific theories. Safety is a difficult subject, where more and broader knowledge was needed to be able to fully understand the topic. Also, it was done to be sure that no major relevant theory or concept was unfairly excluded.

Q methodology has become a popular method of investigating perceptions, in particular with medical (technology), public opinion, communication, policy analysis, landscape planning, environmental issues and education (Ten Klooser, Visser & De Jong, 2008). Doing a Q-study in the field of safety sciences is not common. Q-studies in this field focus mainly on risk or safety perceptions. For example, safety-risk perception in the construction-industry (Zhang et al., 2015) or the exploration of stakeholder perspectives on flood management strategy (Raadgever, Mostert & Van de Giesen, 2008). With Q methodology the results cannot be generalized to a larger population, but can be used to

explore and elicit hypotheses. The result describes a population of viewpoints or perceptions, which can be helpful for exploring key considerations on policies for decision-makers (Strickert et al., 2015).

Q methodology is based on factor analysis. It aims to reveal patterns of association between a series of measured variables (Watts & Stenner, 2012). This leads to the identification of factors. A factor represents a group of persons who have ranked the statements in a very similar way and therefore share a similar perspective, viewpoint or attitude about the topic at hand (Watts & Stenner, 2012; Cuppen et al., 2010; Van Exel & De Graaf, 2005). The method complements the (quantitative) factor analysis with interviews with the same respondents to help interpreting the identified perspectives. Q methodology differs from other methods, because it asks the respondents to express their views within the context of all statements (Cuppen et al., 2010). A strength of Q methodology is that it gives respondents the freedom to provide their opinion instead of only making an observation (Diliou, 2013) This makes Q methodology a very suitable method, because it is able to reveal what people are thinking and what their opinions are at the same time (i.e. the mind-set).

A focus group and interviews with experts[4] is held to confirm the findings from the Q-study and explore possible (root) causes. The choice has been made to use both a focus group and interviewing experts, because it is two different ways of interpreting the findings. Therefore the confirmation will be stronger and the suggested causes and possible measures more applicable, and will nuance (future) discussions. Possible disagreement can point out differences in understanding or deeper issues which can be interesting to explore further.

A focus group is normally organised to explore a specific set of issues such as people's views and experiences, thoughts and opinions (Nili et al., 2014; Duggleby, 2005; Kitzinger, 1994). The focus group distinguishes itself from group interviews by the use of the group interaction as research data. The interactions can even lead to the appearance of group norms, something what regular surveys can do barely (Nili et al., 2014; Duggleby, 2005; Kitzinger, 1994). It is a useful method for research which focuses on how and why instead of what people think (Kitzinger, 1994).

1.3. Reading guide

In chapter 2 the ammunition chain will be elaborated and the relevant core concepts from the literature for this research are presented. Chapter 3 will present the conducted Q-study. The Q study will provide perspectives which will be validated in chapter 4 with a focus group and interviewing experts. In chapter 4, based on the focus group, will also be discussed how the perspectives can be explained. In chapter 5 the conclusions and recommendations will be presented and a discussion on the research will be held.

[4] Both intern as extern Ministry of Defence.

2. Theory

In this chapter the ammunition chain will be elaborated and literature will be reviewed. The aim of the literature review is to explain the concepts Normal Accident Theory and High Reliability Theory in order to be able to understand the implications for the safety of the findings in this thesis. The literature has also been used to provide input for the statements of the Q-study. Appendix A provides additional theoretical background on risks and safety. An elaborated literature review on NAT can be found in appendix B and on HRO in appendix C. A discussion on the integration of NAT and HRO is held in appendix D.

2.1. The ammunition chain

The ammunition chain is organisationally complex since it goes through multiple branches and organizational layers (Potter, 2019). Figure 2 shows the organization chart of the Dutch Ministry of Defence. For the ammunition chain the Defence Material Organisation (DMO) and the military branches, also called 'Operationele Commando's (OPCO's)[5], are important.

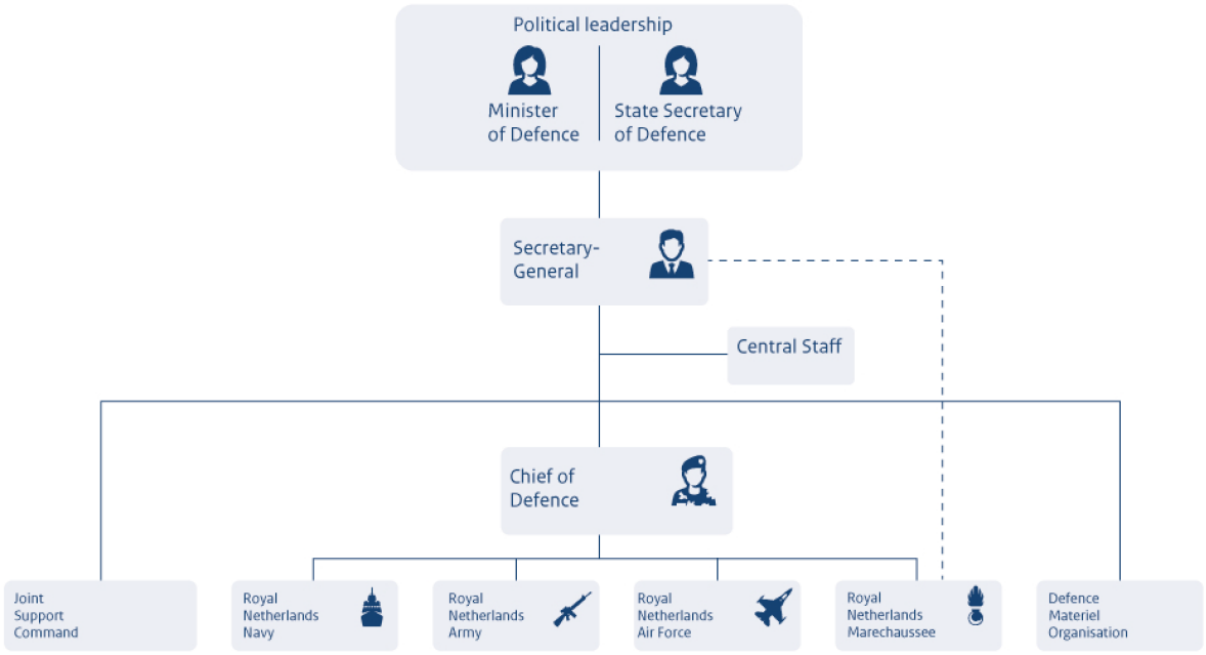

Figure 2: Organization chart of the Dutch Ministry of Defence (Ministerie van Defensie, 2017b)

The DMO originates from 2005 and was put in place because of a new governance model of the Ministry of Defence and to cope with budget cuts (Kamp, 2004). The development, acquiring, maintaining and disposal of Defence materiel was centralised in one organisation instead of every OPCO doing it for themselves (Kamp, 2004). The relationship between the DMO and the OPCO's can be compared with that of a service provider and its (regular) customers (Reijling, 2015). Ammunition was centralised under the wings of DMO as well: the 'Defensie Munitiebedrijf' (DMunB) as part of the Directie Wapensystemen & Bedrijven (DWS&B) (Ministerie van Defensie, 2019).

[5] OPCO is a general designation for the Navy, Army, Air Force and Military Police.

The DMunB is the most important organization within the ammunition chain, because it controls all centralised processes and the central ammunition stock.[6] Together with the OPCO's it is part of the ammunition chain. Figure 3 shows the ammunition chain with all the chain links and which branch is responsible. The DMunB can be seen as wholesaler and as service provider, and the OPCO's as clients.

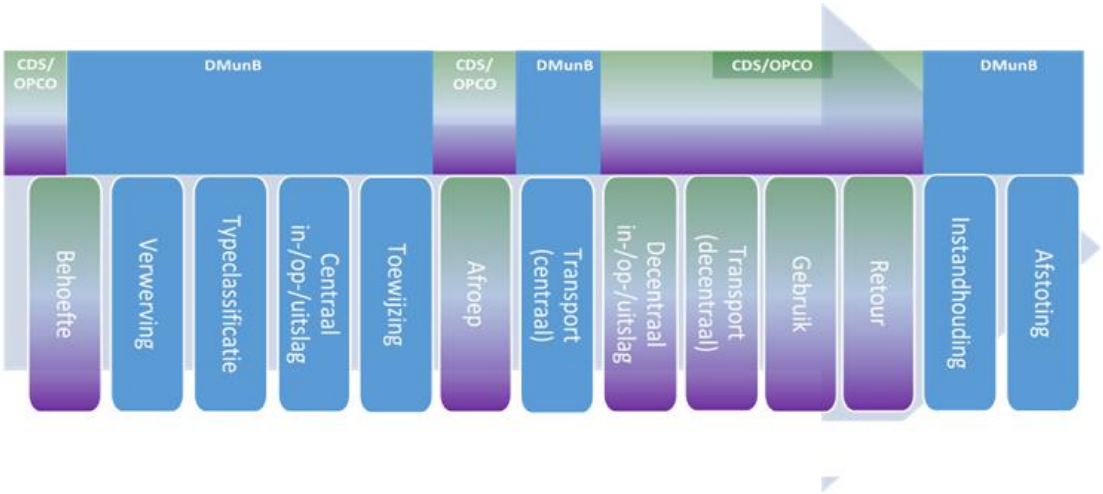

Figure 3: the ammunition chain of the Dutch military

An exception on the central ammunition stock are the 'Joint Hoofdlocaties' (JHL's).[7] The JHL's belong to the OPCO's and are used as decentral locations, where ammunition assigned to the concerning OPCO are stored. This is visualised in figure 4. Figure 4 shows the Dutch storage locations and organizational designation.

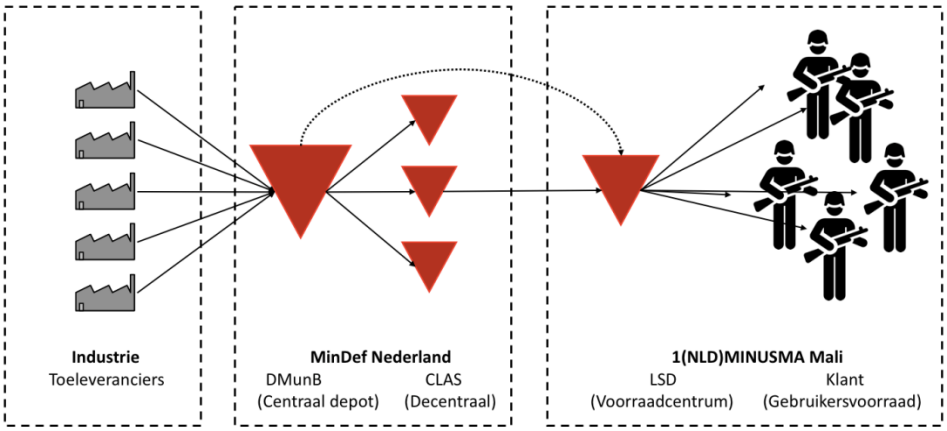

Figure 4: Visualization of the ammunition chain supplying a mission area like MINUSMA (Bokma, 2018)

In principle, all handling of ammunition is done within the DMunB. OPCO's only transport, issue and prepare ammunition for direct use on site.

Safety in the ammunition chain and the operational dimensions of the Armed Forces

The main objective of the ammunition chain is to provide ammunition within the context of military operations. Safety Management Systems (SMS)[8] are focussed on stability, where military operations are very dynamically complex (Moorkamp et al., 2014). SMS can be useful for ammunition handling in

[6] Source (2015) only available on intranet: link.
[7] Source (2015) only available on intranet: link.
[8] See appendix A for further elaboration of SMS and proceduralization.

The Netherlands and for supplying ammunition for exercises, but not for military operations. One issue is that processes regarding handling of ammunition during military operations differ from the processes in the Netherlands and are mission specific (DOPS-J4, 2019).

Another issue is that the environment of military operations is dynamic and unstable in contrast to exercises which are stable and static. The environment of military operations can be plotted on a scale as figure 5 shows (OTCO, 2009). SMS is only suitable in stable, static environments, the peacetime environment or the green part of the scale in figure 5. The more to the right in the figure, the less suitable SMS is.

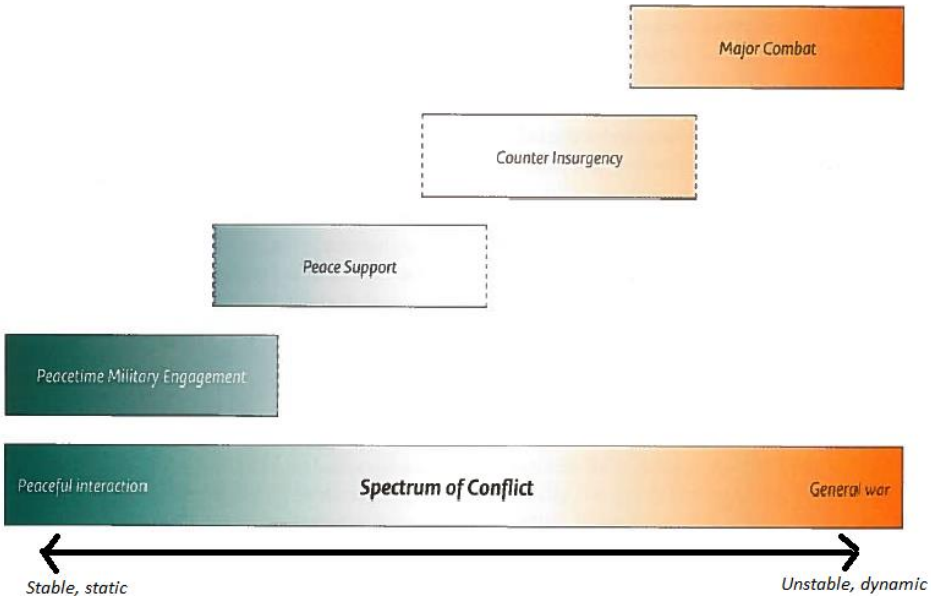

Figure 5: campaign themes (adapted from OTCO, 2009)

Figure 5 shows the dimension of military deployment, the core business of the armed forces. But most operations, activities or work take place within the 'peacetime environment' which is visualized in figure 6. The other dimensions are training (preparing for deployment), education (e.g. educating new recruits) and 'normal'/daily business (i.e. business operations).

The Ministry of Defence operates in all the four quadrants at the same time. At any one time there are multiple international missions going on in conflict areas abroad (e.g. Mali) , during peacetime at home in the Netherlands. The military personnel has to be able to switch regularly between the quadrants. Within each quadrant a different safety and risk situation is present and thereby a different safety regime is applied.[9] Figure 5 is an elaboration of the quadrant military operations and shows that each quadrant of figure 6 has underlying dimensions. SMS is suitable for the left side of the quadrant in figure 6, but less for the right side.

[9] BS2019020340.

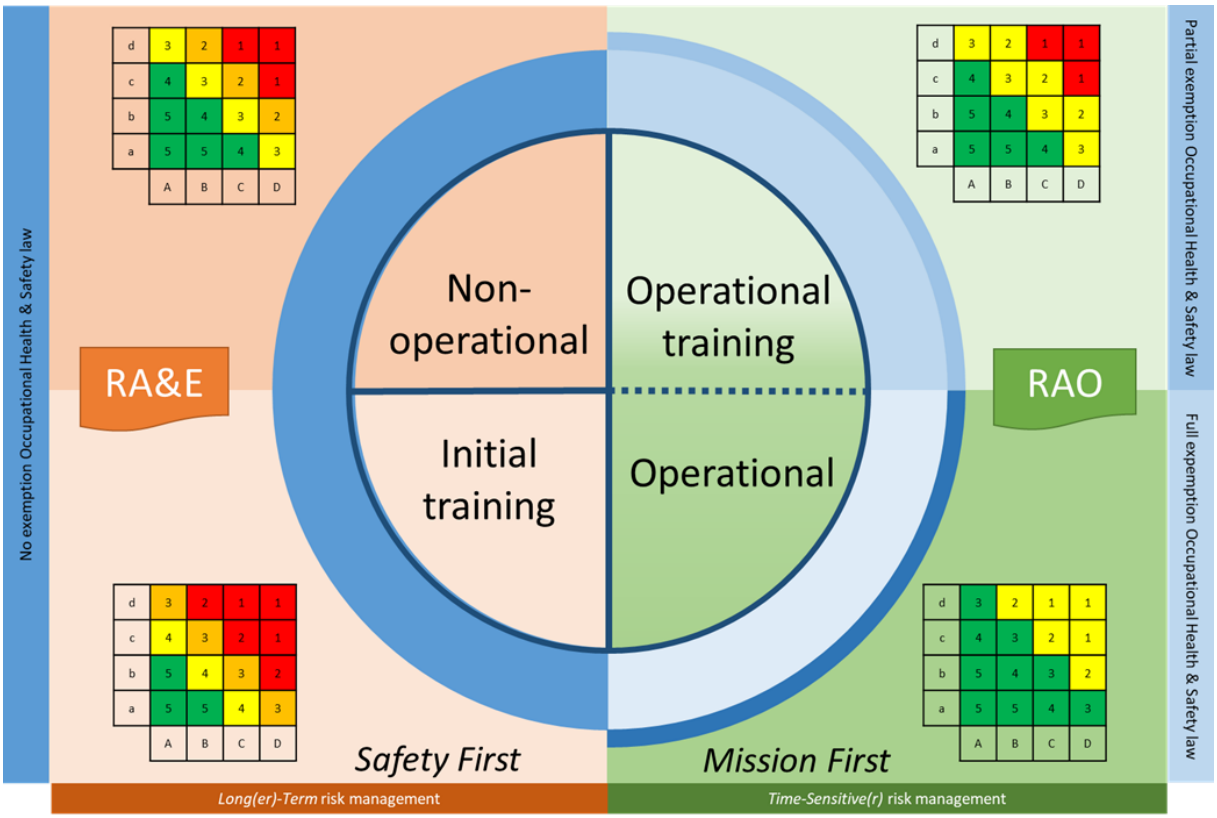

Figure 6: quadrant of operations of the Ministry of Defence under different conditions[10]

Figure 6 shows four separate quadrants, but in reality they are interlinked and not sharply delineated. Operations in one quadrant can directly influence other quadrants. An example is rejecting the quality of a part of the regular ammunition stock in response to a quality inspection, resulting in an acute ammunition shortage in mission areas which results in distortion of training.[11] The safety measure of rejecting the quality in the "normal"/daily business non-operational quadrant creates a safety risk both direct and indirect in the operational quadrant of the 'military operations', because they do not have sufficient ammunition to execute their operations (direct) and because people get less training resulting in decreasing readiness and standards (indirect). This implicates that the Ministry of Defence cannot solve all safety problems by, for example, adding a set of general rules and regulations, because the ammunition chain is active and linked with all four quadrants.

Ammunition is essential stock for military operations, so the ammunition chain has to operate according to the conditions set by the specific operation. SMS is not suitable to cover all types of operations of the ammunition chain. It is also unsatisfactory in explaining why an accident with ammunition or disruption of the chain happened. It feels uncomfortable to claim that if the organisation is complaint, nothing will or can happen. Therefore, the focus will be on NAT and HRT.

2.2. Normal Accident Theory

The Normal Accident Theory (NAT) studies systems and tries to explain why accidents occur. NAT argues that disasters, or large-scale cascading failures, are the product of systemic factors (design, equipment, operators, procedures or environment). A single failure within a complex system does not

[10] BS2019020340.
[11] This example is derived from reality, see for example Van Joolen (2019a) or Kuijpers (2016).

cause disasters, but multiple, cascading failures do (De Bruijne, 2006). The key definition of normal or systemic accidents is the unanticipated interaction of multiple failures in systems with high-risk technologies (Hopkins, 1999). According to the (fatalistic view of) NAT, all it takes to create a disaster is enough time to allow the multiple failures to happen (De Bruijne, 2006).

Organisations have the following characteristics according to the NAT (De Bruijne, 2006, p59):

- Interactive complexity
- Tight coupling
- Operators have little experience with the system characteristics
- Deficient organizational control over the operators
- The elite doesn't get threatened by system failure
- Reliability is socially exchangeable

2.3. High Reliability Theory

High Reliability Organizations (HRO's) are organisations which practice a form of organizing that reduces the impact of incidents and speeds up the process of recovering (Weick & Sutcliffe, 2007). HRT scholars believe that no human behaves with perfect rationality, so HRO's compensate this by perfectly rational and intelligent designs of their organisation. Therefore, HRO's behave more rational and effective than individual people (Smart et al., 2003). HRO's perform very demanding tasks which require extraordinary effort from both equipment and personnel, while the tolerances for error of the services they provide are extremely slim. A major incentive for the high performance is the knowledge that failure would be catastrophic for the organizations' success and survival. This is reflected in the constant monitoring of the performances of the HRO. HRO's collect a lot of data and measure the performances on clearly defined goals and standards (De Bruijne, 2006). With HRT comes a strong focus on the safety culture concept (Saleh et al., 2010).

HRO's differ from other organisations, because they understand that reliability is not the result of organisational invariance, but rather from a continuous management of fluctuations in job performances and human interactions (Sutcliffe, 2011). To be able to cope with such fluctuations, HRO's build capabilities for resilience. Resilience involves three abilities: to absorb strain and to preserve functioning in spite of the presence of adversity, to recover or to bounce back from untoward events (instead of collapsing) and to learn and grow from previous episodes of resilient action (Sutcliffe, 2011). The ideal HRO has a strong organizational culture, clarity of organizational objectives, the presence of slack and redundancy, mindful behaviour and the ability to prosper in the paradoxes (Saunders, 2015).

HRO's have the following characteristics (De Bruijne, 2006, p63):

- The involvement in reliability is apparent from the mission and goals
- Ongoing technical performances
- Structural flexibility and redundancy
- High level of responsibility and accountability
- Flexible decision-making processes
- Continuous urge to improve and to train in order to prepare for crises
- Reliability as a value is not exchangeable
- Organizational culture of reliability
- Dominant presence of external groups with sufficient operational information

High reliability is much harder to achieve and maintain in a setting involving multiple organisations that are jointly responsible for reliable output (De Bruijne, 2006). The Dutch ammunition domain has such setting.

The opposite of HRO's, or non-HRO's, are organisations that unwittingly institutionalize practices that encourage gradual erosion of standards. An acceptable outcome of risky behaviour in the immediate past is allowed to set the expectation for risky behaviour on the next occasion. The small incremental changes in the harmful direction get adopted in the daily routines by normalization of the deviance so repetitiously that it is impossible to detect this until it is too late (Shrivastava, Sonpar, & Pazzaglia, 2009). In short this was the conclusion of the analysis of NASA's inability to learn from previous experiences, especially after the two major accidents with the space shuttles Columbia and Challenger (Vaughan, 2005).

3. Q-study

3.1. Method

A Q-study has been conducted. Information on the method can be found in appendix E. The design of the conducted Q-study follows the steps as presented in figure 7. These steps are elaborated in appendix F. This section will present only a summary of the design. The next section will present the interpretation and narratives (step 6 in figure 7).

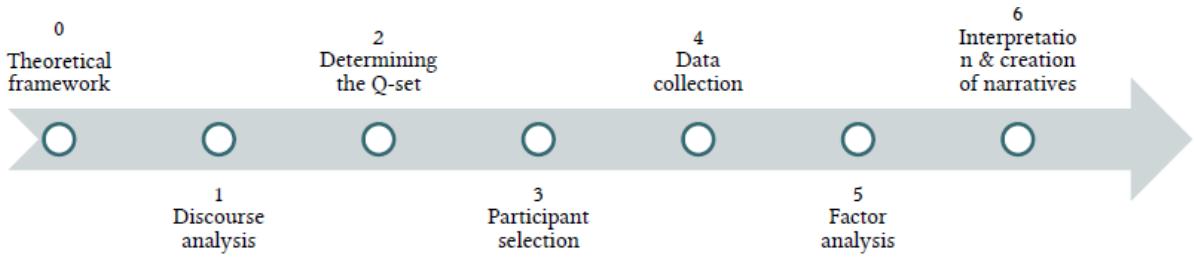

Figure 7: process steps of Q methodology (Van den Ende, 2018)

A concourse has been constructed by deriving statements from reports, theory and news items. In total, 227 statements were collected. From this concourse, a Q-sample with 49 statements concerning 10 themes has been selected.

From a RASCI-matrix of the ammunition domain (Potter, 2019), contacts of Obelix and people working in the ammunition chain, a list has been constructed with potential participants for the Q-study. A selection of 10-15 people were approached and from there snowballing was used to identify more key-players which could be approached as participant. In total 27 people participated in the Q-study.

The data was collected face-to-face. The participants were asked to sort cards with the statements on a sorting grid (appendix I). After the sorting, the participants were asked to elaborate the statements they agreed and disagreed most with.

The factor analysis was done with Centroid Factor Analysis (CFA) and Varimax rotation. As best solution, a CFA with four factors was used for further interpretation. One factor had no participants with significant loading, so this factor was excluded (appendix I). This resulted in three factors for the interpretation and creation of narratives, which will be explored further.

3.2. Factor interpretation & narratives

Three factors have been selected: 1, 2 and 4. Factor 1 has 10 unique significant loadings (USL), factor 2 has 8 and factor 4 has 3. 6 Q-sorts did not load uniquely and significantly on any of the factors, because these had high loadings on multiple factors (appendix K).

In the next sections, these factors are interpreted by building narratives based on the distinguishing statements from each factor. The most important statements for each perspective are presented in appendix L.

3.2.1. Perspective 1: *"Safety first!"*

This perspective is all about safety and protection against incidents. For example, if a commander has to make a trade-off between preserving equipment, mission objectives or the safety of his people he always has to choose for the safety of its people (44: +5*). Without the people, having equipment or a

mission is not enough substance to meet objectives. There should be no haggling about safety. Safety should never be expressed in terms of money (23: +4*). If it is expressed in terms of money, safety will often lose out in a trade-off against other priorities because there are always insufficient funds. Safety has to be seen in a broader perspective than only as protection against incidents. The belief is that a safer ammunition chain will also be more effective and reliable in supplying ammunition (24: -4).

Personnel is the key to preserving the safety in this perspective. The biggest issue with ammunition safety is the lack of sufficiently trained and qualified personnel (26: +4*). This holds especially for ammunition, which is a specialism. Nevertheless, the lack of sufficiently trained and personnel with up to date qualifications does not mean that mission objectives should be prioritized over the overall safety. Incompletely qualified personnel should never participate in trainings, military operations or other work. The belief is that this holds true even if that would mean that the operation has to be cancelled (34: +5*). As an employer the Ministry of Defence has the obligation to ensure the training of their personnel is up to standards. Safety is priority one. But the respondents do not see the lower levels reflect the same mind-set, because they perceive that there is more a culture of working unsafe rather than that there is a lack of the necessary resources (19: -1*).

The quality of ammunition has to be ensured at all times. Good management of the ammunition will ensure the safety. This will remain important, because weapon systems and mission deployments keep getting more complex and often have to be carried out in joint missions with other branches and coalition partners. Therefore internal quality inspections may never be skipped (3: -5*) and ammunition storages, even in operational areas, always have to be inspected (6: -3*). People who work with ammunition are focussed on preventing common (daily) incidents and not on rare events with high impact (25: -4*). Being safe means being free of errors (30: -3*), but here being free from errors does not mean the same as complying with the regulations. Deviating from regulations on ammunition may be allowed in some situations (43: +0*) if errors can be prevented. If an accident occurs, it is never acceptable (33: -5*). Accidents are also not inevitable, but can be prevented if enough efforts are put in safety (28: -2*).

The safety within the ammunition domain can be safeguarded and be improved with an ammunition authority like the MLA for aviation (47: +4*). There should be one body that regulates all ammunition processes clearly. The ammunition authority can be seen as one of the 'three lines of defence', because it is all about accountability. Maybe such a solution can resolve the perceived obstruction for improving the safety, namely the discrepancy between the "reality of The Hague" and the "reality in the field" (18: +3*).

The Ministry of Defence has to make the right priorities. They need to invest and should not being led by 'percentages'. If that would mean that the ambition level of the Armed Forces has to be lowered, then so be it (38: +0*).

3.2.2. Perspective 2: *"Know what you are doing"*

This perspective sees safeguarding the safety as important, but is not that strict about it and wants to handle it in a more pragmatic way. An example of this, is the strong belief that the Ministry of Defence should not focus on rule violations but should evaluate the worker's conduct in light of what was reasonable to do in the circumstances (27: +5). Rules are perceived to be useful, but are seen more as a tool to meet an objective. Not everything can be captured in regulations and procedures. A Safety Management System will help in being more proactive and preventing incidents (13: -3*) and

therefore focus on a Safety Management System will help (29: -3*). But it is not the most important element in safeguarding ammunition safety (15: -0*). That is logical, because higher safety risks are acceptable during international missions for example (4: +4*). In the end, a severe accident will always happen regardless of the efforts put in safety (28: +4*). A 100% level of safety does not exist.

In this perspective, it does not mean that safety is not important. For example, reliable safety of ammunition is seen as much more important than the reliable acquisition and deployment of ammunition (5: -5*). In the end, a safer ammunition chain will be more effective and reliable in supplying ammunition (24: -4).

Within this perspective, there is a strong focus on the human factor in causing incidents and also on the learning abilities of the Ministry of Defence. Accidents do not mainly happen because of unsound equipment for example, but because of the human factor (39: -5). People are the centre point of the systems and not the other way around (31: +3*). In order to be able to cope with the human factor, the learning capabilities of the Ministry of Defence are the key aspect to make the systems more robust. To safeguard this principle, the allocation of guilt of a (near) incident should not be the aim of an investigation to an incident (22: +1*). But most of all, transparency (to the public) is absolutely necessary to learn from accidents regardless of the potential backlash (36: +5*). This transparency is also important for safety, because the top of the Ministry of Defence only prioritizes safety after incidents occur (16: +3*).

It is about knowing what you are doing and making reasonable decisions. Therefore, not only specialists but also the decision-makers, commanders and leaders, should have knowledge of the basics of ammunition (11: +4). Then they can make a good decision and manage the risks proportionately. For example, when confronted with unsuitable equipment to stock and to handle ammunition in operational areas, which sometimes is the situation (1: +1*). They can then also make a decision when confronted with incompletely qualified personnel as the only means to get the job done. In case of incompletely qualified personnel, the military operation must not necessarily be cancelled (34: -3*) but there should be a way that the risks can and have to be managed in an adequate way. A possible mismatch in resources and the ambition level of the Armed Forces does not mean that operations cannot be executed safely (37: -0*).

In this perspective, the ammunition chain does not need to be centralised in one organisation (e.g. in DMunB), but can continue operating with multiple players and chain links (12: -4*).

3.2.3. Perspective 3: *"Just fulfil the requirements and we can sort it out ourselves"*

This perspective sees a clear mismatch in the available resources and assigned objectives and responsibilities. The commander who does not have the resources to meet his responsibilities (21: +5), will still be held accountable when things go wrong. From a higher point of view, the resources of the Armed Forces should be determined depending on the ambition level (37: +5*). The available resources and ambition level have to be balanced. The belief is that there is no culture of working unsafe, but rather a lack of the necessary resources (19: +3*). Safety costs money, therefore it should be expressed in terms of money (23: -3*) in order to be able to justify getting the required funds. Money can be only spent once.

The focus in this perspective is mainly on the financial resources, but personnel is also an important resource. The personnel need to be adequately equipped in order to do their jobs safely. Therefore

training and exercises should have the highest priority, because it influences the overall safety level the most (40: +4). But it is not only about specialists. The commanders and leaders should have knowledge of the basics of ammunition as well (11: +4). In general, people need more specific education regarding safety and safety awareness (7: -5*). But with ammunition safety, the lack of sufficient and current personnel is not the biggest issue (26: -1*).

Personnel is not only a resource. Experience shows that it is also the main cause of accidents (39: -5). Therefore human mistakes and culpability should be the focus of investigations to incidents (22: -4*). It is not believed that external oversight on safety will contribute significantly to the safety. Internal oversight is more important (42: -4), because then you have the knowledge, learning abilities and possibilities to enforce in-house. With internal oversight the oversight is constant and close to the executive level. But the need for internal oversight does not have to mean that an ammunition authority is necessary (47: -0*). Particularly, because of the specific work conditions of the Armed Forces. For example, when a commander has to make a trade-off between preserving his equipment, mission objectives and the safety of his people, he does not necessarily have to prioritize the safety of his people (44: -3*). Unwritten rules help the organisation and having them should not been seen as a threat to the safety (8: -3*).

It is not believed that the top of the Ministry of Defence prioritizes safety only after incidents occur. The belief within this perspective is that safety is already given the right priority (16: -4*). The “reality of The Hague” and the “reality in the field” do not differ enough to be perceived as an obstruction to achieving adequate safety (18: -1*).

Therefore, in this perspective, to improve the safety, the Ministry of Defence primarily has to be more responsive to signals and notifications regarding ammunition (13: +2*). If an accident occurs despite all the safety measures, it is acceptable regardless the consequences (33: +3*) because ‘shit happens’. The need to focus on rare events with high impact or on common incidents is not perceived (25: +0*).

Safety is important, but it should not stand in the way of the military power of the Armed Forces. Working safely does not mean being free of errors, but rather that errors do not disable the organisation in its fulfilment of objectives (30: +1*). Therefore the Ministry of Defence should not focus too much on preventing (minor) errors as a prime objective.

This implies that an advice or inspection body does not always have to assess the design of every ammunition storage in operational areas for example (6: +2*). It is desirable to have special procedures that bypass the normal procedures if there is a need for purchasing ammunition at shorter than normal notice (2: +2*). Internal quality inspections may even be skipped if that is necessary to deploy ammunition on time in operational areas (3: +0*).

3.3. Safety implications of the perspectives

Three perspectives with thoughts and opinions about safety were found. In this section, the perspectives will be explored by looking into their characteristics, meaning and potential safety implications. It is important to note that this is an attempt to interpret the findings and cannot be presented as a hard conclusion that is representative for all the people in the ammunition chain.

It is also not the intention of the Q-study to judge the perspectives on how good or bad their thoughts and opinions are on safety. The findings can, however, be used to explore the extent to which a way

of thinking is present. This is done by comparing the perspectives with the characteristics of NAT and HRO as described by De Bruijne (2006). In this section, the comparison is presented in table form, but an elaboration can be found in appendix M.

Perspective 1

Perspective 1 (factor 1) explains 17% of the study variance. 10 Q-sorts are uniquely and significantly associated with this factor. These sorts are from participants that all have a long career and experience with the Ministry of Defence, nearly all within the ammunition domain. They all are in senior management positions and a mix from all branches.

Perspective 1 exists with people who work of have worked extensively with ammunition. They are really concerned about safety and prioritize safety above anything else. They see safety as something absolute. Thus in this perspective there must be some threshold between sufficiently safe (ALARA) and unsafe. They are willingly to accept that the Dutch Armed Forces have less military power to project if that would be necessary to preserve safety.

Characteristic NAT	**Present?**	**Characteristic HRO**	**Present?**
Interactive complexity		The involvement in reliability is apparent from the mission and goals	
Tight coupling		Ongoing technical performances	X
Operators have little experience with the system characteristics		Structural flexibility and redundancy	
Deficient organizational control over the operators	X	High level of responsibility and accountability	X
The elite doesn't get threatened by system failure		Flexible decision-making processes	
Reliability is socially exchangeable		Continuous urge to improve and to train in order to prepare for crises	X
		Reliability as a value is not exchangeable	X
		Organizational culture of reliability	X
		Dominant presence of external groups with sufficient operational information	X
	1/6		**6/9**

Table 1: Comparison of perspective 1 to the characteristics of NAT and HRO (De Bruijne, 2006)

Perspective 2

Perspective 2 (factor 2) explains 14% of the study variance and 8 Q-sorts are uniquely and significantly associated with this factor. The Q-sorts are sorted by a mix of people from the Army and the Air Force. Their main characteristic is that they work mainly in the more operational domain, but are not direct involved in working with ammunition.

Perspective 2 exists with people with a greater distance to the ammunition chain, but give priority to safety in general. These people seem to prioritize safety at the same importance priority as perspective 1, but have a more pragmatic way of thinking regarding (ammunition) safety. They consider decision-making on risks central and think that taking responsibility for decision-making about risks very important. They try to mitigate the risks as much as possible or accept the (residual) risks if required or further mitigation is not possible.

Characteristic NAT	Present?	Characteristic HRO	Present?
Interactive complexity		The involvement in reliability is apparent from the mission and goals	
Tight coupling		Ongoing technical performances	X
Operators have little experience with the system characteristics		Structural flexibility and redundancy	X
Deficient organizational control over the operators		High level of responsibility and accountability	X
The elite doesn't get threatened by system failure		Flexible decision-making processes	X
Reliability is socially exchangeable		Continuous urge to improve and to train in order to prepare for crises	X
		Reliability as a value is not exchangeable	X
		Organizational culture of reliability	X
		Dominant presence of external groups with sufficient operational information	
	0/6		**7/9**

Table 2: Comparison of perspective 2 to the characteristics of NAT and HRO (De Bruijne, 2006)

Perspective 3

Perspective 3 (factor 4) explains 10% of the study variance. 3 Q-sorts are uniquely and significantly associated with this factor. The participants that have sorted these Q-sorts all work in The Hague, two are with the BS and one with the CDS. Two are from the Army and one is civilian. They are mainly dealing with administrative and political issues, as opposed to direct operational issues.

Perspective 3 was mostly found in people working in 'The Hague' in the political, policy-making and administrative field. They focus more on the lack of fulfilment of minimum requirements that are needed to meet the objectives of the Armed Forces. They believe that the military and ammunition are so specific that only the Ministry of Defence can and should design, execute and oversee ammunition safety and not an outside inspection or oversight department. The people with this perspective allow for a continuous trade-off on safety depending on the external goals set by politicians and the given means for the Ministry of Defence to reach these goals. They want to have more resources and focus on creating a good set of regulations and compliance. This perspective focusses strongly on the balance between responsibilities and resources, and enforcement of regulations in order to minimize the human factor.

Characteristic NAT	Present?	Characteristic HRO	Present?
Interactive complexity		The involvement in reliability is apparent from the mission and goals	
Tight coupling		Ongoing technical performances	
Operators have little experience with the system characteristics		Structural flexibility and redundancy	
Deficient organizational control over the operators		High level of responsibility and accountability	
The elite doesn't get threatened by system failure		Flexible decision-making processes	
Reliability is socially exchangeable	X	Continuous urge to improve and to train in order to prepare for crises	
		Reliability as a value is not exchangeable	
		Organizational culture of reliability	
		Dominant presence of external groups with sufficient operational information	
	1/6		**0/9**

Table 3: Comparison of perspective 3 to the characteristics of NAT and HRO (De Bruijne, 2006)

Comparison of the perspectives

The perspectives from the conducted Q-study show thoughts and opinions on safety. People with perspective 1 and 2 seem to have thoughts and opinions that show most of the characteristics of HRO's as mentioned by De Bruijne (2006). That can be seen as an indication that those perspectives are similar to how HRO positions itself regarding safety. The main difference between perspective 1 and 2 is that safety is absolute for perspective 1, while perspective 2 is more pragmatic and wants to manage risks.

Perspective 3 does not show the characteristics of HRO's. Characteristics of NAT are not really seen in any of the perspectives. That is not unexpected, because it has a more systemic approach in contrast to HRO which has more a focus on the way of thinking. The two mentioned NAT characteristics points to potential weaknesses at the top level of the Ministry of Defence. This is supported with perspective 3 not showing 'HRO-thinking', while this perspective exists with people at the top level of the Ministry of Defence.

Reflecting on the discussion on the suitability of SMS, NAT and HRO regarding the unstable and dynamic operational environment of conflicts in chapter 2, one can say that the people related to perspective 1 and 2 operate in the unstable, dynamic operational environments while people related to perspective 3 operate only in a peacetime environment. This can be seen as another indication that perspectives 1 and 2 are in line with HRO and perspective 3 is not.

3.4. Conclusions sub-question 1

The Q-study was conducted in order to answer sub-question 1: "*What are the perspectives of the key-players in the ammunition chain on safety?*"

Three perspectives were found:

1. "Safety first!"
2. "Know what you are doing"
3. "Just fulfil the requirements and we can sort it out ourselves"

In all three perspectives, a clear priority regarding safety was observed. Ammunition safety is about sufficiently well trained and experienced personnel and about keeping ammunition in good condition. The perspectives 1 and 2 are correlated and characteristics of 'HRO-thinking' can be seen with both. The main difference is that perspective 1 is more absolute, while perspective 2 is more pragmatic. Perspective 3 focusses on different aspects regarding safety. This perspective seems to allow for trade-offs on safety. With perspective 3, no HRO characteristics can be seen.

The Armed Forces operate in a high risk environment where risks cannot be eliminated, but should be dealt with in a reasonable way. To be able to do this, the resources (money and qualified personnel) are scarce. Here is a tension, because the three perspectives have different approaches to deal with the risks. People with perspective 1 will want to stop the mission if not all minimum requirements are fulfilled. Those with perspective 2 will want to mitigate the risks as much as possible but also take the responsibility to accept the residual risk whereas people with perspective 3 will want to try to find more resources or another way to let the mission continue.

The differences between the three perspectives are visualized in a caricature (figure 8) to illustrate the conclusion of the findings of the conducted Q-study.

Figure 8: caricature of the three perspectives

One other significant finding in this study is that no noticeable differences have been found between the different branches of the Dutch Armed Forces or between military and civilian personnel, or between the ranks. By contrast, differences have been found between the organisational positions and roles of the participants.

4. Validation and exploring the safety in the ammunition chain

With the Q-study three perspectives have been found. These have to be confirmed. If so, the insights can be used to explore potential measures to improve the safety within the ammunition domain. The aim is to get to understand the perspectives.

4.1. Method

For both the focus group and the interviews, a topic list with topics to discuss has been constructed and can be found in appendix N. The topic list is used to check for completeness and not to structure the focus group and interviews. The choice was to have mostly an unstructured focus group and interviews in order to be free to deepen certain topics, depending on the expertise present. In this way, the expertise present can be used to its maximum.

The main aim of the focus group and interviews is sometimes more on validation and sometimes more on exploring potential deeper causes and possible measures, depending on the expertise present. During the focus group and interviews, the participants do the most of the talking while notes are made by the researcher. These notes are covered per topic in the rest of this chapter.

For the focus group, participants were approached which have an overview of the ammunition chain as a whole and, preferably, who are concerned with the safety and performance levels of the ammunition chain. These requirements restrict the potential participants for the focus group to a small and specific number of people.

For the expert interviews, participants were approached both within as outside the Dutch Ministry of Defence. Based on the outcome of the Q-study, it was decided to approach potential participants who are involved with safety and/or governance. The list of interviewees is not exhaustive and the final selection is partly subjective. Their opinions have to be seen as mere indications and not as 'hard' facts. Therefore, the conclusions in this thesis, that are based on their indications are only possible explanations for what has been observed in the conducted Q-study.

Both the participants of the focus group as the interviewees can be found in appendix O. In this chapter statements derived from the focus group or interviews will be referred to by using the corresponding number in appendix O. Except in appendix O, their names will not be used for privacy and security reasons.

4.2. Confirmation of the perspectives

The three perspectives, derived from the Q-study, have been presented to a focus group and interviewed experts for further exploring. They read the three perspectives and were asked if they were able to recognize the perspectives and if they thought a perspective or view was missing. Each perspective as presented in section 3.2. was recognized by all interviewees and no other perspective seems to be missing. The belief of the executive level having a strong and absolute safety mind-set (perspective 1), an operational pragmatic mind-set in general (perspective 2) and a different, more ambiguous perspective at the administrative level (perspective 3) is shared by the focus group (1) and interviewed experts (2, 3, 4, 5 & 6). No-one substantively disagreed with the three perspectives.

One of the observations with the perspectives, was that they have a lot to do with the position the person that has the perspective resides in and is not based on branch, military or civilian or rank. This

has been confirmed by the focus group (1) and respondent 4. The position in an organisation determines very strongly the perspective of people. People have been seen to switch positions and from one day to the other switch in their mind-set, presumably because of different responsibilities in their new position according to the focus group (1). Therefore people should rotate between the different positions to bring the different perspectives together and reach a common understanding (4). On the other hand, this seems to be more persistent because with different roles come different responsibilities and therefore perspectives will shift (1).

The Dutch Ministry of Defence already has a strict job rotation policy where people have to rotate every 2-3 years. But it does not have a positive effect on working safely, because with the rotation the job specific knowledge disappears (Verbeet et al., 2019). The already existing policy also supports that the perspectives are strongly determined by the role or position of the person in the organisation and will shift when his role or position changes, because otherwise it would be more likely that the perspectives would be more homogeneous.

This is in line with other studies which indicate that the values and beliefs of the organisation's employees have less influence on organisational performance than the level of intra-organisational agreement (Falconer, 2006). In terms of safety, it seems to point out that the organizational design is key for the Ministry of Defence. If the organization is designed in such way that it enforces a common understanding, i.e. one shared perspective, a strong shared safety mind-set will prevail.[12]

4.3. Implications for (ammunition) safety

According to respondent 4, the existence of different perspectives on safety is a safety risk by itself, because having consensus on the basic values of safety is a minimum requirement for an organisation to be able to operate safely. Respondent 4 proposes that a consensus on the basic values has to be created, before the Ministry of Defence will be able to proceed with increasing the safety. This can, for example, be done by letting the people talk to each other on the basis of certain cases (4). The attitude on safety is very dependent on the knowledge and skill of a person according to respondent 6. In the end, respondents 4 and 5 have the opinion that the Ministry of Defence has to reach one perspective that does justice to all other currently existing perspectives. This requires discussion and connection between the organizational fragments. But one should be careful to not fall into the trap of thinking that norms and values can be imposed on organisations, that is not possible according to respondent 4.

Similar to aviation, the degree of regulation is involved as well says respondent 6. More regulation, means less space to mess around and less discussion. According to respondent 6, the ammunition domain is strictly regulated. The three perspectives are perceived to be logical and linked to the degree of regulations and knowledge and skill in the opinion of respondent 6.

According to respondent 4, perspective 1 and 3 are perpendicular to each other, because perspective 1 has an absolute, black-and-white perspective while perspective 3 perceives safety more grey and has no absolute lower bound on safety. People at the work floor work perceive things differently than at the top level of the Ministry of Defence. The top level has more generalistic and abstract work. That

[12] And would be in line with recommendations 1, 5 and 7 of Van der Veer et al. (2018) and in line with recommendation 1a of the OVV (Joustra et al., 2017a).

difference is problematic, because the top level has no common awareness on operations says respondent 3. Therefore, wrong interpretation of signals and wrong decisions are plausible.

Perspective 3 is perceived to be a risk by the focus group (1) and one of the experts (3), because people without understanding of the issue at hand make the decisions while allowing trade-offs on safety. They seem to make decisions on topics that they don't understand fully and therefore are not able to oversee the implications on safety. The belief that safety is a problem in The Hague and not a culture problem at the executive level has specifically been confirmed by one of the respondents (2).

If more resources are granted, the perspectives 2 and 3 will be improved and strengthened. Perspective 3 will never solve itself. It is the worst-case solution, a mind-set like perspectives 1 and 2 is always preferred according to respondent 3.

According to experts 2 and 4, the perspectives 1 and 3 can be compared with the concept 'work as imagined' and perspective 2 with 'work as done'.[13] Perspective 3 will create its own reality in order to be able to obtain more resources (4) and perspective 1 pursues an ideal situation.

Perspective 3 seems to have no lower limit on safety, while, according to respondent 4 it is important to have a clear lower limit about safety, because it defines when operations will be shut down. In the focus group (1) was said that if the policy-makers have no lower limit about safety than is that a serious safety risk. According to them (1), perspectives 1 and 2 accept risks explicitly, while perspective 3 accepts risks implicitly. This perspective is on a slope regarding safety, therefore people from this perspective should discuss regularly with people from perspective 1. Respondent 4 has the opinion that people from perspective 1 are the custodians of the lower limit. Especially the policy-makers need to be 'contaminated' with the operators according to the focus group (1).

The focus group (1) and two experts (4 & 5) are of the opinion that perspective 2 more or less resembles the people that embody the work as done the most and are the people that make the operational decisions (1, 4 & 5). They have a lot of knowledge and a high level of experience (6). These are also the people that show the most 'can-do' mentality (1). Their pragmatic view on safety is favourable, because more communication on risks and more factual risk-analyses are needed (4). Creating a mix of perspectives 1 and 2 is desirable, thinks the focus group (1). It is about the exchange of knowledge (5). The Ministry of Defence needs to shift from rule-thinking to risk-thinking. This will especially be challenging for the people from perspective 1 (4), i.e. to shift the focus from compliance to identifying and managing risks.

The perspectives from the Q-study showed that the perspectives are based on the roles and positions people have in the organisation. According to respondent 4, there should be one perspective instead of three, or at least consensus on the basic values on safety. According to the focus group (1), the preferred perspective is a mix of perspective 1 and 2. Perspective 3 should go, because it poses a safety risk. This can be achieved by letting people from those perspectives (in particular from perspectives 1 and 3) talk to each other with the aim to exchange knowledge on the subject (i.e. ammunition in this case).

[13] E.g. the paperwork can result in an illusion of safety with the managers (work as imagined), while the work as it actually was performed can differ (work as done) (Borys, 2009).

4.4. Exploring the factors that shape the perspectives

The perspectives 1 and 2 are quite straightforward. Perspective 3 is not and seems to have some implications on safety. Therefore, this section will be used to get to understand perspective 3 more and to find a possible explanation for the existence of this perspective. Based on the input of the focus group and interviews (appendix P) and literature a scheme has been made on the complexity of the governance in practice (figure 9). This scheme is a simplification of the reality.

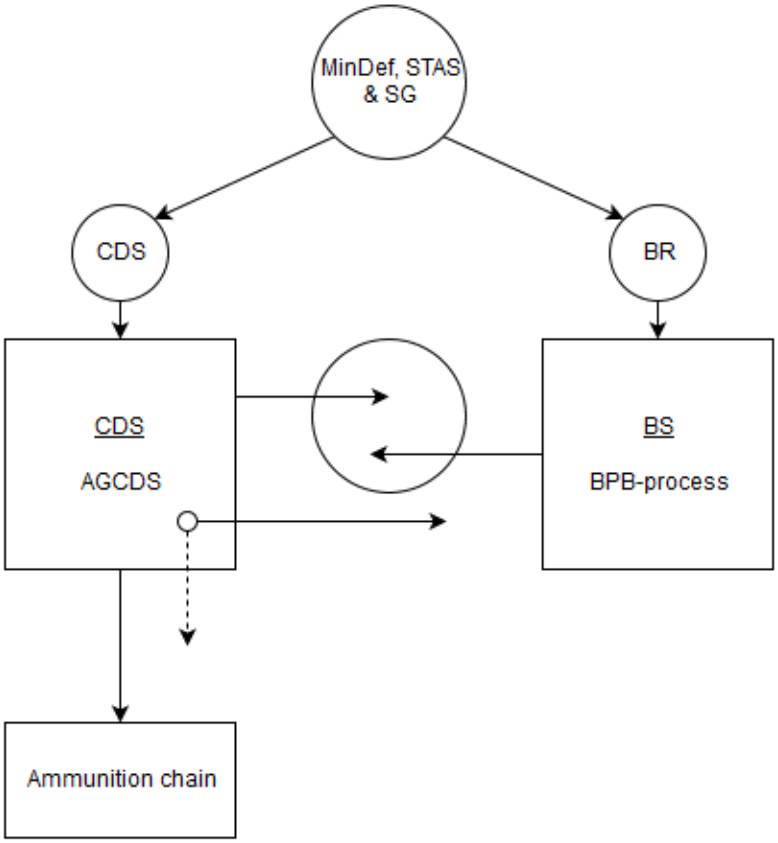

Figure 9: complexity of the governance in practice

The central staff of the Dutch Ministry of Defence can be seen as split in two: the CDS and the BS. The CDS is charged with the execution (i.e. the military business). The BS is charged with policy-making (DGB) and finance & control (HDFC). The main process of the CDS is the AGCDS (preparation objectives) and the main process of the BS is the BPB-process (policy-making and financial budget) (HDB, 2017). The ammunition chain consists of the DMunB and the OPCOs which are all part of the CDS, therefore the CDS is responsible for the whole ammunition chain.

A function within the CDS (the small circle) must manage or administer a process or situation in the ammunition chain (the dotted arrow). But in practice, he is too busy with dealing with the BS that he does not have time for his actual work, the ammunition chain. The CDS has certain (operational) objectives to meet, but to achieve these policies and funds are required. Both policy-making and the allocation of funds lie with the BPB-process. The function within the CDS can decide to ignore the BS and invest his time in governing the ammunition chain, but is likely to run against a wall. The BS is necessary to be involved because they make the required policy and are able to allocate funds.

In theory the CDS and BS work together and have each their tasks and responsibilities. In practice, that means that they have to play 'a game' where they deal, negotiate and fight each other. This can be seen as internal politics, because there the different interests of the various organizational entities get aligned (or prioritized). This is visualized with the two arrows and the circle in figure 9.

The CDS and BS are constantly and intensively interacting with each other. This causes two problems which affect the safety in the ammunition chain:

1. The intention is that the two pillars are equal, but in practice, the money governs.[14] In times of heavy budget cuts (like in 2012), the CDS depends heavily on the choices made by the BS because they make the policies and allocate the funds. This means that the balance of power shifts to the BS. Which seems to implicate that the generals are not in charge of the Armed Forces, but the accountants are. It is doubtful that this kind of governance is likely to protect the safety in the ammunition chain at all costs, especially during a period of heavy budget cuts. After all, they work with numbers and seem not to have awareness on what happens at the operational level.[15]
2. A lot of complex mechanisms, forums and other procedures exist to align the CDS and BS. This has the result that the people within the CDS don't have the time to govern the ammunition chain, or that signals and needs from the ammunition chain drown in the alignment process between the CDS and BS. The ammunition chain is one of many responsibilities (and priorities) of the Ministry of Defence that require alignment between the CDS and BS. Safety is difficult to quantify[16], therefore it is likely to lose in a battle between many priorities in the alignment process.

To conclude, in this proposed explanation, the two problems result in negligence of the ammunition chain (among other things). This complex governance model can also explain the existence of perspective 3 from the Q-study, because the perspective exists with the people who have to play this complex alignment game between the CDS and BS. It seems also be able to explain how the (safety) problems of the ammunition chain are mainly caused by the governance at the top level of the Ministry of Defence, and that the causes have a structural organizational character.

This scheme is also able to explain the success behind program Obelix. The program consists of 5-6 people without any formal authority, but are able to 'solve' the major structural problems in the ammunition chain in a time period of only 2 years (Snel, 2019). Obelix is a joint program commissioned by DMO (part of CDS) and HDBV (part of BS). Therefore, Obelix is able to connect the ammunition chain, the CDS and BS together and facilitates the alignment. With the present political pressure, Obelix is very effective in aligning the key players. This observation supports the described possible explanation.

Both perspective 3 and the governance of the ammunition chain can be addressed by resolving the complex, difficult and bureaucratic alignment process between the CDS and BS. Two potential measures are proposed:

1. Combine the two pillars. Give the CDS the ownership over the required policy-making and allocation of resources. This takes away the need for the interactions that drive the alignment.

[14] Or to quote my team members of Obelix: "No money, no Swiss.".
[15] According to the focus group and respondent 5 in appendix P.
[16] See also appendix R.

This has some resemblance with the governance model of the Ministry of Defence from the period before 2003 (Reijling, 2015).

2. To set up an Integral Ammunition Management program with the task to facilitate and smoothen the alignment process. If done right, it can solve both issues. The program can focus on quality control, manage the regulations on ammunition and manage the knowledge & training of personnel that work with ammunition for example.

If nothing is done, perspective 3 and the complex governance process will continue to exist. Even if safety measures have been taken, it is likely that over time structural problems will reoccur. The large degree of interactive complexity and tight coupling[17] makes this more likely. The loss of accountability for the ammunition chain due to the complexity of the governance model of the Ministry of Defence needs to be addressed in order to ensure the safety of the ammunition chain. This should be done in accordance of HRO.[18] For example, the top level needs to have sensitivity to operations (i.e. know what is going on with the operations) to know how they must adjust their policies.

4.5. Conclusions sub-question 2

The focus group and interviews were conducted to confirm the results from the Q-study. Both the focus group and all the interviewees confirmed the perspectives.

The other reason was to answer sub-question 2: "*How can the perspectives of the key-players in the ammunition chain on safety be explained?*"

The perspectives 1 and 2 are already explained in chapter 3. Based on the findings of the Q-study, focus group and expert interviews a possible explanation for the existence of perspective 3 has been elaborated. The perspectives and possible explanation of perspective 3 seem to indicate that the root cause of ammunition related accidents lies outside the ammunition chain. People within the ammunition chain (perspectives 1 and 2) are safety-minded, but perspective 3 seems to be not, while they set the boundary conditions and objectives for the ammunition chain.

The (dual) design of the Central Staff seems to create a complex playing field. This playing field seems to shape perspective 3 and the loss of accountability for the safety in the ammunition chain. The possible explanation presented in this chapter can also explain the distance between the top level (the Central Staff) and the people in the ammunition chain. Perspective 1 and 2 have a high correlation and perspective 1 and 3 are perceived to be perpendicular, implicating a difference in thinking between the people in the ammunition chain (perspectives 1 and 2) and the people at the top level (perspective 3). According to the presented possible explanation, the people with perspective 3 are swallowed up by this complex playing field where the CDS and BS need to be aligned, while the people with perspectives 1 and 2 seem to focus on the risks exposure from (working with) ammunition.

[17] See also the elaboration of the literature on NAT (appendix B).
[18] See also the elaboration of the literature on HRO (Appendix C).

5. Conclusions, discussion & recommendations

In this chapter the conclusion on the main research question and a discussion on the conducted research and its limitations will be held. Furthermore, recommendations will be presented.

5.1. Overall conclusion

The sub-questions have been answered in the respective chapters. This section will answer the main research question based on the research and the sub-questions. The main research question was: *"What are key characteristics of the mind-set regarding safety of the various key-players involved in the ammunition chain and how can they be explained?"*

Three perspectives were found when conducting a Q-study with the key-players involved in the ammunition chain. Two were found with people working in the ammunition chain. Both seem to be in line with how HRO thinks about safety. One of these two perspectives has a more absolute way of thinking about safety and the other a more pragmatic way of thinking with more focus on managing the risks. The third perspective has been found with people at the top level of the Dutch Ministry of Defence (Central Staff). It focusses on the lack of resources and internal oversight (compliance). This perspective seems to allow trade-offs on safety, i.e. seems to have no clear lower limit for safety. However these are the people that set the objectives and boundary conditions for the ammunition chain.

The ammunition domain of the Dutch Ministry of Defence is very fragmented. Nevertheless such (organizational) fragmentation has not been found in the mind-set on safety with the participants of the conducted Q-study. This finding for the ammunition chain is not in line with the general assumption that the mind-set on safety is related to the different branches within the Dutch Ministry of Defence.

The conducted research seems to indicate that the mind-set regarding safety is shaped by the organisational position and roles of the people involved with ammunition. This means that the mind-set on safety shifts with the position in the organisation and roles of people involved (with the various parts of the ammunition chain). This finding for the ammunition chain is important, because it implicates that the design and organisational structures of the Dutch Ministry of Defence determine the mind-set on safety.

What this research seems to show is that the governance model of the Ministry of Defence, based on two parallel but interdependent main processes, makes prioritizing safety at the top level difficult. A possible explanation has been elaborated for the existence of perspective 3 and why that perspective differs from the other two perspectives. The theories NAT and HRO are able to support the opinion of the focus group and interviewed experts, namely that the existence of perspective 3 is in itself a safety risk (and therefore the governance model as well).

Q methodology is not used often in the field of safety science. The outcomes in this thesis show that it is a useful methodology for this field. The findings show that the perspectives of people are shaped by the environment people operate in, therefore the perspectives from Q methodology can be seen as an indicator. This can help with exploring the (latent) factors that shape the perspectives of people which can result in the identification of organizational design flaws for example.

In hindsight, the outcomes of Q methodology were difficult to interpret. Having a good background knowledge of safety theories like NAT and HRO was necessary to be able to understand the implications of the perspectives and to be able to explore the environment of the perspectives further in order to find a possible explanation for certain specifics of the perspectives. This makes the methodology difficult to apply in the field of safety science if the researcher is not a subject matter expert.

5.2. Discussion

The conducted research had an explorative nature. One of the drawbacks of this kind of research is unpredictable outcomes. At the start of the thesis, it was the expectation to find fragmentation and differences between the branches regarding the mind-set on safety in the ammunition chain. Therefore, the focus was on identifying these differences and on organizing safety. It turned out to be different. Only a difference between the ammunition chain and 'The Hague' was found with the Q-study. This changed the focus from organizing safety to explaining the existence of the perspectives, which pointed to the governance structure. In the progression of the thesis the use of safety theories (NAT & HRO) moved to the back. However, the theories were very important to be able to interpret the perspectives. For the understanding of the findings and its implications for the safety (in the ammunition chain), it is important to have the knowledge of the safety theories. Therefore the literature review on these theories remained in the thesis. The change in focus is not bad, because the aim was to conduct an explorative study. This implicated from the beginning that the results would be more likely to fuel discussions and generate more questions rather than answering them.

But this is only possible when the value of the findings is clear. Therefore, the limitations of the methodology will be discussed and its implications for the findings.

5.2.1. Method and execution

Q methodology was used to find the perspectives. The methodology has a holistic approach with a small number of participants. Therefore it is very important to have a participant selection that covers the whole subject of the study. The number of participants was 27. This is sufficient (Watts & Stenner, 2012; Cools et al., 2009; Van Exel & De Graaf, 2005), but more had been better (e.g. 35-45). It was not possible to approach more participants because of time constraints. Because of the holistic approach, one participant more or less can result in (small) shifts in the perspectives. Having more participants makes the perspectives more 'stable' i.e. reduces the size of the (small) shifts when a participant is added or deleted from the data-set. Another reason why having more participants would be preferable is that it increases the confidence that all possible perspectives are captured in the study. The participant selection of the study does cover the whole ammunition chain and consists of most of the key players,[19] therefore it can be assumed that all relevant perspectives are captured. Nevertheless more participants would have been better if that had been feasible.

Another issue with the participant selection is the scope. All participants work in the ammunition chain or are directly involved (e.g. EODD). Some participants are from the administrative level and influence or set boundary conditions for the ammunition chain. They were included because policy-making and the politics directly influence the ammunition chain. But confronted with the findings (i.e. the

[19] See appendix F.

implications of perspective 3), including more participants from the administrative level would have been better to strengthen the support for the findings.

The users of ammunition (e.g. the soldier who shoots the rifle) were not included in the Q-study. The users work with ammunition in more demanding conditions and environments. There is some discussion within the Dutch Ministry of Defence on where the ammunition chain ends. Especially in the light of the finding that the perspectives are determined by the organizational position and role, it is interesting to look into the users of ammunition. They were not included for a practical reason, the users of ammunition are very divers and comprise practically all military personnel. The Q-study did include multiple participants with experience as commander or part of operational units with combat experience. They aligned with perspective 2. The findings of the study regarding rules and safety with naval divers (Van Joolen, 2019b) supports the presumption that users (or at least the commanders) can be found mostly in perspective 2. But what the perspectives on safety are with the actual operators is unknown. Further research can be done to investigate this. But because of the large number of participants that it would require, it is not likely that Q methodology is the suitable method for this kind of research.

Q methodology uses 'subject matter experts' to explore perspectives. Within the military these are commonly the seniors which became experts through accumulated experience. The mind-set of the middle management is crucial for safety, therefore it will be interesting to research the mind-set of the middle management (non-commissioned officers) in the ammunition chain according to respondent 4. The Q-study did not include juniors or non-commissioned officers. This is a big limitation, because they have a big impact on the work floor. One of the interviewees pointed this out as well, but he expected that the non-commissioned officers would have the same three perspectives and that juniors would be likely to have more perspective 1 (6). But senior military people tend to score higher in safety climate assessments than junior military people (Adamshick, 2007). Q methodology is not suitable to accommodate for such variance within the population, because it studies the variety of perspectives. It does not score a level of some scale or the support for the perspectives (Cuppen et al., 2010). If required it can be studied, but with a different method. Therefore the findings from the conducted Q-study are useful, but do not include everything, such as possible variance with juniors and non-commissioned officers.

In the factor analysis part of the Q-study, the choice has been made to go with CFA with four factors and not with PCA or a different number of factors. The arguments for this choice have been elaborated in appendix F. Still, other choices could have been made. A brief look at other factor analyses with the same data-set learned that the essence is the same, but the interpretation will differ. The perspectives found in the Q-study should not be seen in an absolute way like it is the truth. The perspectives are a product of certain choices made during the Q-study and provide useful insights.

One of the problems with Q methodology is its reliability in how replicable the results are. If a participant would repeat the sorting, it is likely it would not be sorted exactly the same way. However, it is claimed that Q-sorts can be replicated by the participants with a consistency of 85% if executed within a year (Brown, 1980). On the other hand, the findings of the Q-study are time-bound. Cultures, mind-sets, etc. change over time, especially after incidents or changes that shake the organization up. The mortar accident in Mali in 2016 was such incident. Within the Dutch Ministry of Defence the accident was clearly a wake-up call to deal with safety differently. In the same year another deadly

accident occurred with an exercise on a shooting range in Ossendrecht. This Q-study was conducted three years after the accidents and two years after the reports of Joustra et al. (2017a; 2017b). It is likely that the culture (of safety) has been shifted and is not the same as it was before the accidents in 2016. It is possible that it will shift again in the future, for example when over time the focus on safety ebbs away. Repeating the study over time can make possible shifts visible. Therefore it can be interesting for the Dutch Ministry of Defence to do a Q-study periodically. The results of repeated studies can even be used to help evaluating the effectiveness of (safety) measures over time.

One limitation with the reliability of Q methodology is that it is a method which is hard to execute and time-consuming for the participants. The participants have to read, interpret and think over, and make choices on all statements. That is hard and time-consuming, especially with larger Q-studies and difficult topics like 49 statements about safety in this thesis. It is possible that participants interpret certain statements differently causing noise in the data. Therefore data-collection has been done face-to-face in order to be able to explain statements if necessary. The statements were set up in such way that they were recognizable for the participants. Furthermore, the factor analysis produces only a number of clusters with statements. The researcher has to interpret these clusters and make up a narrative. Explanations of the participants during the data-collection are helpful, but too much subjectivity of the researcher remains a risk. Therefore the findings of the conducted Q-study have been confirmed. The confirmation was done in two ways: with a focus group and subject experts. Both approaches confirmed the findings, so it is not likely that this limitation has affected the research much.

In the end it is important to remember that the collected statements and the results of the Q-study are just a snapshot. Therefore it would be interesting to see if the findings can be supported with more research with different methods and how the mind-set on safety will evolve over time. In general, a mind-set evolves over time. Therefore it would be interesting to study how (safety) thinking evolves over time and how this compares to other armed forces like from Australia or Great Britain. Because of time constraints, such a comparison study has not been done within this thesis.

The focus group gave some interesting points concerning the conducted Q-study. One participant expected perspective 1 and 2 to be turned around regarding which people they were found with. He thought that if people know how things work, they know which risks they can take and therefore will be pragmatic regarding safety. The Q-study indicated that this is not the case. If people know how things work, they know which risks they should not take. This confusion shows how difficult the concepts of safety and risk management are and why more research and broad knowledge exchange on safety is necessary to improve safety and safety awareness.

Another point that was made was that the research was conducted in a peacetime context, while a person's risk appetite will be different during military deployment. It is unclear if a (temporary) shift in risk appetite will mean that the mind-set will shift as well. It seems plausible that shifts in risk appetite, because of changing contexts, is part of perspective 2. This question mainly concerns the user of ammunition, who for this research was put outside the scope of the ammunition chain. Nevertheless, it can be useful for the Dutch Ministry of Defence to set up a study where the mind-sets regarding safety during peacetime in The Netherlands and during deployment of a unit are compared.

Although the participants of the focus group were kept unaware of it, all three perspectives were present during the focus group session. It was made sure that some of the participants from the Q-

study were included in the focus group. It was interesting to see that they had different or opposing views, but were able to reach consensus on executive issues quickly after some explanation from one or more participants. The initial difference in views was mostly caused by unfamiliarity with some of the participants about the issue at hand. But on the issues related to accountability and complexity, in particular at the top level, they disagreed strongly and were not able to reach a consensus even after discussion. Perspective 3 was strongly opposing the views of perspectives 1 and 2. Perspectives 1 and 2 pointed out complexity at the top as problematic, while perspective 3 focussed on behaviour of individuals at the top. The set up was too small to draw conclusions from this focus group, but it can be seen as an indication for what will happen if people with the different perspectives are put together and discuss the issues. This seems to confirm the statement of respondent 4 that discussion and knowledge exchange between the perspectives will help in growing more understanding and eventually reaching one shared perspective on safety. It seems also to confirm the issues with the accountability and complexity (at the top level).

As already mentioned, the OPCO's are part of the ammunition chain as well.[20] Therefore the people of the OPCO's that are concerned with ammunition safety were approached. The Army did not have such a function, leaving a white spot in the participant selection to cover the ammunition chain. In the other OPCO's such function could be recognized, but with the Army this was not possible.

At the level of the staff of the Army, people referred to the new safety program. But this program did not cover the safety function fully. This also became apparent by looking into the incident database of the Army: incident reports remain unprocessed for a long time. This was compared with the Air Force where the reports were processed within a week, while with the Army examples of nearly a year were seen which shows the lack of a function that covers safety within the Army. It may seem irrelevant for this thesis, but the execution plan of this safety program is analysed in appendix Q. This was done to make sure that this 'white spot' in the participant selection is inevitable, besides it can be seen as by-catch. The problem is also in line with the theory used in this thesis.

The reason why there is (still) a white spot has not been explored. A possible and speculative explanation that came up during the interviews with the experts is that the Army, in contrast to for example the Air Force or the oil exploration industry, has no actual positive incentive to operate safely and to evaluate processes and organisation design for safety aspects. This means that the Army should make an effort to study any lack of positive incentive to operate safely and how it can be created. The organisational position and set up of a department safety directly under the C-Las can help and should therefore be included in such study.

For the participant selection of the Q-study, the alternative was to approach commanders of the units where safety is currently allocated. Because of the diversity and number of commanders and units, this was not feasible. But the (recently) former commander of '13 Herstel Compagnie' was included to correct this white spot at least partly. On the other hand, the Army was the largest branch in the participant selection. However, given the fact that they all have been commanders of different units in the past. it is unlikely that this white spot affected the Q-study much.

[20] See figure 3 in chapter 2.

5.2.2. Findings

A focus group and interviews with experts were used to explore the implications of the findings further. Both the focus as the approached people are prone to subjectivity with the selection. The possible subjectivity can affect the value of the validation. Therefore the findings are discussed and compared with other (independent) reports.

The conclusion on the mind-set regarding safety in the ammunition chain is in line with Verbeet et al. (2019).[21] This thesis is case-specific, but can be seen as a confirmation of the presumption of Verbeet et al. (2019). Both go against recommendation 7 of Van der Veer et al. (2018).[22] It argues all the more for more research on this subject. Especially because the case of the Army (appendix Q) shows that much value is ascribed to the recommendations of Van der Veer et al. (2018).

The focus group and interviews complemented each other, which strengthens the findings of the conducted research. The findings, in particular on the accountability and complexity at the top level, are in line with the research of Reijling (2015). He points out that the administrative component is focussed on the nationwide government, while the military component is focussed on the international military domain. This results in a split which affects the CDS in particular (Reijling, 2015).

The findings reveal that a clear desire to work safely exists within the ammunition chain, but seem to point out a governance problem with the ammunition chain. It is interesting to see that most reports focused on the work floor whereas a latent cause of the safety-related issues apparently lies in the governance above the work floor.

The journalist Davidson (2019) comes to a similar conclusion based on the year reports of the KMCGS. He points out, while using different sources, that the increasing number of violations of ammunition regulations is due to the (lack) of governance within the Dutch Ministry of Defence. This can be seen as support for the findings in this thesis.

5.3. Recommendations

Based on the research the following major recommendations are made to the Dutch Ministry of Defence:

Ammunition chain

1. Investigate to set up an Integral Ammunition Management program which can facilitate the line management. The program should focus on quality control of ammunition, managing regulations regarding ammunition and to manage knowledge & training of personnel working with ammunition.

2. Achieve a single perspective on safety, or at least consensus on the basic values. This can be achieved by bringing the different perspectives together and exchange knowledge with the aim to improve the common awareness of what the product of operations is.

General governance

3. Bring the military control (AGCDS), internal policy-making and resource allocation (BPB-process) together in the organizational design of the Dutch Ministry of Defence. Policy-making and resource

[21] Verbeet et al. (2019) did not observe a 'culture of working unsafe'.
[22] Van der Veer et al. (2018) calls for a change in safety culture.

allocation should be subordinate and support the military control. The Chief of Defence needs to have control over the policy-making and resources to fulfil his objectives and responsibilities.

4. Reconnect the top level of the Dutch Ministry of Defence and the operational work floor with the aim to create common awareness on the operational output. For example, by increasing the number of military people with operational experience at the top level. Especially at the administrative, policy-making and political level, there are more people with military operational experience needed.[23]

Further research

5. Research on the current governance model of the Ministry of Defence and how it is able to secure safety.

6. Research on the mind-set about safety with the (young) non-commissioned officers.

7. Research how the mind-set on safety evolves over time.

[23] See appendix P and page 275-283 of Reijling (2015).

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Appendix A: Theoretical background on safety

Safety within the context of military operations is a difficult concept, because mission areas are inherently unsafe and accidents are therefore unavoidable (Moorkamp, 2017; Moorkamp et al., 2014). Safety can be defined as the absence of hazard, risk or injury (Ale, 2009, p10) or as a concept where the risk is perceived as something that will not become reality (Aven, 2014). The first definition perceives safety as a physical condition, the second as a subjective perception. With ammunition, the focus is on thephysical safety concept and therefore on the definition of Ale (2009).

Easy preventable accidents and mishaps continuously degrade the readiness of the military forces and thereby their deployment capabilities (Adamshick, 2007). Therefore, safety is not only on preventing, for example, injuries but also the preservation of effective (military) capabilities.

Safety risks

Safety risk can be defined as the combination of frequency and the consequence of a specified hazardous event (Motet & Bieder, 2017; Woodward & Pitbaldo, 2010). A hazardous event (or a hazard) is the physical situation with the potential for human injury, damage to property, the environment, or some combination of these (Woodward & Pitbaldo, 2010).

There are different kinds of risks with different characteristics. The risk of damage caused by a flood is different from the risk of death by traffic accident and requires different measures, decision-making and acceptance. The most important risks of using ammunition are uncontrolled explosions. The characterization of this type of risk is one with a small probability but large consequences, see figure 10 below (Ale, 2009).

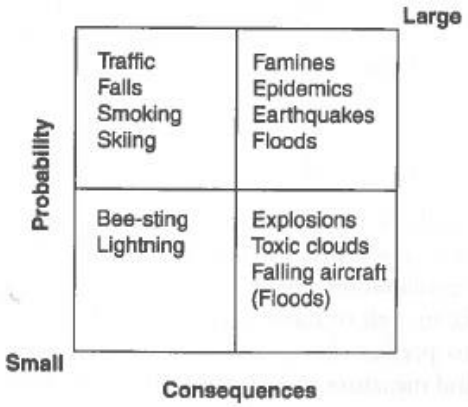

Figure 10: risks divided according to their consequences and probabilities (Ale, 2009)

There are many strategies to deal with risks and to prevent incidents from happening. Which strategy is suitable depends on the type of risk and its context. Risk management strategies can be categorized in four main categories (Zsidisin & Ritchie, 2010; Hubbard, 2009):

- Elimination of the risk
- Reducing the frequency and the consequences of the risks
- Transferring of the risks by insurance or other means
- Acceptance of the risk

Most of the time elimination of the risk is only possible by not doing something. When being exposed to a risk is an effect of the operation or business activity, elimination of the risk will not be possible. In that case a certain amount of risk always has to be accepted (Reniers et al., 2006). But risks have

to be reduced to the level of as lows a reasonably practicable or acceptable (ALARP or ALARA), what implicates that certain risks have to be accepted even when it is (theoretically) possible to reduce it even more (Ferdous et al., 2013; Ale, 2009; Reniers et al., 2006).

Safety by regulation

Safety Management Systems (SMS) is an approach which is inspired on business management and quality control methods. SMS consist of series of interlocking problem-solving cycles focussed on the prevention and correction of deviations of parameters or safety norms (Hale et al., 1998). These systems describe what the organization should be explicitly and intentionally do for safety under the leadership of its managers (Pariès et al., 2019). SMS are predominantly bureaucratic, so they are mainly developed in and for large stable and static organizations (Moorkamp, 2017). But SMS are doomed to fail if they become too bureaucratic, because its bureaucratic burden distracts from the primary (production) processes (Swuste, Frijters & Guldenmund, 2012), and are limited because incidents keep occurring despite the presence of a SMS (De Bruine, 2018).

To ensure safety, organizations can proceduralize operations. Rules enforce uniformity and standardization in order to reduce the possibility of errors and failures. In the aviation sector the airlines are challenged with a contradiction: proceduralization is promoted at the risk of reducing the human role of decision-making, while at the same time pilots are seen as far more intelligent than the procedures. Some airlines give more freedom to pilots, others do not (Pélegrin, 2013).

But proceduralization does not guarantee safety. There are six main reasons that make it very difficult to stick strictly to procedures (Fucks & Dien, 2013):

- The structural incompleteness of the rule
- The variability of the process and persons
- Undefined use conditions
- The application conditions are not always defined
- Organizational variability
- Referencing to ideal situations

Or, in other words, there is a gap between the reality of operations and its routines and the abstraction of the written rules that are supposed to guide safe behaviour (Hale & Borys, 2013). The Naval Air Forces of the USA found that eliminating poor performers along with effective monitoring programmes gave significant results in elevating the safety performances (Adamshick, 2007). This would suggest that proceduralization in a high-risk military environment is not necessary.

Disciplinary measures or more rigorous training in rule-following will be seen as the solution to prevent deviations from the procedures and therefore accidents. Especially extensive use of disciplinary measures may cause people to withhold information that could trigger disciplinary measures. This is called the ‘learning trap’ (Rosness, 2013). When confronted with an ‘unsafe rule’, military personnel tend to express their concerns only verbally via the chain of command, while at the same time almost nobody tries to ignore the rule (Falconer, 2006).

The pitfall for the management is to think they are doing well by adding extra regulations to the laws (Niskanen, 1994). This can also be seen in the Dutch military. The top level tried to make the organisation safer by introducing more rules and procedures, while the operational level is complaining about the lack of feasibility in the field (Van der Veer et al., 2018). A worrying effect of this is the big discrepancy between written and unwritten rules through the whole organisation (Royal

HaskoningDHV, 2015). Another problem with adding extra regulations to improve the safety is that they only achieve this goal if they are actually enforced (Hagenzieker, 1991). Rules are necessary, but in moderation (De Bruine, 2018).

Systems approach to safety

Safety is a dynamic condition of a system and therefore not directly measurable. Safety can only get measured indirectly by proxies (Swuste et al., 2016). Two types of proxies exist to measure safety: leading (before an accident) indicators that measure for example hazards, scenario's or management factors and lagging (after an accident) that measure the consequences after an accident occurs (Swuste et al., 2016). However unrelated to each other, both types of measuring indicators are needed to have an effective safety monitoring system (Swuste et al., 2016). There is no clear consensus on what has to get measured, but for example Dutch research suggested (Swuste et al., 2016):

- Safety-critical deviations from normal procedures (e.g. leaks, accidents)
- Monitoring (e.g. inspections aimed at human actions, observations)
- Safety audits, organizational risk factors, training, safety inspections of equipment
- Culture index (e.g. attitude survey, questionnaire)

The traditional high-risk organizations predominantly operate in a relative stable operation environment that presents the organization with a fixed set of familiar problems. Therefore safety management is mostly defined in terms of creating stability by aiming on the creation of sufficient constraints in order to keep behaviour between predetermined boundaries (Moorkamp et al., 2014). In other words, safety management tries to control or stabilize dynamic situations and systems.

This is very difficult with military operations, because the environment of military operations is dynamically complex resulting in a varying flow of unfamiliar instead of a stable flow of familiar problems for the (military) organization (Moorkamp et al., 2014). In dynamic complex operating environments is stability absent, so the focus should be on dealing with absolute uncertainty and the ever presence of unpredictable environmental risks (Moorkamp, 2017). The environment can be influenced only partly. Some risks manifest in a chaotic reality. Apart from simple and complex risk problems, uncertain and ambiguous risk problems can be distinguished (Brenninkmeijer, 2011). An implication of this, is that safety cannot be attained by simply following rules and procedures but by means of self-organization and adaptive capabilities of employees at the operational level (Moorkamp, 2017).

Safety in linked infrastructures

In order to be able to create safety in institutional fragmented infrastructures the following aspects are important (De Bruijne, 2006):

- Resilience
- Flexibility
- Experience
- Informal communication and coordination
- The ability to improvise in the control room

Safety and professionalism

A concept that is linked to safety inescapably is professionalism. Professionalism is linked to vocation, public trust and authority deriving from knowledge, rather than organizational position (Hayes, 2013). Professionals have the following features (Middlehurst & Kennie, 1997):

- Technical and theoretical expertise and the authority and status flowing from such expert and highly valued knowledge, understanding and skill
- The establishment and the exercise of trust as a basis for professional relationships
- Adherence to particular standards and professional ethics often, but not always, represented by the granting of a licence
- Independence, autonomy and discretion
- Specific attitudes towards work, clients and peers involving dedication, reliability, flexibility and creativity in relation to the 'unknown'
- Different approaches to safety exist which have evolved over time.

Appendix B: Normal Accident Theory

The two systemic characteristics within NAT that influence the reliability of the system strongly are interactive complexity and tight coupling. Interactive complexity is defined as the ability of parts of a system to interact in an unanticipated manner (De Bruijne, 2006). According to NAT, systems are either complex with interactions in an unexpected sequence or linear with interactions in an expected sequence. This means that complex systems do not necessarily have a high technological level (De Bruine, 2018). The difference between linear and complex systems is visualized in figure 11.

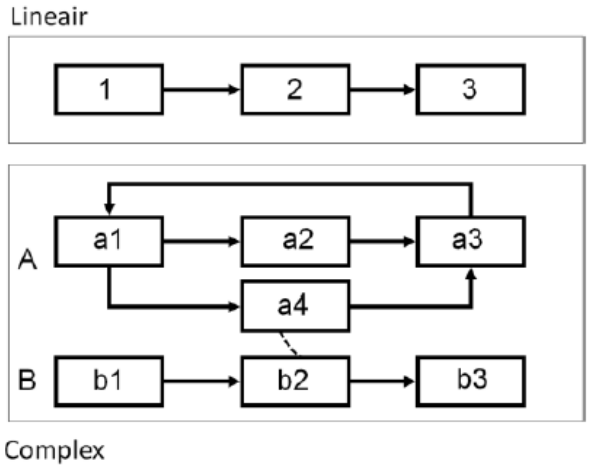

Figure 11: complex versus linear systems (De Bruine, 2018)

Linear systems are more easier to manage, while complex systems generate unexpected problems because of their unpredictable nature of interactions (Van den Eede, Van de Walle & Rutkowski, 2006). NAT also argues with the same arguments that redundancy does not make systems inherent safer (Leveson et al., 2009). Using 'technological fixes' like automatic safety systems increase the complexity and only postpone accidents. This causes tension with the desire to improve the reliability of systems (De Bruine, 2018).

Tight coupling is defined as a mechanical term meaning there is no slack or buffer between two items (De Bruijne, 2006). Coupling is also defined as the degree of variables shared between subsystems (Skilton & Robinson, 2009). The two characteristics can be used as dimensions to plot organisations on: the higher they score on both characteristics, the more vulnerable is the organization for disasters (De Bruijne, 2006). In essence, accidents occur, according to NAT, because the system runs out of control caused by an ordinary defect (Skilton & Robinson, 2009). An overview of the differences between both complex and linear and tight and loose coupling is presented in figure 12.

Complex	Linear
Component proximity	Spatial segregation (of components and subsystems)
Common-mode connections	Dedicated connections
Interconnected subsystems	Segregated subsystems
Limited substitutions	Easy substitutions
Unfamiliar or unintended feedback loops	Few feedback loops
Multiple and interacting controls	Single purpose regulating controls
Indirect or inferential sources of information	Direct information
Limited understanding of the processes involved	Extensive understanding of process technology.

Tight-coupling characteristics	Loose-coupling characteristics
Time-dependent processes which cannot wait	Processing delays are possible
Rigidly ordered processes (as in sequence A must follow B)	Order of sequence can be changed
Only one path to a successful outcome	Substitution is available
Little slack (requiring precise quantities of specific resources for successful operation).	Slack in resources is possible, buffers and redundancies available

Figure 12: complex vs. linear systems and tight vs loose coupling (Van den Eede, Van de Walle & Rutkowski, 2006)

The complexity and tight coupling of systems make it almost impossible for any one individual to understand such system in its entirety, which can lead to accumulation of latent conditions that increase risks. If no one person can comprehend the existence of all those risks, then no one person can be responsible for them (Reason, 1998). According to NAT even the smallest, most insignificant or unthinkable incident or disruption can potentially lead to a derailing system. It all depends on how the incident is connected to the system, the complexity of the system and the degree of coupling. An example is the suggestion that a change in the general work life, affects safety and the risks of occupational incidents (Hovden, Albrechtsen & Herrera, 2010).

The two main dimensions of NAT, complexity (interactions) and coupling, can be plotted and uses for classification of organisations. This is done in figure 13 with some organisations as examples.

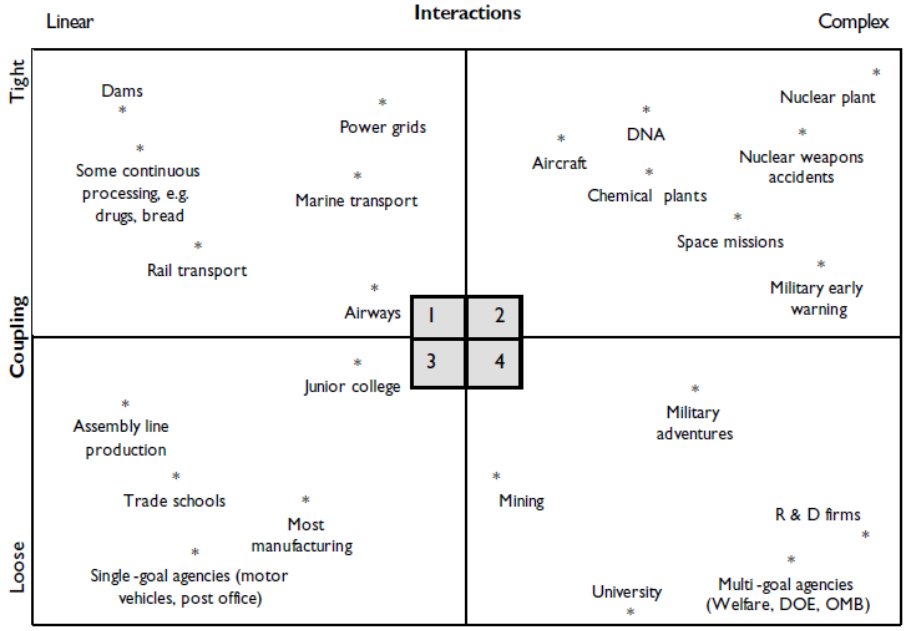

Figure 13: NAT coupling/complexity (interactions) chart (Shrivastava, Sonpar, & Pazzaglia, 2009)

Normal Accident Theory in supply chains

Supply chains (or networks) are complex when there is a complicated transformation process and feedback loops and branching are common. Interactions between heterogeneous participants in multiple modes, based on heterogeneous materials and information flows, can make it even more complex (Skilton & Robinson, 2009). Supply chains which require specialization of skill or knowledge in an organization, which has organizations with (relatively) more hierarchal levels and which have a bigger spatial spread are more complex (Bode & Wagner, 2015).

Supply chains (or networks) are tight coupled when they are highly integrated and complexly interrelated in such way that single events have influence across subsystem boundaries. Supply chains with a high level of dependency are more prone to disruptions (Scheibe & Blackhurst, 2017). Loosely coupled supply chains allow for example for easy substitution and delays (Skilton & Robinson, 2009).

The complexity and tight coupling in supply chains causes difficulties for risk management and risk mitigation strategies. Because of all the (tight) connections, measures to mitigate risks can cause another risk (Scheibe & Blackhurst, 2017). For example, a (temporary) shift in demand can cause a shift in shipment size which causes the need for a different transport mode resulting in a switch of transporter or supplier. In supply chains the impact disruptions are studied mostly in isolation, but barely on the level of the whole chain. That is notable, because phenomena like the Bullwhip Effect are known for a long time (Scheibe & Blackhurst, 2017).

Modern supply chain management has evolved to optimize the fulfilment of demand and to prevent out-of-stock situations in a cost efficient way, e.g. just-in-time. This makes the supply chain more effective, but also more vulnerable to disruptions because there is less slack (Yang & Yang, 2009; Knemeyer, Zinn & Eroglu, 2008). In supply chains the interactive complexity has three dimensions (Yang & Yang, 2009):

- Product complexity: the number of parts and components needed
- Process complexity: the number of potential interactions between parts
- Interconnection complexity: the level of interaction between various parts and process operations

The complexities can be reduced or mitigated by making the products (and their processes) modular and by creating the capacity to shift production quickly elsewhere in case of a disruption (Yang & Yang, 2009). Simplifying the supply chain and therefore less complexities is a general approach to improve the safety within supply chains (Bokma, 2018).

The cascading effect of an accident or the propagation of a disruption can be halted by monitoring the whole supply chain and address it appropriately (Scheibe & Blackhurst, 2017). It is easy to understand that in tightly coupled systems or organizations the information exchange is standardized, unambiguous and enforced. But in many tightly coupled systems, little information is exchanged. Increasing levels of familiarity and trust, which often characterize strong relationships based on shared goals, have a decrease in levels of monitoring and formal information exchange (Skilton & Robinson, 2009).

Criticism on Normal Accident Theory

NAT tries to explain accidents caused by system failures in social-technical systems with high-risk technologies. It does not present itself as ‘the silver bullet’, but comes up with an explanation for certain situations. Nevertheless, NAT has some strong criticism.

NAT has limited relevance

NAT only explains accidents in complex, tightly coupled systems. It cannot explain disasters which occurred due to 'component failures'. Examples of such disasters with large impact are the nuclear reactor incident in Chernobyl and the Challenger space shuttle accident (Hopkins, 1999). Most incidents are caused by component failures or had a lengthy period where human intervention to avoid the incident was possible. The share of NAT-incidents in the total amount of incidents is limited (Hopkins, 1999).

NAT argues that complexity and tight coupling is problematic because it increases the risk of accidents. It can be criticised

No clear definition of system

NAT has not formally defined 'system', even though it is the core of the theory. NAT does not even make an ontological commitment to system theory (Shrivastava, Sonpar, & Pazzaglia, 2009). However, with the use of this term NAT shifts the focus from individual failure to the failure of systems. Or in other words, individuals no longer become the cause of accidents but the organisational systems in which the accidents occur have to take the blame (Numan & Di Domenico, 2015; Shrivastava, Sonpar, & Pazzaglia, 2009). This means that, according to NAT, the management is the key contributor to (industrial) accidents and not the worker (Saleh et al., 2010). Perrow even degrades the faults of an human operator to the same level and impact as a malfunctioning valve (Shrivastava, Sonpar, & Pazzaglia, 2009).

The problem of having no clear definition of 'system' is more than only shifting the blame or responsibility for accidents. Based on NAT, an increase in safety systems will increase the complexity resulting in difficulties with managing accidents (Okoh & Haugen, 2014). This implies that safety systems contribute to the root cause of accidents instead of managing them.

No criteria for measuring complexity and coupling

NAT gives an explanation for a limited class of accidents, but is not able to define the two core characteristics: complexity and coupling (Hopkins, 1999). Multiple researchers point out this problem and even that Perrow, the founder of NAT, is inconsistent with his criteria (Leveson et al., 2009; Hopkins, 1999). Perrow has to be inconsistent because otherwise he would have to classify low risk systems like bakeries as high risk systems because of their complexity for example (Leveson et al., 2009). Perrow also classifies domains as complex or tight coupled instead of looking closer to the actual designs or technologies which results in more inconsistencies (Leveson et al., 2009).

Another problem is that HRO's perform better than can be expected according to NAT. Perrow solves this critique by responding that the HRT and NAT are applied to different systems, thereby restricting the relevance of NAT even further (Hopkins, 1999). NAT was originally developed to explain the near disaster at the nuclear power plant Three Mile Island. Applying NAT beyond its original context raised doubt about the applicability (Hopkins, 1999). On the other hand, the actual study that gave this conclusion made the same misclassifying mistake as Perrow did. In the study, the actal case was not complex and loose coupled (Leveson et al., 2009). Still, this endorses the critics about the problematic lack of clear criteria or definitions for complexity and coupling.

No clear authority structure

NAT is based on complex and tight coupled systems. Complex indicates a preference for a more decentralized autonomous authority structure where tightly coupled indicates a strong centralized authority structure. This conflicts with each other and makes it impossible to design an authority structure which will reduce the risk in such systems. It explains why accidents in complex and tight coupled systems are inevitable according to NAT (Hopkins, 1999). Critics have observed in HRO's that it is possible to have both. They saw with HRO's that they routinely functioned in a highly bureaucratic way with rules and standard operating procedures to maximise operational predictability. At times of the greatest pressure, the authority shifts downwards to frontline operators who have considerable decision-making discretion. This is called 'nested authority structures' (Hopkins, 1999).

Perrow argued that the authority structure problem is one of the main reasons that accidents in complex and tight coupled systems are inevitable. The critics who observed the 'nested authority structures' with HRO's argue that the authority structure argument of Perrow is wrong and that therefore the inevitability of accidents according to NAT may be not the case as well (Numan & Di Domenico, 2015; Hopkins, 1999). Another point is the observation that Perrow makes some larger points about which he feels strongly, but there are no theoretical reasons to do that (Shrivastava, Sonpar, & Pazzaglia, 2009).

No solution

NAT explains accidents in certain situations, while claiming that they are inevitable (Numan & Di Domenico, 2015; Saleh et al., 2010). NAT provides no solutions or policy recommendations to minimize the risks and improve the safety. The only recommendations that can be derived from NAT are the abandoning of using such systems, decreasing the complexity or loosening the coupling (Saleh et al., 2010; Hopkins, 1999). They are not very useful or feasible given what society demands, or in other words why these systems exist in the first place.

Similar critique is the oversimplification by NAT. It lacks of understanding of technical choices and engineering design. NAT has primarily a sociological focus, rather than a technical and operational focus (Saleh et al., 2010).

Another problem is that to get NAT working, or better said to solve the issue with complexity and tight coupling, in supply chains, both isolation and strict discipline need to be achieved (Skilton & Robinson, 2009). With those factors added, NAT starts to look quite similar to HRT. But as said before, NAT-founder Perrow denies strongly that NAT is similar to HRT. Therefore, it is difficult to see how NAT can do more than explaining why an accident happened. It gives no solution to improve the safety.

Appendix C: High Reliability Theory

High Reliability Theory (HRT) does not try to explain how or why accidents occur, but tries to observe how certain organizations are able to ensure the safety. The theory has been developed by a group of researchers at the University of California (Berkeley) to capture observed commonalities of operations among aircraft carriers, air traffic control and nuclear power. These organisations have as similarities that they operate in unforgiving social and political environments, their technologies are risky and present potential for error, the scale of possible consequences from errors precludes learning through experimentation and to avoid failures complex processes are used to manage complex technologies (Sutcliffe, 2011).

HRO's pursue achieving high reliable performance through two approaches: prevention or anticipation and resilience or containment (Sutcliffe, 2011). Prevention requires that organisational members try to anticipate and identify the events and consequences that must not happen. Identifying all precursor events and conditions will lead to the causes and then procedures can be established to avoid them. From the prevention perspective, reliability depends on counteracting unwanted variance in the performance and is thought to be achieved by highly standardized operating procedures and routines (Sutcliffe, 2011). HRO's are truly obsessed with detailed operating procedures, contingency plans, rules, protocols, guidelines and to use science and technology to improve the behaviour of organisational members to avoid errors.

An organization with a culture of safety that supports HRT has three central attributes: trust in the colleagues and management, reporting of incidents and unsafe situations and improvement of the organisation (Chassin & Loeb, 2013; 2011). Trust is established by eliminating behaviour that suppresses reporting, act timely on the reports and to communicate the action or improvement to the individuals that reported the problem. This is a reinforcing circle (Chassin & Loeb, 2013) as can be seen in figure 14.

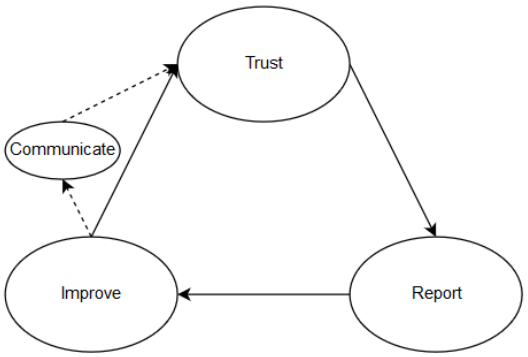

Figure 14: visualization of the culture of safety according to Chassin & Loeb (2013)

The five principles of HRO's

HRO's are able to perform successful and have nearly no accidents by applying five core principles. The first three principles (preoccupation with failure, reluctance to simplify and sensitivity to operations) are based on anticipation. The fourth and fifth principle (commitment to resilience and deference to expertise) are based on containment. With HRT anticipation and signalling disruptions as fast as possible is most important. But HRT accepts the unpredictability of the world and thereby that disruptions will occur, so it focusses on containment of disruptions as well (De Bruine, 2018).

1. Preoccupation with failure

HRO's track small failures strictly. They treat any lapse as a symptom that something may be wrong with the system or can have severe consequences if several separate small errors coincide (Weick & Sutcliffe, 2007). HRO's have well developed systems for reporting near misses, process upsets and small and localised failures of all sorts for example (Hopkins, 2007). This is a matter of organisational design. HRO's employ whole departments whose exclusive jobs is the collection and analysis of relevant data (Hopkins, 2007).

An important difference between robust and vulnerable organisations is the focus within the learning loop. When there is a discrepancy between desired and actual results, single loop learners only look to the immediately preceding actions to explain and learn. This leads to narrowed targeted efforts. On the other hand, double loop learners look beyond the immediate actions to the (basic) assumptions and conditions that gave rise to them. This leads to managers questioning their core beliefs and to recognize systemic errors (Reason, Carthey & De Leval, 2001). The single and double learning loop is shown in figure 15.

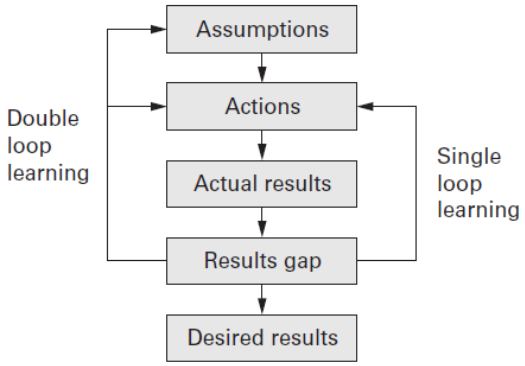

Figure 15: single versus double loop learning (Reason, Carthey & De Leval, 2001)

Preoccupation with failure also means to tell people about accidents in order to learn from it and to make the people more alert. This also warns for the dangers of distancing through indifference or the 'it would never happen to us' attitude (Harvey, Waterson & Dainty, 2019).

2. Reluctance to simplify

Simplification means discarding some information as unimportant or irrelevant, but this is dangerous because this information may be the very information necessary to avert the disaster (Hopkins, 2007). Knowing that the world is complex, unstable, unknowable and unpredictable, HRO's take deliberate steps to create more complete and nuanced pictures of what they face and who they are as they face it. With this, HRO's try to avoid misjudgements and wrongly dismissing the danger of events or errors (Weick & Sutcliffe, 2007). HRO's favour free-flowing information and avert fragmentation of problem-solving (Dekker & Woods, 2010).

This is the opposite from traditional management, which favours simplification (e.g. the use of Key Performance Indicators) by reducing the complexity through aggregated indicators (Van den Eede, Van de Walle & Rutkowski, 2006).

A way to achieve this principle is to embrace complexity and to pursue requisite variety. Organizations can increase their variety by raising ad hoc teams, re-training, selecting workers with non-typical skills and to encourage job rotation (Shrivastava, Sonpar, & Pazzaglia, 2009).

3. Sensitivity to operations

HRO's are sensitive to operations, they operate to the front line where the real work gets done. People have well-developed situational awareness, so they can make continuous adjustments that prevent errors from accumulating and enlarging (Weick & Sutcliffe, 2007). The opposite of sensitivity to operations is 'silo thinking', where employees operate within their own small sphere of influence without thought of the impact of their activities on the rest of the organisation (Hopkins, 2007). Trust relations seem to play an important role here, because it has big effects on the amount of information shared and openness of the communication within organizations (Cox, Jones & Collinson, 2006).

Workers, especially in decentralized organizations, tend to not inform 'the boss' on negative developments to avoid interference. HRO's have a culture of 'every news is good news', because when the system stops communicating it is unexpected which points to problems, which is bad news. Therefore no news is bad news (De Bruine, 2018). Another reason for workers to stop communicating is the assumption that a person in a central position will know if something in his interest occurs. They think the manager has seen or read about the situation, while that is not always the case (De Bruine, 2018).

4. Commitment to resilience

No system is perfect. Resilience is the ability of an organization to respond or bounce back from a disruptive event in order to ensure the operational continuity during a crisis (Grabowski & Roberts, 2019). The essence of resilience is the intrinsic ability of an organization (or system) to maintain or regain a dynamically stable state, which allows it to continue operations after a major mishap or in the presence of continuous pressure and stress. HRO's are not about being error-free, but that errors don't disable it (Sutcliffe, 2011; Weick & Sutcliffe, 2007; Hopkins, 2007).

By adding (more) robustness, damage tolerance and redundancy to a system, it will also be able to cope better with rare events and to reduce their impact (Motet & Bieder, 2017; Nafday, 2011).

Resilience Engineering is a new research trend in the field of socio-technical systems in general (Pariès et al., 2019). Resilience Egineering sees human adaptability as an important asset and designs systems around human attributes (Harvey, Waterson & Dainty, 2019). This is important, because this means that HRO's put the people in the centre instead of using the people to serve the systems. Or in other words, human errors are not the cause of failures but a symptom of (underlying) failures, therefore the human is not the most important failure factor according to Resilience Engineering (De Bruine, 2018).

There are four cornerstones for resilient systems (Pariès et al., 2019):

- Have the ability to react (the system must know what to do)
- Have the ability to monitor (the system must know what to watch)
- Have the ability to anticipate
- Have the ability to learn

5. Deference to expertise

HRO's cultivate diversity to notice more in complex environments and to be able to better deal with the complexities they spot. Errors at higher levels, especially in rigid hierarchies, tend to pick up and combine with errors at lower levels, thereby making the resulting problem bigger, harder to comprehend and more likely to escalate. HRO's avoid this by pushing decision-making down and

around: decisions are made on the front line and authority migrates to the people with the most expertise, regardless of their rank (Weick & Sutcliffe, 2007; Hopkins, 2007).

The authority and thereby decision-making always lies with the operational staff on site. Even if the management is present, for example in the control room of a plant, the authority remains with the operational staff (Hayes, 2013).

In literature a certain disregard for formal hierarchy is encouraged. The concept of 'conceptual slack' brings more autonomy on the lower levels and centrally determined goals together in order to keep the hierarchical organizational structure. Conceptual slack is a form of organizational redundancy by allowing for a divergence in perspectives. It can lead to an engaged work force that vigorously debates different viewpoints and negotiates to reach an acceptable solution, but has as a flip side the risk of confusion during crises (Shrivastava, Sonpar, & Pazzaglia, 2009). The higher the level of conceptual slack, the greater the ability of the system to cope with complexity.

Mindfulness

In the HRT-literature the concept mindfulness is often used to show that HRT is mostly about awareness or a state of mind regarding safety (Weick, Sutcliffe & Obstfeld, 1999). It is more than just situational awareness (Quigley & White, 2013). Mindfulness means that everyone in the organization is actually aware that even small failures can lead to catastrophic outcomes (Chassin & Loeb, 2011). In other words, HRT is mostly about a culture of safety. As can be seen in figure 16, the concept mindfulness is the five principles of HRO's (mentioned above) combined.

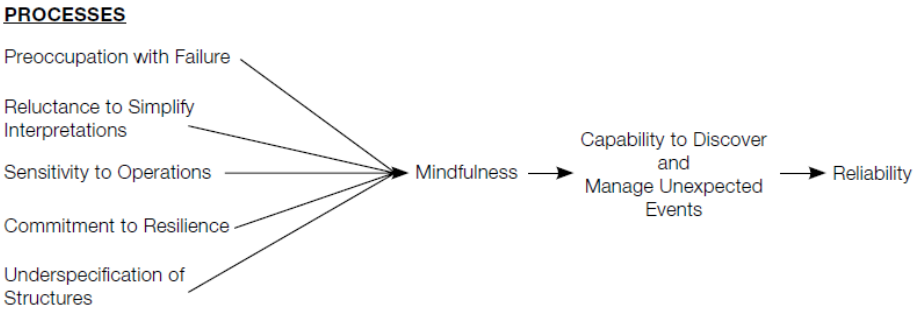

Figure 16: the relations between the five principles, mindfulness and reliability (Weick, Sutcliffe & Obstfeld, 1999)

Mindful organising is about leaders and organisational members paying close attention to shaping the social and relational infrastructure of the organisation, and to establish a set of interrelated organising processes and practices, which jointly contribute to the system's overall culture of safety (Sutcliffe, 2011).

The general tendency of organisations is to respond to weak signals with weak responses. Mindfulness preserves the capability to see the significant meaning of weak signals and to give strong responses to weak signals (Hopkins, 2007). The key difference between HRO's and other organisations is the interpretative work of (weak) signals and situations (Hopkins, 2007).

Mindfulness is often operationalized by three activities (Hales & Chakravorty, 2016):

- Frequent mediation
- Having the willingness on the part of the providers to objectively solve problems using context-specific solutions
- Making time to meaningfully communicate with others on the problem at-hand

Achieving high reliability

To achieve high reliability three functions have been identified in the literature (Bellamy et al., 2005):

- Improving normal operations
- Detecting potential problems
- Recovering from emerging problems

Improving normal operations

The fewer errors or failures are allowed, the less the organisation has to adjust when an accident occurs. It is not all about preventing accidents from happening, but to prevent major adjustments after an accident as well (Bellamy et al., 2005). Improving normal operations includes strategies with the aim to recruit, train and support people with strong technical expertise, providing intensive and ongoing training and developing simulations of rare or unexpected events (Bellamy et al., 2005). Bringing in fresh perspectives is important in order to be able to improve normal operations (Dekker & Woods, 2010).

This includes the monitoring of the safety monitoring system (or meta-monitoring). Organizations need to avoid obsolete coping mechanisms, misplaced confidence in their safety monitoring system and to miss new possibilities for failures to occur (Dekker & Woods, 2010). All efforts to improve the normal operations will contribute to the organizational learning capabilities, what improves the organizational capacity to respond to challenges in the future (Bellamy et al., 2005).

Improving normal operations often involve centralizing control and building tightly coupled structures to support standard use of effective practices (Bellamy et al., 2005). On the other hand, a large distance between management and operations can become problematic. A marker of resilience is the distance between management imagining how operations go on and how they actually go on. A large distance can cause a miss-calibrated management to the challenges and risks encountered in real operations and it can cause the management missing how safety is created while the operators do their job and to gather meaning from it (Dekker & Woods, 2010).

Detecting potential problems

Unexpected threats, human error and system weaknesses always exist. Past successes cannot be taken as guarantee of future safety. Even confidence in equipment and training does not take away the need that operators need to have to constantly look for signs that a potential dangerous situation is developing (Dekker & Woods, 2010). Organisations need to constantly monitor and detect signs of increasing organizational risk, especially when production pressures are increasing or pushing the limits (Dekker & Woods, 2010). Within HRO's this is very important, because accidents in HRO's are by definition extremely rare and therefore unexpected (Harvey, Waterson & Dainty, 2019).

Strategies can be used to identify problems early enough to prevent that they escalate beyond repair. HRO's develop a reporting culture in which workers are encouraged and rewarded for reporting errors or near misses, so the organisation is alerted on time and can make adjustments before an accident happens. Of course, such a culture depends a lot on the organisational conditions that make defensive actions or saving face unnecessary (Bellamy et al., 2005). HRO researchers even found that front-line operators not only treat their operational environment as inherently risky, but also as actively hostile to those who misestimate that risk (Dekker & Woods, 2010). Redundancy in assigned personnel can help to improve the detection and reporting of errors or near misses, because 'two see more than one' (Bellamy et al., 2005).

Recovering from emerging problems

Once problems are detected, organisations must have the motivation and capabilities to respond to the situation and make adjustments. Most of the time this means that in a situation the organisation shifts to a back-up strategy. This can be shifting to individual problem solving or collective procedures for example (Bellamy et al., 2005).

Effective recovery will always require alternatives. Alternatives will normally mean a measure of eclecticism, a tolerance for competing views and interpretations. Organisations that always operate centralized or decentralized appear to be far less effective in containing problems than organizations that can operate in both modes (Bellamy et al., 2005).

To be able to successful be highly reliable, organizations need to have the resources and authority to make investments in safety at precisely the time it appears to be the least affordable. Organizations also need to have the means to recognize when and where to make targeted investments to act on rising signs of organizational risk and to rebalance the trade-offs between safety and operational productivity (Dekker & Woods, 2010).

Criticism on High Reliability Theory

Just like NAT, HRT is not perfect. It has received some criticism and has some negative characteristics as well.

Lack of a theoretical anchor

The HRT literature has introduced several constructs that has relevance for non-HRO's as well, but HRT has been unable to connect itself with mainstream organization theory. This is attributed by HRT lacking a theoretical anchor (Shrivastava, Sonpar, & Pazzaglia, 2009). HRT has produced a list of factors associated with HRO's, but no systematic comparison with non-HRO's has been made yet (Shrivastava, Sonpar, & Pazzaglia, 2009). HRT studies special cases in order to learn lessons, but this makes generalization difficult (Leveson et al., 2009). This criticism is linked to the criticism that HRT only studies technological advanced and complex organizations most of the time, but over the years HRT has been applied and studied in other fields as well like fire-fighting, banks and hospitals (Grabowski & Roberts, 2019).

Open operational environments

According to HRT, a HRO is a rational, stable and closed system. NAT uses this assumption as an argument against HRT, because most organisations operate in and must interact with an open, complex environment. Their predictability and complex interactivity cannot be recognized or anticipated by organizational designers (Shrivastava, Sonpar, & Pazzaglia, 2009; Smart et al., 2003). HRT is not able to incorporate the organizational design and its relations with safety into its concepts (Moorkamp, 2017).

HRT has nuanced the need of a HRO to be a closed system by saying that for HRT it is particular important to build an organizational culture that puts safety first. Culture building exercises are often influenced by external regulatory bodies, therefore efforts to grow a HRT-culture are more consistent with an open rather than a closed system perspective (Shrivastava, Sonpar, & Pazzaglia, 2009). This still does not fully take away the criticism from NAT. But it can be argued that both claims that NAT treats organisations as open systems and HRT as closed systems are untenable (Shrivastava, Sonpar, & Pazzaglia, 2009).

Reliability is not the same as safety

HRT confuses reliability with safety, but they are different properties. It is possible for a component to be reliably unsafe or vice versa for example (Pariès et al., 2019; Saunders, 2015; Dekker & Woods, 2010; Leveson et al., 2009; Shrivastava, Sonpar, & Pazzaglia, 2009).

The problem becomes clear with the case of the loss of the Mars Polar Lander. The device was designed to deploy its legs during the descend. The deployed caused a noise from which the device deducted that the landing already had occurred because the software engineers designed it that way, therefore shut down prematurely the engine resulting in a crash. Everything performed correctly, but still a crash occurred because the designers failed to account for all interactions between the leg deployment and the descent-engine control software. The Mars Polar Lander was reliable but unsafe (Leveson et al., 2009).

Sometimes reliability even conflicts with safety sometimes. For example, to reduce accident rates on aircraft carriers, only allow for landings in perfect weather with the most experienced pilots. This would conflict with other goals like conducting exercises. Actually, in systems multiple goals often conflict with each other (Leveson et al., 2009).

Redundancy comes with costs

HRT promotes to increase redundancy, for example duplication in systems design to insure against failure. But that comes with costs by increasing the complexities and opportunities for failure. Especially when the redundant component is not incorporated in the original design, but added later after problems are recognized (Shrivastava, Sonpar, & Pazzaglia, 2009). But the costs can pay off by preventing the much higher costs of process failures which are the highest costs of all (Hales & Chakravorty, 2016).

Difficulties of recognizing warning signals

The key of HRT is to recognize risks, intervene on time and thereby avoiding accidents. This means that with warning systems and signals the system has to be monitored constantly (preoccupation with failure). Perrow argues that talking about warning signals and possible interventions in hindsight is pointless, because it can be very difficult to interpret the meaning of and attend to dozens of simultaneous signals against the background of noise and false alarms before an accident (Shrivastava, Sonpar, & Pazzaglia, 2009; Hopkins, 2007). The warning signs are only obvious in retrospect and it is often not possible to perceive their significance beforehand (Hopkins, 2007).

Sometimes the warning signals are strong but are ignored, because the organisations concerned have no capacity to listen to those signals. This was one of the causes of the near meltdown of the Three Mile Island nuclear reactor in 1979 (Hopkins, 2007).

Practical drift

The issue of the difficulties of recognizing warning signals has also been observed in the Black Hawk friendly fire incident in 1994, where was concluded that signals were ignored but no individual could be blamed for ignoring them. The systems in place worked as designed, but still they failed (Snook, 2000). This was possible because of ‘practical drift’. It occurs when individuals adjust their behaviour because the rules don’t match the current task demands (Pettersen & Schulman, 2019). Figure 17 visualizes the phenomenon of practical drift and its safety implication.

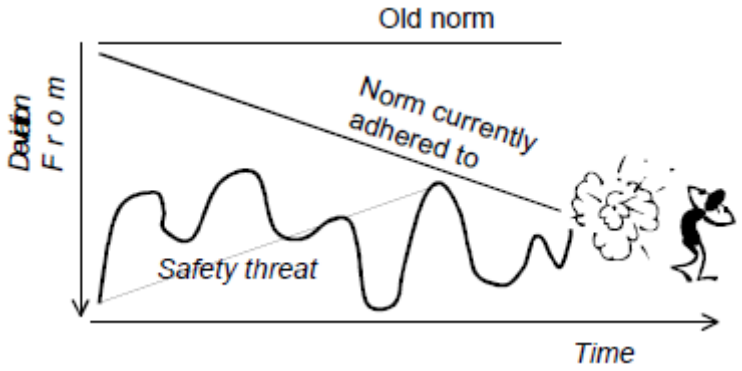

Figure 17: visualization of practical drift (Dekker, 2001)

Practical drift is defined as the slow and steady uncoupling of local practice from written procedures (Snook, 2000). It means that most organizations are tightly coupled to be prepared for the worst case scenarios, but they seem so remote that people gradually start to ignore them. At the local level, people start to adopt unauthorized practices to complete their tasks as efficient as possible (Shrivastava, Sonpar, & Pazzaglia, 2009). So when the system has to perform a particular operation requiring the knowledge of the formal procedures and a failure occurs, then the chances that a system accident occurs increases exponentially. This is because by then the system has drifted so far from the original state that none of the remaining people is capable of responding sensibly to the unfolding events (Shrivastava, Sonpar, & Pazzaglia, 2009).

A major cause for practical drift is pressure leading to narrowing focus on some goals while obscuring the trade-off with other goals. This usually happens when acute goals like production or efficiency take precedence over chronic goals like safety (Dekker & Woods, 2010).

No anticipation by standardization

As mentioned before, HRO's use detailed operating procedures, rules, etc. to avoid errors. A limitation of making a standardized and detailed procedure for everything is that unvarying procedures cannot handle what they cannot anticipate (Sutcliffe, 2011). It is not possible to make procedures to anticipate all situations and conditions that can appear during the processes. Even when it would be possible, it would come with the costs of the added complexity that come with having too many rules (Sutcliffe, 2011). It would hurt the flexibility of the organisation.

Decentralization of decision-making not necessarily better

The principle of shifting down safety-related decision-making makes the assumption that front-line workers have the necessary knowledge and judgement. That is not always true, especially when system-level information is required to make the right call (Leveson et al., 2009).

Appendix D: Integration of NAT and HRO

The theories NAT and HRO have been elaborated. This section will discuss on how the two theories compare to each other and can be used for this thesis.

As already has been mentioned, SMS seems not to be useful for the purpose of improving the safety (and reliability) of the ammunition chain in all situations, because it requires static and stable environments while the Armed Forces (including the ammunition chain) also operate (partly) in dynamic and unstable environments. NAT and HRT seem to be more suitable, because they study organizations and operations that are similar to the Armed Forces.

Both the two theories, NAT and HRT, received critiques and disagree with each other on certain points.[24] The debate on which theory is right or to integrate the two theories has proven to be inconclusive and has reached a dead-end (Shrivastava, Sonpar, & Pazzaglia, 2009). To complicate things further, both NAT and HRT appear to be non-falsifiable. The concepts cannot be tested, because they are able to rationalize any outcome and can nearly always explain their failure to make a prediction (Shrivastava, Sonpar, & Pazzaglia, 2009).

On the other hand NAT and HRT make different claims and do not contradict each other (Shrivastava, Sonpar, & Pazzaglia, 2009). For example, measures identified by HRT (strategic concern for safety and safe design, redundancy, simultaneous centralization and decentralization, training, organizational learning and mindfulness) can be seen as attempts to either directly or indirectly deal with the challenges of complex interactions and tight coupling, the two core dimensions of NAT (Shrivastava, Sonpar, & Pazzaglia, 2009, p1365). It can even be argued that NAT and HRT are not incommensurate with each other, but look at the same phenomenon at different points of time (Shrivastava, Sonpar, & Pazzaglia, 2009). The more pluralistic and post-modern view on NAT and HRT is that they are complementary rather than competing theories (Smart et al., 2003). An example of this, is the disagreement on the effects of redundancy. According to NAT redundancy does not make systems safer, but according to HRT it does. While looking closer, it can be concluded that NAT talks about the risk of design errors etc. or in other words system faults. HRT sees redundancy as doubling certain technical components and personnel. Both mean different things, but do not disagree with each other in the end (Leveson et al., 2009). Although NAT and HRT give different explanations, it can be assumed that they can be seen more as complementary than contradictory theories (De Bruijne, 2006).

In the literature, most research has been done with HRT as theory. Sometimes NAT was used as a complementary theory to HRT (Haavik et al., 2019). HRT studies mainly operations which are conducted on the same location and where people can see each other face-to-face for example. An extreme opposite of this would be a virtual organization for example. HRT cannot be applied on this kind of organizations without overcoming some difficulties like not having a precise and fixed description of the network (links) or organization (Grabowski & Roberts, 2019).

NAT has more a focus on how everything is linked together, while HRT describes how an organization should be organised and behave. For complex organisations like the Armed Forces, both are useful. Therefore, NAT and HRT will be used as complementary theories to research the safety mind-set in the ammunition chain.

[24] See appendices B and C.

Appendix E: Background on Q methodology

A Q-study has been conducted in order to identify the perspectives of key players in the ammunition domain. The Q-methodology is a cluster-analytic approach, but has as distinguishing characteristic that respondents subjectively weight their beliefs relative to each other instead of measuring their beliefs for each item separately (Carlin, 2018). Q methodology is able to collect information from stakeholders that show multiple and different perceptions, which have been shown to have impact on the support for adaption strategies (Armatas, Venn & Watson, 2016).

Q methodology appeared in 1935 as an adaption of Spearman's factor analysis method (Watts & Stenner, 2012). The core principle of factor analysis is to explore correlations or associations between variables or tests. Q methodology also explores correlations or associations, but between persons (Watts & Stenner, 2012). Technically the factor analysis correlates the columns of the data matrix, while the Q methodology correlates the rows. Therefore the explored variables with Q methodology are persons, while with factor analysis they are the questions.

In order to be able to do this, the data need to have the same measuring unit. With Q methodology this is achieved by asking persons to rank certain characteristics or statements: the Q sort (Watts & Stenner, 2012). The respondents rank the Q sort on a scale from 'most disagree' to 'most agree'. In addition it is possible to ask respondents to rank the Q sort within a prearranged or forced-choice distribution, mostly a quasi-normal distribution like figure 18 (Watts & Stenner, 2012; Van Exel & De Graaf, 2005). The exact choice of the shape of the distribution is not very important, because other distributions would lead to the same outcomes (Van Exel & De Graaf, 2005). The ranking scale is relative, so a respondent who ranks a statement under most disagree does not necessarily disagree with the statement but grants it less importance compared to statements ranked with higher agreement (West, Cairns & Schultz, 2016).

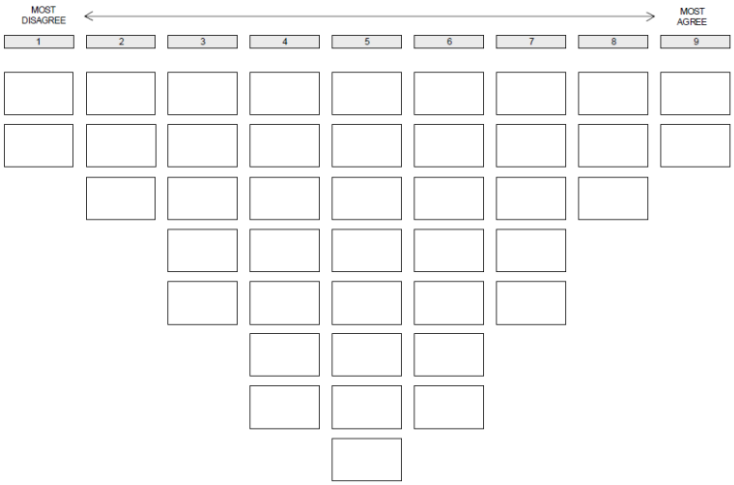

Figure 18: an example of a forced-choice Q sort distribution (Van Exel & De Graaf, 2005)

The entire set of Q sorts of all the respondents produces a correlation matrix. A Q methodological factor analysis can be applied to the correlation matrix to look for groups of persons who have ordered the Q sorts in a comparable way (Watts & Stenner, 2012). These groups with similarities can be understood as manifestations of a single latent factor. Each revealed factor can potentially identify groups with shared viewpoints, perspectives or attitudes about a particular topic within a certain context (Watts & Stenner, 2012; Van Exel & De Graaf, 2005). In other words, Q methodology explores

the subjectivity or point of view of persons (Cuppen et al., 2010; Van Exel & De Graaf, 2005). Q methodology does this by observing broader profiles, their constraints and which orientations distinguish the profiles, but without forcing a choice between explicit and implicit indicators (Carlin, 2018).

Subjectivity is a broad term. According to Stephenson (the creator of Q methodology), subjectivity is not a mental concept like mind or consciousness, but a behaviour or activity that is best understood relative to its impact on the immediate environment (Watts & Stenner, 2012). Subjectivity can only be interpreted within a context, because it is shaped by its context. Each identifiable universe (or context) is called a concourse (Watts & Stenner, 2012). A Q-concourse is a body of literature which aims to represent the full range of ideas and opinions on the issue of the study (Howard et al., 2016). In practice a concourse is the overall population of statements from which a final Q set is sampled (Watts & Stenner, 2012). Therefore, the first step of conducting a Q-study is to analyse the concourse. This can be done by collecting statements from every source available, for example: reports, interviews or the news (Van Exel & De Graaf, 2005). This way of collecting statements has the advantage of not influencing or constraining the respondents like with Likert scales wherein the researchers defines the issues or attitudes which are at stake but not necessarily need to correspond to the complexity of the attitudes of the respondents (McKeown et al., 1999).

For the design of a Q-set the general criterion is that the set provides good coverage in relation to the research question. It has to be broadly representative of the concourse (Watts & Stenner, 2012; Van Exel & De Graaf, 2005). It is not necessary to ensure a balance in positive and negative statements or any other balances. The only additional criterion is to ensure that the set is not value-laden or biased towards a particular viewpoint or opinion (Watts & Stenner, 2012). The set can be constructed in a structured and unstructured way. Structured means that key themes are identified and for each key theme a certain amount of statements is selected. Unstructured means that the statements are selected representatively from the whole population. Unstructured Q-sets are more challenging to make than structured Q-sets, because the researcher needs to have more knowledge and expertise on the topic at hand (Watts & Stenner, 2012). Identifying key themes and sample statements can be done during and based on a literature review or some theory (Van Exel & De Graaf, 2005). The size of Q-sets normally is between 40 and 80 statements (Watts & Stenner, 2012).

With Q-methodology it is common to strategically select the participants. The aim of participant selection is to find persons who have interesting thoughts or things to tell (Cuppen et al., 2010). Depending on the straightforwardness of the research question and topic, it is possible to formulate a clear participant recruitment strategy (Watts & Stenner, 2012). The ideal amount of participants varies from ratios of a participant for every two statements to 40-60 persons in general (Watts & Stenner, 2012). The number of participants does not affect the generalization power of the research, because Q methodology aims to explore subgroups instead of relationships which can be generalized. The only real requirement concerning the number of participants is that the selection needs to cover the whole target field and their viewpoints must matter (Watts & Stenner, 2012). The number of participants associated with a certain factor is even of less importance than who the participants are within the population (Van Exel & De Graaf, 2005). A larger set of participants will not benefit the Q-study, because Q methodology is based on the assumption of finite diversity. Adding more participants will not result in 'chaotic multiplication' of patterns, because there are only a limited number of ordered patterns within a particular discourse domain (Cools et al., 2009). The criticism on the reliability of Q

methodology can be warded off by the notion that the primary purpose of Q methodology is to identify a typology, not to test its proportional distribution within the larger population (Cools et al., 2009). A common perceived drawback of Q methodology is the assumption that it will require more efforts of the researcher and the respondents compared to the ordinary questionnaire. This seems not to be true (Ten Klooser, Visser & De Jong, 2008).

With the Q-sorts of all participants, a correlation matrix can be made with the intercorrelation of each Q-sort with every other sort (Watts & Stenner, 2012). In the matrix high intercorrelations will appear, showing similarities. Or in other words, the high intercorrelations are already hinting on factors that can been extracted (Watts & Stenner, 2012). The essence of factor analysis is to identify factors which can explain or fit the data better. The data points vary, which can be dissected into three kinds of variance: common variance, specific variance and error variance. Common variance is the proportion of the total variance which can be attributed to characteristics held in common by the group. The specific variance is the proportion of the total variance which can be attributed to the added factor. The error variance is unexplained variance. The goal of factor analysis (or factor extraction) is to identify factors which maximize the explained variance (common and specific variance) and minimize the error variance (Watts & Stenner, 2012). With Q methodology the centroid factor analysis is the method of choice (Watts & Stenner, 2012; Brown, 1980). To be able to extract more clear factors, the axes can be rotated. This means that the data-points (and thereby their interrelationships) do not change, but by rotating the axes it gets easier to fit or explain the data-points with the factors (Brown, 1980). It is common to use Varimax-rotation with Q methodology (Watts & Stenner, 2012).

After the factors are extracted, they will be interpreted. The interpretation focusses on the creation of a narrative or story based on the interrelationship of the many items within the particular factor array (Watts & Stenner, 2012). With the interpretation of the factors, the focus is on the statements that receive the highest and lowest scores (most agree/disagree with) and on the statements that distinguish most between one factor and the others (Cuppen et al., 2010). Q sorts are often done in combination with interviewing the participant which gives the participant the opportunity to explain his sorting. This can help with the interpretation of the factors (Cuppen et al., 2010; Van Exel & De Graaf, 2005). Apart from identifying shared beliefs, the importance of factors can be interpreted (Armatas, Venn & Watson, 2016).

Appendix F: Execution of the Q-study

1. *Concourse analysis*

Statements will be derived to construct the concourse. The aim of the statements is to cover all the statements, opinions and thoughts about safety related to the ammunition chain. To be sure that the concourse covers everything, the sources for statements are drawn more broad, including also safety within the Armed Forces in general.

The past few years multiple incidents occurred. Several studies were conducted, not only to the specific incidents, but on the broader perspective as well. This gave multiple current sources of reference about safety within the Dutch Ministry of Defence. Because of the internality and completeness of these studies, they were used to describe the concourse. Some of these studies were conducted internally, others by external bodies. The studies and documents are from a variety of sources, have a different angle and focus on different parts of the ammunition chain. Thereby, the listed sources cover the entire subject and illustrate the fragmentation of the ammunition chain. It is considered plausible that the concourse derived from the sources as used will be complete.

The following sources were used (in alphabetic order):

- Application of Risk and Safety principles in the ammunition domain (Potter, 2019)
- Het begin is er (Verbeet et al., 2019)
- Het moet en kan veiliger! (Van der Veer et al., 2018)
- Implementatie van een veiligheidsmanagementsysteem binnen LVS[25]
- Inzet Nederlandse krijgsmacht voor VN-missie in Mali (Algemene Rekenkamer, 2018)
- Lessen uit schietongeval Ossendrecht (Joustra et al., 2017b)
- Mortierongeval Mali (Joustra et al., 2017a)
- Munitievoorziening bij CBO (ADR, 2018)
- Onderzoek bedrijfsveiligheid Defensie (Royal HaskoningDHV, 2015)
- Onderzoek munitieketen na maatregelen CDS 2015 (HDFC, 2017)
- Verslag Obelix Infodag[26]

This was supplemented with statements derived from the literature review in chapter 2 to ensure that all relevant safety concepts are included in the concourse. Both these studies and the literature have a scoped view of the subject, because they work with a specific instruction or research question. To be sure to cover the whole concourse, journalistic articles were used to derive statements as well.

The following articles were used (in time order):

- Veiligheid militairen in gevaar door tekorten Defensie (Kuijpers, 2016)
- Defensie jaagt vergeefs op lekkend personeel (RTL Nieuws, 2017)
- Het lot van de nieuwe minister van Defensie lijkt nu al bezegeld (Schramade, 2017)
- De Nederlandse krijgsmacht moet minder Brits en meer Australisch (Boon & Berkhout, 2018)
- Toespraak minister Bijleveld bij de startbijeenkomst Inspectie Veiligheid Defensie (Bijleveld, 2018)
- Defensie: Geen autonoom meldpunt voor misstanden binnen het leger (Keultjes, 2018)

[25] Source (2019) only available on intranet: link.
[26] Source (2019) only available on intranet: link.

- 'Het is droevig gesteld met de veiligheidscultuur in Nederland' (Schreuder, 2019)
- Investeer ook in personeel van defensie, dat is veiliger (Debie et al., 2019)
- Tijd van 'pang pang pang' voorbij, maar armoe bij defensie blijft knellen (Van Joolen, 2019a)
- 'Fouten Defensie leidden tot hitteletsel militairen' (Heilbron, 2019)
- Het huishoudboekje van Defensie (1): Hoe de tekorten zich vijftien jaar opstapelden (Kuijpers, 2019)
- Hollandse helden zijn gedoemd van hun voetstuk te vallen (Berkhout & Versteegh, 2019)

In total 227 statements were derived from these sources and the literature review.

Out of a total of 227 statements, 130 statements had overlap with one or more other statements which could be merged into 40 'subjects'. The overlap in statements shows that multiple sources state the same things. Although difficult to tell, it can be perceived as some sort of confirmation of the completeness and impartiality of the concourse. This can be said, because of the mix of internal and external (oversight) studies and journalistic reports as sources for the concourse analysis.

2. Q-sample

The research has an inductive approach: the goal is to explore the perspectives among key-players involved with the ammunition chain. First the statements were selected based on what was found from the available sources. From the statements of the concourse a selection has been made to use for the Q-study, i.e. the Q-sample, with the aim to reach a complete, balanced set without doubling. This has been done by categorizing all statements of the concourse to a theme linked with the literature, see table 4. By categorizing the statements first, it is possible to create a structured statement selection and a balanced selection can be ensured.

To be sure that the themes cover the whole subject, 13 randomly chosen participants of the Q-study were asked to validate the completeness of the themes during the interviews. Among them were persons with knowledge on safety. They were shown the ten themes after the sorting and interview with the question if these themes cover the whole subject 'safety' and if not what is missing in their opinion. They confirmed the themes in table 4.

Theme	**Number of statements**	**Number of selected statements**
Decision-making	46	8
Information & communication	30	5
Inspections & audits	17	5
Knowledge & training	19	5
Learning	24	5
Organisational design	21	5
Process design	14	3
Redundancy	19	5
Regulations & procedures	31	5
Technology	6	3
Total	**227**	**49**

Table 4: categorization of the statements

Decision-making

The concept of risk management[27] shows that risks are always present and are, therefore, not the issue. The issue is how people deal with risks when planning ahead and when actually confronted with their occurrence. On a higher level, decision-makers have to take risk mitigating measures or make ad-hoc trade-offs while giving out orders. The decision-making will determine for the largest part how the risks will manifest themselves. The theme contains all statements regarding decision-making, risk management, risk acceptation, etc. The statements are mainly related to decision-making on deployment at the political or official level or on the ability of commanders on site to carry out their given tasks safely.

Information & communication

All the safety approaches make use of information and communication. Information and communication are necessary to be able to monitor situations and to intervene (or mitigate) when necessary. The theme contains all statements regarding making information related to the safety available and to communicate this information to the relevant stakeholders. The statements in the concourse are mainly related to monitoring, Key Performance Indicators and reporting.

Inspections & audits

Formal oversight (or inspections & audits) are a formal and more extensive tool to monitor safety or the ammunition chain, while information & communication is more informal and suitable for the daily business. The discussed safety approaches rely on (formal) inspections & audits. The theme contains all statements regarding formal oversight and enforcing the regulations. The statements are mainly related to external oversight and oversight in mission areas.

Knowledge & training

The theme contains all statements about the knowledge, training, experience and readiness of the people within the Ministry of Defence. The statements are mainly related to the training and experience of the people working with ammunition and to the knowledge present with the people higher up in the hierarchical line, for example the staff.

Learning

The safety approaches attach great importance to learning. The whole concept of reporting are based on the aim to learn from (near-)incidents. The theme contains all statements regarding the ability of the organization to learn from incidents, reports and audits. The statements are mainly related to how the organization can respond to incidents and to the willingness to respond.

Organisation design

SMS, monitoring, learning from incidents, etc. all need to be incorporated in the organisational design. Therefore this can only be discussed by looking at the full picture. The organisational design is part of that (Moorkamp, 2017). The theme contains all statements regarding the design of the organisation(s).

Process design

The theme contains all statements regarding the design of the work processes within the organisation. The statements are mainly related to how the design of certain processes function and to (re)designing certain processes with the aim to work safely and ensure the quality of the ammunition.

[27] See also appendix A for an elaboration.

Redundancy

Safety approaches (mainly HRO) aim to be resilient. In order to be resilient, redundancy has to be built in (Saunders, 2015). The theme contains all statements regarding the importance of building in redundancy on certain points. The statements are mainly related to the choice for redundancy and its relationship with the resilience of the systems.

Regulations & procedures

A big part of the safety approaches (mainly SMS) are based on regulations and proceduralization. They prescribe a safe way of operating and following them (in normal conditions) will prevent unsafe situations. The theme contains all statements regarding the use of rules and proceduralization, i.e. compliance. The statements are mainly related to the desirability of rules and proceduralization.

Technology

Risk is a combination of humans, the environment and technology (Ale, 2009). With ammunition the technology itself (explosives) is a risk. Technology in the ammunition chain has a double role: it is a risk, but it also mitigates risks (e.g. special tools or climate controlled storage). The theme contains all statements regarding the use of technology. The statements are mainly related to the ammunition itself or the equipment.

Selecting the statements for the Q-sample

The two main criteria for the Q-sample, full coverage and unbiased (Watts & Stenner, 2012), have been secured by the choice of the sources for the concourse analysis. The statements of the concourse analysis are all from independent sources to prevent bias. Because of the variety of sources used for the concourse analysis, the coverage should be complete or as complete as reasonably possible.

Normally, for every category 2-5 statements get selected for the Q-sample. The theme 'decision-making' has 8 selected statements. In this case, there was no possibility but to deviate, because of the complexity of this theme.

In total 49 statements were selected as Q-sample. An overview of all selected statements for the Q-study can be found in appendix G.

The selected statements are not abstract but are close to the language of the organisation. This was done on purpose in order to make them more 'recognizable' for the participants. Making the statements more 'recognizable' has some advantages. Firstly, it demands less thinking of the participants, thereby decreasing the hardness and possibility for mistakes of sorting by the participants. Secondly, this reduces the threshold for participants to participate. This is especially important to let people on the more executive level participate. Thirdly, it reduces the risk of interpreting statements in different ways (Brown, 1980). Fourthly, it reduces the need for the researcher to explain statements or to intervene in other ways thereby minimizing influences on the participant during the sorting in order to preserve the participant's subjectivity (Brown, 1980).

3. Participant selection

The participant or respondent selection (also called P-sample) is not random, but strategically picked. These are all key-players, relevant decision or policy makers and the servicemen. All the participants are part of the Dutch Ministry of Defence. The list of participants can be found in appendix H.

For the Q-study it is important to cover the whole ammunition chain with the participant selection. To be able to do this, the domain and its players need to be mapped first. This has recently been done with a responsibility matrix (Potter, 2019). In addition, visits of Obelix and the invitation list of the 'Obelix Infodag' served as input.[28] Furthermore, people with knowledge of the domain and organisation were asked to give input for the participant selection ('snowballing') and to validate the selection on their completeness.[29]

This lead to a list of potential candidates. The list was screened on suitability for the goal of the research. Then the people on the list where prioritized in order to reach a selection of 10-15 people. This selection served as initial P-sample. During the interviews the respondents were asked to recommend other people as participant. The list with all the people was used to check the completeness of the final P-sample and to add some participants strategically if that was necessary. This was done in order to avoid bias in the P-sample, but without compromising the aim of covering the whole ammunition chain.

The 27 selected participants are from the following organizations within the Ministry of Defence:

- BS (5x)
- CDS (2x)
- CZSK (2x)
- CLSK (3x)
- DMO (3x)
- DMunB (10x)
- EODD (1x)
- KMCGS (1x)

Because of the focus on the key-players, the respondents consist mainly of people on the management or staff level. The Armed Forces differs from other organizations, because of its unique obligatory career path. Every serviceman starts at the operational level and grows only after several years to the staff level. The result of this is that all military people on the management or staff level are familiar with the operational level. Therefore they are able to capture with their experience the operational level as well (or at least partly). Besides this, the Armed Forces have a rotation system for their personnel resulting in regular exchanges between the different levels of the Armed Forces. When approaching the respondents, their earlier functions and experiences were taken into account by assessing their suitability for this research.

The key part of the participant selection is that they capture the whole field and/or organization. Diving into especially the Army a problem emerged: safety has not been defined as an organizational function. Several functions like environment and working conditions are present, but very fragmented. No function is responsible for safety as a whole except unit commanders (usually as a side-job).

For the Q-study it was not insuperable, but it makes it more difficult to capture the whole organization. The Army is part of the chain (e.g. as 'client', single-service manager of transport, etc.), so not the whole field/organization has been captured with the participant selection. In the final participant

[28] Reports are available on intranet: visits Obelix and Obelix Infodag.
[29] Members of program Obelix and supervisor col Mac Gillavry.

selection is 37% from the Army, but are currently working in a position outside the Army. It is likely that in case of an Army-specific perspective, it will emerge in the Q-study.

4. Data collection

The data consists of Q-sorts, the statements ranked by the respondents, and interviews where the respondents were asked to elaborate their Q-sort and viewpoints. This can be done face-to-face or digital. Collecting the Q-sorts face-to-face is done by writing each statement onto a piece of card or paper and numbered randomly. Respondents are asked to sort the statements according to the forced Q-sorting grid. When the respondent is satisfied with the configuration of the statements, the Q-sort is recorded by writing the positions of each numbered statement in a Q-sorting grid (appendix I) (McKeown et al., 1999). Both collecting the Q-sorts and the elaborating interview questions can be done digitally with a tool like FlashQ (Diliou, 2013). The Q-sorts and the list of numbered statements will be used as input for the factor analysis.

The preferred choice for the data collection is face-to-face.[30] In practice, collecting the data digitally is only suitable for research looking to test or confirm strong and clear hypotheses. This research is explorative, so the data collection has been done face-to-face.

The selected statements (appendix G) are in both English and Dutch. To the participants the presented statements were in Dutch only. This was done because they were all native Dutch speakers and not used to speak or read English on a daily basis. Showing the participants the statements in English or both Dutch and English would not add anything to the research, but only increase the risk of confusion or overthinking.

After sorting the statements, the respondents will be interviewed. The aim of the interview is to let the respondents elaborate their Q-sort. This can be done by asking what the highest ranked statements mean for them for example. Or the respondents can be asked to write down or tell what the they think of the topic in general (Watts & Stenner, 2012). This helps the interpretation of the factor analysis, because it tells more about why they ranked the statements in this way or what their specific view is on the specific statement.

7. Factor analysis

To analyse the Q-sorts, the tool Ken-Q Analysis has been used.[31] The data-input is shown in appendix J. The Ken-Q Analysis tool produces the factors that will be interpreted further.

Correlation matrix

Firstly, the correlation matrix is calculated (table 5). The correlation matrix shows the degree of similarity among the Q-sorts of the participants. Participants that positively correlate with each other have sorted the statements similarly. Negative correlations indicate opposite sortings (Watts & Stenner, 2012). The correlation matrix forms the quantitative basis for calculating factor loadings, which will be discussed in the next section.

[30] Statement of a PhD-candidate (2019) based on her personal experience with both options. Van Exel & De Graaf (2005) show the same preference.
[31] https://shawnbanasick.github.io/ken-q-analysis/

Participant	Qmm01	Qmm02	Qmm03	Qmm04	Qmm05	Qmm06	Qmm07	Qmm08	Qmm09	Qmm10	Qmm11	Qmm12	Qmm13	Qmm14	Qmm15	Qmm16	Qmm17	Qmm18	Qmm19	Qmm20	Qmm21	Qmm22	Qmm23	Qmm24	Qmm25	Qmm26	Qmm27
Qmm01		0,23	0,51	0,25	0,59	0,26	0,41	0,24	0,2	0,21	0,26	0,28	0,15	0,43	0,37	0,16	0,1	0,37	0,47	0,39	0,26	0,15	0,34	0,22	0,09	0,33	0,42
Qmm02	0,23		0,28	0,25	0,47	-0,03	0,02	0,38	0,33	0,14	0,11	-0,05	0,15	0,48	-0,01	0,01	0,22	0,38	0,37	0,08	0,4	0,23	0,31	0,28	-0,04	0,19	0,19
Qmm03	0,51	0,28		0,36	0,61	0,15	0,21	0,48	0,38	0,48	0,45	0,43	0,31	0,47	0,29	0,17	0,13	0,54	0,48	0,59	0,39	0,18	0,53	0,3	0,16	0,53	0,44
Qmm04	0,25	0,25	0,36		0,26	0,2	0	0,39	0,43	0,43	0,23	0,12	0,25	0,24	-0,04	0,13	0,09	0,39	0,4	0,32	0,31	0,44	0,3	0,24	0,18	0,27	0,06
Qmm05	0,59	0,47	0,61	0,26		0,21	0,46	0,51	0,24	0,28	0,34	0,3	0,1	0,5	0,31	0,13	0,15	0,53	0,48	0,29	0,55	0,16	0,48	0,33	0,15	0,41	0,43
Qmm06	0,26	-0,03	0,15	0,2	0,21		0,23	0,19	0,38	0,1	-0,06	0,24	-0,01	0,06	0,02	-0,07	0,13	0,22	0,19	0,03	0,2	0,11	0,03	0,22	0,3	0,05	0,21
Qmm07	0,41	0,02	0,21	0	0,46	0,23		-0,14	0,14	0,03	0,09	0,25	0,09	0,3	0,48	0,06	0,09	0,2	0,21	0,19	0,32	0,05	0,38	0,31	0,38	0,15	0,23
Qmm08	0,24	0,38	0,48	0,39	0,51	0,19	-0,14		0,12	0,34	0,49	0,33	0,17	0,38	-0,01	0,13	-0,13	0,41	0,56	0,22	0,26	0,33	0,3	0,18	-0,06	0,32	0,42
Qmm09	0,2	0,33	0,38	0,43	0,24	0,38	0,14	0,12		0,29	-0,06	-0,07	0,06	0,32	0,06	0	0,48	0,43	0,31	0,2	0,43	0,19	0,29	0,2	0,33	0,33	0,14
Qmm10	0,21	0,14	0,48	0,43	0,28	0,1	0,03	0,34	0,29		0,34	0,08	0,34	0,4	0,06	0,4	0,14	0,49	0,24	0,25	0,41	0,12	0,49	0,4	0,16	0,45	0,17
Qmm11	0,26	0,11	0,45	0,23	0,34	-0,06	0,09	0,49	-0,06	0,34		0,41	0,37	0,41	0,2	0,36	-0,02	0,36	0,49	0,49	0,04	0,33	0,33	0,11	-0,24	0,41	0,36
Qmm12	0,28	-0,05	0,43	0,12	0,3	0,24	0,25	0,33	-0,07	0,08	0,41		0,35	0,16	0,25	-0,04	-0,23	0,22	0,38	0,39	-0,08	0,34	0,26	0,09	0,07	0,42	0,29
Qmm13	0,15	0,15	0,31	0,25	0,1	-0,01	0,09	0,17	0,06	0,34	0,37	0,35		0,3	0,33	0,06	-0,16	0,1	0,29	0,42	0,07	0,32	0,45	0,06	-0,12	0,43	0,17
Qmm14	0,43	0,48	0,47	0,24	0,5	0,06	0,3	0,38	0,32	0,4	0,41	0,16	0,3		0,23	0,27	0	0,38	0,48	0,44	0,29	0,21	0,58	0,12	0,22	0,3	0,35
Qmm15	0,37	-0,01	0,29	-0,04	0,31	0,02	0,48	-0,01	0,06	0,06	0,2	0,25	0,33	0,23		-0,15	-0,1	0,1	0,13	0,31	0,17	0,21	0,36	0,18	-0,03	0,46	0,37
Qmm16	0,16	0,01	0,17	0,13	0,13	-0,07	0,06	0,13	0	0,4	0,36	-0,04	0,06	0,27	-0,15		0,34	0,07	0,19	0,07	0,29	-0,03	0,14	0,23	0,02	0,01	-0,04
Qmm17	0,1	0,22	0,13	0,09	0,15	0,13	0,09	-0,13	0,48	0,14	-0,02	-0,23	-0,16	0	-0,1	0,34		0,25	0	-0,17	0,4	-0,19	0	0,36	0,11	-0,03	-0,07
Qmm18	0,37	0,38	0,54	0,39	0,53	0,22	0,2	0,41	0,43	0,49	0,36	0,22	0,1	0,38	0,1	0,07	0,25		0,45	0,34	0,37	0,23	0,46	0,5	0,37	0,47	0,43
Qmm19	0,47	0,37	0,48	0,4	0,48	0,19	0,21	0,56	0,31	0,24	0,49	0,38	0,29	0,48	0,13	0,19	0	0,45		0,52	0,13	0,19	0,31	0,2	0,13	0,4	0,55
Qmm20	0,39	0,08	0,59	0,32	0,29	0,03	0,19	0,22	0,2	0,25	0,49	0,39	0,42	0,44	0,31	0,07	-0,17	0,34	0,52		0,03	0,24	0,34	0,11	0,06	0,43	0,43
Qmm21	0,26	0,4	0,39	0,31	0,55	0,2	0,32	0,26	0,43	0,41	0,04	-0,08	0,07	0,29	0,17	0,29	0,4	0,37	0,13	0,03		0,18	0,44	0,47	0,27	0,24	0,17
Qmm22	0,15	0,23	0,18	0,44	0,16	0,11	0,05	0,33	0,19	0,12	0,33	0,34	0,32	0,21	0,21	-0,03	-0,19	0,23	0,19	0,24	0,18		0,19	0,17	-0,1	0,23	0,18
Qmm23	0,34	0,31	0,53	0,3	0,48	0,03	0,38	0,3	0,29	0,49	0,33	0,26	0,45	0,58	0,36	0,14	0	0,46	0,31	0,34	0,44	0,19		0,26	0,22	0,45	0,17
Qmm24	0,22	0,28	0,3	0,24	0,33	0,22	0,31	0,18	0,2	0,4	0,11	0,09	0,06	0,12	0,18	0,23	0,36	0,5	0,2	0,11	0,47	0,17	0,26		0,25	0,19	0,27
Qmm25	0,09	-0,04	0,16	0,18	0,15	0,3	0,38	-0,06	0,33	0,16	-0,24	0,07	-0,12	0,22	-0,03	0,02	0,11	0,37	0,13	0,06	0,27	-0,1	0,22	0,25		0,02	0,27
Qmm26	0,33	0,19	0,53	0,27	0,41	0,05	0,15	0,32	0,33	0,45	0,41	0,42	0,43	0,3	0,46	0,01	-0,03	0,47	0,4	0,43	0,24	0,23	0,45	0,19	0,02		0,4
Qmm27	0,42	0,19	0,44	0,06	0,43	0,21	0,23	0,42	0,14	0,17	0,36	0,29	0,17	0,35	0,37	-0,04	-0,07	0,43	0,55	0,43	0,17	0,18	0,17	0,27	0,27	0,4	

Table 5: correlation matrix Q-sorts

In the correlation matrix, the negative values which correlate -0,1 or more have been made visible by giving them a red colour. Smaller negative correlations have not been made visible, because they are practically indifferent/zero. The most negative (or opposing) correlation is -0,24. The concerning participants are from the administrative/political level and from the work floor. On other dimensions, like branch, they do not differ.

The positive values which have a correlation greater than 0,4 have been made visible by giving them a green colour. Smaller values have not been made visible, because then practically the whole table would be green and would serve no purpose. The most positive (or agreeing) correlation is 0,61. The concerning participants are directly involved and have long experience with ammunition.

As can be seen, most participants agree with each other. A small number of participants seem to agree with each other, but disagree with the rest. This can be seen as an indication that there exist roughly two perspectives.

One participant (Qmm16, a senior manager of DMunB and from the Air Force branch) is different. He correlates nearly zero with every other participant, meaning that he is indifferent with them. It is not likely that this will show up as a separate perspective.

Factor extraction

Factor analysis is the process of identifying and extracting sorting patterns from the data. In Q methodology factor analysis is commonly executed by one of two procedures: centroid factor analysis (CFA) and principal component analysis (PCA). The main characteristic of PCA is that it will resolve itself into a single, mathematically best solution which is the one that should be accepted (Watts & Stenner, 2012). PCA is not the preferred method within Q methodology, because it narrows the interpretation down to a mathematically optimized solution. Most Q methodologists do not think that the mathematical best solution is necessarily also the best, most meaningful or most informative solution for the goal of the research (Van den Ende, 2018; Watts & Stenner, 2012). Therefore, CFA is the preferred choice for Q methodologists and also the method that will be used here. CFA is the oldest factor extraction technique and was developed even before computers and is notable for its ease and simplicity (Watts & Stenner, 2012).

CFA requires the researcher to decide how many factors to extract. It is common practice within Q methodology to start with 7 factors (Watts & Stenner, 2012). Table 6 shows the results of CFA for 7 factors. Factor 1 has 27% explained variance which means that by adding factor 1 the results of the Q-

sorts can be explained for an additional 27%. All 7 factors can explain up to 50% which means that 50% is either unexplained or random or error variance.

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Eigenvalues	7.3031	2.372	0.244	1.4279	1.0592	0.9308	0.2353
% Explained Variance	27	9	1	5	4	3	1
Cumulative % Expln Var	27	36	37	42	46	49	50

Table 6: CFA for 7 factors

In order to decide how many factors will be kept for further analysis, is a choice from the researcher. But several accepted approaches exist to help the researcher. Four will be applied and the results will be used to decide how many factors will be kept.

The first is to accept those factors that have two or more significant factor loadings following extraction (Watts & Stenner, 2012). A significant factor loading at the 0,01 level can be calculated with the following equation: 2,58*(1/√no. of statements in the Q-set). In this case, that means that factor loadings equal to 0,3685 or larger load significant on a factor. This is the case for the factors 1 and 2.

The second is to look to the Eigenvalues. Factors with eigenvalues greater than 1 can be accepted (Diliou, 2013; Brown, 1980). According to table 6 that is the case for the factors 1, 2, 4, and 5.

The third is Humphrey's rule: a factor is significant if the cross-product of its two highest loadings (ignoring the sign) exceeds twice the standard error (Watts & Stenner, 2012). The standard error is calculated with: 1/√no. of statements in the Q-set. In this case, the threshold is 0,29. According to Humphrey's rule, the factors 1 and 2 can be accepted (see table 7).

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
Cross-product of its two highest loadings	0,57	0,36	0,06	0,22	0,13	0,13	0,04

Table 7: cross-product of the two highest factor loadings

The fourth is the scree test. The scree test is frequently used, but it was designed to use only in the context of PCA (Watts & Stenner, 2012). Therefore, a PCA was run on the data in order to get the scree plot. The scree test looks where the slope changes in order to be able to say how many factors are optimal. The scree plot is shown in figure 19. According to the plot, extracting two factors is optimal for further analysis.

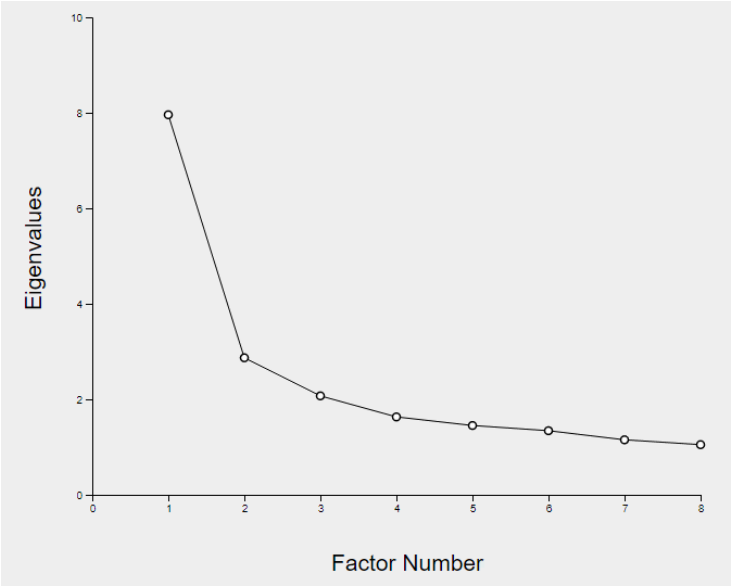

Figure 19: scree plot with PCA

Therefore, based on the four approaches, two factors will be kept for the further analysis. As elaborated before, Varimax rotation will be used. For the factors loading on a factor, the significance level of p<0,01 will be used. Safety is a very broad topic and the statements were diverse while the sorting depends on the level and part the organisation the participant is from. Making a stricter significance selection results in the more striking characteristics of the perspectives. This will make the interpretation of the factors for this topic easier and probably more useful for the goal of the research.

Unfortunately the two factors turned out to have around 25 distinguishing statements and therefore were too big and complex to interpret. Normally that is a sign that more factors need to be extracted. Therefore, the rules of thumb of the eigenvalue and the number of participants loading significantly on the factor (at least two) will be used to explore the possibility of extracting more factors.

Other solutions were explored: CFA with 3, 4 and 5 factors and PCA with 3, 4 and 5 factors. Based on the output, explained variance and correlations between the factors the option CFA with 4 factors has been chosen (appendix K).

No participants load significantly on factor 3, therefore only factor 1, 2 and 4 will be selected from the CFA with 4 factors for further interpretation. Together, these factors explain 41% of the study variance which is considered as a sound solution (Armatas, Venn & Watson, 2016). But explained variance is not considered as a relevant measure in Q methodology, because in Q methodology one is not interested what percentage of the population this perspective has (Cuppen et al., 2010).

The CFA with 4 factors has a high correlation between factor 1 and 2 (table 8). The correlation is high, but acceptable[32]. The similarities and differences between the factors make sense based on the type of participants and how they load on the factors.

[32] The correlation is lower than some correlations in other research with Q methodology (e.g. Cuppen et al., 2010).

	factor 1	factor 2	factor 4
factor 1	1	0.4955	0.2318
factor 2	0.4955	1	0.3475
factor 4	0.2318	0.3475	1

Table 8: factor correlations for CFA with 4 factors, without factor 3

A PCA with more factors has higher study variances (e.g. 5 factors: 59% variance), but problems arise with high correlations between the factors and the higher number of participants that do not load significantly on one of the factors. Therefore, a PCA with more factors was dismissed as a feasible approach for this study.

A bipolar factor means that there are factor loadings with different signs (positive or negative) on the factor. Normally, that means that those participants have the same perspectives, but in an opposite way. No bipolar factors have been found in the results, so no opposing perspectives are present in the Q-study.

Appendix G: Q-sample

Nr.	Statement	Theme
1.	We don't have suitable equipment to stock and to handle ammunition in operational areas *We hebben niet het materieel om munitie op te slaan en te bewerken in inzetgebieden*	Technology
2.	To be able to purchase ammunition fast, it is desirable to have special procedures to bypass the normal procedures *Bijzondere procedures om snel munitie te kopen buiten de normale inkoopprocedures om zijn wenselijk*	Process design
3.	Internal quality inspections may be skipped if that is necessary to deploy ammunition on time in operational areas *Interne kwaliteitscontroles mogen overgeslagen worden als dat nodig is om munitie op tijd in inzetgebieden te krijgen*	Inspections & audits
4.	Higher safety risks are acceptable during international missions *Hogere veiligheidsrisico's zijn acceptabel tijdens internationale missie*	Decision-making
5.	Reliable acquisition and deployment of ammunition is more important than reliable safety of ammunition *Betrouwbare levering van munitie is belangrijker dan betrouwbare veiligheid van munitie*	Decision-making
6.	An advice or inspection body always does not haveto assess the design of every ammunition storage in operational areas *Een advies- of inspectieorgaan hoeft niet altijd de inrichting van elke munitieopslag bij militaire operaties te controleren*	Inspections & audits
7.	People don'tneed to have more specific education regarding safety and safety awareness *Mensen hebben niet meer specifieke scholing nodig met betrekking tot veiligheid en veiligheidsbewustzijn*	Knowledge & training
8.	Unwritten rules within the organisation(s) are a threat to safety *Ongeschreven regels binnen de organisatie(s) zijn een bedreiging voor de veiligheid*	Regulations & procedures
9.	An adaption of the leadership styles is needed to improve the safety awareness on all levels *De leiderschapsstijlen moeten worden aangepast om het veiligheidsbewustzijn te verbeteren op alle niveaus*	Knowledge & training
10.	Mixing and roulating personnel from different functions and branches strengthens the safety *Het mixen en rouleren van personeel van verschillende functies en onderelen versterkt de veiligheid*	Organizational design
11.	Not only specialists, but also commanders and leaders should have knowledge of the basics of ammunition *Niet alleen specialisten, maar ook de commandanten en leidinggevenden zouden kennis van de grondbeginselen van munitie moeten hebben*	Knowledge & training
12.	The DMunB should be responsible for every aspect of the ammunition chain such as transportation instead of only delivery of ammunition *Het DMunB zou verantwoordelijk moeten zijn voor alle aspecten van de munitieketen zoals transport in plaats van alleen het leveren van munitie*	Organizational design
13.	The Ministry of Defence just has to be more responsive to signals and notifications on ammunition in order to improve the safety *Het Ministerie van Defensie hoeft alleen meer responsiever te zijn op signalen en meldingen over munitie om de veiligheid te verbeteren*	Information & communication
14.	The focus of the Ministry of Defence should be on stocking more ammunition instead of reducing the requests for too much ammunition for training *De focus van het Ministerie van Defensie moet liggen bij het opslaan van meer munitie in plaats van het verminderen van overvragende aanvragen voor munitie bij O&T*	Redundancy
15.	A Safety Management System will safeguard ammuniton safety, even in operational areas *Een Veiligheidsmanagementsysteem zal de munitieveiligheid waarborgen, zelfs in inzetgebieden*	Regulations & procedures
16.	The top of the Ministry of Defence only prioritizes safety after incidents occur *Het topniveau van het Ministerie van Defensie geeft alleen prioriteit aan veiligheid nadat er ongelukken gebeuren*	Learning
17.	Monitoring safety with KPI's and dashboards at all levels will improve the safety *Het monitoren van de veiligheid met KPI'n en dashboard op alle niveaus zal de veiligheid verbeteren*	Information & communication
18.	The discrepancy between the "reality of The Hague" and the "reality in the field" is an obstruction for the improvement of the safety *Het verschil tussen de "Haagse werkelijkheid" en de "werkelijkheid in het land" vormt een obstakel voor de verbetering van de veiligheid*	Information & communication

19.	There is no culture of working unsafe, but a lack of the necessary resources *Er is geen cultuur van onveilig werken, maar een tekort aan noodzakelijke middelen*	Redundancy
20.	It is more the obligation of the organisation to enforce safety than of the individual person in the field *Het is meer de verplichting van de organisatie om veiligheid af te dwingen dan van de individuele persoon in het veld*	Inspections & audits
21.	The resources of commanders don't match their responsibilities *De middelen van commandanten komen niet overeen met hun verantwoordelijkheden*	Decision-making
22.	In order to stimulate the learning abilities of the organisation, the allocation of guilt of a (near-)incident should never be an aim of the investigation *Om het leervermogen van de organisatie te stimuleren, zou de schuld van van een (bijna-)ongeluk nooit onderzocht moeten worden*	Learning
23.	Safety should never be expressed in terms of money *Veiligheid mag nooit in geld uitgedrukt worden*	Decision-making
24.	A safer ammunition chain will be less effective and reliable to supply ammunition *Een veiligere munitieketen zal minder effectief en betrouwbaar zijn in het leveren van munitie*	Process design
25.	Preventing rare events but with high impact is more important than to prevent common incidents *Het voorkomen van zeldzame gebeurtenissen maar met een hoge impact is belangrijker dan het voorkomen van gewone incidenten*	Organization design
26.	The biggest issue with ammunition safety is the lack of sufficient trained personnel and to track its currency *Het grootste probleem met munitieveiligheid is het gebrek aan voldoende opgeleid personeel en het bijhouden van hun currency*	Redundancy
27.	The Ministry of Defence should not focus on rule violations, but on evaluating the worker's conduct in light of what was reasonable to do in the circumstances *Het Ministerie van Defensie moet niet focussen op overtredingen van regelgeving, maar op het evalueren van het handelen van de werknemer naar wat redelijk was gezien de omstandigheden*	Learning
28.	After a certain amount of time a severe accident always will happen regardless of the efforts put in safety *Na verloop van tijd zal er altijd een groot ongeluk gebeuren, ongeacht de moeite die in veiligheid wordt gestoken*	Decision-making
29.	The Ministry of Defence should focus on anticipation and containment of incidents instead of a safety management system *Het Ministerie van Defensie moet zich focussen op het anticiperen en beheersen van incidenten in plaats van een veiligheidsmanagementsysteem*	Regulations & procedures
30.	Being safe is not being free of errors but that errors do not disable the organisation *Veiligheid is niet het vrij zijn van het maken van fouten, maar dat fouten de organisatie niet lamleggen*	Process design
31.	People are not there to serve the systems, but are at the centrepoint of the systems *Mensen staan niet in dienst van de systemen, maar zijn het middelpunt van de systemen*	Technology
32.	It is better for the reliability of the ammunition chain to be able to operate both in a centralised and decentralised way *Het is beter voor de betrouwbaarheid van de munitieketen om zowel centraal als decentraal te kunnen werken*	Organizational design
33.	If an accident occurs despite all the safety measures, it is acceptable regardless the concsequences *Als een ongeluk gebeurt ondanks de genomen veiligheidsmaatregelen, dan is het acceptabel ongeacht de gevolgen*	Regulations & procedures
34.	Incompletely qualified personnel should never participate in trainings, military operations or other work within the Ministry of Defence, even if that would mean that the operation will have to be canceled *Onvolledig gekwalificeerd personeel mag nooit deelnemen aan oefeningen, militaire operaties of ander werk binnen het Ministerie van Defensie, zelfs als dat betekent dat de operatie niet door kan gaan*	Knowledge & training
35.	Loyality is a safety risk *Loyaliteit vormt een veiligheidsrisico*	Decision-making
36.	Transparancy (to the public) is necessary to learn from accidents, even if the public gets angry *Transparantie (naar buiten toe) is noodzakelijk om te leren van ongelukken, zelfs als men boos wordt*	Informating & communication

37.	The resources should be determined depending on the ambition level of the armed forces *De financiele middelen moeten bepaald worden aan de hand van het ambitieniveau van de Krijgsmacht*	Decision-making
38.	In order to prevent accidents, the Ministry of Defence should lower its ambition level for the next ten years drastically *Om ongelukken te voorkomen zou het Ministerie van Defensie zijn ambitieniveau voor de komende tien jaar drastisch moeten verlagen*	Redundancy
39.	Accidents happen mainly because of unsound equipment and not because of other reasons *Ongelukken gebeuren voornamelijk vanwege ondeugdelijk materieel en niet vanwege andere redenen*	Technology
40.	Training and exercises should have the highest priority, because the level of training of the personnel influences the overall safety most *Opleiding en training hebben de meeste prioriteit, want het opleidingsniveau van het personeel beïnvloedt de algemene veiligheid het meest*	Knowledge & training
41.	The Ministry of Defence sdoes not need to have the same norms and values on safety at all layers *Het Ministerie van Defensie hoeft niet op alle lagen dezelfde normen en waarden over veiligheid hebben*	Learning
42.	There needs to be external oversight on safety, not internal oversight from within the Ministry of Defence *Toezicht op veiligheid moet extern zijn, niet intern binnen het Ministerie van Defensie*	Inspections & audits
43.	Deviations from regulations on ammunition should never be allowed, even in case of deployment *Afwijkingen van de regelgeving over munitie zou nooit toegestaan mogen zijn, zelfs in het geval van inzet*	Regulations & procedures
44.	If a commander has to make a trade-off between preserving the equipment, the effectivity of meeting the mission objectives or the safety of his people, he always has to choose for the safety of his people *Als een commandant moet kiezen tussen het behoud van zijn materieel, de effectiviteit van de missie of de veiligheid van zijn mensen, dan moet hij altijd gaan voor de veiligheid van zijn mensen*	Decision-making
45.	A management that reguraly acknowledges and rewards contribution from the workfloor will improve the overall safety *Een leiding die regelmatig de werkvloer erkenning geeft en beloont voor hun bijdrages zal de veiligheid verbeteren*	Learning
46.	The ammunition chain is designed based on efficiency, but should be based on effectiveness and redundancy *De munitieketen is ontworpen op basis van efficientie, maar dit zou moeten zijn op basis van effectiviteit en redundantie*	Redundancy
47.	There should be an ammunition authority like the MLA for aviation *Er moet een munitie-autoriteit zijn zoals de MLA bij de luchtvaart*	Inspections & audits
48.	Chain-thinking does not fit within the way of thinking of the Ministry of Defence, therefore we should go back to an hiarchical design of the ammunition chain *Ketendenken past niet binnen de manier van denken bij het Ministerie van Defensie, daarom moeten we teruggaan naar een hiërarchisch ontwerp van de munitieketen*	Organizational design
49.	The organisation is too big to improve the safety with only the focus on improving behaviour and communication *De organisatie is te groot om de veiligheid te kunnen verbeteren met alleen de focus op het verbeteren van gedrag en communicatie*	Information & communication

Table 9: Q-sample

Appendix H: Participants Q-study

DO	Position	Branch	Rank
Bestuurstaf	HDBV/M&B	Civilian	N.a. (A5)
	HDBV/TASKF PM	Army	Luitenant-kolonel b.d. (OF-4)
	HDB Chef Kabinet	Army	Luitenant-kolonel (OF-4)
	HDB Beleidsmedewerker	Civilian	N.a. (A4)
	DV	Air Force	Kolonel b.d. (OF-5)
Defensiestaf	DAOG/OOG	Army	Luitenant-kolonel (OF-4)
	DOPS/J4	Army	Luitenant-kolonel (OF-4)
CZSK	H-MUNMAG	Civilian	N.a. (A2)
	ML : V&M	Navy	Luitenant-ter-zee 1 (OF-3)
CLSK	AMRO/IV SYST	Air Force	Luitenant-kolonel (OF-4)
	AMRO/SREGKLOG	Air Force	Kapitein (OF-2)
	H-OPSLOG & H-MOAT Leeuwarden	Air Force	Kapitein (OF-2)
DMO	PD-DMO	Army	Generaal-majoor (OF-7)
	Vz-Obelix (recently C-13 Hrstcie)	Army	Kolonel (OF-5)
	H-MCGS	Civilian	N.a. (A4)
DMunB	C-DMunB (new, recently Masterplan DMunB)	Civilian	N.a. (A6)
	C-DMunB (previous)	Civilian	N.a. (A5)
	CS-DMunB	Army	Luitenant-kolonel (OF-4)
	H-Log	Air Force	Kolonel (OF-5)
	H-LVM	Air Force	Kolonel (OF-5)
	H-VHMGMT	Air Force	Luitenant-kolonel (OF-4)
	H-KCW&M	Army	Luitenant-kolonel (OF-4)
	H-FYSDISTR	Civilian	N.a. (A4)
	H-Productie	Army	Majoor (OF-3)
	Uitvoering	Civilian	N.a. (C2)
EODD	PC-/CS-EODD	Army	Luitenant-kolonel (OF-4)
KMCGS	C-KMCGS	Military Police	Luitenant-kolonel (OF-4)

Table 10 : participants of the Q-study

The participants of the Q-study are shown in table 10. The respondents are all part of the ammunition domain, but most work in the ammunition chain itself. People from the Army (not necessarily working directly for the Army) are with 37% the larges branch in the sample. The Air Force follows with 26% and both the Navy and the Military Police are 4% of the participants. The remaining 30% are civilian and work for all the branches. The ranks (including the civilian scales) are from all levels, but the most are senior officers.

Appendix I: Q-sort

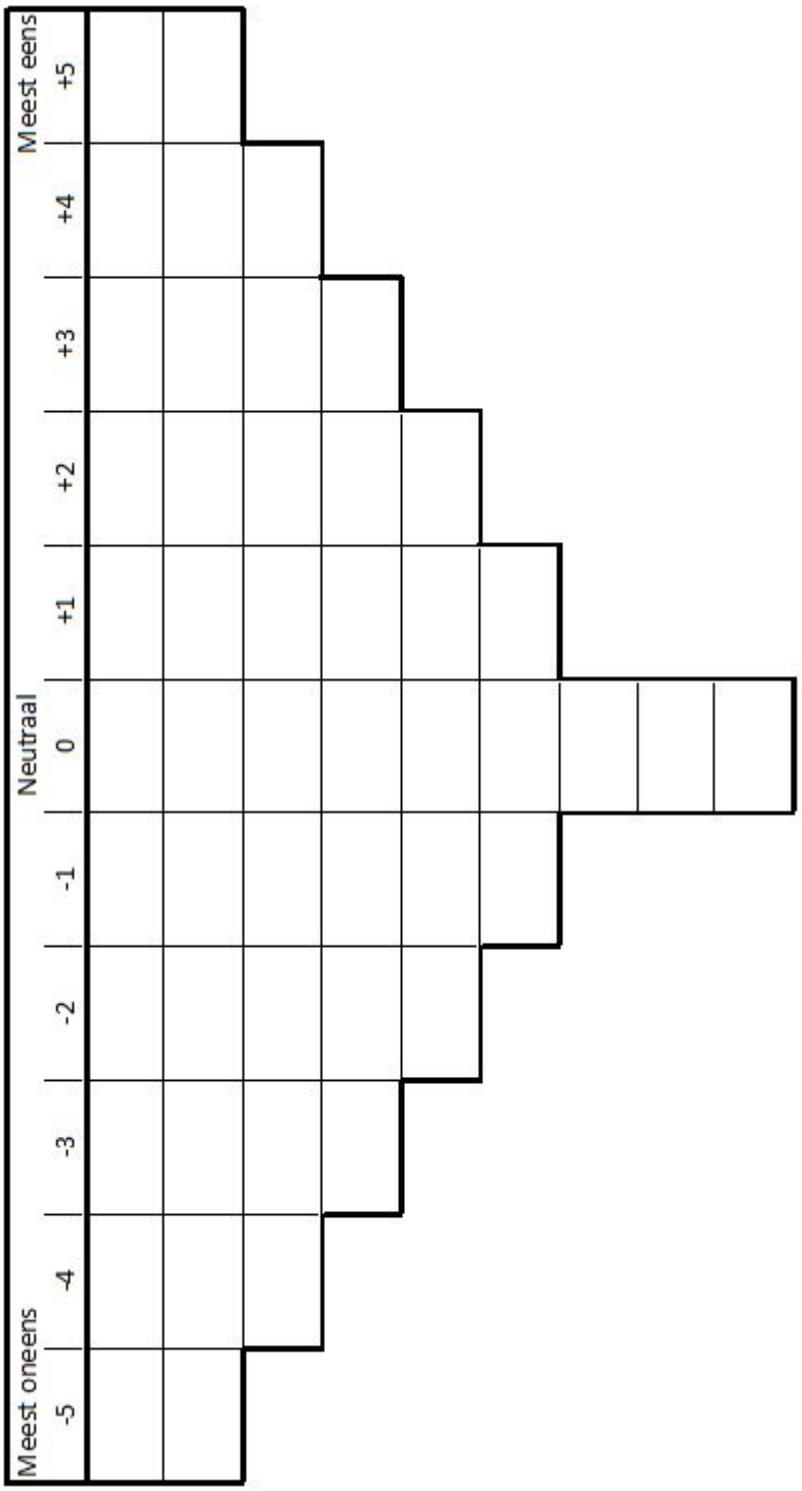

Figure 20: Q-sort distribution

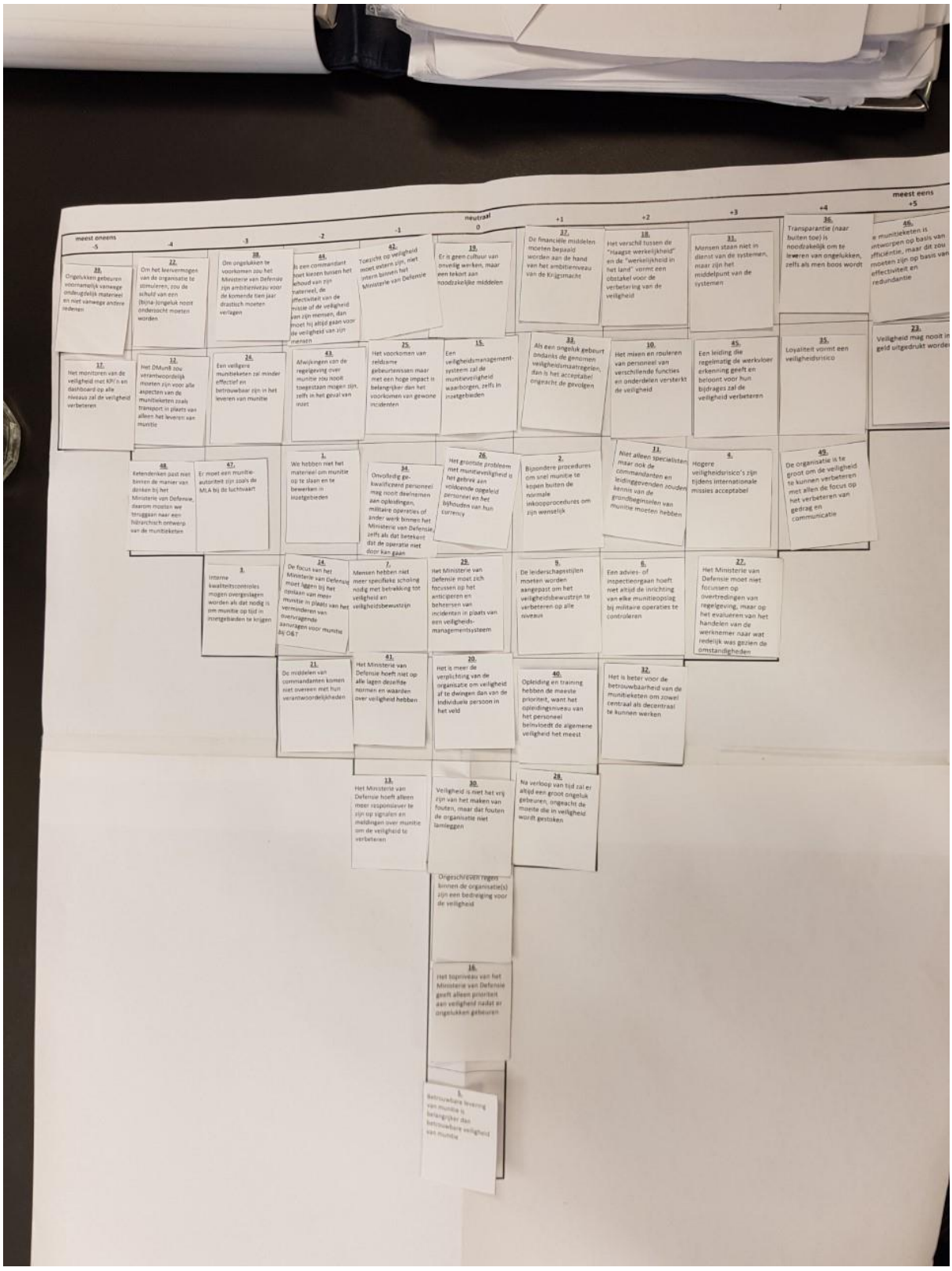

Figure 21: example of a Q-sort

Appendix J: Ken-Q Analysis data input

For the Ken-Q analysis, the data-input was done with the Excel type 2 option:

Project Name	Do not change the blue cells
Obelix	

participants	s1	s2	s3	s4	s5	s6	s7	s8	s9	s10	s11	s12	s13	s14	s15	s16	s17	s18	s19	s20	s21	s22	s23	s24	s25
Sort Pattern	-5	-5	-4	-4	-4	-3	-3	-3	-3	-2	-2	-2	-2	-2	-1	-1	-1	-1	-1	-1	0	0	0	0	0
Qmm01	2	-1	-4	-1	-5	1	-2	-3	2	1	0	3	-4	-2	5	1	2	0	-2	4	1	0	0	0	-1
Qmm02	-3	-1	0	-1	-5	2	-1	5	3	0	1	-3	-4	-2	1	2	-3	0	3	2	1	4	0	-4	-2
Qmm03	3	1	-5	2	-4	0	-2	-1	0	2	1	0	-2	0	5	0	1	2	0	-3	-1	-2	3	-3	-4
Qmm04	2	-5	-5	4	-4	-2	-2	2	2	-4	1	-3	-2	-1	0	0	1	0	-1	-1	0	2	3	-1	1
Qmm05	0	1	-3	1	-5	1	-4	0	1	4	3	-1	-4	-2	1	0	3	0	-1	0	5	-2	-1	-3	-3
Qmm06	0	1	-5	2	-1	-2	-2	-3	-4	-1	2	0	-1	0	4	-2	1	-3	0	4	5	-5	0	-2	-1
Qmm07	-1	4	1	-2	-1	3	-4	-2	0	0	3	0	2	0	2	-4	1	-1	2	-2	4	-2	-3	0	1
Qmm08	0	-1	-5	2	-4	-3	1	0	0	0	3	-4	-2	-2	-2	-3	2	2	-1	3	1	-1	4	-5	-2
Qmm09	4	1	-4	2	-2	1	-3	-2	1	-1	3	-1	-2	2	0	4	0	1	3	1	3	0	-1	0	0
Qmm10	2	0	-3	3	-4	-1	-1	1	0	1	2	-2	-1	-3	0	3	1	2	-2	-4	0	4	5	-2	-1
Qmm11	0	0	-5	-2	-5	0	3	3	2	-1	1	0	2	-2	-2	1	2	2	-4	-2	4	-1	5	-4	-1
Qmm12	-1	-1	-3	-3	-2	-4	-2	1	-1	0	-1	4	3	1	1	-5	0	0	2	2	2	-5	5	-3	-4
Qmm13	-1	-1	-4	-3	-1	-4	-1	5	2	0	-2	-1	0	1	2	0	1	2	-2	-2	1	4	0	0	-5
Qmm14	0	0	1	0	-4	-2	-1	0	4	-1	2	-3	0	0	1	3	2	-2	2	-3	4	5	0	-3	-4
Qmm15	-4	5	1	-1	-3	-1	0	-4	0	1	1	4	-2	-1	0	0	-2	-1	0	-2	2	-1	-2	2	0
Qmm16	1	-3	-4	1	-1	0	2	2	0	3	2	-5	-2	1	0	1	0	1	-2	-2	2	5	5	-3	4
Qmm17	4	2	-3	1	-3	5	0	-3	0	3	0	-4	-2	1	0	4	-1	2	-2	3	0	2	-1	-5	2
Qmm18	2	0	-1	1	-4	0	-3	0	4	0	1	-2	-1	-3	-2	3	0	5	-3	-1	2	-5	3	-4	-2
Qmm19	-1	0	-5	0	-3	-1	-4	0	2	-3	2	-2	-1	-4	1	3	1	2	1	2	4	-2	3	-4	-2
Qmm20	2	-1	-5	-1	-1	-3	-2	1	0	-1	2	0	2	0	5	4	-2	4	1	-5	3	-1	1	0	-2
Qmm21	0	2	-5	5	-4	1	0	0	-1	2	4	-3	-4	2	-2	1	0	1	3	-1	0	2	-4	-2	0
Qmm22	-3	-5	-4	-3	-2	1	-2	1	1	-2	2	2	0	4	-4	-2	-1	-3	0	0	1	1	5	0	-1
Qmm23	-2	0	-1	4	-5	0	0	3	3	-1	2	0	-1	2	0	0	0	2	-3	-3	1	1	-2	2	-4
Qmm24	-2	1	-3	3	0	2	-1	0	1	2	2	-4	-1	-2	0	0	-5	2	0	0	-2	-4	5	-3	-1
Qmm25	0	-3	1	3	1	0	-3	-5	3	-3	2	-2	2	0	1	-1	2	1	5	-2	3	-4	-4	-3	0
Qmm26	2	3	-2	0	-3	-5	-1	2	2	-3	5	5	-4	0	-1	1	0	4	-1	-1	4	-1	4	-2	-4
Qmm27	-3	1	-4	-1	3	1	0	-5	1	-2	3	0	-1	-4	-1	1	3	2	0	0	3	-3	0	-5	-3

participants	s26	s27	s28	s29	s30	s31	s32	s33	s34	s35	s36	s37	s38	s39	s40	s41	s42	s43	s44	s45	s46	s47	s48	s49
Sort Pattern	0	0	0	0	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	4	5	5
Qmm01	2	3	-1	-5	0	1	-2	0	3	-1	-1	4	0	-3	5	-3	-2	-3	3	1	4	0	-4	2
Qmm02	1	2	1	-5	0	0	4	-1	-2	2	3	-1	0	-2	1	0	5	-4	4	3	-2	0	-3	-1
Qmm03	4	3	1	-3	-1	1	-1	-5	3	0	4	2	-3	-4	1	0	-2	-2	5	2	-1	4	0	-1
Qmm04	4	2	5	0	0	-1	0	1	-3	0	4	0	3	-4	3	-3	-3	1	-1	1	-2	5	-2	3
Qmm05	4	5	0	-2	2	-1	0	-2	2	0	2	2	-3	-5	3	-4	4	-2	3	2	0	-1	-1	1
Qmm06	-3	-1	1	-1	1	0	1	5	-2	0	3	2	2	-4	3	2	0	1	-3	3	4	3	0	-4
Qmm07	0	4	1	-1	0	0	0	2	5	3	-1	5	-3	-5	3	-5	-3	-3	-2	2	1	-1	-4	1
Qmm08	4	3	-3	0	1	2	1	-4	-1	-1	3	1	2	0	1	-3	5	-1	4	0	0	5	0	-2
Qmm09	-1	0	5	-4	-5	3	0	2	-4	2	4	-3	-2	-5	2	0	-1	-3	0	1	-2	5	-1	-3
Qmm10	1	2	3	3	1	4	0	-4	-3	0	4	2	-2	-3	1	-2	-5	-1	0	0	5	0	-1	-5
Qmm11	2	1	-3	0	-1	1	0	-3	4	1	-1	4	0	-3	-4	-3	-2	3	5	1	0	3	-1	0
Qmm12	2	3	0	1	-4	-1	1	-3	4	0	1	4	0	-2	5	-2	-2	3	3	0	0	0	2	-1
Qmm13	-3	-2	0	4	-3	0	4	-5	3	3	1	2	0	-1	3	-3	-4	-2	1	3	2	5	0	1
Qmm14	1	3	-5	-4	-1	4	0	0	1	-1	3	3	-1	-5	2	-3	-1	-2	5	1	1	2	-2	-2
Qmm15	2	0	-1	3	-4	0	-2	-3	5	3	0	1	1	-5	2	-3	-3	-5	3	4	3	2	1	4
Qmm16	-1	4	-1	0	-1	2	0	3	4	-4	-2	3	-5	-2	-3	1	-3	-1	0	-4	3	-1	0	0
Qmm17	-2	1	4	-1	-5	0	1	5	-1	3	2	0	-4	-3	-2	3	-1	0	-1	1	-2	-4	0	1
Qmm18	2	5	3	-5	0	3	1	-2	1	1	4	0	2	-4	2	0	-1	-2	-1	4	1	0	-1	-3
Qmm19	3	1	0	-1	-2	2	4	0	5	-3	1	1	0	0	3	-3	0	-1	4	-2	-1	5	-5	0
Qmm20	5	0	-4	-3	-2	0	-1	-4	4	1	0	0	2	-3	3	-2	-4	2	3	1	0	3	-3	1
Qmm21	1	5	4	-3	0	-1	3	-2	-1	0	3	3	-3	-5	-1	-2	1	-3	-2	2	4	-1	0	1
Qmm22	3	1	0	-4	-1	0	3	-2	-1	4	2	-1	4	-3	0	-5	-1	0	0	2	3	5	3	2
Qmm23	1	4	-1	0	-2	3	1	-3	3	2	5	5	-2	-5	4	-3	-2	-4	1	0	-1	1	-1	-4
Qmm24	0	3	1	0	0	3	2	1	-1	4	4	1	-3	-5	1	-1	-1	-2	-2	3	5	-3	-4	4
Qmm25	-1	5	2	-1	2	4	1	0	-1	-1	3	1	-2	-2	4	4	-5	-2	-4	0	0	-1	0	0
Qmm26	2	0	3	1	-3	0	-1	-5	1	1	1	0	-2	-2	2	-2	-3	-4	3	3	1	0	0	0
Qmm27	5	1	-2	-2	-1	1	2	-4	2	0	-1	0	0	-2	4	2	-1	-2	5	4	4	2	-3	0

Appendix K: Ken-Q data output

Table 11 shows the output from Ken-Q after the centroid factor extraction with 4 factors and Varimax rotation. The check marks show the participants that significantly ($p < 0,01$) load on a factor.

Num	Participant	FG	Factor 1	F1	Factor 2	F2	Factor 3	F3	Factor 4	F4
20	Qmm20	F1-1	0.717	✓	0.1199		0.0077		0.0457	
11	Qmm11	F1-2	0.701	✓	0.2439		0.01		-0.1662	
12	Qmm12	F1-3	0.6301	✓	-0.1051		0.0298		0.1588	
19	Qmm19	F1-4	0.5987	✓	0.3252		-0.08		0.1915	
26	Qmm26	F1-5	0.5758	✓	0.2628		-0.0711		0.1826	
3	Qmm03	F1-6	0.5714	✓	0.4406		-0.0978		0.3026	
27	Qmm27	F1-7	0.5606	✓	0.0227		-0.0565		0.3773	
13	Qmm13	F1-8	0.5254	✓	0.1634		-0.0192		-0.1026	
8	Qmm08	F1-9	0.4662	✓	0.3436		-0.0676		0.0377	
15	Qmm15	F1-10	0.4191	✓	-0.1339		-0.0378		0.3537	
22	Qmm22	F1-11	0.3607		0.1543		-0.0483		0.0644	
10	Qmm10	F2-1	0.2593		0.6247	✓	-0.0255		0.0285	
21	Qmm21	F2-2	-0.0323		0.6246	✓	0.2408		0.4589	
9	Qmm09	F2-3	0.0407		0.5919	✓	0.0961		0.2126	
18	Qmm18	F2-4	0.3142		0.5651	✓	-0.0304		0.3577	
4	Qmm04	F2-5	0.2741		0.5486	✓	-0.0396		-0.0209	
17	Qmm17	F2-6	-0.3251		0.486		0.3822		0.2007	
14	Qmm14	F2-7	0.4217		0.4821	✓	-0.0742		0.1843	
24	Qmm24	F2-8	0.0288		0.4533	✓	0.1015		0.437	
23	Qmm23	F2-9	0.4179		0.4357		-0.0748		0.2683	
2	Qmm02	F2-10	0.206		0.4181	✓	-0.0285		0.0491	
16	Qmm16	F2-11	0.0567		0.3215		0.0041		-0.0281	
7	Qmm07	F4-1	0.1725		-0.0784		-0.0357		0.7288	✓
5	Qmm05	F4-2	0.4354		0.3479		-0.0807		0.5172	
25	Qmm25	F4-3	-0.1375		0.2228		0.1364		0.4549	✓
1	Qmm01	F4-4	0.4117		0.216		-0.0768		0.4391	
6	Qmm06	F4-5	0.0553		0.0854		0.0014		0.4024	✓

Table 11: CFA with 5 factors and Varimax rotation showing significant participants

Appendix L: Factors

The three factors that resulted from the factor analysis are interpreted as three different perspectives. The statements that received the highest and lowest scores and the statements that distinguish the factor most are the most useful for the interpretation. These are presented in the tables below. The distinguishing statements are presented in *italics.*

	Statement nr.	**Statement**
Agree (+5)	*44*	*If a commander has to make a trade-off between preserving the equipment, the effectivity of meeting the mission objectives or the safety of his people, he always has to choose for the safety of his people*
	34	*Incompletely qualified personnel should never participate in trainings, military operations or other work within the Ministry of Defence, even if that would mean that the operation will have to be cancelled*
Agree (+4)	*47*	*There should be an ammunition authority like the MLA for aviation*
	26	*The biggest issue with ammunition safety is the lack of sufficient trained personnel and to track its currency*
	23	*Safety should never be expressed in terms of money*
Disagree (-5)	*33*	*If an accident occurs despite all the safety measures, it is acceptable regardless the consequences*
	3	*Internal quality inspections may be skipped if that is necessary to deploy ammunition on time in operational areas*
Disagree (-4)	24	A safer ammunition chain will be less effective and reliable to supply ammunition
	25	*Preventing rare events but with high impact is more important than to prevent common incidents*
Other D-statements	*18 (+)*	*The discrepancy between the "reality of The Hague" and the "reality in the field" is an obstruction for the improvement of safety*
	38 (+)	*In order to prevent accidents, the Ministry of Defence should lower its ambition level for the next ten years drastically*
	43 (+)	*Deviations from regulations on ammunition should never be allowed, even in case of deployment*
	30 (-)	*Being safe is not being free of errors but that errors do not disable the organisation*
	6 (-)	*An advice or inspection body always does not have to assess the design of every ammunition storage in operational areas*
	28 (-)	*After a certain amount of time a severe accident always will happen regardless of the efforts put in safety*
	19 (-)	*There is no culture of working unsafe, but a lack of the necessary resources*

Table 12: factor 1

	Statement nr.	Statement
Agree (+5)	*36*	*Transparency (to the public) is necessary to learn from accidents, even if the public gets angry*
	27	The Ministry of Defence should not focus on rule violations, but on evaluating the worker's conduct in light of what was reasonable to do in the circumstances
Agree (+4)	*28*	*After a certain amount of time a severe accident always will happen regardless of the efforts put in safety*
	4	*Higher safety risks are acceptable during international missions*
	11	Not only specialists, but also commanders and leaders should have knowledge of the basics of ammunition
Disagree (-5)	*5*	*Reliable acquisition and deployment of ammunition is more important than reliable safety of ammunition*
	39	Accidents happen mainly because of unsound equipment and not because of other reasons
Disagree (-4)	*12*	*The DMunB should be responsible for every aspect of the ammunition chain such as transportation instead of only delivery of ammunition*
	24	A safer ammunition chain will be less effective and reliable to supply ammunition
Other D-statements	*16 (+)*	*The top of the Ministry of Defence only prioritizes safety after incidents occur*
	31 (+)	*People are not there to serve the systems, but are at the centrepoint of the systems*
	22 (+)	*In order to stimulate the learning abilities of the organisation, the allocation of guilt of a (near-)incident should never be an aim of the investigation*
	1 (+)	*We don't have suitable equipment to stock and to handle ammunition in operational areas*
	29 (-)	*The Ministry of Defence should focus on anticipation and containment of incidents instead of a safety management system*
	13 (-)	*The Ministry of Defence just has to be more responsive to signals and notifications on ammunition in order to improve the safety*
	34 (-)	*Incompletely qualified personnel should never participate in trainings, military operations or other work within the Ministry of Defence, even if that would mean that the operation will have to be cancelled*
	15 (-)	*A Safety Management System will safeguard ammunition safety, even in operational areas*
	37 (-)	*The resources should be determined depending on the ambition level of the armed forces*

Table 13: factor 2

	Statement nr.	Statement
Agree (+5)	21	The resources of commanders don't match their responsibilities
	37	*The resources should be determined depending on the ambition level of the armed forces*
Agree (+4)	40	Training and exercises should have the highest priority, because the level of training of the personnel influences the overall safety most
	11	Not only specialists, but also commanders and leaders should have knowledge of the basics of ammunition
Disagree (-5)	*7*	*People don't need to have more specific education regarding safety and safety awareness*
	39	Accidents happen mainly because of unsound equipment and not because of other reasons
Disagree (-4)	*22*	*In order to stimulate the learning abilities of the organisation, the allocation of guilt of a (near-)incident should never be an aim of the investigation*
	16	*The top of the Ministry of Defence only prioritizes safety after incidents occur*
	42	There needs to be external oversight on safety, not internal oversight from within the Ministry of Defence
Other D-statements	*19 (+)*	*There is no culture of working unsafe, but a lack of the necessary resources*
	33 (+)	*If an accident occurs despite all the safety measures, it is acceptable regardless the consequences*
	2 (+)	*To be able to purchase ammunition fast, it is desirable to have special procedures to bypass the normal procedures*
	13 (+)	*The Ministry of Defence just has to be more responsive to signals and notifications on ammunition in order to improve the safety*
	6 (+)	*An advice or inspection body always does not have to assess the design of every ammunition storage in operational areas*
	30 (+)	*Being safe is not being free of errors but that errors do not disable the organisation*
	25 (+)	*Preventing rare events but with high impact is more important than to prevent common incidents*
	3 (+)	*Internal quality inspections may be skipped if that is necessary to deploy ammunition on time in operational areas*
	8 (-)	*Unwritten rules within the organisation(s) are a threat to safety*
	23 (-)	*Safety should never be expressed in terms of money*
	44 (-)	*If a commander has to make a trade-off between preserving the equipment, the effectivity of meeting the mission objectives or the safety of his people, he always has to choose for the safety of his people*
	18 (-)	*The discrepancy between the "reality of The Hague" and the "reality in the field" is an obstruction for the improvement of the safety*
	26 (-)	*The biggest issue with ammunition safety is the lack of sufficient trained personnel and to track its currency*
	47 (-)	*There should be an ammunition authority like the MLA for aviation*

Table 14: factor 4

Appendix M: Perspectives compared with NAT and HRO

The perspectives will be compared with the characteristics of NAT and HRO. This will be done for each characteristic. NAT has characteristics which are more factual (e.g. interactive complexity or tight coupling). It will be more difficult to search for those characteristics in the perspectives derived from the Q-study. This is similar with the characteristics of HRO. For example, the characteristic 'the involvement in reliability is apparent from the mission and goals' is not reflected in the statements of the Q-study. The comparison in this appendix gives an impression, but with certain limitations.

Perspective 1

Perspective 1 agrees with statement 18, which implicates that there is a discrepancy between the reality of The Hague and the reality in the field. This can be seen as an example of the NAT characteristic 'deficient organizational control over the operators'. People with this perspective agree with statement 23 which states that safety should never be expressed in terms of money. They also strongly disagree with statement 33 which implicates that the occurrence of accidents is never acceptable. This can be interpreted as that reliability is not socially exchangeable. The perspective seems only to show one characteristic of NAT.

Perspective 1 prioritises the safety of the people. Safety is seen as an absolute boundary condition for all processes. People with this perspective also believes that a safer ammunition chain will be more effective and reliable in supplying ammunition. These beliefs are examples of some of the characteristics of HRO's (De Bruijne, 2006): high level of responsibility and accountability, reliability as a value is not exchangeable and organizational culture of reliability.

Furthermore, people with this perspective believe that personnel, qualifications and training are important to ensure the safety. This can be seen as an example of another characteristic of HRO's (De Bruijne, 2006): a continuous urge to improve and to train in order to prepare for crises.

The focus on ensuring and continuously monitoring the quality of the ammunition can be seen as an example of the characteristic 'ongoing technical performances' (De Bruijne, 2006).

The distinguishing statement about an Ammunition Authority has strong agreement, which can be seen as an example of the HRO characteristic 'dominant presence of external groups with sufficient operational information' (De Bruijne, 2006).

The perspective does not reflect the HRO characteristics: the involvement in reliability is apparent from the mission and goals, structural flexibility and redundancy and flexible decision-making process. The rigidity of the thoughts and opinions on safety of this perspective limits the flexibility.

Perspective 1 checks for nearly all the characteristics of HRO's. Therefore, the perspective can be seen as an example of 'HRO-thinking'.

Perspective 2

Perspective 2 does not seem to check positively for any of the characteristics of NAT.

People with perspective 2 has the same strong belief as people with perspective 1 that a safer ammunition chain will be more effective and reliable in supplying ammunition (statement 24). The focus is very strong on the human factor as cause, according to their opinion, for nearly all accidents since they disagree with statement 39. The focus in perspective 2 is on learning from errors and

accidents, therefore the allocation of guilt should not be the aim of an investigation and transparency is very important in order to be able to learn according to their agreement with statements 22 and 36. Here the HRO characteristics (De Bruijne, 2006) 'high level of responsibility and accountability', 'continuous urge to improve and to train in order to prepare for crises' and 'reliability as a value is not exchangeable' are visible.

Furthermore, this perspective has a strong focus on flexibility in decision-making regarding risk management. The flexibility in decision-making is another HRO characteristic as mentioned by De Bruijne (2006). Overall, the sorting that underlie perspective 2 shows that there is or should be an acceptable balance between a clear responsibility for safety but also for the continuation of the mission. This could be an indication that the HRO characteristic (De Bruijne, 2006) 'organizational culture of reliability' is also present in the people who are associated with perspective 2.

This perspective shows a 'can-do' mentality (e.g. being neutral towards statement 37) which indicates that structural flexibility and redundancy are or should be in place. Because of the 'ongoing technical performances' (De Bruijne, 2006), the people with this perspective have the opinion that decision-makers, commanders and leaders should have knowledge of the basics of ammunition (statement 11).

The two remaining characteristics seems not to be visible in perspective 2. Perspective 2 checks for nearly all HRO characteristics, therefore it can be seen as an example of 'HRO-thinking' as well.

Perspective 3

People with perspective 3 allow safety to be expressed in terms of money which seems to allow that safety or reliability is socially exchangeable, which is a characteristic of NAT.

In perspective 3 there do not seem to be many links with HRO and NAT. For example, perspective 3 values internal oversight, close to the executive level more than external oversight which would be more in accordance with HRO's.

In this perspective, the lack of necessary resources (statement 19) is pointed out as one of the causes for working unsafe. Therefore it can be assumed that within this perspective it is believed that there is no structural flexibility and redundancy.

By agreeing with statement 33, the people with perspective 3 have the opinion that accidents are acceptable if they occur despite the safety measures put in place. This sounds realistic, but it can also be perceived as a sign of having a lower level of feeling responsible or accountable for safety.

In the opinion of people with this perspective, compliance is more important than the training of people, which is the opposite of the HRO characteristic of the continuous urge to improve and to train in order to prepare for crises.

People with this perspective agree more with the statement that safety should be expressed in terms of money. If safety can be expressed in terms of money, it becomes an exchangeable value during negotiations about policies and budget allocations. But a characteristic of HRO's according to De Bruijne (2006) is that reliability as a value is not exchangeable.

By agreeing with statements 2, 3 and 6, people associated with perspective 3 would possibly allow quality checks to be skipped if necessary. Therefore there does not seem to be an organizational

culture of reliability in this perspective, because these people seem to be willingly to accept the increased risk of a potential accident if the mission objectives that require.

These are examples of opinions from perspective 3 which show that this perspective is not typical of 'HRO-thinking'. The characteristics 'involvement in reliability is apparent from the mission and goals', 'ongoing technical performances' and 'flexible decision-making processes' do not seem to occur in perspective 3.

Appendix N: Topics for the focus group and interviews

1) The three perspectives
    a) Can you confirm the perspectives?
    b) What implications do you think they have on (ammunition) safety?
    c) What measures can be taken to improve the safety in the ammunition domain?
2) Organisational design
    a) Is the organisation too complex? Is the decision-making process flexible enough? What are the safety implications? How can this be solved?
    b) Who bears the accountability for the ammunition domain? What are the safety implications? How can this be solved?
3) Safety in the Army
    a) How is the current situation?
    b) Is the plan of action sufficient to cope with safety?
    c) What should the Army do in order to have sustainable safety policies?

Appendix O: Focus group and interviewees

For chapter 5 a focus group and expert interviews were used. The numbers correspond with the references in chapter 5.[33]

1) Focus group
    a) Program Obelix
    b) C-DMunB (& Masterplan DMunB)
    c) H-VHGMT DMunB

Program Obelix has a good overview of the whole ammunition domain. In Obelix multiple expertise are present (e.g. in ammunition or in governance). The C-DMunB has a better overview of the ammunition chain and the DMunB in particular. The H-VHGMT is the person that has a good overview of the safety in the ammunition chain.

2) LTZ1 [redacted] MSc MA (Van Joolen, 2019b)
3) Lkol [redacted] (CDS/DAOG/afd veiligheid)
4) Dr. Herman de Bruine
5) Kol b.d. dr. Reijling
6) Kol b.d. [redacted] MSHE (BS/AL/DV)

As expert the professor Governance of Safety from the Radboud University was also approached. He was not available for this research, because he is also part of the 'Visitatiecommissie Defensie en Veiligheid'. Members of the Visitatiecommissie may not be approached by people from the Dutch Ministry of Defence in order to protect their independence and integrity. The author of this thesis works also at the Ministry of Defence and was therefore not allowed to involve the professor or other members of the Visitatiecommisise in his research.

[33] The names of the people currently employed by the Ministry of Defence are not published publicly. The names can be requested by the author (MAK.Potter@mindef.nl)

Appendix P: Exploring the perspectives further

In this appendix the input on exploring the implications of the perspectives from the focus group and expert interviews can be found. Their remarks are clustered into three topics: accountability, complexity and compliance.

Accountability and the political level

Two respondents perceive that the accountability at the executive level is adequate (2 & 3). Accountability at the top level will never work properly, because there will always be someone who is willing to do it according to respondent 2. Another reason is that they have so many priorities, while the operating speed is so high that there is no time to consult the subject specialists. This implies, according to respondent 6, that with the Ministry of Defence, safety is not a cultural problem but a structural problem.

Everyone is accountable for the ammunition domain, therefore you end up in perspective 3 where everyone acts from its self-interests according to respondent 3. The last years, the governance of the Ministry of Defence has been according to perspective 3 (6). Respondent 3 considers the fragmented organisation a higher safety risk, which according to him requires that accountability on the subject of ammunition is settled at the top. Program Obelix can give advice on this matter thinks respondent 3.

However, the focus group differs from the experts that were interviewed. Within the focus group two different views were present which were not able to reach a consensus (1). One view sides with the experts and agreed with the lack of accountability: it is only talk about money and costs. The other view disagreed and thinks that it is not about accountability but people not taking their roles: it is about behaviour. This would implicate that changes to the organizational design and structures will not solve much regarding safety. This can be illustrated with the following quote: *"If the people on the chain links would talk to each other, everything would be all right"*. Another participant made the remark that a lot of problems end up at the level of the Secretaris-Generaal (SG), meaning that apparently the top level is not able to sort out the problems and issues and has to escalate to the SG.

Accountability is the answerability, blameworthiness, liability and the expectation of account-giving. If people are expected to pick up a certain role or to communicate with certain people, but do not do this then it is evidence of not feeling accountable or not expecting to be held accountable. Either way, this shows that there is a low level of accountability regardless of the organizational design, etc. Therefore, the disagreeing view can be interpreted as a view that says things in a different way and focusses on different things but in the end means the same as the other, agreeing view in the focus group. Also researchers have found no empirical evidence that supports the idea of a negative organisational culture posing a threat to safety (Falconer, 2006). This implies that the 'threat' must come from somewhere else (e.g. the organisational structure).

The Central Staff (BS) and the work floor need to come together with regards to get a shared perspective (on safety). This is only possible when the BS takes its responsibility to perform its tasks thinks respondent 5. The BS has not formulated any indicators on authority and responsibility for itself. Otherwise the distance between the BS and the work floor will become the real problem, because then the top level has no awareness on what happens on the work floor which will affect their policies and decisions according to respondent 5. He thinks that without the BS taking her responsibility, it seems likely that nothing will change in this respect for the Dutch Ministry of Defence (5).

The Central Defence Staff (CDS) is the employer of the (military) personnel. They need to ensure the safety of its personnel, but very often an incident becomes on the top level (CDS) a political issue according to respondent 3. He thinks that safety has become a political instrument (3).

Ammunition authority

The execution of quality management is missing at the level of the ammunition chain. With ammunition it is not clear who checks this for the whole chain. This means that the accountability is missing, resulting in errors. An entity for audits and quality control with perseverance power is needed. An Ammunition Authority is needed by the Ministry of Defence thinks respondent 6.

Creating an Ammunition Authority will not solve the problems regarding safety in the ammunition domain think the respondents 4 and 5. Safety is a line responsibility and needs to have a focus on operations according to them (4 & 5). Only the line can enforce safety, and not an external or internal authority. If the line does not take responsibility for safety, the organisation will never become safe according to respondent 4.

An authority can facilitate the line in enforcing the safety (4), so this does not mean that an Ammunition Authority can be omitted directly. An authority can have the role to connect the people and (sub-)organisations for example thinks respondent 5. The Dutch Ministry of Defence should have more eye for the Ministry of Defence as a network organisation. According to respondent 5 an authority has to have more a role as a chain director instead of being an authority. For example, the MLA oversees the functioning of the chain and does not lead the chain (5).

According to respondent 5, accountability it is all about having a common conception on the final output of the organisation. Accountability is enforced with human interactions and not with forms or organizational structure. People need to be connected with each other in the opinion of the focus group and respondent 5.

Program Obelix makes sure that the pain is felt by the right persons. People need to feel the pain of the existence of the problem. This shows that there is a need for something like an ammunition chain forum or a continuation of Obelix. An authority is lacking for this aspect (1).

Complexity at the top level

In the ammunition chain, more actors are involved. But the chain itself and the ammunition are simple. All other (governance) processes are the same as other domains. That something does not work, does not mean that it is complex as well thinks respondent 6. This opinion surpasses that the ammunition chain depends (like all other domains) heavily on the top level of the Ministry of Defence, and the administrative part in particular. The chain can be simple, but if the top level is complex it will make the whole ammunition domain complex.

Since 2003 the operational focus has been replaced with a business-economical focus within the Ministry of Defence. This led to fragmentation of the organisation according to respondent 5. Previously, within a operational column a common awareness on ammunition as part of the operational output existed. This is gone, because of the fragmentation according to respondent 5. The Q-study confirms, according to him, that the Ministry of Defence has lost this common awareness. Furthermore, kingdoms have emerged which have to be connected to each other (5).

Complexity has to be seen in a coherent way. The main problem is the unclarity of the allocation of roles. The Ministry of Defence has devised so much that the role allocation has become fuzzy and problematic according to the focus group (1). This has resulted in the commander having no influence except making some noise and that people are not addressed when things are outside his sphere of influence (1). This is an indication that the Dutch Ministry of Defence is more concerned with the administration than operations.

The Dutch Ministry of Defence has to make a choice between an operational focussed organizational design or a design based on economies of scale according to respondent 5. With operations based on services and knowledge exchange, centralization is not the best design most of the time thinks respondent 5. It seems to be that more competency and resources should flow from the centralised (top level) parts of the Ministry of Defence back to the work floor or operational commanders.

Disentangling

It is believed that organisations constantly sway like a pendulum, between centralization and decentralization. The Ministry of Defence is no exception. At this moment the Ministry of Defence is believed to be too complex, therefore it will decentralize more in the coming years thinks respondent 2. This is seen as something positive by him, because people should be responsible and should be able to be responsible (2). Nevertheless, it is an absolute requirement that all links of the ammunition chain talk with each other to exchange information. Without this, the ammunition chain will never be safe according to respondent 4.

The realisation of the operational output has to be central within the Dutch Ministry of Defence. Therefore, the distance of the policy-makers or "The Hague" should not be too long or too bureaucratic according to respondent 5. This advocates for bringing the administrative level closer to the operational level. For example by mixing the people on the administrative level with more people from the operational level.

At the NATO, a military advice is given. At the Dutch Ministry of Defence the advice is a mix of military and administrative according to respondent 3. He thinks that, like NATO, the Dutch Ministry of Defence should separate the military and administration (3).

The Dutch Ministry of Defence should look how the organisation worked before (2003). Based on what is learned, the organisation can be adjusted according to respondent 5. The Ministry of Defence should not go back to the situation as before, but lessons can be learned on some points thinks respondent 5.

The focus on compliance

Perspectives 1 and 3 have among other things a strong focus on compliance. The focus on compliance is recognized, but is perceived as having a negative influence on safety according to respondent 2. A focus on compliance creates tunnel vision and the necessary holistic aspect of an incident gets lost. When an accident occurs the pragmatic approach will easily lose out and only compliance to rules, plans and standards will be looked at. The set of regulations is never comprehensive, especially in hostile and uncertain environments. This quote of respondent 2 illustrates the perception of the focus on compliancy regarding safety within the Ministry of Defence: *"After an accident, a picture gets taken and they only look at compliance. What is the added value of this? It makes the suggestion that the fatality could be prevented, if only you were compliant."*

According to respondent 6, many safety rules are detailed prescriptions of means and prescriptions of targets. This mainly originates from (technocratic) top-down pressure, with the presumption that the world is makeable. Sometimes this originates from distrust of people using the degree of freedom that a rule gives. This occurred with OHS as well (6).

The strong focus on compliancy is seen as more problematic in perspective 3. "The Hague" steers only on compliance according to respondent 2. This is perceived as inconsistent, because they make trade-offs on safety in their decisions thinks respondent 2: *"This does not apply to us, but with another we will look".* Meaning that they want to enforce compliance, while they are making policies that do not prioritize safety.

Being in control without compliance

The Ministry of Defence has designed three lines of defence regarding safety:

1) The commander
2) VKAM/safety specialists
3) Audits

According to respondent 3, the third line of defence has been given too little substance. He thinks that audits, both internal and external, need to be better designed and executed. According to the focus group seems perspective 3 to lean on the third line of defence, while the perspectives 1 and 2 seem to lean on the first line of defence, because of the focus on internal oversight (perspective 3) and of the focus on the decisions of the commander (perspectives 1 and 2).

The ammunition chain has issues with regulations and knowledge, with both inflation occurred according to respondent 6. With certain (specialistic) jobs, the ranks have been devaluated. Knowledge, skills and status of regulations have diminished as well. The lower limit of risk acceptation also diminished over time. In aviation lists exist with minimum requirements which have to be present in order to be allowed to fly. This list is the lower boundary for flying safely. It could be implemented in the ammunition chain as well, in order to define the lower boundary of safety clearly thinks respondent 6.

The safety within the Ministry of Defence can be improved by making everyone aware that compliancy is not the same as safety. Instead, the resilience within people should be enlarged by training more and giving more responsibility thinks respondent 2. A crucial measure for improving the safety is education and personnel capacity according to respondent 3.

Another way to be in control is by building a good (management) information system according to respondent 3. But knowledge is a duty to collect, not duty to bring. A duty to bring information will not make the receiver of the information any smarter thinks respondent 5. Every time a lot is talked about culture, but it is the execution in practice that is the crux according to respondent 5. It starts with collecting knowledge: *"Let the commander explain what they have on their liver, then you really get to know what is going on. Then you start building up insight. That is culture change!"* (5). This quote illustrates the opinion of respondent 5 that it is not about reporting management information to the top and focussing on compliance, but to let the top and persons with the problem talk directly to each other. The top is there to solve the problems at the operational level and not vice versa.

Rules do not make the Ministry of Defence safer, but investing in people does thinks respondent 3. The political level (perspective 3) should suppress the risk-regulation reflex according to respondent 2.

In the end, the middle-management (non-commissioned officers) is crucial for improving the safety in organisations. Therefore, the culture with the non-commissioned officers should be the focus and not rule-making thinks respondent 4.

Appendix Q: Safety in the Army

During the Q-study a problem was encountered regarding the topic of safety in the Army. At the staff level, no single function is responsible for the overall safety. The Directorate Personnel and Organisation (DP&O) is responsible for workers health & safety (OHS) and the Directorate Materiel and Services (DM&D) is responsible for environmental safety. At the level of the brigades, safety has a similar design and role allocation. Overall safety is a responsibility of the commanders, but they have nothing or nobody to fall back on if a problem is outside their spheres of influence.

At a central level the CDS has a department of safety[34] which advises on safety and investigates incidents. The Central Staff (BS) has a Directorate Safety (DV) which advises on and makes policy on safety. The DV has been split in two: physical safety and social safety.

The Air Force has an independent department of Safety, which reports directly to the commander of the Air Force (C-LSK). Thereby they ensure the independence of the department, because it is placed above the directorates. Not only ensures this their independence, but their power as well.

The Navy has a different design. With the Navy there is a section VKAM, which is allocated with the Directorate Maintenance and Sustainment (DMI). On paper they are one of many sections, but in practice they have a lot informal power.

The Army recently has started a program to improve the safety situation in response to the report of Van der Veer et al. (2018). This program focusses on structure (organisation/governance), system and culture.[35] The Army is focussed on implementing all recommendations from the report of Van der Veer et al. (2018), but that, according to respondent 2, has no chance to be successful according. In general, this program to improve the safety situation is seen as insufficient by respondents 2, 3, 4 and 6.

The program focusses on OHS. It fills in the role of the prevention officer according to respondent 4. The Ministry of Defence works with dangerous goods which requires a different safety regime. Basic Safety Orientation is far more comprehensive than OHS (4). The program does not cover a large chunk of the risks according to respondent 4. He said that what this program describes is standard practice for a long time (nearly 20 years).

The main problem with this program is that it does not integrate safety in the line according to respondent 4. Safety can never be a department within the hierarchy, but has to be put directly under the commander (C-Las) like the Air Force has done (4). According to respondent 4, It is good that the Army looks into safety, but it should reconsider the organisational position of the program.

Structure

The first focus of the program, structure, is translated into the need for an occupational safety organisation. This will be realised by institutionalizing the recently started program under DP&O. In the plan of action, the core believe for this organisation is mentioned: *"integrity (social safety) is the basis for everything"*.[36] Both this belief and the allocation of the organisation under DP&O is problematic, because it overlooks physical safety. For example, what happens when the problems with

[34] Part of CDS/DAOG.
[35] Source (2019) only available on intranet: link.
[36] Source (2019) only available on intranet: link.

chrome 6 in paint or faulty equipment start to become an 'HRM-matter'? How can DP&O influence the requirements and design of equipment?

Traditionally, the Army has safety in the 1-line (personnel), but there the least affinity with safety is found, because in the 4-line (logistics) a lot happens as well. Safety could be embedded in the 3-line (operational planning), but the best would be directly under the C-Las according to respondent 6.

Risks are to be studied and controlled as a system consisting of Man, Environment and Technology (MTE). The interactions between these three elements produce the required product or service on the one hand and are the source of trouble and risk on the other. Managing risk is all about controlling the MTE system (Ale, 2009). Social safety is important of course, but only a part of one of these three elements (Man). Because these three elements interact with each other, it is not possible to divide the organisational structure of the Army in separate sections for each element. They all have to be bundled in one central organisational entity like with the CDS, BS, Air Force and Navy. Therefore, the organisational design or structure of the Army seems insufficient in this respect and will not be enough to cope with safety.

System

The second focus, system, is updating of the outdated 'VMS Defensie' to a new 'VGM Defensie' and its translation to a new 'VGM CLAS'. In addition, a self-assessment checklist for commanders will be developed.[37] This focusses only on an effective Safety Management System (SMS).

The basics of safety are allocating the accountabilities and responsibilities fully and well and to put the right people on the right places according to respondent 6. The efforts put in the VGM CLAS seems more to focus on regulations instead of these basics.

As already discussed in chapter 2 of this thesis, Safety Management Systems (SMS) are useful tools to manage safety in static and stable environments such as running the daily business. It will not be sufficient to manage safety in dynamic and unstable environments, like with military operations. For example, the mortar accident in Mali occurred in a training exercise during a military mission. That is different, i.e. more unstable and dynamic, than a regular training exercise 'by the book' back in The Netherlands. It is the same activity, but has different safety regimes.

Also making more rules may not have the desired effect. Practice shows that it will only create a false sense of security (Van Joolen, 2019b). It is not likely that a (new) SMS and creating a new rule-making body will solve the safety problems within the Army. A quote from the Ministry of Defence says something similar:

"Over het lerend vermogen van Defensie oordeelt de commissie dat er geen sprake is van een sluitende leercyclus. Dit alles betekent volgens de commissie overigens niet dat werken bij Defensie zonder meer onveilig is. Er is volgens de commissie sprake van 'praktische veiligheid'. Dit is veiligheid die voortkomt uit het volgen van procedures, oefenen, trainen, ervaring van oudere medewerkers en met gezond verstand omgaan met gevaarlijke situaties. Deze biedt echter onvoldoende waarborgen voor risicobeheersing die bij een professionele organisatie als Defensie hoort."[38]

[37] Source (2019) only available on intranet: link.
[38] BS2018000857 (link).

If the Army only focusses on creating a SMS and/or keeps relying on 'practical safety' it does not acknowledge that it can manage risks only partially. Part of the risks arise in a chaotic environment and are difficult to be foreseen (Brenninkmeijer, 2011). If the Army tries to manage the chaotic risks by continuously updating the SMS and adding more rules, the regulation and oversight systems will become too complex to know which criteria apply in which circumstance. This will affect the rationality in the decision-making, resulting in more chaos (Brenninkmeijer, 2011).

In order to be able to improve and maintain safety, more is needed than only SMS or rules. As Van der Veer et al. (2018) already mentioned it is about the learning ability of the organisation (i.e. closing the PDCA-cycle). If risks are recognized they have to be managed, because incidents are often a source of poor risk responses (Webb, 2011).

Culture

The third focus, culture, is about looking to the culture aspects per unit. The goal is to get safety *"between the ears"* of every worker. According to this plan, a safety culture has to be created where risks will be recognized and where risk management will be naturally and professional. The boundary condition is a social safe environment.[39] This goal is elaborated further, but seems to have a very top-down approach that fails to appreciate the professionalism of the executive level.[40]

The problem with wanting to improve the safety culture is that it is broad, vague and hard to define, but always consist of being the result of the perceptions, attitudes and behaviour within an organisation. A (safety) culture does not actively interfere in the organisation. A (safety) culture is descriptive rather than active (Kines et al., 2011; Guldenmund, 2000). Therefore, a (safety) culture is a result and not the cause of certain behaviour.

Safety culture is often managed by a top-down initiative that dictates safe working practices rather than exchanging knowledge about safety among equal partners (Falconer, 2006). According to Luria (2010), Military leaders are more focused on controlling the behaviour of their soldiers than on controlling the work conditions. This seems to be the case with the program of the Army to improve the safety. According to them, this may turn out to not be as effective as desired. This view is supported by respondent 3 from the CDS: safety should not be top-down according to them. The difficulty with a top-down approach is, according to respondent 4, that norms and values cannot be imposed on organisations.

With this program the Army uses as one of the starting points that the current culture of the (operational) units are obstructing the improvement of the safety.[41] This 'claim' seems nowhere to be supported with a source or an elaboration with what they mean with this. For example, the report of Van der Veer et al. (2018) which was the motivation for this program of the Army, points out a control problem and not a culture problem in its conclusion.

[39] Source (2019) only available on intranet: link.
[40] Source (2019) only available on intranet: link. See page 15 and 16 in particular.
[41] Source (2019) only available on intranet: link. See page 28 in particular.

Conclusion

The initiative of the Army tries to fill in the encountered organizational gap, but seems to struggle with the approach. It may be prudent to do a short but thorough evaluation of how well the current approach is able to achieve the desired effects.

Appendix R: Paper

Safety improves the delivery of effective military power

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Abstract - Military operations are performed in unstable and dynamic environments resulting in a constant exposure to (high) safety risks. It is unknown if safety theory (mainly developed in the civilian industrial world) can be used within the context of the Dutch Ministry of Defence (MoD). The literature and design of the Dutch MoD has been analysed . A clear causal relation has been found between safety and military deployment capabilities. Enhancing safety can improve the military power as well as reducing costs. Therefore, safety should be an integral part of every process within the Dutch MoD.

Key words: safety, military power, high reliability organisation, value chain

1. Introduction

The Dutch Ministry of Defence (MoD) recently was confronted with multiple incidents in a short period of time. The subsequent investigation reports showed strong conclusions (e.g. Joustra et al., 2017a; Joustra et al., 2017b). The picture emerged that the MoD was not in control regarding safety. The conclusions of the report about the mortar accident in Mali even led to the resignation of the Minister of Defence and the Chief of Defence (Ministerie van Defensie, 2017).

Safety can be defined as the absence of hazard, risk or injury (Ale, 2009). Within the military context, safety has a broader meaning than for example preventing occupation injuries. Preventable accidents and mishaps continuously degrade the readiness of the military forces and thereby their deployment capabilities (Adamshick, 2007). Or in other words, safety within the military context also includes the preservation of effective capabilities.

The Armed Forces have to operate in unstable and dynamic environments resulting in a constant exposure to (high) safety risks. The impact of incidents caused by avoidable internal mistakes is increased when working in a hostile environment. The question can be asked if it is possible (or desirable) for the Armed Forces to execute military operations safely. Military missions are inherently unsafe. Getting wounded or killed by enemy fire should not be seen as a symptom of unsafe operations but as part of the job. However friendly fire can be seen as a symptom of unsafe operations for example (Moorkamp et al., 2014). Most of the safety theories are developed in and for civilian environments. It is unknown if there is a tension between the two environments in the current safety theories. The Armed Forces have to be able operate on a scale between stable and static peacetime operations and unstable, dynamic full war operations (see figure 1).

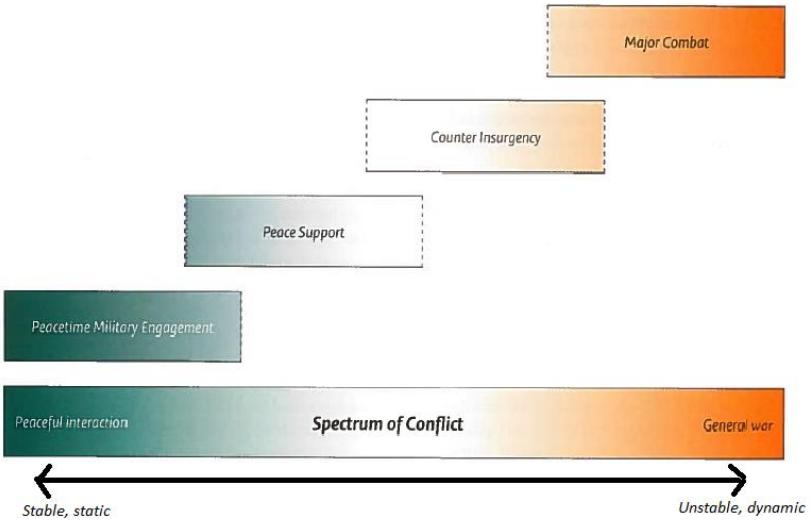

Figure 1: campaign themes (adapted from OTCO, 2009)

This paper will explore the value of safety for military operations. This will be done by looking into the safety literature and into how the Dutch MoD wants to design the Armed Forces.

2. Military power as logistical costs

Organizations exist, because they produce a product or deliver a service. Like other organizations the Dutch MoD has to define why they exist. This section will explore how the Dutch MoD legitimizes itself by defining their output and how safety fits in the processes required to produce the desired output.

The constitutional tasks of the Dutch MoD (art. 97 GW) have been translated to a value chain by the MoD. The final output or product of the value chain is mission deployment, i.e. military power. The driving processes that lead up to the delivery of military power are preparation (for deployment) and maintenance. Input for the preparation and maintenance activities are personnel and material requirements. As can be seen with the value chain of the MoD (figure 2), the military 'production process' can be perceived as a logistical chain.

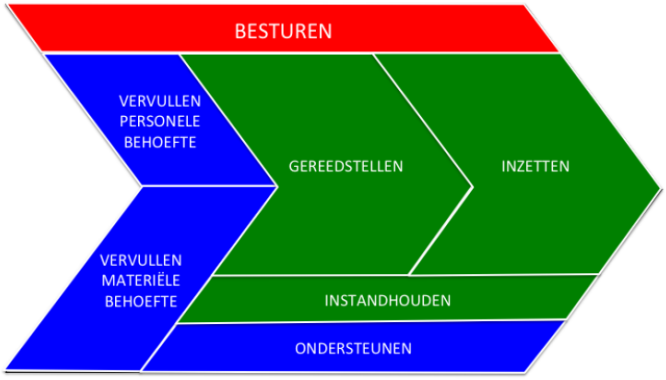

Figure 2: value chain of the Dutch MoD (CDS, 2013)

In a logistical frame of reference, cost-benefit thinking to define priorities and to set decision limits is inevitable. The military is not the only organization with logistical chains and a strong focus on safety. An example is (military) aviation.

Military aviation defines the costs of safety measures as the costs of purchase, installation, maintenance and operation of the risk control measure, and any impact on productivity/capability as a result of the introduction of the control measure (RAAF, 2018). The benefit gained from safety measures is defined as the benefits from the reduction of likelihood and/or degree of harm (consequence) plus any savings from fewer incidents, injuries and illnesses, and potentially improved productivity/capability (RAAF, 2018). The decision-making is based on the justification of the proportionality of the costs in light of the benefits gain and not on the absolute monetary values (RAAF, 2018).

The Royal Australian Air Force (RAAF) approaches safety in line with the logistical mind-set of the Dutch MoD in which the decision which safety measures to put in place, is a cost-benefit decision. However, in contrast to the Dutch MoD, for its definition of the costs and benefits, the RAAF clearly links safety directly to productivity and/or capability, or in military terms, to military (deployment) power. The RAAF incorporates the direct and indirect impact on the military capabilities in its cost-benefit decision-making.

The United States Air Force (USAF) does not use such a cost-benefit approach. It perceives safety as the product of likelihood and consequence (USAF, 2017). This is a commonly used risk management approach (Ale, 2009). It has a strong focus on the (potential) costs of a risk or hazard resulting in mishap, i.e. the risk impact (USAF, 2017). The USAF therefore perceives safety risks as logistical costs factors. The USAF seems to focus more on the quantification of the safety benefits than the RAAF.

The Dutch Air Force[42] has its risk management incorporated in every aspect of their business operations. It views safety as integral part of product and process quality (CLSK, 2019). In other words, the Dutch Air Force links risk and safety directly to the quality of their (mission) operations and output and does this in every proces. Safety is part of the cost of quality which is inherently linked to the output: military power. This can be perceived as a similar approach as the RAAF. However, the Dutch Air Force is not representative for all the Dutch MoD.

Different approaches have been seen. The common denominator is the link between costs or investments in safety measures to the benefits gain from the output of the value chain, which is not necessarily expressed in a monetary value.

3. High Reliability Theory

High Reliability Organisations (HROs) have been studied by a group of researchers at the University of California (Berkeley). Their aim was to capture observed commonalities of operations among aircraft carriers, air traffic control and nuclear power stations. These organisations have as similarities that they operate in unforgiving social and political environments, their technologies are risky and present potential for error, the scale of possible consequences from errors precludes learning through experimentation. To avoid failures, complex processes are used to manage complex technologies (Sutcliffe, 2011). In essence, HROs are organisations that practice a form of organizing that reduces the impact of incidents and speed up the process of recovering once incidents have occurred (Weick & Sutcliffe, 2007).

[42] Part of the Dutch MoD, but not representative because of branching/organizational fragmentation.

HROs are able to perform successfully and have nearly no accidents by applying five core principles. They have a *preoccupation with failure*. HROs track small failures strictly. They treat any lapse as a symptom that something may be wrong with the system or can have severe consequences if several separate small errors coincide (Weick & Sutcliffe, 2007). They have a *reluctance to simplify* Simplification means discarding some information as unimportant or irrelevant, but this is dangerous because this information may be the very information necessary to avert the disaster (Hopkins, 2007). HROs are *sensitive to operations*. HROs operate close to the front line where the real work gets done. People have well-developed situational awareness, so they can make continuous adjustments that prevent errors from accumulating and enlarging (Weick & Sutcliffe, 2007). HROs have a strong *commitment to resilience*. No system is perfect. Resilience is the ability of an organization to respond or bounce back from a disruptive event in order to ensure the operational continuity during a crisis (Grabowski & Roberts, 2019). HROs are not about being error-free, but that errors don't disable its primary business process(es) (Sutcliffe, 2011). HROs also show *deference to expertise*. Errors at higher levels, especially in rigid hierarchies, tend to accumulate and combine with errors at lower levels, thereby making the resulting problem bigger, harder to comprehend and more likely to escalate. HROs avoid this by pushing decision-making down deeper into the organisational hierarchy and around: decisions are made at the front line and authority migrates to the people with the most expertise, regardless of their rank (Weick & Sutcliffe, 2007; Hopkins, 2007).

4. Safety as integral part of the value chain

Supply chains (or networks) are complex when there is a complicated transformation process (transforming resources to output) and feedback loops and branching are common. Interactions between different stakeholders with different interests in multiple modes, based on heterogeneous materials and information flows, can make it even more complex (Skilton & Robinson, 2009).

Supply chains with a high level of dependency are more prone to disruptions (Scheibe & Blackhurst, 2017). In supply chains the impact of disruptions are mostly studied in isolation and barely on the level of the whole chain (Scheibe & Blackhurst, 2017). Optimizing a supply chain in a cost efficient way, makes it more effective but also more vulnerable to disruptions because there is less slack in the chain (Yang & Yang, 2009).

The MoD can be seen as a complex logistical supply chain which produces military power. As with every supply chain, the Dutch MoD is prone to disruptions (especially after longer periods of budget cuts). In other words, risk and incidents disrupt the supply chain and thereby the military capabilities of the Dutch MoD as final product of this supply chain. This line of reasoning points to a causality between safety and military power. As figure 3 shows, the military capabilities can be maintained or even improved when the MoD will focus on prevention of incidents and on reducing or containing the impact of the disruptions.

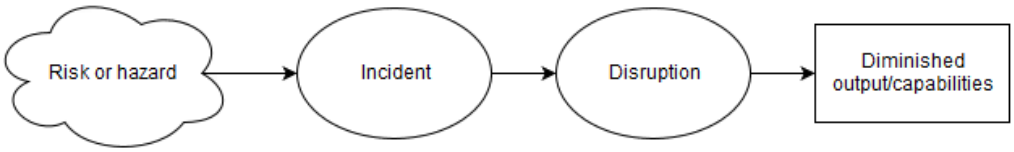

Figure 3: causality between safety and military power

HROs pursue achieving high reliable performance through two approaches: prevention or anticipation and resilience or containment (Sutcliffe, 2011). With regards to containment of the consequences resulting from incidents, it is much harder to recover from incidents when operating in a hostile environment. Thus hardening the system or increasing resilience is important. Firstly both because incidents create disturbance and waste energy and resources needed to deliver military power. Secondly because it is harder to recover or reduce the impact of consequences while delivering military power in a hostile environment, compared to a peacetime or more forgiving environment. Shutting down operations is not always possible.

Organisations that unwittingly institutionalize practices that encourage gradual erosion of standards are the opposite of HROs. An acceptable outcome of risky behaviour in the immediate past is allowed to set the expectation for risky behaviour at the next occasion. The small incremental changes in the harmful direction get adopted in the daily routines by normalization of the deviance so repetitiously that it is impossible to detect this until it is too late (Shrivastava, Sonpar & Pazzaglia, 2009).

Safety is one of the prime factors which determine the performance level of the ammunition supply chain for example (Bokma, 2018). If price and efficiency are dominant, it will be at the expense of the flexibility, sustainability and resilience of the organisation (Bokma, 2018). Efficient organisations themselves are at risk to focus too much on the more visible cost-reductions, thereby forgetting the less visible increase in risks and their additional costs due to errors and accidents (Bokma, 2018).

Organisations need to constantly monitor and detect signs of increasing organizational risks, especially when production pressures are increasing or pushing the limits (Dekker & Woods, 2010) like with military operations. Within HROs this is very important, because accidents in HROs are extremely rare and therefore unexpected (Harvey, Waterson & Dainty, 2019). It can be argued that implementing HRO with the Dutch MoD will improve the military capabilities (or safety in general), because reducing the number and impact of incidents will result in less diminishing of the military capabilities. The fewer errors or failures allowed, the less the organisation has to spend effort and resources to adjust when an incident occurs. This is not only about preventing incidents, but to prevent major (and costly) adjustments after an incident as well (Bellamy et al., 2005). Furthermore, potential problems should be detected. Once problems are detected, organisational members must have the motivation and capabilities to respond to the situation and make adjustments. Organizations need to have the means to recognize when and where to make targeted investments to act on rising signs of organizational risks and to rebalance the trade-offs between safety and operational productivity (Dekker & Woods, 2010).

In the case of the value chain of the Dutch MoD, improving or ensuring safety can be seen as part of governance or support (also mentioned in the value chain, see figure 2) and thereby as a secondary process. However, safety is involved with almost all part of the primary processes. Within military deployment, less incidents and smaller disruptions will result in higher effective capabilities on site. Being able to reduce incidents, means that it is possible to adapt quickly when a (potential) disruption appears. Or in other words that the organisation and therefore operational capabilities will be more flexible. HRO, for example, is about integrating safety in all the processes and rejects the possible view of safety being part of governance or support processes.

Within preparation (for deployment) this will mean that more resources (both personnel and material) are available to deploy, or less support and governance will be needed to prepare and

maintain the Armed Forces because less action is needed to reach the required level of availability. This will translate in a lower need for personnel and materiel, because there are less failures, injuries, etcetera. Because the links in the value chain of military operations are interdependent, safety is an integral aspect of all the processes in the value chain of the Dutch MoD.

Focussing on safety and achieving a higher safety level within all processes throughout the value chain will mean that less resources will be required to achieve the goals of the MoD. In other words, the Dutch MoD can become more effective by increasing their output, protect their personnel and material better and reduce costs if safety will be integrally included in all processes. Safety seems to have a multiplier effect on the output (see figure 4). In the end, safety will contribute positively to the military capabilities of the Dutch MoD.

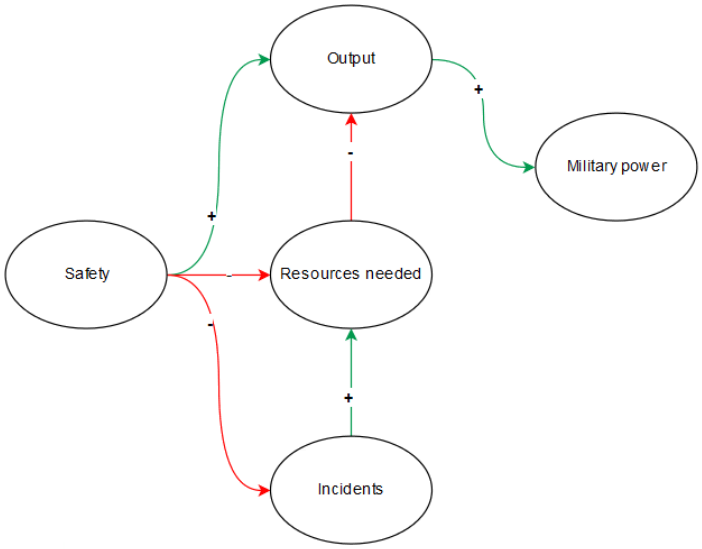

Figure 4: causal relations between safety and military power

5. Cost of quality problem

Safety is inherently linked to the level of military power. A problem occurs when decisions on safety are simply sees as a benefit decision. This becomes likely when an organisation that defines itself as a logistical chain and is regularly faced with budget constraints. If the main benefit of a safety measure will be preserving or improving the military power, the effects of military power have to be quantified and monetized in order to get a positive cost-benefit result i.e. the cost of maintaining a minimum standard of quality (costs of quality). Quantifying and monetizing military power is hard, because its effects are unsure, unclear and most of the time economic effects of having or projecting military power are not easy to calculate. Even if a safety measure directly is linked to a specific consequence (e.g. plane crash) it is very difficult for the Armed Forces to quantify and monetize all the effects. Because of the very different, quickly changing environments that the Armed Forces have to operate in, most of the consequences of a specific incident are unsure and unclear and therefore not easy to quantify in terms of money.

For example, if a plane crashes in a city (or on an aircraft carrier) the consequences are very different compared to a crash in the desert (or in the ocean). The Armed Forces operates in all possible environments, often at the same time. How can the MoD define the exact consequence and therefore the exact financial costs of the potential incident? Assumptions can be made, but will always be doubtful. This problem exists with nearly all risk analyses. Private companies have profit as

overall goal and can relate every risk and measure to the total profit. For the military, finding an overall goal which can be measured in order to be able to judge the investments costs of safety measures seems not possible.

Two approaches to deal with this problem are possible. The first is to try approximating the quantification and monetization of the effects of (changes in) military power. This will be hard, case-specific and it may take a very long time to reach consensus to define an useful standard way of quantification. The second is to adopt a different mind-set or philosophy regarding the costs of safety. This implicates that cost-benefit thinking should be disregarded, because the main benefit is not included. This in turn, means that the implicit assumption is that the benefit of preventing the potential incident is always higher than the costs of the safety measure. The second approach demands a shift in safety-thinking with more focus on preventing incidents and disruptions. Adopting HRO can help the MoD to let go of the unnecessary limiting nature of cost-benefit thinking.

6. Conclusion

This paper started with the question if there is a tension between safety and military operations and what the value of safety is for the Armed Forces. The paper takes the view that the Dutch MoD has designed the Armed Forces as a logistical supply chain with military power or capabilities as the output. It is argued that investing in safety will contribute to the preservation and improvement of the military power of the Dutch MoD by minimizing the number of incidents and the impact of the disruptions on the production or deployment of military power. The causal relations of safety are such that in terms of costs they are smaller than the gained value in terms of military power. When deciding on safety measures one should not simply see the cost of additional safety measures relative to the cost of damage, resulting from individual errors and accidents, but should also look at the benefit relative to the delivery of military power. This way of thinking is already visible in the field of military aviation, for example.

Therefore it can be claimed that safety is a necessary requirement for the Dutch MoD to be in full control of their operations. The importance of safety can be compared of what the engine is to a tank. Safety is as much a weapon as the soldier or material that is used to deploy military power.

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