Safety management theory and the expeditionary organization:
A critical theoretical reflection

Abstract

Management of safety within organizations has become a key topic within safety science. Theorizing on this subject covers a diverse pallet of subjects that ranges from fairly broad safety management theory to specific safety management systems design. Recent studies seem to point to some crucial deficiencies of such theorizing. Our interpretation of these shortcomings is that much confusion originates from not explicating (meta-) theoretical roots, which may be interpreted as a symptom of the state of the art. This paper provides a framework that will be able to explicate such meta-theoretical roots. With this framework, three theoretical approaches to safety management are identified. This paper will show that these three approaches have fundamentally different perspectives on solving a practical safety problem: managing safety of military expeditionary organizations. By means of this confrontation we are able to conclude how the state of the art of safety management theory is to be characterized. Furthermore, we conclude that implicitly applying meta-theoretical aspects may result in explicit difficulties with practical safety management.

Keywords: safety management theory, paradigm, (general) systems theory, military operations

1. Introduction

The past decades have seen a vastly growing interest in the application of safety management within organizations. Some examples are the ICAO safety management guidelines in aviation (ICAO, 2012), the SEVESO-III directives for working with hazardous materials (European Union, 2012) and the Safety Management System for the Dutch ministry of Defence (VMSdef; ministry of Defence, 2010). Consequently, theorizing on what safety management is, or should be, has increased as well. At the one hand, a wide array of fairly broad safety management practices and concepts are studied, ranging from safety culture (e.g., Guldenmund, 2000) to accident investigation (e.g., Roed-Larsen & Stoop, 2012), and from Normal Accidents Theory (Perrow, 1999) to high reliability theory (e.g., Roe & Schulman, 2008; Weick & Sutcliffe, 2007). Safety management systems (SMS) theory, on the other hand, seems to be a somewhat more specifically oriented towards the organization's management and control processes (e.g., Hale et al, 1997). Fuelled by the directives of the international standardization organization (ISO), management processes that are oriented towards safety control are awarded increasing importance (e.g., Vinodkumar & Bahsi, 2011).

Recent studies criticize the "state of the art" of contemporary safety management theorizing. In their review on occupational health and safety management systems, Robson et al (2007) stated that: "There is no consensus on what an OHSMS is and its scope is potentially wide. Some definitions are simply too vague to be helpful in determining which literature should be included in a systematic review". Also Reiman and Rollenhagen (2011) point to this conceptual confusion and additionally argue that: "In practice different definitions of safety that are used explicitly or implicitly affect safety management priorities and practices". Moreover, Hale (2003) argued that: "[…] safety management is still in a prescientific stage of development in many respects. It has only a limited, but luckily growing, research literature. It is governed by fashion and not evidence, and it has a one-sided, rationalistic view of what it is trying to do".

According to these authors, safety management theory is confronted with theoretical difficulties. In our interpretation, a contributing factor to these theoretical issues in safety management theory is that crucial meta-theoretical assumptions are not explicated consistently. In this paper we will reflect on contemporary safety management theory, by means of the work of Kuhn (1962) on scientific paradigms and Blom (1997) on general systems theory. We argue that for tackling specific and practical safety management issues, whether that regards a safety culture intervention or conducting accident investigation, rather abstract paradigmatic assumptions are of seminal importance.

Therefore the goal of this paper is to characterize the state of the art of safety management theorizing in order to show that choices regarding abstract meta-theoretical assumptions have implications for solving practical safety problems. This goal is achieved in four steps. Firstly, by means of the theory of Kuhn we aim to explicate what is meant by a "paradigm" and how this concept might be applied to safety management theory. Furthermore, we point out that the quotes presented above might be interpreted as symptoms of the stage of scientific development safety management theorizing finds itself in. Secondly, we will introduce a meta-theoretical framework that will be employed to explicate underlying assumptions and to identify three mainstream safety management approaches. Thirdly, we introduce the practical safety management problem that the Dutch ministry of Defense is confronted with: managing safety of its missions abroad. Fourth, the case is used to reflect on these approaches. This strategy enables us to conclude whether the identified mainstreams in safety management theory are indeed to be characterized as paradigms, and whether these mainstreams influence the solutions for a particular safety management problem.

2. Characterizing the state of the art by means of the concept "paradigm"

In this section we aim to define what is meant by a paradigm and how the "state of the art" of safety management theory can be understood by using this concept.

Kuhn (1962, p. 11) defines a paradigm as the shared commitment to particular concepts, theory, instruments and methodology within one particular scientific community. A paradigm however, is the result of movement and competition on the very elements of which it is constituted. In the early developmental, pre-paradigmatic, stage there is continuous competition and debate between different views on paradigmatic aspects such as concepts, theory and methodology. As Kuhn states: "on the road to a firm research, consensus is extraordinarily arduous" (1962, p. 15). Once some form of consensus has been reached, science finds itself in the stage of "normal science". This means: "research (is) firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time as supplying the foundation for its further practice" (1962, p. 10). Kuhn compares doing normal science to the activity of puzzle solving, in solving a puzzle one aims to find a particular solution through a set of known rules that: "limit both the nature of acceptable solutions and the steps by which they are to be obtained" (1962, p. 38).

In the "normal science" stage of scientific development the mutual commitment among scientists on how to do science (i.e. the paradigm) is *not* subject to debate. However, in doing normal science: "Sometimes a normal problem, one that ought to be solvable by known rules and procedures, resists the reiterated onslaught of the ablest members of the group within whose competence it falls. On other occasions a piece of equipment designed and constructed for the purpose of normal research fails to perform in the anticipated manner, revealing an *anomaly* that cannot, despite repeated effort, be aligned with professional expectation." (italics added; 1962, p. 5-6). Initially, the scientific community that has committed itself to a particular paradigm will not abolish their commitment that easily, instead they might invent: "numerous articulations and *ad hoc* modifications of their theory in order to eliminate any apparent conflict" (italics in original; 1962, p. 78). Eventually, anomalies may raise such fundamental doubt on the prevailing paradigm, that it is attempted to build new theories to explain and account for these anomalies.

Some indications seem to point us to what the traditional paradigm in safety management theory looks like. For example, Hale (2003) argues that most safety management systems literature originates from large bureaucratic organizations, he states: "The structural models that we have, have also tended until recently to be static ones. The picture they give implies that an SMS could be designed perfectly once and for all and then simply left to function, […]." Moreover, Grote (2007; 2012) finds that two approaches to dealing with uncertainty seem to emerge from safety management literature: a minimizing uncertainty approach and, a more flexible, coping with uncertainty approach. To Grote, the minimizing uncertainty approach is grounded in Taylor's scientific management and aims to achieve a high level of standardization and specialization. The coping with uncertainty approach stresses: "the need for flexible adaptation in highly flexible networked business processes" (Grote, 2012 p. 1985).

She states that: "Safety management tends to follow the first paradigm in view of potentially disastrous consequences of uncontrolled uncertainties" (Grote, 2012). Although Grote does not define what she conceptualizes as a paradigm, most safety management theory seems to adhere to principles that can be interpreted as originating from a "bureaucratic" management approach (see also: Hale, 2003). Furthermore, over the past decades indications can be noticed for what Kuhn (1962) called anomalies to the traditional paradigm. Grote (2012) writes: "However, even in high-risk domains, there is an increasing awareness of companies' needs to be flexible and adaptive in response to environmental and internal uncertainty". This quote indicates that even in high-risk domains such as nuclear power plants and chemical factories, in which the minimizing approach appears to be born, some events seem to occur for which the traditional approach has no answer. Normal accidents theory (Perrow, 1999), high reliability theory (e.g., Roberts, 1990) and resilience engineering (e.g., Holnagel et al, 2006) can be perceived as theorizing to account for such anomalies.

The point here is that when a particular science, such as safety management, finds itself in the stage of "normal science" anomalies are mostly absent. However, the quotes that were highlighted in the introduction clearly indicate that different definitions and theories are found in safety management literature, which lead Hale (2003) to conclude that safety management theory has not yet achieved the state of "normal science". The question arises whether safety management theory is indeed to be classified as pre-scientific. As we have shown, there seems to be a "traditional" normal-science paradigm in safety management that is confronted with anomalies, which has might have lead to building novel theory in an attempt to explain the seemingly unexplainable.

In our interpretation the problem that safety management theorizing faces stretches over several different levels of knowledge generalization. Van Strien (1986) refers to these levels of knowledge generalization as A, B and C respectively. Level A represents general assumptions and rather philosophical meta-theoretical "laws" on, for example, whether to think in causal arcs or causal loops (e.g., Weick, 1974) or how an organization should aim for best survival and adaptation (regardless whether that is done explicitly or implicitly in a particular study). Level B knowledge represents the application of those "laws" on a specific area of study or problem orientation, in this paper: that of safety management. Level C knowledge refers to contextualized knowledge on, for instance, safety management of the expeditionary Dutch armed forces.

The quotes highlighted in the introduction and the theoretical efforts that we identified as theorizing on anomalies seem to indicate that the problem safety management theory is confronted with, is that different *implicit* A assumptions result in an *explicit* debate on level B and C. That is, the theorizing that aimed to explain the anomalies might hold different assumptions at level A then the “traditional” safety management paradigm. In our perspective, these level A assumptions are interpreted as centering on a common safety management theme: how can an organization manage uncertainty in the best possible way in order to prevent dangerous interactions within the organization and between the organization and its environment. We will argue that three theoretical approaches are identified in organization science at level A, can be employed to identify three mainstreams of level B theory within contemporary theorizing on safety management. Moreover, in confronting level B theory with the safety management case of the Dutch armed forces (at level C) we will point out that, seemingly a-pragmatic choices regarding level A, have a profound effect on the ability to deal with very practical safety issues.

Also, such a confrontation enables us to conclude whether or not these three streams of safety management theory represent three different paradigms in safety management. That is, do these different streams in safety management theory have what Kuhn calls: “incommensurable ways of seeing the world and of practicing science in it” (1962, p. 4). The concept of incommensurability means that: “the proponents of competing paradigms practice their trades in different worlds.” (p. 150). Furthermore, Kuhn (1962, p. 200) states: “Two men who perceive the same situation differently but nevertheless employ the same vocabulary in its discussion must be using words differently. They speak, that is, from what I have called incommensurable viewpoints.”.

The next section will aim to describe a meta-theoretical frame that will enable us to address the issue of multiple levels of knowledge generalization.

3. Meta-theoretical frame

Within organization science and sociology the debate between different schools of thought on how an organization can deal with (environmental) uncertainty in the best possible way in order to survive, has a profound tradition in (general) systems theory (e.g., Blom, 1997; Kramer, 2007; De Sitter, 2000; Stacey, 1993). According to Kramer (2007, p. 57), insight into a problem that has multiple levels of knowledge generalization can be created with a framework that is sufficiently wide in order to connect the different levels of analysis. Consequently, he cites Clark (2000, p. 59) who stated that: “Systems theories are at the heartland of orthodox and much current organizational theory”. Kramer interprets this as: “many useful theoretical insights are based on, or somehow related to systems theory” (2007, p. 61). Moreover, Kramer cites Von Bertalanffy when he argues that one of the main advantages of using systems theory is that it has the ability to address the *organization* of elements in order to explain complex phenomena (2007, p. 63) in contrast to the reductionist approach that aims to study elements in isolation. We interpret that systems theoretical concepts are widely employed within all safety management theory. However, we argue that at a meta-theoretical level these different concepts can be traced back to incommensurable systems theoretical approaches.

Consequently, this section aims to employ systems theory as a framework that has the ability to connect different levels of knowledge generalization. Blom (1997) distinguishes between three systems theoretical approaches: classic, open and self-referential. These approaches are based on Luhmann's *leitdiffernz*: the system-environment distinction (Blom & Haas, 1996). To Luhmann, every system is –by definition- a reduction of environmental uncertainty. The three approaches identified by Blom can be interpreted as having a fundamental different view on how environmental uncertainty is to be reduced in the best possible way in order to survive as a system (i.e. to adapt successfully). According to Blom (1997), the classic approach acknowledges an environment, however, interaction between the environment and the system is static. This means that, because the system is oriented towards internal stability and predictability (i.e. compliance to a prescribed, top-down, "normative order") it is inflexible and insensitive to any *change* in the operational environment. In other words, the organization of elements is not questioned but determined from inside the system.

According to Blom and Haas (1996, p. 190), the open systems approach -developed by Von Bertalanffy, Ashby and many others- defines a system as a set of elements standing in interrelation among themselves and with the environment. The relationship between system and environment is theorized as dynamic and interactive. Within open systems theory the central issue of concern is adaptation of the system to a changing environment. This means that it is assumed that sensing an environment and making subsequent changes within the system is not bound or restricted by anything, that every change can be sensed and recorded. In other words, while it is emphasized that the process of adaptation itself can be complicated, open systems theory assumes that the concept of openness itself is unproblematic. Within the system, the "right" signals should be strengthened (amplified) and the "bad" ones dampened in order to accomplish a best fit with the environment. Processes within the system are perceived as a pure functionalist reaction to a complex and sometimes threatening environment (Blom & Haas, 1996). According to Blom and Haas (1996) this leads to the primacy of the environment: a never-ending hunger for endless adaptation that eventually may lead to dissolving of the system in the environment.

The self-referential systems approach (e.g., Luhmann, 1990) explicates that this dynamic relationship is not that straightforward as often assumed within "open" systems theory. Sensing the environment and subsequently adapting the system can be regarded as somewhat more problematic.

Weick's organizing model that Kramer calls a "self-referential model *avant-la-lettre*" (2004, p. 78, italics in original), can be interpreted as detailing the problematic sensemaking process that systems employ in trying to sense and adapt to an environment. Weick (1979) highlights that selection of relevant environmental cues is based on "what is already retained within the system" (see: Figure 1). This meant that, in selecting what activities are needed for operating (enactment), systems fish in their own activity-pond. In that sense, systems refer to themselves in reproducing the elements of the system. Kramer (2007) emphasizes that self-referential systems theory does not assume openness; instead, it acknowledges a fundamental closedness. Trying to "reach some degree of openness" is regarded as the fundamental problem within this approach. Ultimately, "true" certainty on the right environmental representation is impossible; instead systems should aim to reach a "workable level of certainty" about their operating environment (Weick, 1979). Consequently, the main issue that self-referential systems theory is concerned with can be interpreted as: "reaching workable openness *through* closedness". In other words, in a dynamic environment systems should be "programmed" to select specific relevant signals for their survival. So, in this sense systems are characterized by closure in order to enable them to be open.

[INSERT FIGURE 1 HERE]

4. Identifying theoretical streams in safety management theory

This section will describe how the three different mainstreams in safety management theory are identified by means of the macro-theoretical framework. In Van Strien's terms: in this section we will describe how different assumptions at level A translate into safety management theory at level B. Central to these level A assumptions, as we highlighted above, was the reduction of environmental uncertainty. Whether a classic, open or self-referential approach is assumed depends on how a particular safety management theory theorizes on reducing environmental uncertainty in the best possible way in order to ensure safe operations. Our aim here is not to provide a detailed literature review. Instead, key publications are examined on their (mostly implicit) systems-theoretical assumptions.

Firstly classic safety management is identified. In their key publication Hale et al (1997) build a theory and model of SMS design. They write: "Quality management systems are designed to detect and correct deviations from quality standards. This concept of deviation from a desired standard or ideal situation is also well known in safety" (1997, p. 128). Furthermore, they propose the Structured Analysis and Design Technique (SADT) method to map in detail the organization's primary process and every step in the life cycle of a produced product. Also this technique is used to model the proposed SMS. Hale et al (1997) write on this model: "In the operational phase the model shows the process of deviation and the possibilities to prevent, detect, recover from, or minimize the effect of the deviation". Subsequently, the Hale et al (1997) SMS is expected to be able to have normative criteria of what the system should produce so that it can notice any deviation from these criteria, which can be subsequently removed following Deming-circle-like "problem solving cycles". In his 2003 article, Hale sums up what activities should constitute a "good" SMS:

1. A clear understanding of the company's primary production processes and all their ancillaries, with all the scenarios leading to significant harm.
2. A life cycle approach to safety management, considering how all the system elements are designed, purchased, constructed, installed, used, maintained, modified, and disposed of.
3. A problem-solving cycle identifying, controlling, and monitoring these scenarios at three levels: people in direct control of the risk, procedures and plans and a structure and policy level that at intervals reviews the current operation of the SMS and makes structural improvements to it.
4. Feedback and monitoring loops ensuring assessment against performance indicators at each of the three levels.
5. Systems at the middle level, linked to the staff and line functions of the company, delivering the crucial resources and controls to safety-critical tasks at the lower level.

The "Hale-approach" to safety management, which can be regarded as eminent and widely applied in safety science, is interpreted to assume that safety standards are to be determined within the system, along precisely defined safety criteria. The use of carefully construed harm-scenario's and performance indicators can be regarded as examples of such criteria. The classic systems theory was characterized by "adherence to a normative order" that is aimed at internal predictability and stability of the system. That is, the "normative order" inside the system selects what is regarded as relevant in the environment; scenarios and performance indicators are formulated and represent what such relevance means. Subsequently, the transformation process of the system and system-inputs are checked by the SMS whether such pre-determined criteria are met. Consequently, the SMS is supposed keep these checks within boundaries by means of problem solving cycles.

Secondly we attempt to identify "open" safety management theory. In our meta-theoretical frame we emphasized that the open systems theory –in contrast to the classic systems theory- is directed towards extreme adaptability to the environment. We interpret that "resilience engineering-theory", which is mainly based on work by Rasmussen (1997) and Hollnagel et al (e.g.: 2006), is an example of "open" safety management. In 1997, Rasmussen pointed to the effects of "dynamic" environmental conditions on the organizational system. He stated that: "Control of activities and their safety by the classic prescriptive command-and-control approach deriving rules of conduct top-down may be effective in a stable society where instruction and work tools at all levels can be based on task analysis. In the present dynamic situation, this approach is inadequate and a fundamentally different view on system modeling is required" (1997, p. 185). In the same paper he proposes that: "safety in the direct interaction with the work environment must be based on an identification of the boundary of safe performance by analysis of the work system, and the criteria that drive the continuous adaptive modification of behavior." (1997, p. 206). Rasmussen points out that the relationship between environment and system can be perceived as being somewhat more complex than the classic safety management approach assumed. That is, behavior within the system seems to be influenced by the environment to which the system consequently adapts. The task of safety management, then, seems to be to keep up with this adaptation. In line with Rasmussen's assumptions on adapting systems, Woods (in Hollnagel et al, 2006, p. 22) states: "Resilience then concerns the ability to recognize and adapt to handle unanticipated perturbations that call into question the model of competence, and demand a shift of processes, strategies and coordination". Within open systems theory, it was pointed out that the relationship between the system and the environment is perceived as being unproblematic. By that it was meant that for the system, sensing relevant queues in the environment and choosing what needs to be changed within the system is unproblematic. However, according to Kramer (2007, p. 64) adaptation of a system involves *strategic* selection of environmental cues and *strategic* change in the internal composition of the system. Otherwise, adaptation would lead to *infinite* questioning and shifting in processes and strategies. The system would then eventually adapt itself into non-existence.

These remarks lead to the third safety management approach that is identified in this paper. Within self-referential systems theory, it was theorized that systems achieve openness *through* closedness. This means that the internal structure of the system is both facilitating and limiting survivability of the system. In other words: interaction between the system and its environment is characterized by the organization of the elements within the system. In our interpretation, the work of Weick et al (e.g.: 2006; 2010) is regarded as an example of self-referential safety management. In their research on (safety) management within high reliability organizations Weick et al (2008, p. 47) argue: "HROs, unlike most organizations, are able simultaneously both to believe and doubt their past experience" and "Here, we want to make the additional observation that effective HROs also have the capability to recombine actions already in their repertoire into novel combinations.". The fundamental problem, -of reaching openness through closedness- of the self-referential system seems to have normative consequences for organizational safety management. As he puts it: "When we argue that organizations need to discredit partially their past knowledge, we also mean that an organization should treat as certain those things which it doubts. To doubt is to discredit unequivocal information, to act decisively is to discredit equivocal information. When things are clear, doubt; when there is doubt, treat things as if they are clear" (Weick, 1979, p. 221). This means that, in contrast to the open safety management, self-referential safety management includes a normative element, doubt, (cf. Kramer, 2007) which implicates the relationship between the organization of elements and survivability of the system in a particular environment.

The major point we want to express in this paper is that for practical safety management problems, theoretical assumptions at Van Strien's level A of knowledge generalization, are of seminal importance. Therefore the next section will introduce a practical case that will be used to reflect on the identified streams of level B theory in safety management in section six of this paper.

5. Safety management for the military expeditionary organization

This section will present the case of the Dutch military and the problem of managing safety for its expeditionary forces.

The post cold-war reality confronts the Dutch military organization with organizational challenges. While for four decades the main goal was to defend NATO territory from Warsaw-pact threats and "real battle" situations were largely absent, nowadays "the war on terror" and anti-pirate missions illustrate a more volatile environmental context and stretches military interests to a global scale. A contrast has emerged between the relatively "stable" operating conditions during the Cold War and the uncertain and "turbulent" conditions of contemporary expeditionary missions. The nature of tasks and goals of military operations has changed dramatically and expeditionary operations serve amongst others: reconstruction, humanitarian, peace keeping and peace enforcing purposes. Modern military operations are characterized as expeditionary because operations for which units are deployed are located abroad. Some examples are recent operations in Afghanistan, Iraq, Former-Yugoslavia and Cambodia.

To accomplish such a wide array of operations, the Dutch defense organization employs a "mixing and matching" organizational design strategy (Kramer, 2007). Kramer (2007) refers to "building blocks" within parent organizations from which temporary (i.e. expeditionary) organizations are built. Because the parent organizations have a high degree of functional specialization, the building blocks mostly consist of units that conduct one particular function (De Waard & Kramer, 2008). The amount of options the organization has to combine all these different units is plentiful. This organizing strategy results in expeditionary organizations that differ substantially from each other in layout and structure.

A recent example is the formation of Task Force Uruzgan (TFU) and its so-called "smallest units of action" (SUA) (see: De Waard & Kramer, 2008). TFU was mainly built up from elements stemming from the Army and the Air Force. In particular within the Army, the functional elements in which the parent organization is organized (brigades, battalions and company's) did not match the functional requirements of the Uruzgan mission. This means that the Army needed to “handpick” several elements from the parent organization and “glue” them together to form TFU. The complicated “mixing and matching” strategy resulted in several operational problems for soldiers operating in these SUA’s (Waard & Kramer, 2008). Kramer et al. (2012) state: “operating in such units requires skills that are normally not trained or simulated”.

Another example of such a “tailor-made expeditionary organization” is the mission “Ocean Shield” near Somalia. For this specific mission, Army, Air Force and Navy units are combined aboard one ship, a Landing Platform Dock called HNLMS “Rotterdam”. The Rotterdam is a multipurpose amphibious transport ship with helicopter capability. Army UAV’s were, for the first time, used for reconnaissance to spot pirate activity, two Air Force Cougar helicopters were deployed to the ship to function as on-board helicopter (Ministry of Defense, 2012).

Within military expeditionary organizations, there seems to be an increasing number of problematic interactions between the units of these military expeditionary organizations that lead to incidents and accidents such as friendly fire and near misses (e.g., Mair et al, 2012; Snook, 2000). A recent example is a recent friendly-fire incident in Uruzgan in which one Dutch Army unit accidently shot another Dutch Army unit, which resulted in two fatalities. Also, ongoing research on the functioning of the Army’s unmanned aerial vehicle unit (UAV) within TFU (see: Moorkamp & Kramer, 2011; Moorkamp, 2012) shows that interaction between the UAV unit and other members of TFU was problematic. These issues included potentially dangerous miscommunication between UAV’s and TFU’s control tower that resulted in near misses between UAV’s other flying members of TFU. Safety management, therefore, can be deemed as relevant for expeditionary military organizations. Despite such relevance, creating a safety management system for these expeditionary forces is regarded as problematic by the Dutch ministry of Defense, at least, that can be interpreted from the choice to develop a safety management system for the parent organizations and not for the expeditionary organizations (ministry of Defense, 2010).

In the next section we will employ the case to reflect on the streams of B-level safety management theory that were identified in section four.

6. Reflection

To be able to reflect on the identified streams in B-level safety management theory, we will firstly point to some key characteristics of the military case that are relevant for such a reflection on safety management theory.

The case highlighted above shows two issues that are of particular relevance to safety management of the expeditionary units. Firstly, the defense organizations seem to encounter, what Eric Trist calls, “environmental turbulence” (cf. Trist, 1980). Tasks and mission goals seem to change quickly. According to Trist, turbulence means that the operational environment is constantly moving by the influence of other parties and that these parties actively impact the operational units in that environment (Trist, 1980 p. 117). Secondly, the military organization seems to have a rather complicated assembly process for its expeditionary missions, which leads to constantly varying temporary organizations. This section will explicate what consequences these characteristics may have for safety management of such organizations. We will confront the three identified mainstream safety management approaches with the safety problem of the Dutch ministry of Defense. In terms of Van Strien, this sections aims to confront operations at level C with theoretical notions at level B. Moreover by means of this reflection the practical problem of the Dutch defense organization is likely to become less ambiguous.

The first approach that we identified was classic safety management. Within classic safety management, the main goal was to get a detailed description of the organizations primary process, determine boundaries/ criteria for these processes and adjust these processes in such a way that they remain within the pre-determined criteria. Hale (2003) referred to mapping "product life cycles" within the primary production process. Once mapped, scenarios and key performance indicators (KPI's) are construed. These instruments enable the SMS to check whether the primary processes are behaving within the boundaries of these scenario and KPI's. The case that we described was characterized by environmental turbulence and constantly changing temporary organizations. Turbulence meant that the operating environment changes constantly through the influence of third parties. In our case this means, for example, that both the nature of the missions varies constantly in tasks and goals but also that within a mission tasks may vary. Such variances lead the defense organization to assemble constantly changing temporary organizations and constantly changing SUA's within the temporary organizations. Applying the principles of classic safety management to such constantly changing organizations would be a challenging enterprise. The process of mapping the primary process and creating accompanying scenarios and KPI's for both the temporary expeditionary organization and the SUA's would have to start over again every time the layout of the organization changes. In terms of Weick (1974, p. 356), this leads us to conclude that: "equilibrium seeking is nonsense when the equilibria themselves change more quickly then can be adjusted".

The second safety management approach that we identified seems more suitable for getting insight into the safety issues of the expeditionary armed forces. The open safety management acknowledged "dynamic operations", Rasmussen (1997) pointed out that safety management of such dynamic organizations should be based on: "an identification of the boundary of safe performance by analysis of the work system, and the criteria that drive the continuous adaptive modification of behavior". In our military case, such an analysis of the work system may lead to recognizing that layout of the work system changes per mission and within the mission. The varying tasks and goals that creates the need to continuously "mix and match" organizational units could be identified as the criteria that drive such –in Rasmussen's terms- "continuous adaptive modification of behavior". Safety management based on such "dynamics" within the open approach was sought in resilience engineering which stated that organization needed to: "adapt to handle unanticipated perturbations that call into question the model of competence, and demand a shift of processes, strategies and coordination" (Woods, 2006, p. 22). One might argue that the continuous change in organizational composition of the different expeditionary organizations can be regarded as adaptation prescribed by resilience engineering. Processes are shifted and also strategies and coordination seems to be altered continuously. Indeed, the design of expeditionary organization can be seen as an attempt to anticipate on "environmental perturbations". However, "true" resilience means that the expeditionary organizations need to have implications for the parent organization. Interpreted along the lines of Hollnagel et al: after each mission, the parent organization should question its model of competence in such a way that it includes the solutions found in the expeditionary organization. As has been pointed out in earlier sections of this paper, expeditionary organizations vary substantially in layout. Also, as we have witnessed over the last decades, differing expeditionary organizations are sent abroad within a short period of time. Applying the principles that we identified as "open" safety management, would lead to a process of continuous questioning within the parent organization. Because no solid ground seems to exist for the missions Dutch defense organization, this process might cripple the parent organization and results in never-ending adaptation. This means that, because the aim of the open safety management seems to be that the organization should possess a similar amount of variance as compared to the environment (cf. Ashby, 1956), the organization eventually seizes to exist. The boundary between the organization and its environment –which according Luhmann represents the systems identity- disappears. If a system becomes as complex as its environment, it becomes indistinguishable from its environment and therefore the reduction of complexity that constitutes its identity, is lost. These conclusions guide the premises of the next safety management approach that aims at more selective, or strategically questioning that might be able to account for the problems of the expeditionary organization.

Self-referential safety management was conceptualized as the ability to create enough "openness" to tackle environmental variation and accomplish survivability but sufficient "closedness" to not dissolve into the environment and keep some form of identity. This meant that survivability of the system in a particular environment is characterized by the organization of the elements within the system. In Weick's terms: enactment of an organization in a particular environment is informed by what is retained within the system. In our interpretation, the parent organization functions as a relevant source of both survivable adaptation and retention. In reflecting self-referential safety management with our case, the way in which the elements are organized in the parent organization then becomes relevant for explaining the survivability of the expeditionary organization. We highlighted in part five of this paper that the parent organization was confronted with the challenging shift between an organization that is mainly confronted with one particular task to an organization that has to accomplish a wide array of different tasks. Although the tasks have shifted significantly, the organization of elements (i.e. the organization's design) within the parent organization did not shift significantly. This means that the parent organization is still built on the cold-war principle of the manoeuvre brigade as the largest autonomous unit (De Waard & Kramer, 2008). The brigade is a unit consisting of about 2500 soldiers and is designed around the concept of "combined arms", meaning that: "a fixed combination of manoeuvre (infantry), reconnaissance, fire support (i.e. artillery), support (i.e. supply), and command elements exists" (De Waard & Kramer, 2008, p. 540). This means that for any organizational form smaller then the brigade, some process of assembly has to take place. Furthermore, the lion's share of the organizations training is conducted within the frame of these brigades. Contemporary tasks however, never require the deployment of an entire brigade. Mostly the deployed units consist of a couple of hundred soldiers. But, more relevant is that the tasks that contemporary missions require are no part of the brigade's tasks and requirements. As De Waard & Kramer (2008, p. 541) point out: "None of the land component's units have in origin been designed to combine security and reconstruction tasks". Because of this problem, the expeditionary organization consists of units that originate from different part of the parent organization. They are expected to function "out of the box" in newly constructed expeditionary organizations that are engaged in significantly differing tasks in significantly differing environments. Consequently, we infer that self-referential safety management might enable us to explain why interactions between these building blocks within the expeditionary organization may be problematic. They seem to be designed and trained to conduct entirely different activities in an entirely different organizational layout. Safety management within the self-referential perspective seems to require some adaptation of the parent organization. However, to use the phrasing that was used in "open" safety management, not every environmental perturbation can be translated into cues for questioning the organization's "model of competence because then, adapting for survivability resulted in endless adaptation. We pointed out that questioning the "model of competence" in such a way to create enough openness for "workable" variation, but enough closedness to remain intact as an organization, had a normative connotation. This argument opens up the road for researching alternative goals, tasks and structural designs that are presumably better in tackling the turbulence in tasks and goals while at the same time preventing the dangerous interactions from happening. De Waard & Kramer (2008) refer to a modular design of the parent organization as a potential fruitful avenue. Concluding, self-referential safety management seems to be able to establish a critical and normative relation between the organization of elements within the organization and survivability in turbulent task environments. Furthermore, self-referential safety management highlights that this relation is characterized by limitation. That is, there seem to be limits to the possibilities of safe adaptation of the parent organization to environmental variation. This leads us to conclude that safety management of the Dutch military organization, from a self-referential perspective, leads to either a strategically questioning, or -in Weick's terms- doubting, the parent organization's tasks, goals and structures, or accepting that dangerous interactions between units of the expeditionary organization continue to be part of the "normal work conditions" of each mission.

7. Conclusion

The goal of this paper was to characterize the state of the art of safety management theory in order to show that choices regarding abstract meta-theoretical assumptions have implications for solving practical safety problems. We pointed out that, in our interpretation, much confusion in safety management was concerned with the problem of having differing implicit theoretical assumptions at Van Strien's level A of knowledge generalizations, whereas the explicit debate seems to take place mostly at level B. We introduced a meta-theoretical frame that was able to explicate level A assumptions and connect the different levels of knowledge generalization. We were able to identify three mainstream safety management approaches and reflect on these approaches with a very practical safety problem. This has shown us that the three approaches that we identified in safety management theory lead to very different safety management solutions for our case. Consequently, this reflection enables us to draw conclusions about the state of the art of safety science and on the incommensurability of the three identified safety management approaches. Subsequently, we are able to conclude whether the three identified theoretical streams in safety management are to be characterized as paradigms.

The main conclusion that can be drawn concerns: what can the confrontation between the levels A, B and C tells us about the state of the art of safety management theory? Is there such a thing as "normal science" in safety management? Or do we have to agree with Hale (2003) that safety management is pre-scientific? In our interpretation, the state of the art in safety management can be characterized along Kuhn's definition of a science in a state of crisis. This means that there seems to be a "traditional" normal-science paradigm in safety management that is confronted with anomalies. Hence creating (the beginnings of) novel paradigm(s), which are subsequently confronted with the "traditional" one. In our interpretation, classic safety management represents such normal science because shared commitment on theory, methods and instruments within this approach resulted in very pragmatic and detailed model of a safety management system, as we have seen in the safety management systems theory of Hale et al (1997). Because events seemed to happen that could not be managed by these fine-grained and well-defined instruments, anomalies came into existence. These anomalies have consequently resulted in building novel theory in an attempt to explain these events. In our analysis, open and self-referential safety management represents such building of novel theory, methodology and safety management instruments. We argue that "novel paradigms" are constructed because the three streams in safety management theory indeed seem to "practice in different worlds". As Kuhn highlighted, incommensurable paradigms "talk in the same words, but mean something different". The three streams all theorize on concepts such as survivability, system and management, however, in their conceptualization and operationalization the concepts can be interpreted as meaning entirely something else. In that sense, one might argue that three paradigms exist in safety management. However, in our analysis it became clear that open and self-referential safety management are not (yet) able to deliver pragmatic safety management instruments. So, although within open and self-referential safety management there seems to be shared commitment on theoretical premises; no explicit shared commitment seems exists on methodology or instruments. This leads us to the second conclusion.

Secondly we conclude that the confrontation between the case and level B safety management theory has shown that one particular stream in safety management theory is more helpful in solving the practical problem that was put forward in the case, then another. In particular, classic safety management did not result in a pragmatic solution to the safety problem that we presented in the case. It resulted in a constantly restarting process of mapping the, quickly changing, primary process of the expeditionary organization. Also we found that the premises of open safety management did not lead to any solution or insight into the problem of the Dutch defense organization. Instead it resulted in a crippling process of endless adaptation. Self-referential safety management was identified as an approach that seemed to create some understanding of the safety issues in the case. We pointed to the ability of self-referential safety management to get insight into the relationship between the layout of the parent organization and the survivability of expeditionary organizations. However, although self-referential safety management was able to conceptualize a normative element for safety management, it was unable to operationalize this element. That is, it was unable to propose alternative goals, tasks and designs for the parent organization in order to ensure survivability of the expeditionary organizations and prevent dangerous interactions from occurring. This opens up the road for future research (see: Moorkamp & Kramer, 2012).

Finally, this enables us to formulate some concluding remarks. We highlighted the relevance of explicating meta-theoretical level A assumptions for level B safety management theory and practical solutions at level C. These mostly implicit assumptions were analyzed to be of determining influence for conducting safety management within organizations. This conclusion holds relevance for various safety management practices such as designing a safety management system, creating a safety culture intervention or conducting accident investigation. For example, engaging in accident investigation while being blind to the effects of choices regarding an organization's design on everyday operations may lead to blaming operators who go to lengths in their struggle to keep the organization afloat in a dangerous and threatening mission environment. Also, trying to improve an organization's safety culture may be ineffective when structural conditions are of such relevance with regard to operational safety as we have shown in our military case. Moreover, implicitly applying the classic safety management paradigm in a dynamic organizational context might lead to very explicit problems, as the Dutch defense ministry's apparent inability to manage its operational safety has shown us.

8. References

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FIGURE 1: WEICK'S ORGANIZING MODEL