The influence of leadership on the prevention of safety incidents: on risk reduction, leadership, safety principles and practices

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> Science is not a purely objective, value-free activity of discovery: science is a creative process in which social and individual values interfere with observation, analysis and interpretation.
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2 Theory, concepts and context

Safety in organisational settings has developed since the late 19th century, from individual initiatives by industrial, transport and health care frontrunners to academically-supported concepts by scholars and safety professionals, who have studied how and why processes sometimes do not result in the desired results. Due to the fact that safety incidents still occur, there is an ongoing drive to develop better theories and more effective concepts. Every publication of a new theory, philosophy, or concept raises a debate between scholars and practitioners, and often a reaction from society. Some approaches are similar; others are opposite in nature, or based on different theories or philosophies. Some of these developments have inspired risk management professionals, have been immediately embraced by many people, and became internationally influential. These theories and concepts serve as references for this research, in order to clarify how contemporary risk management methods influence leaders in organisations in their efforts to prevent safety incidents.

In this chapter we will elaborate on the theories and concepts related to safety, risk management and leadership. We will then discuss the contextual factors that leaders are facing (and part of) during their day-to-day work.

2.1 Safety

Nobody wants to be involved in, or held accountable for safety incident scenarios, but, like it or lump it, these scenarios are part of the real world; things may run differently than expected. Primary processes may be disturbed and escalate into safety incidents without warning. Organisations attempt to prevent operational disturbances in different ways, but simultaneously, in order to survive economically in a competing environment, or simply to make life easier, people take initiatives that are counterproductive to this preventive process. Most of the time, they do this with the best intentions. This not only applies at the operational level; under the influence of, for example, personal, economic, political, or peer pressure, people deviate from approved policy strategies and agreed scopes of work.

This is the case in any phase of an operational process; be it design, engineering, procuring, construction, selection and hiring of personnel, education and training, operat-

ing the primary process, inspecting, auditing and testing, maintenance, or decommissioning. During all these different activities, individuals at different organisational levels take initiatives and people may have reasons to deviate from agreed safe practices; on operational, supervisory, managerial and boardroom levels as well.[1]

Apparently, safety risks are not always waiting in front of people's eyes to be clearly observed or otherwise identified. It is often difficult after a safety incident, even for professional investigators, to identify the trigger that initiated the disaster, and the underlying factors which contributed to the occurrence of the incident. From the positive point of view that people do not cause operational disturbances deliberately,[2] it is reasonable to say that their actions, including deviations from instructions, procedures, standards, etc., are performed in good faith, often with the intention to increase the efficiency and effectiveness of the primary process. As a matter of fact, this is the way many process improvements have been invented. Hale and Borys also claim that strict compliance to a static set of rules is probably not the best solution to reduce safety risks.[3] To support this, a statement by Reason is considered relevant: "If people would always have followed the rules, we would still live in the caves…"[4]

An incident-free operation in sectors where serious safety risks exist is a myth.[5] Therefore it is no surprise that in the safety-critical sectors subject to this research, there are no organisations with an incident-free track record and, on the contrary, despite intensive risk management programmes, the list of organisations that have proven *not* to be able to prevent safety incidents shows many names.[6] In these sectors, safety risks, obvious and known, hidden and unknown and uncertainties are part of reality; therefore, an ongoing and continuous effort to identify and reduce safety risks is as fundamental as anything else for these organisations to stay in good health.

2.1.1 *Defining safety*

In the health care sector, patient safety is defined as: "The (near) absence of (the risk of) the patient inflicted injury (physical/mental)."[7] In the rail sector the term 'safety' has not been formally defined,[8] but the companies which operate railway systems in the European Union are obliged to comply with EU Directive 2016/798, which contains extensive safety requirements (although no definition of 'safety' is given). In this directive the clos-

1 Hollnagel, Woods and Leveson (2006).

2 In case process disturbances are caused by deliberate subversive actions, the term 'sabotage' applies instead of an 'unintended incident.' This has no relationship with safety, but with the security discipline. Security cases are outside the scope of this research.

3 Bieder and Bourrier (2013).

4 Commentary by Reason in the documentary "Impossible Accident" about the sinking of the Herald of Free Enterprise in 1987.

5 Yoe (2012).

6 Swuste, Van Gulijk and Groeneweg (2017).

7 De Bruijne, Zegers, Hoonhout and Wagner (2007), p. 16.

8 Directive 2016/798 of the EU (2016).

est indication of what is meant by the term safety is that safety performance is measured in terms of the number of injured people and material damage.[9]

From an entirely different angle, Yoe refers to legislative and administrative frameworks, in which safety is defined as: "a reasonable certainty of no harm."[10] The notion of 'reasonable certainty' suggests that uncertainty plays a role, which Yoe connects with the possible existence of residual risk after all measures aimed at controlling safety risks have been undertaken; he argues that because of this uncertainty, safety in any absolute sense is a psychological fiction. Van Asselt suggests that 'uncertainty' is an inevitable element of operational activities, and she therefore advocates raising consciousness regarding the impossibility of escaping uncertainty and risk.[11]

Aven claims that many safety professionals and researchers use definitions like "safety is the absence of accidents"[12] and similar versions in which safety is associated with low/acceptable risk. Other researchers argue that it is counterproductive to define safety as the antonym of risk, due to the different views on the definition of risk. Nevertheless, Aven recommends using risk-related definitions of safety (and safe), and he suggests that "…by using the risk interpretation we acknowledge that being safe is a subjective judgment dependent on institutional processes to determine what is acceptable risk and what is not." Aven thus rejects definitions in which safety is related to the concept of an "absence of accidents."[13]

Aven finds support from Dekker, who claims that defining safety in terms of the absence of something, because systems are already safe, is a faulty assumption. In his view, all systems contain incompatible opposing goals and are always short of people or technical safety characteristics, both of which are considered too expensive. He suggests that people at all levels in organisations are the only ones who can resolve these shortcomings and thereby create safety through practice. Dekker claims: "Safety is not about the absence of something. It is about the presence of something."[14] The medical discipline gives a clear example of this approach: the term 'health' is usually described by its implicit properties (e.g., vitality, fitness, or well-being, etc.). No unambiguous solution has yet been developed for safety.

Weick's definition is in line with the previous options, as it proposes to define safety as "a dynamic non-event".[15] In his managerial concept of High Reliable Organizing (HRO), reliability is a precursor of safe operations. Weick claims that reliability is a moving target, and therefore transient, and that reliability is a dynamic non-event, and therefore continually re-accomplished. He explains that operational activities are constantly subject to interference, and therefore 'balancing' is required to reliably perform activities and pre-

9 Heimplaetzer and Busch (2006).
10 Yoe (2012), p. 4.
11 Van Asselt (2000).
12 Aven (2014), p. 16.
13 Ibid., 16–17.
14 Dekker, Hollnagel, Woods and Cook (2008), p. 2.
15 Weick (2011), pp. 21–27.

vent an event. Weick argues that "when balance is interrupted, cognition and feeling arise and turn a non-event into an event."[16] According to Weick, continual actions to keep the balance form the dynamics required to ensure that we achieve our operational goals in a safe way. In order to elucidate the dynamic nature of safety, he uses the example of rope walkers, who continually react to the forces that affect their balance.

This brings us to Hollnagel, who also recognises that the status of safety science is contested. In a discussion in which he reasons that safety science is 'the study of safety', he concludes that

> … unlike the celestial objects, unlike matter, even unlike faculties, organisations, goods and services, *safety* does not represent an agreement on what it is that should be studied, nor can it be said to exist in any concrete or material sense, or to be real. Because of this we cannot resolve disputes about what safety is by referring to something that exists independently of our thinking, as if it was an object (as the term is used in semiotics). Yet we need to be able to refer to what *safety* is in a way that is open to intersubjective verifiability…[17]

Hollnagel[18] has noted that safety is often defined as a condition where no incidents happen, or a condition where the number of incidents is acceptably small. He refers to various definitions in use, such as:

- The state in which harm to persons, or property damage, is reduced to and maintained at or below, an acceptable level through a continuing process of hazard identification and risk management. (International Civil Aviation Organisation);
- Freedom from accidental injury. (U.S. Agency for Health-care Research and Quality);
- A major incident is an incident or natural event that poses a serious and immediate risk to safety and includes a derailment of rolling stock, a collision, a fire or explosion. (Transport Safety Victoria).

Hollnagel states that these definitions are merely defining a 'lack of safety', rather than safety. A lack of safety is measurable, as incidents can be counted but it is impossible to measure safety when defined as a state of non-incidents. Here we face the core problem with defining safety solely by an absence of incidents. Hollnagel developed a solution for this problem: safety should be defined by 'what IS there', instead of 'what is NOT there'. Therefore, he proposes focusing on 'what goes right' rather than on 'what goes wrong'. This approach has been termed Safety II, and the related definition reads:

> Safety is the ability to succeed under expected and unexpected conditions alike, so that the number of intended and acceptable outcomes (in other words, everyday ac-

16 Ibid., p. 23.
17 Hollnagel (2014), p. 21.
18 Ibid.

tivities) is as high as possible.[19]

Apparently, the safety-world feels (rightfully) uncomfortable with the old view that 'safety is no accidents'. Nowadays there is growing support for the new view – the Safety II view – in which, according to the founding fathers of Safety II (Hollnagel, Woods and Leveson), "… the notion of resilience has gradually emerged as the logical way to overcome the limitations of existing approaches to risk assessment and system safety."[20]

Hollnagel himself realises that "the real difficulty in this approach is to change the mindset of safety scientists, from a focus on that which goes wrong to a focus on that which goes right",[21] and we agree with him; safety professionals and researchers are puzzled, and the discussion about what is referred to as Safety I and Safety II in the profession is very much alive. Despite an active debate among numerous safety experts, there has been no unambiguous agreement among the safety community about how these two concepts relate to each other, until now.

2.1.2 *Safety theories*

2.1.2.1 Domino theory and accident pyramid

At the turn of the 20th century, the industry in general, suffering from bad safety records, became aware that their employees deserved a higher level of protection. Unions had taken occupational safety as an important topic. As a result, companies and trade unions initially focused on raising awareness of the (mostly mechanical and electrical) safety risks by warning general employees of their dangerous surroundings; awareness was considered the key preventive measure. In 1931 Herbert W. Heinrich, an employee of the Travelers Insurance Company (Hartford, CT) published his book 'Industrial Accident Prevention: a scientific approach.'[22] Of significant influence was his description of a 'domino theory', advocating that an accident follows a deterministic (if>then) causal path. Also, he described an 'accident triangle' or 'pyramid', showing a ratio between different severities of incidents and accidents. Many criticise the scientific validity of the domino and triangle concepts and these are still subject to discussion. But the completeness of his work is striking and its impact on industrial safety is beyond any doubt, as, scientifically proven or not, these concepts have survived as 'a way to look at the management of safety.'

Heinrich introduced four fundamental principles of accident prevention: 1. executive interest and support, 2. investigation and analysis of accidents, 3. selection and application of remedial action and 4. executive enforcement of corrective practices. These principles are of significant interest regarding the role of leaders. Apparently, Heinrich's

19 Ibid., p. 23.
20 Hollnagel, Woods and Leveson (2006), p. xi.
21 Hollnagel (2014), p. 23.
22 Heinrich (1941).

four principles touch on the central topic of this dissertation: the role of leaders in the prevention of safety incidents.

2.1.2.2 Normal Accident Theory

Since 1937, many organisations have supported the Bell System Safety Creed: "No job is so important and no service is so urgent – that we cannot take the time to perform our work safely."[23] But in 1979, Charles Perrow had the courage to declare that "Most high-risk systems have some special characteristics [...] that make accidents in them inevitable, even 'normal'."[24] This statement forms the centre of Perrow's Normal Accident Theory (NAT). He explains that accidents have to do with the complexity of systems and the way system components are tied together. The term 'normal accident' means that, given these system characteristics, unexpected interactions of different failures are inevitable. Perrow claims that by understanding this causal theory, "... we are in a better position to argue that certain technologies should be abandoned and others, which we cannot abandon because we have built too much of our society around them, should be modified."[25] Perrow's theory initiated an ongoing debate between risk management professionals and organisational leaders. Many reputable organisations still ignore NAT and support the 1937 Bell creed, proclaiming a 'Zero Accident' policy. However, NAT does not provide an indication of the frequency or probability of occurrence, but only indicates the plausibility of accidents occurring.

Perrow's theory relates a great deal to (the design of) technological systems, but this is put into the perspective of the number and quality of people present in operational areas. He emphasises the requirement that designers of technological systems ought to consider the intellectual and physical restrictions of operating people; e.g., people may be afraid to report small deviations of 'normal system behaviour', which appear infrequently and which never really disturb the production process ('weak signals'), but which potentially may lead to a safety incident. Already in 1979, Perrow included organisational influences in analyses of the integrity of the system as a whole (hardware and human-ware). NAT explicitly includes the option to refrain from an intention of building an innovative system if the system is too complex and the elements too tightly coupled for a person (or team) to understand the potential for failure or the recovery of failure. In NAT risk awareness in the design phase, leadership and courage to intervene on work floor level are considered important to prevent safety incidents.

23 First stated in 1937 in a speech by W.T. Wooters, Plant Manager of the Bell of Pennsylvania Company.
24 Perrow (1999), p. 4.
25 Ibid., p. 4.

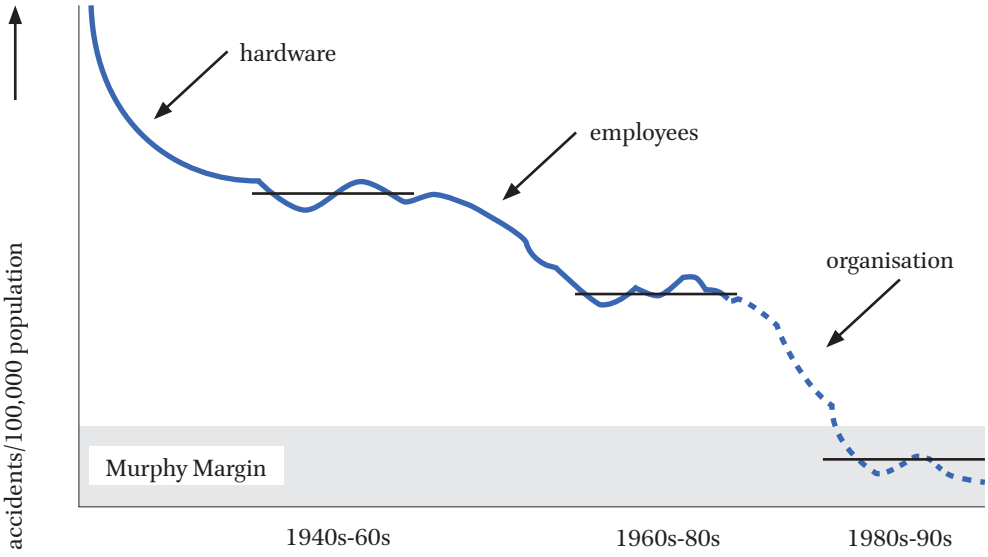


FIGURE 1 Trends in risk management (Groeneweg, 1992)

2.1.2.3 Murphy margin

In 1992, Groeneweg published *Controlling the Controllable*.[26] In this book, the author presents the theory that operational workers commit suboptimal acts (e.g., slips, lapses, mistakes, violations) due to the context and conditions in which they operate. This theory suggests that operational disturbances, potentially resulting in safety incidents, are the consequences of a suboptimal organisational process.[27] This publication initiated a trend which is characterised by a shift in attention from individual employees as the primary cause of accidents to organisational factors as precursors and underlying causes. Groeneweg also presented a so-called 'Murphy Margin', representing an area where effective risk management has achieved a level where very few accidents occur and where statistical analysis does not add to better understanding of why accidents happen. Groeneweg[28] explains our mental incapability to control all unexpected and undesired operational disturbances, as follows:

> There seems to be a zone of creeping entropy where factors beyond the control of both management and the people on the floor influence the number of accidents. This is a base level of the number of accidents and it seems impossible to reduce it further. This is a statistical phenomenon, since chance of getting an accident will

26 Groeneweg (1992).
27 Swuste, van Gulijk and Zwaard (2016).
28 Groeneweg (1992), p. 6.

never be zero in the long term and given a large enough sample size, there will always be accidents. Companies with a fluctuating number of accidents are not necessarily already in this zone, they could also be stabilising at a higher level. If and only if a company can prove that they have managed to control all technical, personal and systemic parts of the accident causation process, they can regard themselves being in that zone of creeping entropy, the Murphy Margin.

2.1.2.4 Disaster Incubation Theory

In 1997, Turner and Pigeon published their 'Disaster Incubation Theory.' This is a theory about the functioning and properties of high tech-high hazard organisations. Extensive observations and fieldwork in the British industry, transport and health care sectors serve as the basis for this theory and form an ethnographic approach.[29] The theory is that, before a disaster takes place (here: notionally normal starting point), various small process disruptions caused by unacknowledged underlying factors take place (Stage 1). People consider these disruptions as surprises and do not realise that these relative weak signals are in fact indicators that the production system is vulnerable to bigger trouble. When these signals are not valued as predecessors of something serious and there are no timely interventions, this period of weak signals is in fact the 'Incubation Period' (Stage 2) before a disaster takes place. When these disruptions lead to a 'Precipitating Event' (Stage 3) the 'Onset of a Disaster' (Stage 4) is inevitable. The model is completed by explaining the 'Rescue and Salvage' (Stage 5) and the 'Cultural Readjustment' (Stage 6), by which the organisation's culture is modified to prevent future process upsets. This theory is depicted in Figure 2 below.

According to Turner and Pigeon, disasters are a by-product of normal operating management and technical systems. The vast majority of underlying factors are of a managerial, administrative, or social nature; technical causes are the minority. The collective failure of the organisation and misconception about safety risks create incubation of safety incidents.

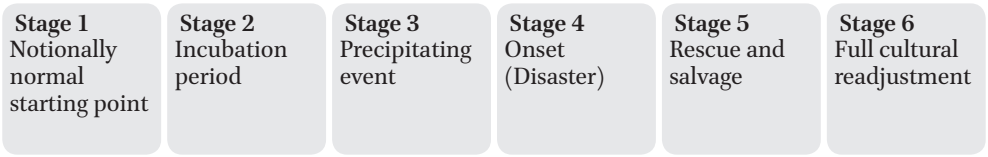


FIGURE 2 Disaster Incubation Theory

People under operational conditions are exposed to different dynamics, requiring various skills, of which being careful not to create a safety event is only one. Hollnagel explains the combination of these different forces as the 'Efficiency-Thoroughness

29 Swuste, Van Gulijk and Groeneweg (2017).

Trade-Off'-principle (ETTO), addressing the continual conflict between producing in the most efficient way and optimally managing safety risks at the same time.[30] Once it has become clear that trade-off decisions were not taken in favour of safety, this is often attributed to a lack of safety awareness among the people involved, however, when their knowledge and awareness of safety risks is tested (e.g., by asking their opinion about the hazards to which they are exposed), such a conversation often shows that people in operations have a surprising depth of understanding of safety-related aspects. People involved in the primary process often know more about operational safety risks due to their operating experiences, and are more creative in finding solutions to tackle incompatible goals than people who are not exposed to the day-to-day operational reality at the work floor level.[31, 32, 33]

Nevertheless, there is one exception to be made with respect to identifying safety risks; 'black swans', the hidden or even unknown-unknown risks (ref. 2.2.3.1.1) that cannot be identified by any individual working at a strategic, intermediate, or operational level. History has demonstrated that safety incidents have been caused by this type of latent hazard.[34, 35, 36, 37, 38, 39, 40]

2.1.2.5 High Reliable Organizing

Being professors in organisational psychology (Karl Weick) and medicine and business (Kathleen Sutcliffe) Weick and Sutcliffe are considered the founders of High Reliable Organizing (HRO). This concept, first published in 2001 focuses on 'managing the unexpected.'[41] This development may be considered a follow-up of Perrow's NAT, in the sense that its theoretical foundation is the acceptance of inevitability of accidents, as each process design contains weaknesses. But where Perrow has a strong focus on the design phase of systems, HRO emphasises more the organisational aspects and how to deal with unexpected developments in the operational stage. HRO is based on five principles: 1. Preoccupation with failures, 2. Reluctance to simplify, 3. Sensitivity to operations, 4. Commitment to resilience, 5. Deference to experience.[42] These principles seem to encompass the full risk management process, from recognition of risks to remedial actions

30 Lundberg, Rollenhagen and Hollnagel (2009).
31 Groeneweg (1992).
32 Dekker (2011).
33 Reason (1997).
34 Taleb (2010).
35 Onderzoeksraad voor Veiligheid (2019).
36 Onderzoeksraad voor Veiligheid (2015).
37 Onderzoeksraad voor Veiligheid (2013c).
38 Onderzoeksraad voor Veiligheid (2012).
39 Onderzoeksraad voor Veiligheid (2008a).
40 Onderzoeksraad voor Veiligheid (2007).
41 Weick and Sutcliffe (2007).
42 Ibid.

to reduce these.

Organisations which are considered 'High Reliability Organisations' distinguish themselves by the fact that their members are permanently alert to identification of (weak) signals of deviation from intended processes; 'collective awareness.'[43]

Westrum argues that when people bring new variables under their control and enlarge their ability to act on them, they also enlarge the range of issues they can notice in a mindful manner. And conversely, if people are blocked from acting on hazards, their observations will, most likely be considered as 'useless'. Consequently, these observations are ignored or denied and errors may cumulate unnoticed.[44] This contemporary approach to risk management has opened new pathways in an entirely different direction.

But not all organisations are prepared to embrace conceptions like 'mindfulness' yet. Therefore, HRO still requires translation by experts to enhance understanding by an operational population. However, the concept has the potential to guide organisations beyond the obstructive level of 'risk management by compliance.'

2.1.2.6 Resilience engineering

As another development, we include resilience engineering. In its development, Hollnagel, Woods and Leveson especially played key roles. The first formal sign of the birth of this concept was the Resilience Symposium in Söderköping (Sweden) in 2004. Dekker explains resilience as "the ability to accommodate change, conflict, disturbance, without breaking down, without catastrophic failure."[45] So, resilience does not focus on reducing incidents or human misbehaviours; it is about stimulating the abilities of people to cope with the challenges of the ever-changing processes they are expected to control. This concept sheds an entirely different light over safety science. In resilience engineering, systems are not protected against 'unreliable' people, who may err unexpectedly on critical moments and 'thus' need more individual discipline.

On the contrary, resilience theory assumes that systems and processes are seldom inherently safe and that only human beings, by their adaptive capacities of observation, interpretation and understanding, are the ones who can take right remedial actions before seemingly minor deviations of planned processes escalate into safety incidents.[46] In resilience engineering, safety is not a system property. Operational disturbances are identical to unexpected operational successes; both are considered surprises. Whether these deviations to the 'normal' are of a positive or a negative nature is considered 'performance variability.' As Hollnagel, Woods and Leveson write: "While we like to think of successes as the result of skills and competence rather than of luck, this view is just as partial as the view of failures as due to incompetence or error."[47] This view on risk man-

43 Ibid.
44 Westrum (1988).
45 Dekker, Hollnagel, Woods and Cook (2008), p. 2.
46 Ibid.
47 Hollnagel, Woods and Leveson (2006), p. xi.

agement may be considered an innovative perspective. The discussions about this concept still take place primarily on an academic level. In organisations, resilience is hardly implemented; only forerunners experiment with it.

But others watch the developments with interest. We expect that once the concept has been operationalised more widely, implemented in the real world and has proven added value in terms of reduction of safety incidents, it will overthrow many of the theories and other 'truths' as described earlier in this chapter. Therefore, we refer to resilience engineering as potential future success.

2.1.2.7 Safety I versus Safety II

The last concept presented here is closely related to resilience engineering and is titled 'Safety I versus Safety II.' This concept by Hollnagel was first published in 2004. In short, the difference between Safety I and Safety II is that in Safety I mode, the focus is on 'things that go wrong' and that in Safety II mode the focus is on 'things that go right.' This is also clearly explained by Dekker. [48] This approach arose from the fact that the far majority of operational activities are successful. Only a very few activities result in safety incidents. But it is also known that people play a key role in the success of those operations and often that is because they have the required skills, knowledge and adaptive capacity to act in unanticipated situations, not foreseen in work instructions, procedures, or protocols. Then, professionals, who know how to prevent escalation, by non-prescribed, maybe even forbidden, creative interventions, may solve the problem and ensure undisrupted continuation of the operational process. This happens often in operational practice and is, in many cases, considered common practice. In actuality, this reality is created by the gap between leaders who are disconnected from work floor level and the operators who experience operational hiccups as part of their daily reality. Dekker refers to this phenomenon as "Work as Intended versus Work as Done", also known as WAIWAD.[49]

With respect to organisational learning, the common practice of 'unexpected' interventions preventing process disruptions embodies a wealth of information about where system design and formal operational procedures fail. Because of the ratio between these interventions and actual safety incidents, there is much more to learn by questioning why things go right than by investigating why things go wrong. The Safety II concept supports this view and aims primarily at improving operational reliability (read: reducing safety risks) by questioning why things go right. But this does not imply that investigations into the causes of safety incidents should be abandoned, but finding the reasons behind 'unexpected' interventions is considered a much richer and relatively easy-to-access source of information. In order to enhance an organisation's Risk Reduction Capacity, leaders might consider enhancing the use of this source of information to the optimum level.

48 Dekker (2006b).
49 Ibid.

2.1.3 *Personal safety versus process safety*

Historically, much attention is paid to personal safety, which, as maximum consequence, may lead to relative perishable injury or minor material damage; the related incidents are generally referred to as 'slips, trips and falls.'[50] These personal safety risks are easy to imagine and have a relatively simple deterministic cause and effect logic. The risks related to this type of incidents are relatively easily to be assessed and managed locally by general employees who know the risk-generating processes by heart and understand how to deal with these. And sometimes they are just not lucky enough.[51] Where general employees lack the awareness, knowledge, or skills to responsibly deal with these individual safety risks, they may be supported by safety professionals who have specialist know-how about these risks and the expertise to know how to control or manage these individual safety risks. Managing these types of risks is relatively simple.

Many safety-climate studies concern 'occupational safety' as the subject of the research undertaken. With respect to this topic, Cheyne et al.[52] offer some detailed examples of what they refer to as 'common hazards'; forklift vehicle movements, using compressed gases, slipping and tripping, working with hazardous substances, electrical hazards, etc. But people are less focused on occasionally appearing process disturbances, called major incidents, potentially affecting the fundamental values of the organisation.[53] The personal safety incidents, as mentioned above, are created by a different type of risk than major incidents are. Major incidents are related to the relative major hazards, which are generated by the primary processes of organisations. In this respect Reason mentions that the latter are "comparatively rare, but often catastrophic."[54] These major incidents are "less 'normal'; even exceptional and, in the minds of people not expected to 'really happen'."[55] This is one reason why these mishaps are not on employees' day-to-day awareness agendas.[56, 57]

The difference between low or high impact incidents is not determined by the complexity of the processes involved, but by the potential energy available to cause serious harm in combination with the vulnerability of the object threatened.[58, 59] Major incidents are the consequences of high potentially strong disturbances of primary processes, and are seldom unilaterally created at the work floor level. Also, the making of a major incident is a process which does not follow predetermined pathways.[60] Often Heinrich's

50 Onderzoeksraad voor Veiligheid (2007).
51 Groeneweg (1992).
52 Cheyne, Cox, Oliver and Tomás (1998), p. 259.
53 Onderzoeksraad voor Veiligheid (2007).
54 Reason (1997).
55 Perrow (1999).
56 Bratspies (2011).
57 Wagenaar and Groeneweg (1987).
58 De Vries, Verhoeven and Boeckhout (2014).
59 Fischhoff and Lichtenstein (1984).
60 Rosenthal (2001).

deterministic domino theory does not apply here.[61] Major incidents find their origin in underlying processes, like the design of technical processes, installations, machinery, equipment and the like, design of business models, contracts between providers and clients, consequential production pressure and focus on client or hospital patient expectations.[62, 63, 64, 65] These underlying processes imply a continuous trade-off that challenges the safe operational envelope of the primary process. Here, the way leaders behave is of great importance; where do they place their priorities and 'how strong is their backbone'?

In this respect, Hollnagel presents his 'Efficiency-Thoroughness Trade-Off'-principle (ETTO), addressing the continuous conflict between producing in the most efficient way and managing safety risks to the optimum.[66] Dekker argues that our society has got ahead of our understanding how systems work and fail.[67] Perrow even advocates that such complicated technologies "should be abandoned", but he concludes that this is an unrealistic proposal, simply "because we have built much of our society around them."[68] Nevertheless, society has accepted the risk of advanced complex processes with the potential of e.g., hospital patients who die due to caregivers who do not comply with the hand hygiene protocol in order to save time;[69] trains that collide because trains are scheduled too tight to be able to transport more passengers per hour;[70] or offshore oil platforms that explode because the leaders decide not to apply readily available safety measures in order to compensate for time lost on earlier days.[71]

2.2 Risk management

2.2.1 *Defining risk*

Like the multiple views on the definition on safety, there are different views on the definition of the term risk. In 1662, Arnaud formulated the essence of risk as: "Fear for damage must be proportionate not only to the severity of the damage, but also to the probability that the damaging event occurs."[72] Ale refers to a definition, used by many: "Risk is a combination of consequences and probabilities".[73] Willett defined risk as "The objectified uncertainty regarding the occurrence of an undesired event".[74] The shortest definition

61 Heinrich (1941).
62 Onderzoeksraad voor Veiligheid (2007).
63 Dahle, Dybvig, Ersdal, Guldbrandsen, Hanson, Tharaldsen and Wiig (2012).
64 Dekker (2011).
65 Reason (1997).
66 Hollnagel (2009).
67 Dekker (2011).
68 Perrow (1999).
69 Pittet, Hugonnet, Harbarth, Mourouga, Sauvan, Touveneau and Perneger (2000).
70 Onderzoeksraad voor Veiligheid (2013c).
71 Flournoy (2011).
72 Ale B.J.M. (2012).
73 Ale (2009).
74 Willett (1901).

is by Knight: "Measurable uncertainty".[75]Yoe describes 'risk' as "a measure of the probability and consequence of uncertain future events"[76] and he describes the equation of Risk=Probability x Consequence as a mental model to help people think about the elements that are required to create a risk.

Safety professionals, in general, apply the term 'risk' in different ways, but overall, they follow one generic logic: risk is the probability of the occurrence of an event, combined with the potential severity of the consequential damage.[77, 78, 79, 80, 81]

The international standard for risk management (ISO 31000) defines 'risk' as the 'effect of uncertainty of objectives'.[82] This definition is complemented by notes, stating that:

1. An effect is a deviation from the expected. It can be positive, negative or both and can address, create or result in opportunities and threats;
2. Objectives can have different aspects and categories and can be applied at different levels;
3. Risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood.

Beck argues that risks are 'latent side effects of production'.[83] This scholar views risk from a social perspective and concludes that "…the social effect of risk definitions is [therefore] not dependent on their scientific validity".[84]

Holzheu and Wiedemann who argue:

> Risk is all in the mind. That is to say, risk is (also) a notion of observation and not just an object to be observed. As a notion of observation, it is a kind of lens trough which we see the world. What we see as a risk is not absolute reality, but instead depends on the kind of lens and the way we look through it. Different disciplines use different kinds of lens and so they may see different things even when looking at the same object.[85]

A frequently used method to broaden people's perspectives on risk, is to present quantitative risk estimates of a certain risk under public discussion (e.g., the construction of a new rail road, using robots in the hospital's operating theatre, expanding an industrial area) and compare this quantitatively with other risks that are known to be generally accepted by the public.

75 Knight (1921).
76 Yoe (2012).
77 Cauwenberghs (2013).
78 Fischhoff and Lichtenstein (1984).
79 Ale B.J.M. (2012), p. 28.
80 Oostendorp, Zwaard and van Gulijk (2013).
81 Soree (2007).
82 International Standards Organisation (2018).
83 Beck (1986), p. 19.
84 Ibid. , p. 32.
85 Holzheu and Wiedemann (1993), p. 9.

About this method Slovic argues: "Even though such comparisons have no logically necessary implications for acceptability of risk, one might still hope that they would help improve people's intuitions about the magnitude of risks."[86]

About judging the potential effects of risk, Lauder proclaims: "Within normal chaos we should always think of such judgements as being an educated guess (where some are more educated than others) rather than being a scientific judgement."[87] And in his contribution to the discussion, Hollander argues that risk is not a universal quantity – it is a social construct, a formula, compiled and adjusted over time, which enable us to cope with the day-to-day threats and uncertainties.[88]

According to Fischhoff et al. risk calculations are conditional and context dependent, because decision makers use different rules, believe different information, or consider different options. From that perceptive, we argue that the quantification of risks, as referred to by some of the scholars above, is not a reliable operation. These authors also conclude that it is not possible to define a universally acceptable risk level.[89]

Based on these different statements we conclude that there is no universal agreement among scholars regarding the definition of risk. We will therefore not claim an unambiguous definition of 'risk'. Instead, in this dissertation, with the abovementioned statements and the scope of this research project in mind, and only as a landmark-term to facilitate communication in this dissertation, risks are understood as: *Unintended and uncertain side effects of primary processes with the potential to generate unsolicited consequences*.

2.2.2 *Risk management theories*

A structured process for managing risks according to the international standard for risk management (ISO 31000), the process of risk assessment and its implementation with respect to the scope of this study, form the structured globally accepted standard. This process contains the phases identification, analysis and evaluation of risks and is of paramount importance for optimising the functionality of controls and defences. These five phases are embedded in a cyclic structure, which is considered a useful model to establish the effectiveness of risk management. As technical progress, operational experience and changes in time are of influence on the character of initially identified risks, a cyclic approach is broadly accepted to be more applicable rather than a linear one-off exercise.

In order to illustrate why ISO-structured risk management systems were introduced in organisations using safety-critical primary processes, we give an explanation of what went wrong during one of the most serious major incidents during the 20th century and how that resulted in the initiation of a structured safety management approach.

86 Slovic (1987), p. 285.
87 Lauder (2015), p. 138.
88 De Hollander G. (2012), p. 58.
89 Fischhoff, Lichtenstein, Derby, Slovic and Keeney (1983).

On July 6th of the year 1988, a major incident occurred on the oil production platform Piper Alpha, which was situated in the Southern North Sea offshore Scotland. This event, resulting in 167 casualties, has been the worst disaster in the oil and gas industry. The case was investigated by an investigation committee chaired by the Honourable Lord Cullen. That committee published their report in October 1990. This report contains 106 recommendations including the recommendation that "The operator (read: oil company) should be required by a regulation to submit to the regulatory body a safety case in respect of each of its installations …" (Recommendation #1). In the report it is further explained what is expected of the contents of such a safety case; the document "… should be a demonstration that the hazards of the installation have been identified and assessed and under control and that the exposure of personnel to these hazards has been minimized …" (ref.17.37) Reference is also made to the role of management and management systems, in a way not described before in the UK oil and gas industry: "… safety is crucially dependent on management and management systems …" (ref. 17.36)[90]

The Piper Alpha major incident changed the world where it concerns the structured management of safety risks. The 'Cullen Report' may be considered the trigger for development of this structured and auditable approach in risk management. The meticulous description of what is expected of operating companies, as the main responsible parties in the industry, regarding their efforts in risk management, served as a basis for a global change in how safety management systems (read: risk management) should be structured. The Cullen recommendation for a more structured and system approach to manage safety risks initiated an innovative view for how to deal with organisational risk in the entire major hazard industry (thus also in the sectors included in this study) worldwide. During the years since the Piper Alpha disaster, the safety risk managing discipline has matured and a wealth of system models and sector-specific and generic risk management standards have been developed. Since then, various parties have worked towards the development of the 'ideal' structure of systems aimed at managing risks.

Structurally managing risks means following the steps of an iterative 'risk management cycle', which contains the elements of: risk identification, risk assessment, decision-taking, risk-reducing action, effect monitoring. This cyclic structure, in its simplest form, is represented graphically by a risk management cycle by Ale, presented below (Figure 3).[91]

90 Cullen (1990).
91 Ale B.J.M. (2012).

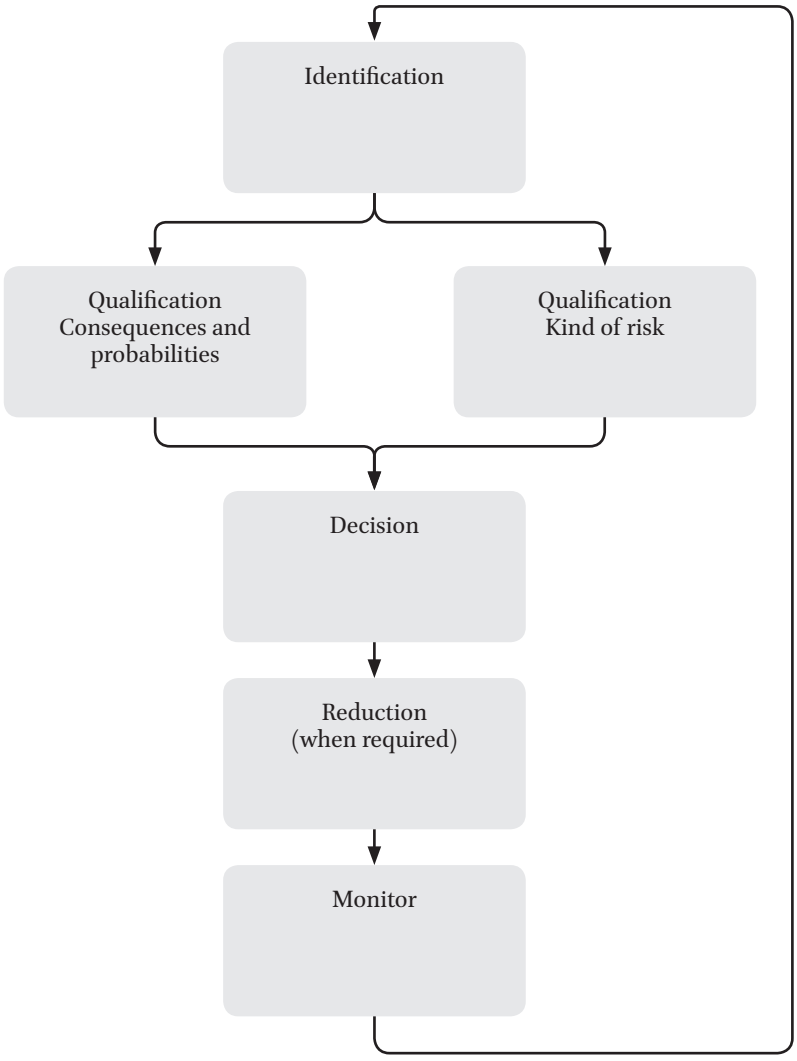


FIGURE 3 Risk management cycle (Ale, 2012)

This figure indeed contains all the principal elements of the risk management process and therefore it clearly shows the principles of cyclic risk management. However, for practical implementation, more detail is required. Following the principles of ISO 31000 risk management should be "systematic, structured and timely."[92] This structure also is found in the Australian and New Zealand Standard, AS/NZS 4360 as well in the Austrian version. Both standards were part of the source documents which evolved into the ISO

92 Purdy (2010), p. 883.

31000 standard.[93, 94, 95] So, according to these standards a structured process is necessary to conduct a risk management process. We find this in the outlines of the management models as issued by the International Organization for Standardization (ISO), and thus selected this international standard as the standard structure for our risk management framework.

2.2.3 *International principles and guidelines (ISO 31000)*

Regarding the development and standardisation of management systems, the ISO is considered the globally accepted authority. Many organisations have adopted the principal structures of ISO standards in the development of their individual risk management systems. Analogous to the conventional quality and environmental management systems design (ISO 9000 and ISO 14000), the structure of the international standard for risk management (ISO 31000) is based on an iterative/cyclic structure (Figure 4).[96]

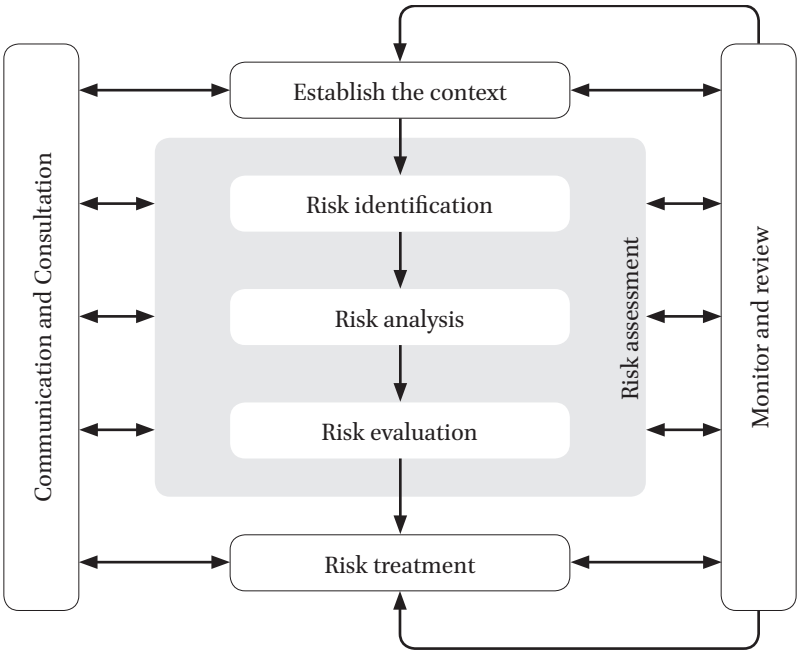


FIGURE 4 Risk management process (ISO 31000: 2009)

93 Standards Association of Australia (1999).
94 Austrian Standards Institute (2004).
95 Purdy (2010).
96 International Standards Organisation (2018).

In this figure, most of the basic elements as presented by Ale are included, but the process is extended by: 1. Establishing the context and 2. Communication and consultation.

'Establishing the context' represents what the organisation wants to achieve where it concerns the management of safety risks. Also, it determines the external and internal factors that may influence success in achieving those objectives.[97] In this step, an organisation declares what risk level is accepted and what measures have to be taken if the minimum acceptance level is not achieved. The step of 'communication and consultation' refers to ensuring involvement of internal and external stakeholders to understand their objectives and take their points of view and critical input into account when defining risk criteria.[98] Here the decision makers in organisations are forced to involve all stakeholders, including (or maybe even especially) general employees on work floor level, who are often exposed to the safety risks as generated by the primary processes. This way of working is considered an adequate procedure for achieving the ultimate result of effective risk management: current, correct and comprehensive understanding of its risks and that these are within its risk criteria.[99] From a legal point of view, implementation of the ISO 31000 guidelines is also supportive where it concerns compliance with the mandatory EU OSH Framework Directive 89/391, which directs organisations how to assess occupational risks.[100]

2.2.3.1 Risk assessment

For the argument of supporting risk management decisions, the need for assessing the safety risks generated by primary processes is strong. Apparently, potential sources of hazard may be latently embedded in operational systems, without anybody being aware and seemingly safe operations may contain latent failures (dormant hazards) for years, without developing into an accident.[101] The ISO 31000 guidelines on risk assessment aims to increase awareness of, and knowledge about hidden hazards. The core of the ISO 31000 model is formed by a group of three different, sequential activities: risk identification, risk analysis and risk evaluation. Despite the different nature of these activities, they are combined into one, highlighted, central block in order to emphasise their complementary function. These activities relate to each other as in a flow diagram; initially a risk is identified, then it is analysed and then evaluated. So, analysis and evaluation are sub-activities of identification and concern the same risk.

97 Purdy (2010).
98 Ibid.
99 Ibid.
100 EU OSH Framework Directive 89/391/EEC (1989).
101 Reason (1990).

FIGURE 5 Risk assessment core of ISO 31000

This process deserves special attention as it represents the core activities required to make risks understood in the organisation. The responsibility to take risk-assessment decisions is typically a leader's task. But its purpose is to ensure that all relevant stakeholders are aware of and understand the potential impact of the identified safety risks and the envisaged control measures. Here leaders on all levels in an organisation must take their role-related responsibilities.

2.2.3.1.1 *Risk identification*

The initial activity of risk identification requires the application of a systematic process to understand what could happen, how, when and why.[102] The design of that process may be different with respect to the specific business sector and/or the type of risks to be identified (e.g., process safety vs. occupational safety). Most organisations identify risks on the basis of standard methods, for which application may be mandated by supervising authorities and/or certifying bodies. As examples, in organisations affiliated to the chemical process industry, internationally accepted methods, e.g., HAZID, HAZAN, HAZOPS, FMEA and relative ranking methods like the Kinney and Wiruth method for occupational safety (RI&E) are used. In the hospital sector, where entirely different risk situations apply, sector-specific translations of some of these risk-assessment procedures are developed, e.g., a modified version of FMEA, named HFMEA (*Health* Failure Mode and Effect Analysis) and a method named Prospective Risk Identification (PRI), based on RI&E is implemented.[103, 104] The identification phase may be considered the heart of risk assessment; risks which are not identified will not be analysed, nor evaluated, nor

102 Purdy (2010).
103 Pasman (2015).
104 Blok, Koster, Schilp and Wagner (2013).

reduced and consequently, remain uncontrolled as latent hazards; a major incident waiting for a trigger to happen. In organisations, safety-critical operating processes which contain the potential for major incidents to occur and in which much effort is put into risk identification, people are confident that 'the majority of serious risks' are known and controlled. But Motet et al. claim that this trust is unjustified and even is an illusion.[105] This claim is supported by the work of Taleb, who explains that safety-critical processes may generate unexpected events in which, during risk-identification sessions, the originating risks were not been disclosed; so-called 'black swans.' Regarding this subject he states that after unpredicted serious incidents, their origins are easily explained as these very unpredictable black swans.[106] The risk identification analyses performed in major hazard industries are not able to eliminate these black swans. A study by Suokas et al.[107] revealed six key problems that may affect the completeness and the quality of risk analyses; 1) a limited selection regarding which part of the primary process system and what kind of risks are to be included in a risk analysis, 2) limitations due to the selection of the process phase (normal or deviated operations) to be considered, 3) the selection of analysis method(s) to be used, 4) limited available resources (calendar time, workforce, finance), 5) limited available information and knowledge, and 6) discrepancies between written documentation and reality.

Lindhout et al. argue that "a significant gap exists between accident scenarios as foreseen by company safety management systems and actual scenarios observed in major accidents. The mere fact that this gap exists is pointing at flawed risk assessments…"[108] They further state:

> Safety managers and regulators, attempting to reduce and eventually close this gap, not only encounter the pitfalls of poor safety studies, but also the acceptance of 'unknown risk' as a phenomenon, companies being numbed by inadequate process safety indicators, unsettled debates between paradigms on improving process safety and inflexible recording systems in a dynamic industrial environment.[109]

They argue for a generally applicable scale indicating 'unknown-ness', analogous to the classification of safety incidents. They conclude that "… safety management can never be ready with hazard identification and risk assessment."[110] and they question "… whether any risk assessment will ever be complete."[111]

Lindhout et al. present a 'Knowledge/Awareness matrix' by Gowland regarding the

105 Motet and Bieder (2017)
106 Taleb (2010).
107 Suokas and Rouhiainen (1989).
108 Lindhout, Kingston-Howlett, Hansen and Reniers (2020), p. 1.
109 Ibid., p. 1.
110 Ibid., p. 1.
111 Ibid., p. 9.

proposed scale, classifying safety risks.[112, 113] Gowland classifies (un)known-ness by integrating knowledge of the risk and awareness by relevant people. This matrix is considered a relevant element in our research. We show this matrix below.

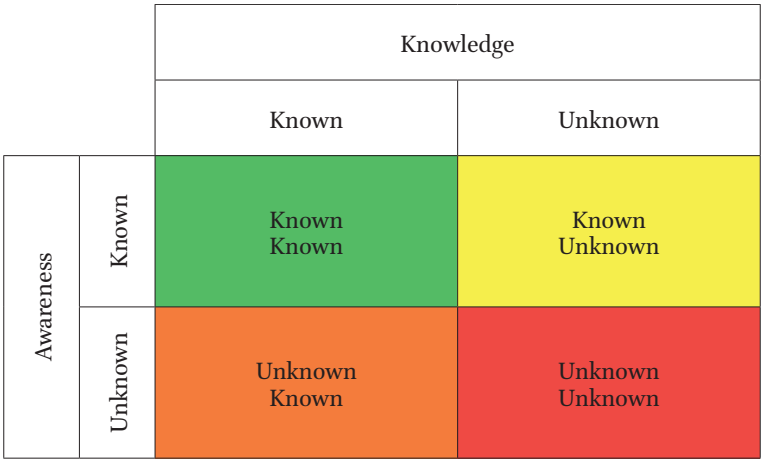


FIGURE 6 Knowledge/Awareness matrix (Gowland, 2011)

As Lindhout explains: "In the resulting square the unknown may be at the awareness side, then requiring constant attention and keeping a sense of vulnerability. It may also be at the knowledge side, then requiring study. When both sides of a scenario are unknown, everything is needed, together with creativity and a pro-active approach around the question "what else?". Clearly this is not a vote for accepting unknown risk as a fact of life, nor for accepting it as a phenomenon which we would not be able to do anything about."[114]

In the most positive sense, risk analysts may know what can go wrong, but apparently the people charged with managing (or exposed to) the risks are not always aware.

Taleb argues that the human mind is subject to numerous blind spots, illusions and biases and that forecasting of the (non-)occurrence of major incidents is pseudoscience.[115] According to Taleb, history is opaque or non-transparent; the occurrence of events is observed, but we are unable to see the script creating these events. In this respect he describes the following 'Triplet of opacity': a. Illusion of knowledge about how things may happen, b. Retrospective bias by hindsight knowledge and c. Overvaluation of factual information, delivered by experts and authorities, which may not be true at all.[116] Due to this triplet (and the comfortable feeling it creates), we take seriously what

112 Lindhout (2019).
113 Gowland (2011).
114 Lindhout (2019), p. 848.
115 Taleb (2010).
116 Ibid., p. 20.

has happened and we ignore what could happen. As Taleb argues: "… we are wrongly concerned about past black swans and not about those that can happen, but which have not yet taken place."[117]

In organisations operating safety-critical processes, it is common practice to conduct a risk-identification process by brain picking in order to gather ideas about the possible causes of potential events. To this effect, groups of people (often experts, as well as experienced general employees) assemble in brainstorm sessions and launch suggestions about potential risk factors. But here 'illusion of knowledge' may act as a source for erroneous expectations; the retrospective bias depends on the individual history of the members of the group and people considered experts in their field or trade may overwhelm other people, who may have better ideas, but remain silent. With reference to this standard type of brainstorm, Kahneman[118] also suggests that this process may not lead to optimal results, as the more assertive people always will take the lead, after which other, less assertive group members adapt to the ideas as brought forward by the more assertive people.

Investigating causes of 190 incidents involving unwanted chemical reactions, Rasmussen[119] found that in 34% of the incidents insufficient knowledge contributed to the occurrence of the accident. With respect to his view on the completeness of risk identification, Perrow argues that: "… we shall see time and time again that the operator is confronted by unexpected and usually mysterious interactions among failures, saying that he or she should have zigged instead of zagged is possible only after the fact. Before the accident no one could know what was going on and what should have been done."[120] Referring to the major incident that occurred at Bhopal in 1985, Perrow[121] holds that:

> … our predictions about the possibilities of accidents and our explanations of them after they occur are profoundly compromised by our act of 'social construction.' We do not know what to look for in the first place and we jump to the most convenient explanation (culture, or bad conditions) in the second place. …

This is confirmed by Kahneman, who refers to our limited ability to imagine possible occurrences (e.g., events and their associated risks), which is restricted to what is present in our memory. This phenomenon is called 'availability heuristics' and in relation to this Kahneman claims that: "Information which cannot be retrieved (not even unknowingly) from someone's memory, might as well not exist."[122] Also, the more impact a certain event has had on us, the easier it is to retrieve this from our memories.[123] So, possible

117 Ibid., p. 148.
118 Kahneman (2012).
119 Rasmussen (1988).
120 Perrow (1999), p. 9.
121 Ibid., p. 359.
122 Kahneman (2012), p. 93.
123 Ibid.

risks that do not come to mind during risk-investigation sessions are not identified, analysed and evaluated. Or, as Kahneman suggests: "Taking into account information that does not come to mind, perhaps because we have never known it, is impossible."[124]

The limited level of control as reported by these authors, however, is a symptom of the mental imperfectness of humankind; many of us try hard, but apparently eliminating all risks is an impossible dream. In his graphical presentation of developments in the way we have attempted to prevent incidents, Groeneweg [125] introduced the so-called Murphy Margin (ref. 2.1.2.3), the area where people have no (more) control over the occurrence of incidents; if something *can* go wrong, it *will.*

After the statements and explanations by these referred scholars, we conclude that it is an illusion to think that we are able to ensure the safety of safety-critical operations to a level where all major incidents are prevented. But this knowledge about what we do not know, may not be a reason to limit our efforts in analysing the risks we *do* know.

2.2.3.1.2 *Risk analysis*[126]

The purpose of risk analysis is to obtain an understanding of the identified risk, including its envisaged consequences and the likelihood that these consequences will materialise. It is the leader's role to reach consensus between all parties, from top management to work force, about the acceptability of safety risks. Often governmental authorities have an approving role where it concerns the outcome of the internal risk considerations. The business continuity may be subject to a licence to operate, issued by these authorities. Thus, the leader who initiated the risk analysis process to be conducted is not only responsible for the health and safety of the people involved, they also have a responsibility with respect to the operational well-being of the organisation as well. For that reason, we elaborate on the subject of risk analysis here.

Leaders face serious uncertainties with respect to preparedness for unexpected operational disturbances (ref. 2.2.1). How can leaders define acceptability of risks and set priorities for risk management activities if the information they have about the potential magnitude of the consequences of a potential rare event is, at best, not more than a 'good guess'? On the same subject, Groeneweg argues that "the acceptability of risks is influenced as much, if not more, by subjective perception as by objective reality."[127] Groeneweg is supported here by the Scientific Council for Government Policy, which states: "Moreover, opportunities, risks and uncertainties can be valued differently by different social actors, partly because the nature of the perceived damage and the source(s) of

124 Ibid., p. 277.

125 Groeneweg (1992), pp. 3–9.

126 The ISO 31000 term 'risk analysis' relates to an activity which often is referred to as 'risk assessment'; for reasons of consistency within this thesis, we concur with the ISO 31000 terminology: we use 'risk analysis'.

127 Groeneweg (1992), p. 18.

threat can differ and because what are considered opportunities and threats need not be the same for every actor."[128]

How then do leaders motivate their subordinates when the organisation has operated flawlessly for a long time? According to Beck, the unreliability of assessing the acceptable level of risk is a logical result of the fact that risks are 'projected dangers in the future', implying that the centre of risk consciousness lies not in the present, but in an undefined future. He argues that "Risks can be legitimated by the fact that one neither saw nor wanted their consequences. Risk positions first have to break through the protective shield of taboos surrounding them and 'be born scientifically' in scientised civilisation."[129]

So, we conclude that the potential consequences of a safety risk can only be realistically established in retrospect, i.e., after the event and its actual consequences have materialised. This means that before an event has taken place, a decision about acceptability should always be considered 'a declaration of hope' based on subjective personal judgement, instead of a scientifically founded given. In that reality, leaders have to be able to align with their followers about the acceptability of safety risks and one approach is to follow internationally accepted risk analysis practices.

About this activity, ISO 31000 gives clear guidance how this understanding may be derived:

> Risk analysis can be undertaken with varying degrees of detail depending on the risk, the purpose of the analysis and the information, data and resources available. Analysis can be quantitative, semi-quantitative or qualitative, or a combination of these, depending on the circumstances. In practice, qualitative analysis is often used first to obtain a general indication of the level of risk and to reveal the major risks. When possible and appropriate, one should undertake more specific and quantitative analysis of the risks as a following step.[130]

This raises the question about the differences between these analysis methods and what may be expected of these three different types of analyses. In the following sections we will elaborate on that.

Quantitative Risk Assessment (QRA)

A quantitative approach presents risk levels in terms of mathematical units, which can be compared with other existing numbers in similar risk assessments and draw conclusions about acceptability of the calculated risk on the basis of a numeric outcome. The outcome of such calculation represents the probability of a certain major incidents occurring. This is a highly scientific exercise, which can be performed only by experts in situations where sufficient and adequate numerical reference and acceptance criteria

128 Wetenschappelijke Raad voor het Regeringsbeleid (2008), p. 2–3.
129 Beck (1986), p. 34.
130 International Standards Organisation (2018), Para. 6.4.3.

and/or history data are available. But in many situations this availability is not the case.[131] In this instance, the numbers cannot be related to relevant references and interpretation may not be representative within the specific context. This numerical approach, also referred to as QRA, is popular (and in many cases required by authorities) in high-risk technical settings and where assessment of environmental risks with respect to spatial planning is required; hence, technical experts are given a pole position in this process.[132] The QRA type of assessment work is often related to complex risk scenarios related to major safety (or environmental) incidents, which may affect people like local residents, who have no relationship to the source(s) of the risks other than that they happen to live in the area at risk. Here the difference in assessment of the risks between operational people who are potentially affected by the risks and the QRA experts, who are seldom part of that group, plays a role.

This coincides with a statement by Jungermann and Slovic, who argue that *probability assessment* is often influenced by the 'prominence' of an event and the extent of potential *damage assessment* is influenced by the 'context' in which an event may take place.[133] What may happen then is that the risk as assessed by these experts/scientists, may, based on their laboratory knowledge, contain questionable physical assumptions and even a naïve model of the part of society.[134] Here the word 'society' is to be understood as the people who are potentially exposed to the consequences of the risk at issue. This may be surrounding residents as well as employees/general employees of an industrial organisation or a group of patients in an hospital.

But, whatever the relationship between the risk-generating organisation and the potentially threatened part of society is, a scientific assessment of safety risks does not suffice to obtain a representative picture of the acceptability of those risks. For the sake of building trust and credibility, the initiators of the risk-assessment activities should always take a reflexive approach and involve the potentially threatened group in these activities from the design phase of the risk-assessment process.[135]

The lack of scientific rigidity in QRA is also referred to by Goerlandt et al., who conducted a study into theoretical views on validity and the validation of QRA. The purpose of their review was to discuss the claims made about QRA in relation to the available scientific evidence. Among other things, they concluded that: "Rejecting the claim that accurate risk estimation is possible, the cost-effective usefulness claim seems plausible, but very little evidence for this claim has been found."[136]

Last but not least: lay people may add unexpected value to the risk-assessment process as they come from different backgrounds, with different know-how/experience and they may see different aspects as they approach risks from a different perspective.

131 Van Asselt (2000).
132 Beck (1986).
133 Jungermann and Slovic (1993).
134 Beck (1986).
135 Ibid.
136 Goerlandt, Khakzad and Reniers (2017), p. 138.

Risk Analysis Matrix

In the previous section we discussed a purely mathematical assessment method, QRA, requiring scientific knowledge only available from specialised QRA experts. But in other risk situations where we feel potentially exposed to involuntary[137] safety risks, we also want to know our opportunities for exposure and then numerical references also communicate well. Apparently, people fancy numerical indicators. Numbers serve as satisfying references to indicate acceptability of risk levels. In this respect, the following mathematical formula is a very popular, globally used one: 'Risk=Probability x Effect.'[138] But how do you quantify these three conceptual qualitative units? There are different approaches to this, but a common practice, visualised by a so-called Risk Analysis Matrix, applies to all of these: in the matrix, a numerical value is assigned to the intersection field of each qualitative category of likelihood and severity.

During the risk-assessment process, individual or, preferably group opinions about the potential of risk are collected, using qualitative terms (i.e., improbable, remote, occasional, etc. indicating the probability component and catastrophic, significant, moderate, etc. indicating the effect component). After all opinions have been collected and discussed, the qualitative results are associated with the relevant intersection fields. Implicitly the outcomes are converted into the numbers attached to the fields where most opinions are clustered. At that moment the assessment process has flipped from qualitative to quantitative terms. Then people can see the results of their opinions in terms of the potential impact of risks in numerical terms. The acceptability grade for this procedure is high; in practice people involved in this assessment procedure consider the outcome of this process as representative of the hazardous potential of the risks assessed. Finally, based on these convictions, leaders set priorities and take risk management-related decisions. The risk analysis matrix is depicted in Figure 7 below.

137 People feel perfectly safe when taking safety risks on a *voluntary* basis; we drive during dark hours on snow-covered roads to the mountains, where, on the next day, we head at a high speed down steep ski slopes (and some even outside the controlled areas); we do sky diving; kite surfing; dive into the deepness of seas; and we ride motorbikes for fun. However, the risks referred to in this thesis are all meant to be induced by others and of an *involuntary* nature.

138 Yoe (2012).

Risk rating = likelyhood x severity

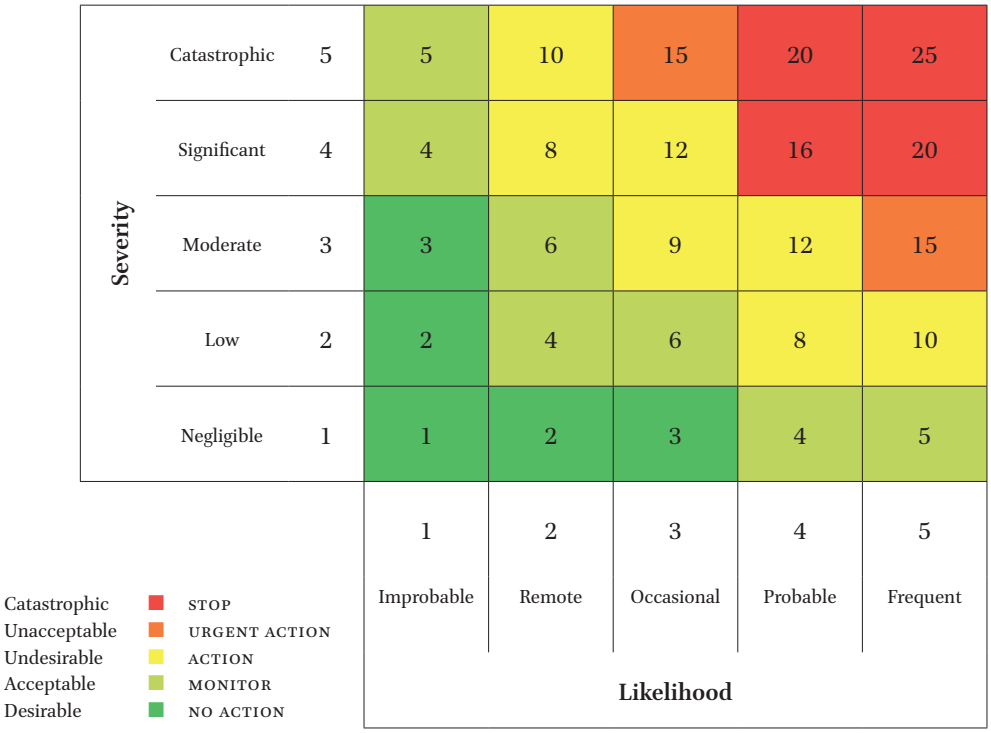


FIGURE 7 Risk Analysis Matrix (Numerical rating)

Based on this approach, different applications and models (e.g., Risk Analysis Matrix, Kinney and Wiruth) exist. Many organisations use this approach as a decision-making tool to determine reasonable surety about what problems can be expected and prepare themselves by setting priorities in taking risk management measures. However, different scholars reject the validity of the Probability X Effect 'formula', but the simplicity of this approach creates support, trust and credibility with lay people as well as organisational leaders, who require the outcome of this analysis to be a credible argument to support their priorities in risk decisions. In operational risk communication the formula is working well indeed, but scientifically, the method is a dangerous house of cards.[139, 140, 141]

139 Beck (1986).
140 Van Asselt (2000).
141 Cox (2008).

Layers of Protection Analysis (*LOPA*)

Another approach, which is often used in (chemical) process industries, is the concept of LOPA. The concept was taken from guidelines by the US Center for Chemical Process Safety (CCPS) on automation, issued in 1993. The initial known application of LOPA as analysis tool for the effectiveness of process risk protection was by Dowell, Huff and Montgomery in 1997 (the acronym was not yet used) and published in the CCPS guidelines in 2001.[142] The LOPA approach involves not assessing the level of risk, but measuring the effectiveness of barriers installed to prevent an uncontrolled release of energy, and/or to mitigate the consequences if prevention has not been successful. The concept of LOPA is connected to so-called barrier-based management (ref. 2.2.6.3). This means that it is to be applied after risk identification has been completed and decisions about the required types and effectiveness of barriers are to be taken, or have been taken.

A LOPA-analysis may address different independent layers of protection, from inherent process safety, to emergency response. These layers represent different process states, from basic process control in undisturbed operations, via alarms, shut-down systems, active damage mitigating (sprinkler, firefighting) systems, and passive damage mitigating systems (bund walls, zoning), to emergency response. LOPA focuses on the effectiveness and reliability of the different measures envisaged to prevent process upsets. They consider, for example, human factors, the rigidity of hardware, expected breakdown frequencies of equipment and automation, and (wireless) communication systems. LOPA is often applied in combination with a risk analysis method, called the Safety Integrity Level (SIL), which has been designed to identify the reliability and expected failure rates of process safety instrumentation components. The SIL concept encompasses a classification system with respect to the probability for failure, known as PFD (probability of failure on demand). The SIL classification of the components installed in a process installation is one of the aspects taken into account in a LOPA analysis.

The LOPA concept suffers from similar uncertainties as the previously discussed risk assessment concepts. In 2018, Van Dort, a Senior Inspector of Major Hazard Control at the Dutch Inspectorate of Social Affairs and Employment Ministry, conducted an analysis into the question of whether the LOPA method offers the ability to determine measures leading to the state of the art in technology, in a reliable and reproducible way. His conclusions, amongst others, were as follows: 1) The reliability and reproducibility of the LOPA methodology is insufficient, 2) The resolution of the LOPA parameters is insufficient, 3) The risk of one individual scenario does not reflect the real risk on the work floor.[143]

ALARP – ALARA Risk Analysis

By the ALARP and ALARA risk analysis methods the acceptability of risk is determined by defining the relationship between the level of risk and the impact of measures (in terms of money, time and trouble) required to reduce an 'unacceptable risk' to an acceptable

142 Pasman (2015).
143 Van Dort (2016).

risk level. This assessment method was initially developed by nuclear power related sectors and has been adopted by various other sectors and by different legislators.[144] This method recognises two options used to determine the acceptability of risk: a) as low as reasonably practicable (ALARP), where the potential energy in the system is expected NOT to be able to create severe disastrous consequences, and the practicability of reasonable risk-reducing measures is defined in relation to the required financial investment; here the financial limitation is the leading argument; and b) as low as reasonably achievable (ALARA), where the potential energy in the system is expected to have severe disastrous consequences and the effectiveness of risk reduction measures is considered important, regardless of the required financial investment; here the feasibility of reducing risks to an acceptable level is the leading factor.

The ALARP/ALARA concept introduces the idea of reasonableness, which opens the management door to the consideration of other factors like cost and social acceptability.[145] The ALARP level applies to e.g., processes like tank farms, railway operations, oil and gas operations, refineries, general hospitals, etc. The ALARA level applies to e.g., aerospace, general technology, nuclear power generation, etc. This concept is depicted in Figure 8 below.

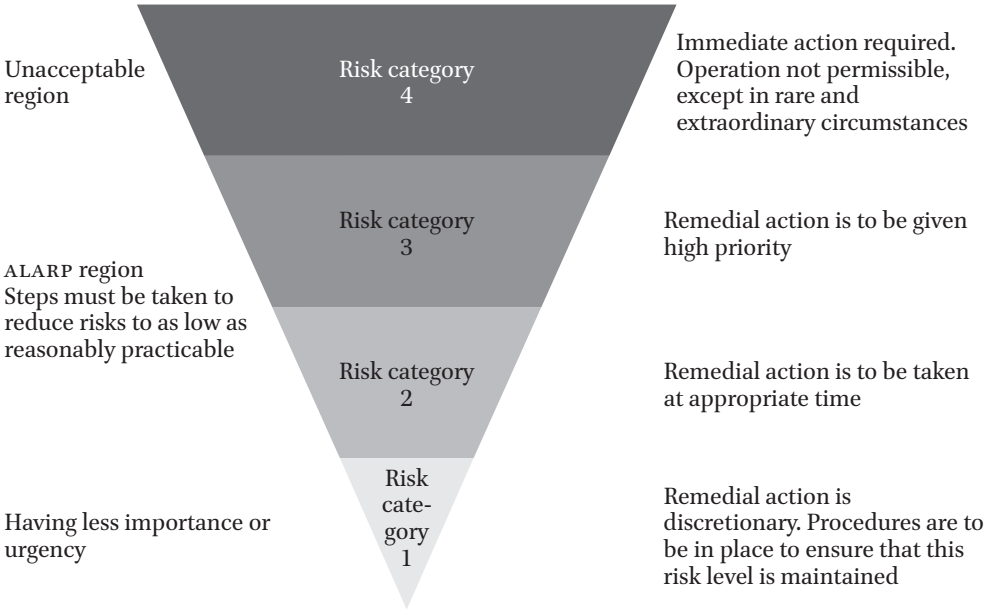


FIGURE 8 ALARP/ALARA Risk analysis method

In the ALARP/ALARA risk analysis concept, qualitative judgement prevails. There are no external formal criteria set; the leaders of the organisation concerned determine what a

144 This method has been proposed by Lord Cullen in the Investigation Report into the Piper Alpha disaster.
145 Yoe (2012).

reasonably acceptable situation is and what is not. Regarding possible criteria to consider in this risk analysis concept, Pasman refers to the Australian 'model Work Health and Safety Bill' in which the following aspects appear: 1. The likelihood of the hazard or the risk concerned occurring; 2. The potential degree of harm; 3. The skills/competences of personnel involved; 4. Availability and suitability of risk-reducing measures; 5. the proportionality of the required investment to manage the risk.[146]

Leaders may set acceptability standards for their specific operations and then initiate a risk analysis process, involving all stakeholders to identify the acceptance or rejection of conducting certain risk-reducing activities. But according to Slovic:

> … risk does not exist "out there", independent of our minds and cultures, waiting to be measured. Instead, human beings have invented the concept of risk to help them understand and cope with the dangers and uncertainties of life. Although these dangers are real, there is no such thing as "real risk", or an "objective risk."[147]

Operations involving intrinsic hazards are part of society as we have shaped it, however, and consciously or unconsciously, we have accepted the inherent risks in order to live life as we prefer it. As Perrow put it:

> … certain technologies should be abandoned and others, which we cannot abandon because we have built much of our society around them, should be modified.[148]

This touches on our individual needs and desires, which shape our expectations about the potential for a safety incident to be realised. These expectations depend strongly on individual imaginations regarding possible causes and effects, and the level of uncertainty we are ready to accept.

2.2.3.1.3 *Risk evaluation*

The international standard for risk management ISO 31000 reads:

> The purpose of risk evaluation is to assist in making decisions, based on the outcomes of risk analysis, about which risks need treatment to prioritise treatment implementation. Risk evaluation involves comparing the level of risk found during the analysis process with risk criteria established when the context was considered. If the level of risk does not meet risk criteria, the risk should be treated.[149]

After safety risks have been identified and analysed, organisations should decide how

146 Pasman (2015).
147 Slovic (2001), p. 19.
148 Perrow (1999), p. 4.
149 International Standards Organisation (2018), para. 6.4.4.

identified risks should be mitigated in order to meet a predetermined risk level. After remedial actions are completed, someone should measure whether the remedial actions have resulted in the desired result. The effects of remedial actions should therefore be compared with the initial risk criteria. This comparison offers an indication of the effectiveness of the risk management process. Conducting this comparison means the process feedback loop will be appropriately closed. Actually, this process can be considered a genuine management of change procedure. If the outcome of the feedback process reveals that remedial action has not resulted in a sufficient positive change, then more action is required to meet the intended risk level.

The Dutch Scientific Council for Government Policy (WRR) claims that the role of quantitative and semi-quantitative methods is limited; the council classifies these methods as a 'classical risk approach' and advocates a qualitative approach in which uncertainty plays a prominent role.[150] That alternative approach is described below.

2.2.4 *Vulnerability; an alternative view*

Knowledge is not equivalent to truth and certainty.[151]

We argued that a classical risk approach, as discussed in the previous sections, would impossibly lead to an assessor-independent, objective indication of the acceptability of risk. In that respect, the following approach, which does not identify risk as the multiplication of *probability* and *severity*, is of interest. It emphasises the *vulnerability* of the threatened object for certain threat(s).[152] Where threats can be defined, vulnerability can be taken as a point of engagement. Here the nucleus query is: "What defines the vulnerability of the primary process?" Attempts to answer this question do not focus on guesstimating the probability of occurrence of a predetermined event or quantifying the potential severity of such event. The emphasis is on the question "Where and how can things go wrong and what precaution and control measures are required and feasible to prevent this?" [153] In this approach, achieving an acceptable risk level is managed by focusing on the identification of control and protection measures based on imagined identified vulnerability for failure. Effectiveness (performance) is not measured by *output* indicators (e.g., incident frequencies), but by *input* indicators expressed in the degree of implementation of precaution measures.

Is this 'vulnerability approach' subordinate to the probability/severity approach? Not really, because the effectiveness of the probability/severity approach, measured by output indicators, depends on the reliability of the probability factor (taking for granted that the severity factor is reliably measurable by an objective rationale), and contains such a high degree of uncertainty and subjective reasoning that predicting a favourable outcome is considered to be no more than a bet.[154]

150 Wetenschappelijke Raad voor het Regeringsbeleid (2008).
151 Van Asselt (2000), p. 81.
152 De Vries, Verhoeven and Boeckhout (2014).
153 Ibid.
154 Ibid.

Van Asselt also recognises that risk perceptions differ among the various stakeholders e.g., scientists, safety experts, managers, operational workers, lay people and even the public potentially being exposed. Moreover, she identifies the problem that uncertainty violates the exactness of risk estimates and that the uncertainty *itself* is part of the determination of the level of risk. Therefore, she suggests that uncertainty and risk are interrelated on three levels: a) the uncertainty reality of what event may occur, b) the uncertainty analysis of assessing uncertain risks and c) the variability in evaluations of the uncertain risk analysis.[155] Following these suggestions, the model explaining the sources of uncertainty as developed by van Asselt is of relevance.[156]

This model shows two distinct, sequential types of uncertainty: uncertainty due to variability and uncertainty due to limited knowledge. Each level of uncertainty is 'fed' by different resources of uncertainty. This collection of resources ultimately results in two resources which feed the final limited knowledge; unreliability and structural uncertainty (Figure 9).

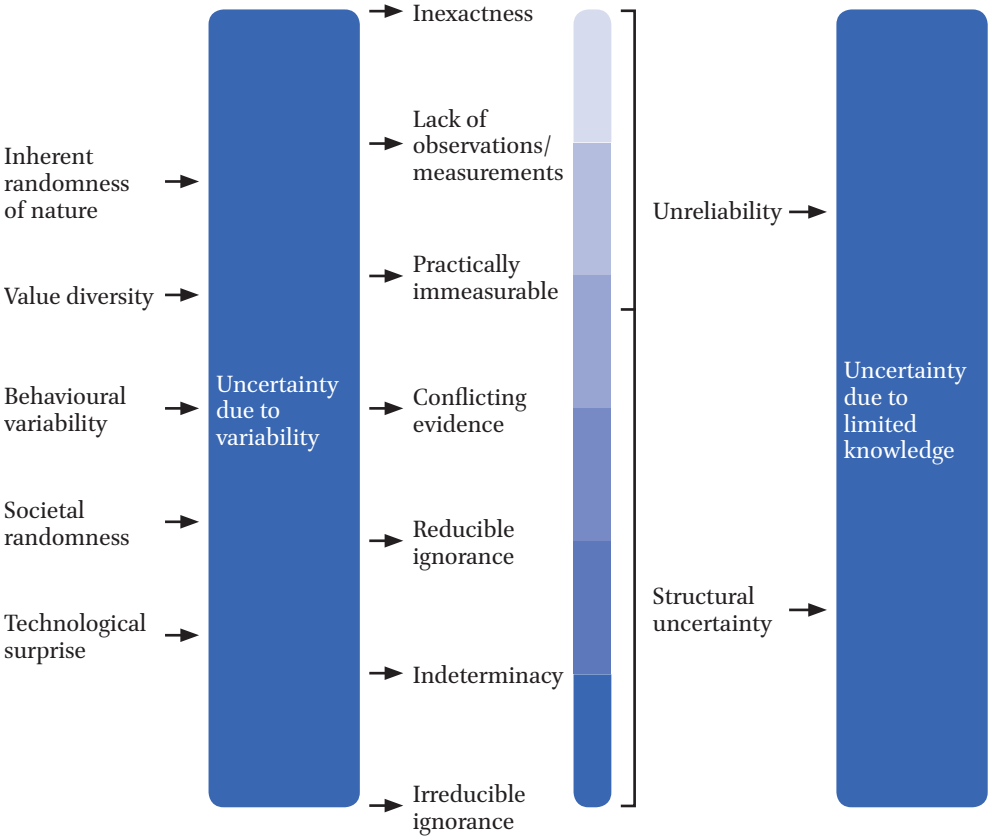


FIGURE 9 Sources of uncertainty (Van Asselt, 2000)

155 Van Asselt (2000).
156 Ibid.

This model is not yet a common approach in the sectors this study is about, but we argue that it could serve as an assistance to leaders in structuring their risk-assessment procedures.

Primary processes and their contexts, as well as the people involved (leaders and followers), are not static entities and may follow unpredictable paths. Uncertainty due to variability and limited knowledge are the biggest threats to the reliability of risk assessments.

Are we able then to quantify risks by using the 'vulnerability approach'? Not really, but why should we put effort into the presentation of subjective numeric values about an unreliable, imaginary concept? On this question the Dutch Scientific Counsel for Government Policy (WRR) has taken a clear stand: according to their advice to the Dutch Government, one should focus on *plausibility* instead of *probability*.[157] So the question is not about the *probability* of a major incident taking place, but about the *plausibility* that it may take place anyway. In this alternative view, a new approach presents itself: the 'precautionary principle.'

In fact, this is a philosophical change in the art of risk analysis, which shifts the risk analysis focus from deterministic, or probabilistic calculative causal thinking onto a focus on uncertain effectiveness of the implementation of the risk-reducing control measures. This alternative view originates from the environmental protection discipline that emerged at the end of the 20th century. Van Asselt explains that essentially uncertainty has two typical origins: process variability and lack of knowledge (ref. Figure 9). These sources can be specified by various sub-sources and they appear in different forms. All these different variances can be synthesised in the following general definition, raised by Van Asselt: "In sum, uncertainty can be defined as the entire set of beliefs or doubts that stems from our limited knowledge of the past and the present (esp. uncertainty due to lack of knowledge) and our inability to predict future events, outcomes and consequences (especially uncertainty due to variability)."[158]

This alternative view is not generally in use in the sectors this study is about. But in European legislation, the term 'precautionary principle' is explicitly referred to. A 'Future brief' by the Science Communication Unit of the University of Bristol (2017) offers the following explanation and definition:

> The precautionary principle is designed to assist with decision-making under uncertainty and is a core principle of EU environmental law, enshrined in Article 191(2) of the Treaty on the Functioning of the EU. The classic definition of a *precautionary approach* comes from the 1992 Rio Declaration on Environment and Development, which states that: "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (UNEP 1992).[159]

157 Wetenschappelijke Raad voor het Regeringsbeleid (2008), p. 117

158 Van Asselt (2000), p. 88.

159 Science Communication Unit of the University of Bristol (2017), p. 3.

The precautionary principle is merely subject of discussion in the context of environmental protection and public health, but this does not restrict the legal application of the precautionary principle solely to these areas. To illustrate this, we quote some phrases of the 'Communication from the European Commission on the precautionary principle' below:

> Recourse to the precautionary principle presupposes that potentially dangerous effects deriving from a phenomenon, product or process have been identified and that scientific evaluation does not allow the risk to be determined with sufficient certainty.[160]

But agreement is still far away:

> The issue of when and how to use the precautionary principle, both within the European Union and internationally, is giving rise to much debate and to mixed and sometimes contradictory views.[161]

And:

> Proportionality means tailoring measures to the chosen level of protection. Risk can rarely be reduced to zero, but incomplete risk assessments may greatly reduce the range of options open to risk managers. A total ban may not be a proportional response to a potential risk in all cases. However, in certain cases, it is the sole possible response to a given risk.[162]

The message from Brussels is clear: the phenomenon of uncertainty and the precautionary principle are part of our legal reality. Legally speaking, this implies a principal change for leaders in the way they exercise their risk management responsibilities, however, the distance between Brussels and operations is still not bridged; according to the European Commission risks are to be measured and *thus* it must be feasible to do so.

2.2.5 *Discussion*

In the business sectors this study is about, the validity and applicability of different risk analyses methods is often subject to debate. With respect to this, Cox claims that there has been little research done to validate the effect of the use of matrices on the quality of risk management decisions. He suggests that this method shows the following limitations: 1. Matrices can assign identical ratings to very different risks by different factors of

160 European Commission (2000), p. 3.
161 Ibid., p. 2.
162 Ibid., p. 3.

probability and severity, while their multiplication produces the same outcome; 2. Matrices can erroneously show lower or higher quantitative ratings, depending the subjective judgement of the individual assessor. This, as Cox claims, can be 'worse than useless', leading to 'worse-than-random decisions'; 3. Allocation of resources of risk-reducing countermeasures cannot optimally be done on the basis of results of risk matrices; 4. Categorisation of severity cannot be made objectively for uncertain consequences: inputs as well as outputs are ambiguous.[163]

Quoting an insurance company that runs the risk of having to reimburse victims (individuals and organisations) after safety risks have developed into incidents: "Only risks that have been perceived can be identified and assessed, ignored or reduced and finally insured and reinsured against, or provided for in some other way."[164]

Also, no risk analysis does answer the question: "How safe is safe enough?"

The answer to this question is always: "It depends…." In order to be able to answer this question properly, it is of importance to make a distinction in the different types of possible events. Here the different nature between 'simple' incidents leading to relatively little injury or damage to the environment and major incidents plays a role. The idea that these 'simple' incidents happen more frequently than major incidents threatening the fundamental values of an organisation, has been considered a fact ever since Heinrich designed the first version of his 'risk pyramid' in 1931.[165] Apparently, we are better in reducing the risks potentially leading to major incidents, than we are able to prevent the less-serious operational disturbances that potentially lead to 'simple' incidents.

Following Tversky and Kahneman, this inability is even one of the reasons why low-frequency major incidents continue to occur. These scholars argue that people consider an event more likely to occur when they are better able to envisage its occurrence; and because major incidents occur with a relative very low frequency, their occurrence is more difficult to envisage. So, people are better able to recognise the signals indicating the development of relatively frequently occurring, 'imaginary', less-serious incidents, than they are able to judge the (weak?) signals of major incidents to develop. Moreover, Tversky and Kahneman argue that "… when faced with the difficult task of judging probability or frequency, people employ a limited number of heuristics which reduce these judgements to simpler ones …"[166] and "A person is said to employ the 'availability heuristic' whenever he estimates frequency or probability by the ease with which instances or associations could be brought to mind."[167] So, where the occurrence of an operational disturbance is difficult to imagine (e.g., because the assessing individual concerned has never experienced a similar situation), we avoid the difficult way of judgement and make life easier than it actually is. This implies that the effectivity of risk reduction depends on the leader's ability to imagine a certain major incident to occur, in which ingenuity is

163 Cox (2008).
164 Bayerische Rückversicherung Aktiengesellschaft (1993), pp. 7–8.
165 Heinrich (1941).
166 Tversky and Kahneman (1973), p. 208.
167 Ibid., pp. 207–208.

influenced by his or her individual knowledge and experience with respect to the safety risks involved. Moreover, referring to Tversky and Kahneman, Ronner[168] suggests that the following psychological factors: self-overestimation, optimism, herd behaviour, congruence, control illusion, wishful thinking, belief in authority, ostrich behaviour and transparency illusion, may also be of influence on the quality of risk assessment. Slovic et al. refer to another psychological factor that affects the evaluation of risk, called the 'affect heuristic.' They discuss the dominant role of emotions over rational argumentation and argue that:

> … people base their judgments of an activity or a technology not only on what they think about it but also on how they feel about it. If their feelings toward an activity are favourable, they are moved toward judging the risks as low and the benefits as high; if their feelings toward it are unfavourable, they tend to judge the opposite—high risk and low benefit. Under this model, affect comes prior to and directs, judgments of risk and benefit …[169]

This affect heuristic suggests a relationship between the expected benefit of an activity or technology, and the inferred risk level associated with it and vice versa. These suggested relationships are shown below (Figure 10).

168 Ronner and Ronner (2012)
169 Slovic, Finucane, Peters and MacGregor (2004), p. 315.

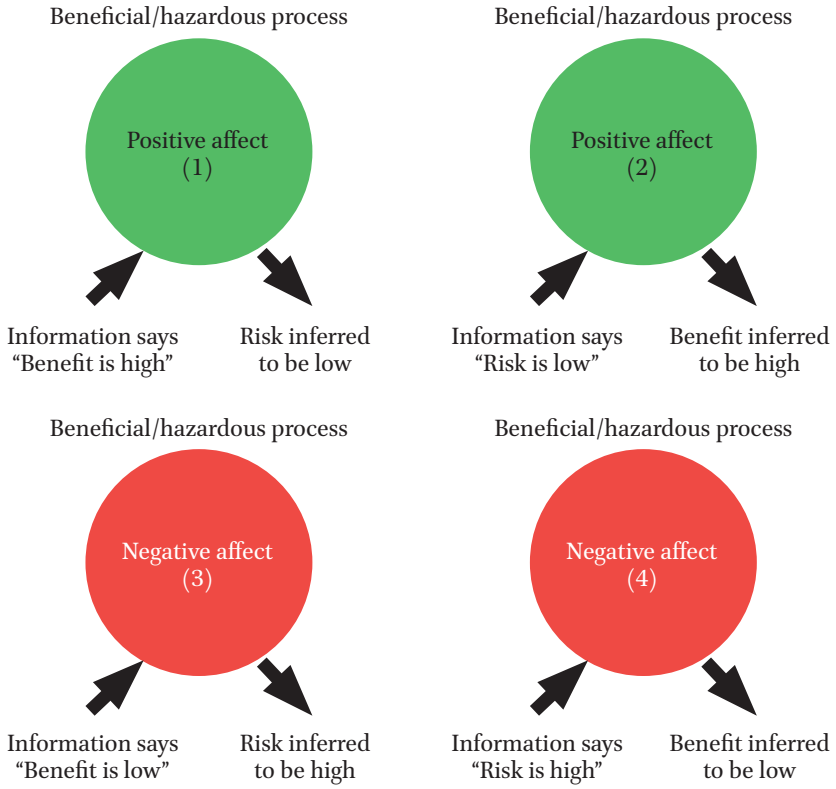


FIGURE 10 Affect Heuristic (Slovic, 2004)

Research by Slovic has shown that people not only judge risks according to what they *think* about them, but also how they *feel* about them; affect precedes and directs rational judgement.[170] Because risk assessment processes are strongly biased by the heuristics as mentioned above, they are by no means to be considered objectifiable processes.

Determination of acceptability of risk requires a broader view on risks at hand. Fischhoff et al. argue that in order to be able to assess whether the level of safety is safe enough, five generic complexities have to be solved: a) uncertainty about how to define the decision problem, b) difficulties in assessing the facts of the matter, c) difficulties in assessing the relevant values, d) uncertainties about the human element in the decision-making process and e) difficulties in assessing the quality of the decisions that are produced.[171] In their elaboration of these complexities, they mention some salient points: 1. Hazards begin with the human need the technology is designed to satisfy, 2. The decision of whether a risk is acceptable may be influenced by an individual who is relatively powerful, but who may be totally wrong, 3. Focus on one aspect that is consid-

170 Ibid.
171 Fischhoff and Lichtenstein (1984).

ered dangerous in the primary process, may encourage the neglect of other, even more dangerous hazards.[172] On this topic Hale argues as follows:

> There is still a further problem with the original definition proposed for 'danger.' This rests in the word 'potential.' This implies some predictable future state of the system in which harm occurs. If we wait long enough, all systems will wear out. Therefore, we have to make an arbitrary decision about excluding 'normal ageing' from our decision of harm to make it useful... We have to impose a restriction, which takes account of what is 'reasonable to expect', 'foreseeable', or 'credible' in order to exclude some (hopefully very low probability) future events, which are theoretically possible and so limit the range of future states of the system that we consider in assessing potential harm... In dealing with this area of very low probabilities we are in any case up against two fundamental limitations. First it is in all practical senses unprovable whether judgements of calculations of probability are accurate or not. We would have to wait too long to accumulate empirical evidence to prove whether failure probability was really one in 100.000 years or actually one in 10.000. Second, hindsight is not necessarily a good predictor of future probability of an event. We have to take into account that systems are goal directed and not totally deterministic.[173]

According to Muller, there is no unequivocal risk management model that can easily be explained after every application. It is always necessary to assess the specific risks, possibilities and limitations of risk management per organisation.[174] As mentioned by Hale, organisations are goal directed. This implies that a 'safest option' is not always the first priority of organisations. Beck supports that argument by suggesting that techno-economic 'progress'[175] is increasingly overshadowed by the production of risks, which he refers to as 'latent side effects' of the production process.[176]

Acceptable-risk problems are decision problems, requiring a choice among alternatives. That choice is dependent on values, beliefs and other factors.[177] Moreover, acceptability of risks is not an independent singular judgement of the potential effects of risks. It is also determined by a rather perverse 'cost-benefit' calculation in which both factors are uncertain. Therefore, in this acceptable-risk decision-making process, individual judgement by the leaders involved is a subjective operation. The many uncertainties, hidden behind the seemingly clear calculations of QRA as introduced by the several different subjectivities as mentioned in this section, open the fair possibility that certain risks are considered 'acceptable', because the way they are managed is the 'preferred' option in-

172 Ibid.
173 Hale and Glendon (1987), pp. 10–11.
174 Muller E.R. (2012b).
175 Inverted commas by Beck.
176 Beck (1986).
177 Fischhoff and Lichtenstein (1984).

stead of the 'safest' option.[178] In that respect Hollnagel argues that in risk management we face a dilemma of conflicting goals, which he labelled as the ETTO-principle, the 'Efficiency-Thoroughness Trade-Off.'[179]

Van Asselt argues that it is an illusion to think that risks can be calculated and that it is therefore a technical issue.[180] In this insight, Van Asselt is supported by Tversky and Kahneman, who argue:

> Most important decisions men make are governed by beliefs concerning the likelihood of unique events. The 'true' probabilities of such events are elusive, since they cannot be assessed objectively. The subjective probabilities that are assigned to unique events by knowledgeable and consistent people have been accepted as all that can be said about the likelihood of such events. Although the 'true' probability of a unique event is unknowable, the reliance on heuristics such as availability or representativeness, biases subjective probabilities in knowable ways.[181]

On the same subject Lauder argues: "Within normal chaos we should always think of such judgements as being an educated guess (where some are more educated than others) rather than being a scientific judgement."[182]

In general, risk analysis studies showing the calculated 'magnitude' of risks meet limits.[183] This is not only because the various quantitative risk-calculation techniques are not alike and do not produce identical analysis results, but also because personal, psychological, social, cultural and political factors are to be included in risk judgements. Quantitative risk analysis techniques do not comprise these socio-technical elements. These inconsistencies result in analyses which are incomplete and have a negative influence on the ability of organisations to define effective safety-incident-prevention strategies.[184] Assessing the potential impact of risks is a subjective process, which impossibly can lead to an objective, assessor-independent assessment, because who decides "How safe is safe enough?"[185]

This question specifically applies to major incidents of which the probability is known to be low, but we do not know just how low; here history data are scarce and by its very nature not useful from one to another case. Moreover, the usefulness of analysis of very small probabilities is questionable. Fischhoff et al. conclude that "no one solution to acceptable-risk problems is now available, nor is it likely that a single solution will ever be found…, they recommend "…to acknowledge the limits of currently available ap-

178 Ibid.
179 Hollnagel (2009).
180 Van Asselt (2012).
181 Tversky and Kahneman (1973), p. 231.
182 Lauder (2015), p. 138.
183 Wetenschappelijke Raad voor het Regeringsbeleid (2008).
184 Cox (2008).
185 De Vries, Verhoeven and Boeckhout (2014).

proaches and expertise…, and …improve the use of available approaches and… develop guidelines for their conduct and review."[186] In particular, conversion of qualitative terms into numerical values is a weak component of quantitative and semi-quantitative risk-assessment procedures.

Groeneweg puts things into perspective, and argues: "The acceptability of risks is influenced as much, if not more, by subjective perception as by objective reality; a situation that may frustrate some engineers and managers but cannot be discounted."[187]

2.2.6 *Risk management concepts*

How a future safety incident will develop is difficult, if not impossible, to determine; only in hindsight we can analyse how it happened.[188, 189] In this obscure and unexpected reality, leaders lead their people in their daily operational processes. Society expects these leaders to ensure these processes proceed in a smooth way and that safety incidents will be prevented.[190, 191, 192, 193] The process intended to prevent safety incidents is called *risk management*. In operational terms, this process aims to prevent unanticipated disturbances in the regular primary processes of organisations. In the context of this study, this process encompasses all activities needed to identify and control the safety risks related to these primary processes in a timely fashion.

According to Pasman: "Hazards and their associated risks can be reduced by well-executed risk management."[194] Operational disturbances happen because the safety hazards threatening the primary processes are not properly controlled. It could be argued, however, that safety incidents have their function; after experiencing an incident, leaders realise that someone somehow failed to control the risks, and this experience often triggers a process with which to improve risk management methods, which sometimes leads to innovative, out-of-the-box solutions. This is not, however, the best way to learn and invent better risk management methods.

The following sections offer an overview of the most influential concepts, without which risk management would not have achieved its present level. This selection includes DuPont (commitment and compliance); Reason ('Swiss Cheese' Model); Unknown (Barrier-based risk model); and Rasmussen and Cook (Dynamic Safety model).

186 Fischhoff, Lichtenstein, Derby, Slovic and Keeney (1983), p. xiii.
187 Groeneweg (1992), p. 18.
188 Stockholm (2011).
189 Dekker (2006a).
190 Leistikow (2010).
191 O'Dea and Flin (2001).
192 Pilbeam (2014).
193 Wu, Chen and Li (2008).
194 Pasman (2015), p. 28.

2.2.6.1 DuPont

On invitation of president Thomas Jefferson, a French chemical engineer E.I. DuPont founded a gunpowder manufacturing plant near Wilmington (Delaware) in 1802. DuPont had a reputation as a respectable professional who recognised the process hazards of producing gunpowder very well. To show his commitment to safety, Mr. DuPont and his family decided to live in a house situated on the black powder fabrication site.[195] This decision is still considered an ultimate sign of trust in the safety of the company's operations. Mr. DuPont invested heavily in the continuity of his business and the safety of his employees through a safe construction of the plant. But he paid attention to organisational factors as well; the accountability for the safe operation of plant was well placed: with management and supervisors. In the year 1811 Mr. DuPont issued his first official safety rules. In 1911 Prevention of Accident Commissions were established within each department and employee safety programs were institutionalised. The company established its own safety standards around 1930 after which the number of accidents significantly decreased. But this trend only reflected the specificity of the DuPont safety efforts: reduction of occupational accidents by focusing on behaviours of general employees. Process safety proved to be a more difficult challenge, as the company kept facing some process-related major incidents: e.g., in 1815 (9 casualties), in 1818 (34 casualties), in 1965 (12 casualties, 61 injured, $50 million loss).

Nevertheless, notwithstanding these major incidents, records of individual accidents showed impressive improvements in occupational safety. This did not remain unnoticed by the outside world. Globally, the industry reacted very positively to this surprising achievement and despite the mentioned safety incidents, soon DuPont was considered the overall pioneer on safety and risk management. During the 1970s the company DuPont decided to share its safety knowledge and experience with the world and founded a separate consultancy company, DuPont Safety Resources (later renamed to DuPont Sustainable Solutions). Nowadays numerous industrial companies all over the globe have embraced the DuPont safety programmes, based on top-down management policies, leadership, management (read: leaders) as the ultimate responsible party for safety and individual accountability for all staff.

2.2.6.2 'Swiss Cheese' Model

In the year 1990 Reason published his book on human error. The original intention for the book was to provide an essentially cognitive psychological account of the nature, varieties and the mental sources of human error.[196] Based on the work of Rasmussen, Reason explains the skill based, rule-based and knowledge-based errors and the psychological mechanisms behind unintended slips, lapses and mistakes and he nuances the different

195 Klein (2009)
196 Reason, Hollnagel and Paries (2006)

types of violations.[197] In addition, Reason presents the 'trajectory of accident opportunity', showing the different roles of latent failures, psychological precursors and unsafe acts leading to the breach of 'barriers' or 'controls.'[198]

Later, this theory was combined and integrated with the so-called 'Swiss Cheese' model, which had its origin in 1987 by Reason during the writing of his book addressing the role of human error in operational disturbances.[199] This model is depicted in Figure 11 below.

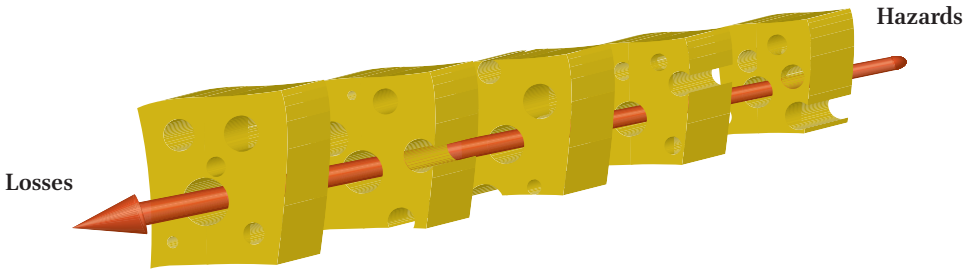


FIGURE 11 'Swiss Cheese' model (Reason 1987)

The 'Swiss Cheese' model has served as basic model for a concept called barrier-based risk management and, at a later stage, for a concept addressing cultural aspects of organisations, called Hearts & Minds.[200] This psychological approach of accident causation opened the eyes of many organisations to the unavoidable role of human error in the accident causation process.

2.2.6.3 Barrier-based risk management

This concept, suggesting that incidents are prevented by inserting preventive barriers between the *hazard* and an *event*, and that detrimental effects may be reduced using defensive barriers between events and *values,* was derived from the 'Swiss Cheese' model by Reason, in which the slices of the cheese represented the barriers; with or without weaknesses, represented by the holes in the cheese. This theory was operationalised by two tools: 1) a prospective pictographic risk identification model of operational disturbances, called Bowtie,[201] and 2) a retrospective incident analysis model, called Tripod Beta. Initially these tools were solely applied in chemical process companies and in the oil and gas industry, but barrier-based risk management tools later made their way into

197 Rasmussen (1983)
198 Reason (1990)
199 Ibid.
200 Van der Graaf and Hudson (2002)
201 The actual origin of Bowties is unclear, but Hudson suggests that a look-alike model of the concept, then called the Butterfly diagram, had been used in the 1970s by the chemical company ICI.

many different high-risk business sectors, including all sectors addressed in this research.

Figure 12 below is a Bowtie diagram showing the safety-incident process where the values exposed are potentially impaired by a hazard (or energy). This diagram includes controls and defences.[202] In situations where all barriers, controls and defences are missing or ineffective, the energy captured in the hazard, once triggered by a certain threat, will release in an uncontrolled way, and the operational disturbance (or incident) may take place and impair the values exposed.[203] If this is the case, then there has been an incident resulting in accidental consequences.

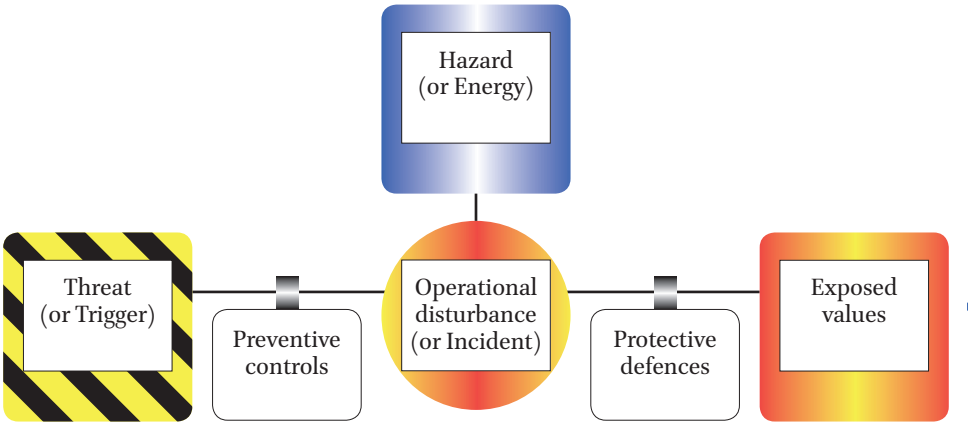


FIGURE 12 Bowtie diagram including controls and defences

The above diagram describes the incident process as a manageable or even controllable process. Proper risk management prevents operational disturbances or inhibits consequential damage (impairment of exposed values). Leaders and everyone else involved may feel safe and confident about the rigidity of the risk management measures taken, and trust the reliability of the implemented controls and defences. The longer an organisation operates free of accidental consequences, the safer everyone feels but 'no incidents' does not mean 100% safety, and feelings of safety do not represent the operational reality; wicked (unidentified or incorrectly assessed) safety risks and/or coincidence, may play a role and 100% certainty about the effectiveness of the measures taken is not realistic.[204] Barrier-based risk management tools facilitate organisations to identify preventive measures up to organisational culture level.

202 The figure uses one symbol to illustrate the concept of controls and defences. In a real major incident scenario, the diagram would probably show more different controls and/or defences.
203 Stichting Tripod Foundation (2015).
204 Yoe (2012).

2.2.6.4 Dynamic Safety Model

During the same period in time, Rasmussen and Cook published their Dynamic Safety model. This model shows that different organisational requirements act in different, sometimes opposite, directions as vectors in one integrated system. In order for an organisation to operate optimally, the leaders of the organisation are responsible for managing the different forces to an equilibrium where all forces are controlled.[205] This model is depicted in Figure 13 below. This model appreciates internal as well as external forces as part of a holistic system in which leaders are required to monitor and control the overall balance. In case any force causes an unbalance, the system's performance reduces and may end up in a (safety) incident. In this model the different, often incompatible, requirements of leaders of organisations as contributing factors in a safety incident development process are clearly presented.

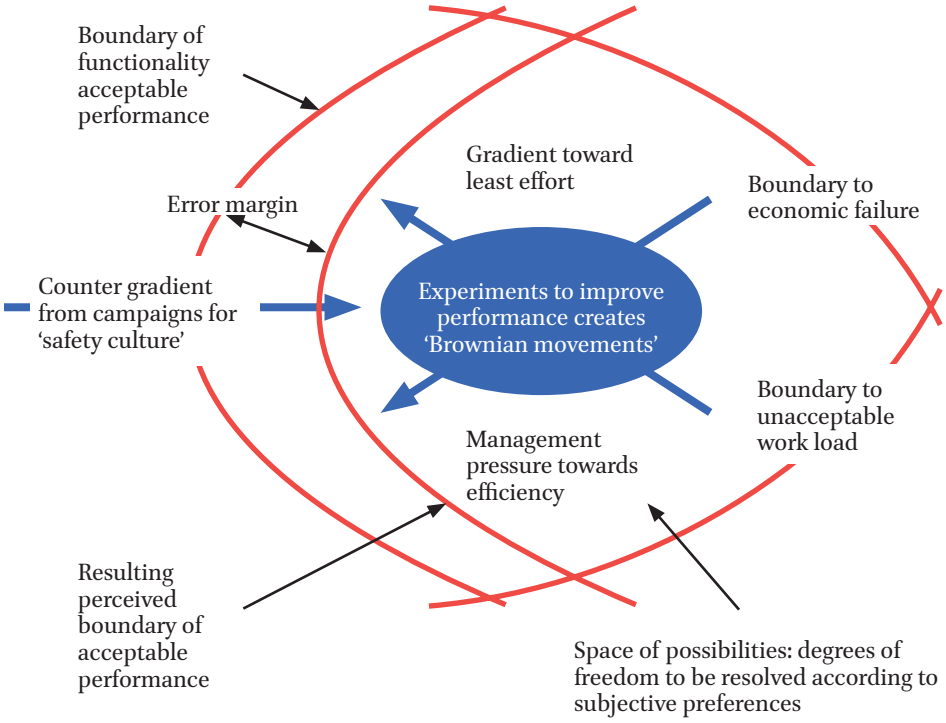


FIGURE 13 Dynamic Safety model (Cook and Rasmussen)

205 Rasmussen (1997).

2.2.7 *Risk reduction*

2.2.7.1 Risk reduction process

In fact, organisations are mechanisms for conversion or transformation (ref. 3.1). Conversion or transformation takes place by the design and operation of what is referred to as a process. Baguley argues that a process is a set of consecutive actions, stretching the path from a strategic decision to achieve certain objectives, to the actual accomplishment of those objectives.[206] This scholar suggests that in its simplest form, a process is characterised by three typical phases: inputs, conversion or transformation and outputs and that a process can be based on tangible and intangible objectives. Different processes may cover different inputs, objectives, conversions/transformations and outputs. Groeneweg has outlined a process where the quality of the working environment is defined as output.[207]

We concur with this latter suggestion and we argue that in a risk reduction process input, conversion/transformation and output can be specified as: input (the risks generated by the primary process), conversion/transformation (skills, knowledge, motivation and courage) and effect (the reduced risk level). With respect to the applicability for risk reduction processes, we translated conversion/transformation into risk reduction by intervening.

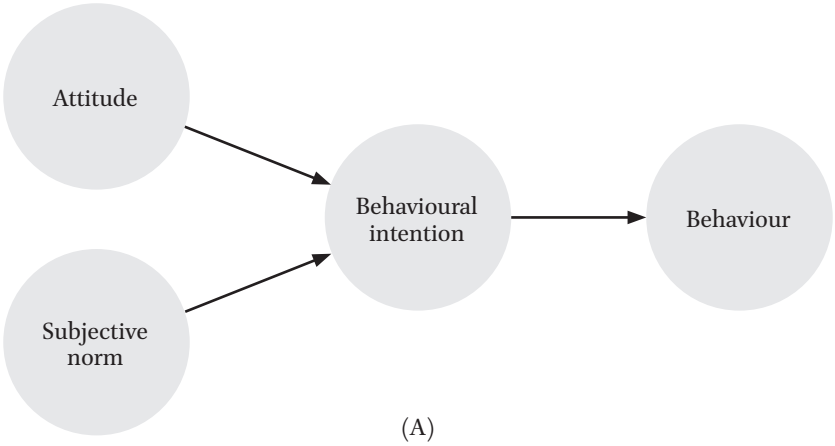
In this translation process, the 'Theory of Planned Behaviour' by Ajzen, the 'Behavioural Change model' by Balm, the Willing-Being-Able-Daring' framework by Elffers, as well as the work concerning 'Moral Courage' by Osswald et al. served as principal theoretical support.[208, 209, 210, 211] In the next paragraphs we elaborate on these theories.

2.2.7.2 Theory of planned behaviour (Ajzen)

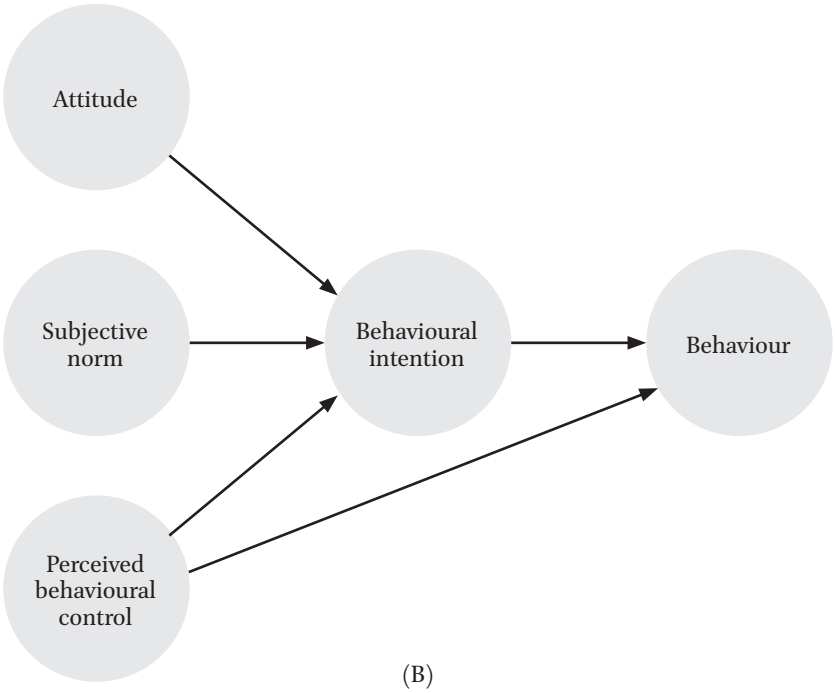
The dynamics of the risk reduction process is located in the conversion/transformation phase. Only when this process is fully completed, will it be clear what remedial action is needed and can be taken. So, the effectiveness of the risk reduction process merely depends on the extent to which people take initiative and how and the extent to which they are able and willing to complete this process. Whether people are willing to participate in this process depends on three distinct factors: their individual attitudes, subjective norms and perceived behavioural control. These factors are the three motivating factors of the 'Theory of Planned Behaviour' by Ajzen[212] as depicted in Figure 14. This theory assumes that people's behaviour is steered by intrinsic (attitude and perception of behavioural control) as well as extrinsic (subjective norm) motivators. If we apply this theory to the risk reduction process phase where interventions take place, along with conversion/transformation, we see that all three theoretical factors are required to achieve the

206 Baguley (1994).
207 Groeneweg (1992).
208 Ajzen (1991).
209 Elffers (2014).
210 Balm, Spoelstra and Quak (2015).
211 Osswald, Greitemeyer, Fischer and Frey (2010).
212 Ajzen (1991).

desired effect (a reduced risk level). All factors contribute to the willingness of people to exhibit certain behaviour. The factor 'attitude' is required to motivate people to pay attention to the safety aspects of their occupational environment and their intrinsic motivation to intervene if safety risks present themselves.



(A)



(B)

FIGURE 14 Theory of Reasoned Action (A) and Theory of Planned Behaviour (B)

The factor 'subjective norm' represents the individual's perception that their leaders and peers consider it 'normal' for an individual to take action when safety risks appear to him or her. The factor 'perceived behavioural control' steers self-confidence in people, by which they believe in their ability to intervene and dare to act. That courage to act is represented by the long arrow directly pointing from 'perceived behaviour control' to 'behaviour.' So, in order to induce the right behavioural intention and its consequential behaviour (a positive contribution to the conversion/transformation), all three factors are required and may empower each other, to ensure the correct interventions required to realise the reduction of safety risks are recognised.

Actually, this model is an expansion of the 'Theory of Reasoned Action', as developed by Ajzen in cooperation with Fishbein and initially published in 1975. This theory is, although often implicitly, widely used for the prediction of behavioural intentions and consequential behaviour. In 1985 Ajzen built upon this earlier theoretical model, by incorporating 'perceived behavioural control' as a third antecedent to behavioural intentions.[213]

2.2.7.3 Behavioural Change model (Balm)

In order to identify the Risk Reduction Capacity, we built on the Behavioural Change model presented by Balm[214] as depicted in Figure 15 below. This model contains some phases which are considered applicable to risk reduction as well. This applies specifically to the phases of: 2. 'Understanding', 3. 'Wanting to', 4. 'Being able to' and 5. 'Doing.' The phases 1. 'Receptiveness' and 6. 'Persevering' are considered as part of strategic decision-making and therefore not considered part of the operational risk reduction process itself. The phases 2–5 identify four specific elements which apply to the risk reduction process as well. In that respect we consider Phase 2. 'Understanding', as the phase in which people identify and evaluate risks. Phase 3. 'Wanting to', indicates the willingness/motivation of someone to create a change; in the context of risk reduction, we consider this as 'being motivated to intervene.' Phase 4. 'Being able to', indicates whether someone is in the position, sufficiently skilled and knowledgeable enough to do something; regarding risk reduction, we consider this as 'being able to intervene.' Phase 5. 'Doing', refers to actual execution of a required change; in relation to risk reduction this means actually performing remedial action after a risk has been recognised and people have intervened in order to create mitigation of the risk and action is taken.

213 Madden, Ellen, Ajzen and Bulletin (1992).
214 Balm (2002).

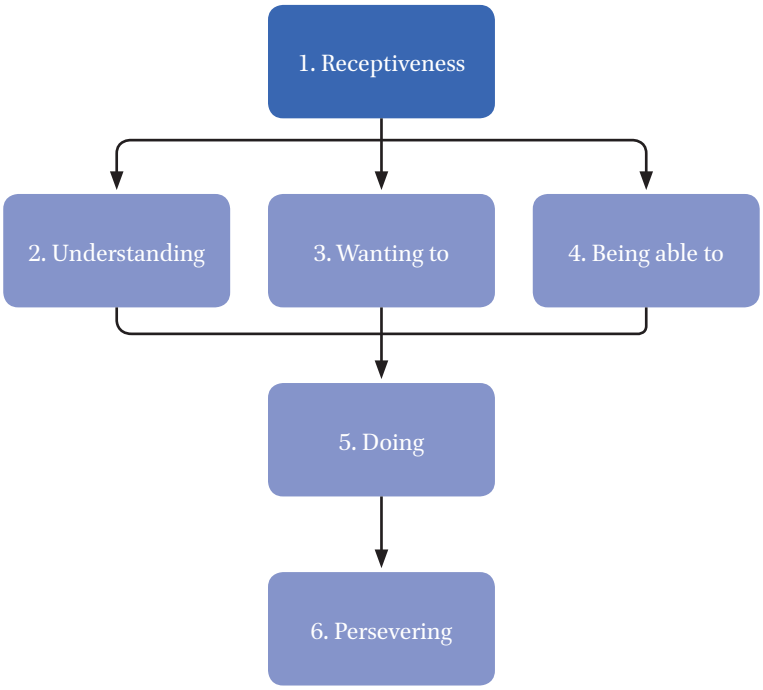


FIGURE 15 Behavioural Change model (Balm, 2002)

Interventions based on identification of safety risks are often needed at unexpected moments in time and, in many instances, are disturbing, possibly even annoying, to the operational process. By default, most leaders are not happy to see operational processes being disturbed. So, safety-risk-related interventions, are often considered as a nuisance by leaders who are responsible for the continuation of the operation. In that context a person who wants to intervene needs to be brave; they need courage to comply with their gut feeling. We therefore refer to the 'Willing-Being Able-Daring' concept by Elffers.[215] This concept resembles the model by Balm, where 'wanting to' and 'able to' are concerned, but Elffers' concept includes an additional element: 'Daring'. Daring reflects the fact that people who recognise risks and are able and willing to intervene, still have to dare to overcome a socio-psychological barrier, named 'courage'. Actually, reducing risk requires communication and physical intervention, sometimes even by interrupting operational processes. In this context courage relates to the phenomenon of 'moral courage'.

215 Elffers (2014).

2.2.7.4 Courage to intervene (Moral courage)

Interrupting operating primary processes means disturbing activities which are executed to achieve an organisation's fundamental goals. Intervening for safety reasons thus requires courage. Moral courage[216] is an essential behavioural property. The first option, taking action, is the result of a mind-set where safety prevails over other priorities. The second option is the denial option, where other priorities (e.g., the production process, career opportunities, peer pressure, etc.) prevail. Individual economic- or status-driven priorities may play a role here. Commitment is stronger and more individual than motivation; it requires courage to take unexpected action to reduce a safety risk. There is a wealth of academic work referring to the complexity of moral courage in the health care sector (especially related to nurses).[217, 218]

Also, Osswald et al. refer to 'moral courage' as a prosocial concept, which overlaps with 'bystander intervention', but is more broadly based. For a definition they refer to Lopez et al. (2003), who define moral courage as "the expression of personal views and values in the face of dissension and rejection and when an individual stands up to someone with power over him or her (e.g., boss) for the greater good."[219] In this respect we also refer to the work by Greitemeyer et al. (2006) who define moral courage as "brave behaviour accompanied by anger and indignation, which intends to enforce societal and ethical norms without considering one's own social costs."[220] Osswald et al. argue: "Moral courage shows certain similarities with heroism, because regarding the possibility of suffering serious physical consequences, moral courage and heroism overlap… when a person acts morally courageously, he or she runs the risk of negative social consequences such as being insulted by a perpetrator."[221]

Amos and Klimoski focus on courage as an act of leadership outside a formally designated role. In these situations, the choice of whether or not to act as a leader on the team is a discretionary choice and often involves risk. They argue: "We consider the qualities of a team member that make up the propensity for them to act like a leader in situations of risk where the choice to act is most problematic. We propose that what we know about the virtue of 'courage' lends valuable insights into this question and offer a framework of three qualities (character, confidence and credibility) that serve as the foundation for the construct."[222] Following the above referred scholars on moral courage, we conclude that there is no difference whether someone is formally assigned as a leader or acts as an informal leader on his/her own initiative. Where intervention aimed at prevention incidents is concerned, formal assignments don't count. In both settings, formal and informal leadership, moral courage is considered to be a virtue to be mastered. Sekerka et al. suggest

216 Osswald, Greitemeyer, Fischer and Frey (2010).
217 Murray (2010).
218 Bickhoff, Levett-Jones and Sinclair (2016).
219 Osswald, Greitemeyer, Fischer and Frey (2010), p. 3.
220 Ibid., p. 4.
221 Ibid., p. 6.
222 Amos and Klimoski (2014), p. 110.

that professional moral courage is a managerial competency. In their work they present five dimensions to be considered when moral courage is to be measured: moral agency, multiple values, endurance of threats, going beyond compliance and moral goals.[223]

2.2.8 *Discussion*

This overview of risk management related theories and concepts is by no means complete, but it represents the historical development from 1802 (DuPont) to the contemporary main body of knowledge about risk management. In this selection appears a trend from a workforce focused, top-down and compliance-driven policy (DuPont, Hellriegel), where workforce is considered a threat by their unsafe behaviours, to a psycho-sociological approach (Rasmussen, Reason, Groeneweg, Dekker, Hollnagel, Woods, Leveson and Weick), where employees are considered valuable sources of information instead of hazards to inherently safe systems. This overview illustrates that since the inception of risk management, the view on the role of operating people has shifted from 'causers' to 'solvers.' Also, the quoted concepts show an increased interest in the role of leaders. The development of risk management concepts has also influenced the relationship between leaders and general employees, the way leaders behave and how they attempt to cope with their own conflicting goal of production versus safety.

All concepts discussed in this overview are still in use. Some are used simultaneously and in parallel with other concepts, some organisations stick to one concept they strongly believe in. Risk management policies of organisations in some sectors may be more compliance based, other sectors may be in favour of more socio-psychological approaches, or even experimenting by conducting experimental pilot projects with resilience engineering and/or the Safety II concept. Nowadays, many risk professionals participate in discussions on risk management on the internet. Internationally renowned scholars participate in brainstorming and discuss innovative developments via the website www.safetydifferently.com.

Many, if not all, organisations have developed their own tailor-made risk management approach in which a mix of the different approaches can be noticed. An international group of risk management professionals/scholars has developed a so-called Zero Accident Vision and operate a 'Zero Accident Network.'[224] The objective of this group is to achieve totally safe organisations, where no incidents occur, or will not result in harming consequences. Whether this initiative will succeed is not agreed upon by everyone. For instance, Yoe claims that: "Virtually everything we do involves risk, and zero risk is unachievable."[225] So, a goal of 'zero accidents' may be useful as motivator, but it is still a dream yet to come true.

We take the position that with respect to the prevention of safety incidents there is no silver bullet yet, but in many organisations, improvement of the safety of primary

223 Sekerka, Bagozzi and Charnigo (2009).
224 Zwetsloot, Aaltonen, Wybo, Saari, Kines and De Beeck (2013).
225 Yoe (2012), p. 167.

processes is feasible, albeit in different sector/organisation specific ways, using different methods. For that reason, in this research different concepts are taken into account. Where in this research risk management is subject of discussion, these concepts are implicitly or explicitly contributing to our argumentation.

A lack of courage to intervene can trigger a safety incident. When people decide that safety is most important, and dare to intervene, we call them 'committed.' People who decide that other priorities are more important, and who refrain from action or leave the decision to others are considered 'irresponsible.' We argue that people's priorities are shaped a great deal by the way that leaders behave. The priorities of leaders are reflected in the priorities of their followers.

2.3 Leadership

The following sections offer insights into the different strategies that leaders can apply to inspire their followers to bring about the movement or change required to achieve intended operational results.[226] The term 'leadership' is defined in the first section, then we discuss leadership as a social construct, and outline the levels of leadership. The leadership process is discussed, the concept of a 'Leadership Moment' is introduced and elucidated, as are 'leaders', 'followers' and 'context'.[227] In the sections about behavioural motives, we give an overview of work by different theorists, with respect to three different motives (achievement, affiliation and power); here these terms are re-named Task orientation, Relation orientation and Self orientation. These sections conclude by profiling leaders, and we explain the behaviours that can be expected of differently oriented leaders. We argue that leaders can be profiled as being Task-, Relation- and/or Self-oriented.

2.3.1 *Defining leadership*

The term 'leadership' is defined in many ways. According to Yukl there is no 'correct' definition; any definition will do, as long as the wording increases our understanding of effective leadership.[228] His version of leadership reads: "Leadership is a word taken from the common vocabulary and incorporated into the technical vocabulary of a scientific discipline without being precisely defined."[229] Yukl couldn't resist offering more clarity about what leaders (should) do, however: "Leadership is the exercise of influence resulting in enthusiastic commitment by followers, as opposed to indifferent compliance or reluctant obedience."[230]

Ladkin claims that "… leadership's complete identity will necessarily always remain elusive."[231]

226 Pardey (2007), p. 15.
227 Winter (1991).
228 Yukl (2010), p. 21.
229 Ibid., p. 20.
230 Ibid., p. 22.
231 Ladkin (2010), p. 28.

Former US president Dwight Eisenhower explained leadership as: "The essence of leadership is to get others to do something because they think you want it done and because they know it is worth while doing."[232] This shows a clear top-down approach; the leader is the *commander*. Kotter puts his idea about leadership as follows: "Leadership is about coping with change."[233] Here the focus is not on the relationship between order and execution, but more on the leader as a *mediator*, who does his job in a situation subject to change. Pardey explains leadership as: "the ability to bring about change in a group or organisation, when there is risk or uncertainty, by inspiring others to head in a particular direction."[234] In this version, the leader is depicted as an *inspirator*.

Gabriel refers to the morality of leadership. In this respect, this scholar argues that: "Followers expect leaders to be competent just as they expect professionals and others; but they also expect leaders to provide moral leadership."[235] This he elucidates by suggesting that leaders are seen as 'good leaders' if they live up to moral (often unspoken, uncodified and even shifting) standards, which are considerably higher than the standards which we apply usually to most other people than leaders. Zaleznik argued that: "The net result of the leader's influence changes the way people think about what is desirable, possible, and necessary."[236] In his approach, the leader is a *motivator,* whose job it is to convince people to concur with the idea that working towards the common goal is good to do.

In these different descriptions of leadership, the leader is presented as the representative of leadership, acting as a commander, mediator, inspirator, or motivator. More different expressions are imaginable, but there is one commonality about these definitions: they all refer to 'creating change', where the objective of leadership is to change a less-desired situation into something more desirable. Creating change means: applying power, push and pull, tension and overcoming resistance to change a certain situation into a different one.

2.3.2 *Leadership as social construct*

Political leaders have been recognised as powerful influencers to humankind since history has been recorded. But notwithstanding their clear existence, the world did not bother to postulate 'leadership' as a specific notion. In a computerised search of 2.614 articles related to political science, appearing between 1906 and 1963, the words 'leader' or 'leadership' appeared only 17 times. Since 1977 this situation has changed and the notion of 'leaders' and 'leadership' have become commonplace, although many people and schools have different and sometimes conflicting, individual opinions about what these notions,

232 Eisenhower (1956).
233 Kotter (1999), p. 4.
234 Pardey (2007), p. 15.
235 Gabriel (2015), p. 316.
236 Zaleznik (1977), p. 71.

especially in situations of high pressure and stress, mean.[237] This may be the result of the fact that, compared with other linguistic terms these notions are relatively young. Apparently consistent views on leadership have not yet matured and one may question whether that ever will happen… In this respect it is not even realistic to expect global uniformity, because the interpretations of leadership depend a great deal on organisational and local/cultural characteristics. The way leadership is looked at shows that this phenomenon is an unequivocal container-notion, encompassing many different aspects, e.g., executing different tasks, using different styles, relating to different people with different attitudes, knowledge and skills, operating in different contexts. And these different factors also relate to the various different definitions in use.

Gergen explains the term 'social construction' as follows: "What we take to be importantly depends on how we approach it and how we approach it depends on the social relationships of which we are a part."[238] We suggest that at the very bottom of this situation lays the basic fact that 'leadership' is not physically visible nor graspable; it is not an object. So, in a particular context at hand, people may think and say about it what they consider right. Their meaning depends on to whom they talk and in what context this conversation takes place. From a philosophical point of view, 'leadership' is a phenomenon derived from social construction and this is probably a valid explanation for its lack of definitional edge.[239]

2.3.3 *Levels in leadership*

Above all, leadership is about the relationship between someone in a leading role and someone in a following role. The main objective of leaders is to *take decisions* which *inspire others to follow* in the desired direction in order to bring about *movement* in order to create a desired *change*. This means that pointing the desired direction to people is not enough; they must also be willing to *move*. About this Pardey[240] concludes that without movement, people are *just queuing.* The effectiveness of leaders in getting people to follow, is twofold: in the capacity of inspiring others and in the voluntarism of followership. His definition of leadership reads: "leadership is a bit like 'good art' – we may have difficulty in defining it, but we know it when we see it (or experience it)."[241]

In the scope of this study, anyone who demonstrates leadership, regardless of their hierarchical position in an organisation, is considered to be a leader. Since organisations are characterised by structures, such as hierarchies, sites, plants, departments, and so on, leaders operate at different organisational levels. We present three commonly distinguished leadership levels.

237 Post (2004).
238 Gergen (2009), p. 2.
239 Ladkin (2010).
240 Pardey (2007).
241 Ibid., p. 9.

Strategic level

Leaders assign the different tasks, manage the conduct of these tasks and lead the people involved to ensure achievement of the organisation's targets and objectives, (earlier in this section referred to as 'change') in a safe and secure manner. Examples of strategic leaders are: Managing Directors, CEOs, General Managers. These leaders are held ultimately responsible for ensuring that operations run as intended: efficient, undisturbed and safe.

Tactical level

On a tactical level, we find the direct reports of these strategic leaders (e.g., Division/Regional Managers, Financial Managers, Operations Managers, Technical Managers, etc.). These leaders are merely unit/department based. They operate according to their individual professional disciplines, as appropriate to the specific type of operations in their units/departments. They understand the processes, technology and procedures that apply to their units. Where applicable, they are able to discuss operational topics with general employees. Hierarchically, their place is in between strategic leaders and operational staff.

Operational level

Leaders on an operational level instruct and supervise the people who physically create the product/service which leads to the intended added value (earlier in this section referred to as 'change'). On this level, people are closest to and sometimes even exposed to, the safety risks generated by the primary process. Leaders on this level are called e.g., supervisor, shift leader, nurse in charge of the ward, team leader, etc. Operational leaders are expected to be aware of risks themselves and able to act (precautionary) to prevent operational disturbances, or (reactively) to mitigate the consequences of these events. Also, these leaders are expected to ensure that in their area of responsibility, operational workers are equally aware and are also able to prevent operational disturbances or mitigate any negative consequences. This is an implicit part of their job.

2.3.4 *The leadership process*

2.3.4.1 The Leadership Moment

According to Alvehus,[242] leadership is about the exercise of influence, it takes place in asymmetrical power relations, and is about striving towards a common goal; their purpose. The Leadership Moment model by Ladkin, discussed later in this section, also refers to this power momentum.[243]

Effectively leading people requires the right combination of personality, power and competence, executed in different formats and styles. Which format or style is used de-

242 Alvehus (2014).
243 Ladkin (2010).

pends on internal properties (e.g., the leader's individual characteristics or traits), as well as external properties: the individual characteristics of his followers as well as the contextual, organisational and/or situational characteristics.[244] The people being led are referred to as 'followers.'[245] These followers are considered to be people who work in the same organisation where their leaders work and where the relationship between leaders and followers is based on their relative hierarchical position or some other type of seniority.[246] Leaders may perceive the purpose differently from how their followers do. And so, it may be with respect to the context in which both types of actors operate. Leadership is not a constant; during the operational practice between leaders and followers, the nature and meaning of leadership is influenced continuously by the dynamics in context and the developing perceptions of the actors.

The sum result of these dynamics is depicted in a model called the 'Leadership Moment' as proposed by Ladkin (Figure 16).[247] Leadership may manifest itself differently, but "the common feature is collective mobilization towards an explicitly or implicitly determined purpose."[248] In this model, the interacting four fundamentals (purpose, leaders, followers and context) create the central entity 'Leadership Moment.'[249] This 'moment' is not a static 'thing', it represents the momentum induced by the social relations of the actors involved and its 'being' depends on their social, psychological, historical and organisational context.[250]

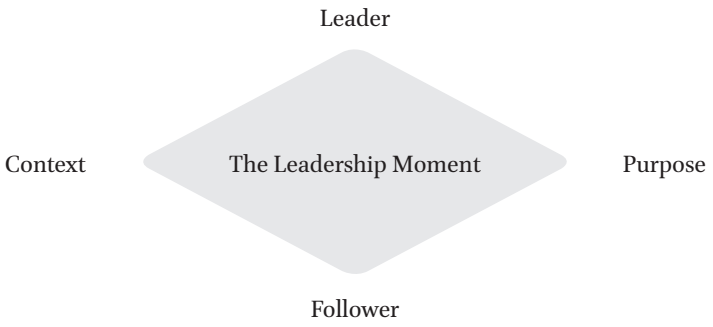


FIGURE 16 The Leadership Moment model (Ladkin)

The following paragraphs explain the notions of 'purpose', 'leaders', 'followers' and 'context'.

244 Yukl (2010).
245 In literature, to indicate followers the terms 'members' and 'associates' are also used.
246 Pardey (2007).
247 Ladkin (2010).
248 Ibid., p. 28.
249 Here the term 'moment' is not related to time, but it is used in relation to the meaning of 'moment' in a mechanical science, meaning 'momentum', like 'torque' or 'power.'
250 Ladkin (2010).

Purpose

In general, the purpose of an operation or process is ensuring an efficient and effective course of all activities required to achieve desired objectives. From the perspective of this study, the purpose of leadership is primarily to warrant that the organisation's primary processes are executed efficiently and free of safety risks which may potentially lead to safety incidents. A purpose, applied to the domain of risk reduction, requires a change process to be conducted in order to change a relatively high-risk situation into a less risky situation. Here we deliberately avoid the use of the term 'safe' in order to emphasise that risk reduction is not identical to elimination of all risks, known and unknown and optimal safety does not necessarily imply a zero-risk condition, because "you don't know what you don't know"[251] (also called: unknown-unknowns). [252, 253]

Leaders

The definition of a leader by Drucker is most concise and very relevant to this study: "A leader is someone who has followers."[254] However, often people refer to the difference between managers and leaders as quoted by Bennis: "Managers do things right and leaders are people who do the right thing."[255] Kotter argues that leaders differ significantly from managers, and claims that "both are necessary for success in an increasingly complex and volatile business environment."[256] We follow Kotter's statement by acknowledging that leaders, in any organisational position, play a role in managing the risks that organisations are facing.

We refrain from elaborating on this distinction in this study because we believe that, with respect to the risk reduction process, both positions are considered influential at their own hierarchical level, and in their own specific capacity. We argue that non-constituted leaders, for example leaders based on seniority, professional experience, language skills, or specific specialist competences, may also play important leading roles in an organisation's efforts to control (the safety risks of) primary processes.[257] In this section we refer to people who are not formally assigned as leaders, but who may be influential to their peers or to their formal supervisors due to their personalities, and individual competences, as mentioned above. In case of a need for leadership, they will take up the leading role, and whether people will accept their roles as followers is highly dependent on the quality of leadership which emerges from collective interaction.[258] Our focus is therefore on the leader-follower relationship in general, in which leaders enable followers to follow the paths (behave) preferred by the leader.

251 Gowland (2011), p. 10.
252 Van Asselt (2000).
253 Lindhout (2019).
254 Drucker (1996), p. 1.
255 Bennis, Nanus and Garnier (2007), p. 11.
256 Kotter (1999).
257 Post (2004).
258 Ladkin (2010).

In a study into the effect of 'knowledge sharing', Lee presents how team roles, including the leader's role, may shift from one to another team member where this is considered functional.[259] Depending on the specific requirements of the actual situation, people may be given or take a leading role. Hierarchy does not necessarily prevail; any member of a group (managers, as well as supervisors or their subordinate followers at the sharp end) can emerge as a leader in his or her specific individual organisational and situational context. The availability of specific relevant qualities in combination with a specific context may put relatively subordinate people into a leader's role, which they may flawlessly fulfil.

In this respect, the work of Hook is of interest; he distinguishes two types of leaders: 'event-making' leaders and 'eventful' leaders.[260]

Event-making leaders lead an organisation proactively in issues where vision, creativity and perseverance are required to obtain innovative results. They represent the constituted leaders, acting on a strategic level.

Eventful leaders, in contrast, stand out by taking the lead in dilemmas, when everybody understands that 'something is to be done', but all are waiting for someone else to take the crucial decisions needed to solve the dilemma. Here it is expected that the more practical people who are operating on tactical/operational level may decide when and how to intervene upon the recognition of safety risks, in order to prevent a safety incident from occurring. Also, in cases of emergency, people may and often even will, ignore the formal organisational hierarchy and follow those who express themselves as extremely stress-resistant or skilled at leading the way to safety.[261] Ladkin also makes reference to 'eventful leaders' by suggesting that leadership that arises from crisis situations (e.g., fires, rescue operations, emission of toxic chemicals, medical emergencies) looks different from entrepreneurial (event-making) leadership in which someone generates a great innovative idea.[262]

Followers

Any member of a group who accepts leadership from someone acting as the leader of this group is considered to be a follower. In an organisational context this is to be understood as: 'followers move behind a leader, following the directions and speed as indicated by that leader and by doing so, creating the change required to reach the intended common goal.' Where leaders are successful as the commander, mediator, inspirator, or motivator, followers will execute their tasks as required to realise the intended change as indicated by the leader, regardless of his or her formal hierarchical position in (or even outside) the organisation.[263]

259 Lee, Gillespie, Mann and Wearing (2010).
260 Post (2004).
261 Cullen (1990).
262 Ladkin (2010).
263 Ibid.

Context

All operational activities are subject to the context in which they take place. This context interacts with the way people in general, including leaders, are able to cope with the physical, organisational and personal surroundings.

Different scholars suggest that the way people behave in an organisational setting, as well as the effectiveness of their actions is strongly affected by the situation surrounding them; their context.[264, 265, 266, 267, 268] The term context is to be interpreted here as physical (type of the task, working environment) as well as conceptual (organisational climate, type of the task, time of the day, ability, etc.) and socio-psychological (social relations of leaders and followers, mutual career competition, peer pressure).[269] Yukl claims that major contextual variables surrounding leaders also include the place of a leader in the organisation, characteristics of followers, the nature of the work to be executed, the type/design of the organisation and the nature of the external environment.[270]

Here organisational habits and hierarchical culture also play a role. People may resist and refuse acceptance of their role as followers of people who act as leaders. Therefore, in order to maintain the effectiveness of their acts, leaders must monitor how their followers react to their performance on a continuous basis. About this Ladkin argues: "leaders must remain within a particular 'identity orbit' in order to remain viable as 'leaders' for particular groups. If a 'leader' moves outside of the bounds of a group's identity, he is no longer able to lead."[271] Here it is assumed that leaders know how their followers look at them and that followers can only recognise themselves as 'followers' through the eyes of their 'leaders.' These perceptions are part of the context in which the people conduct their activities. If these perceptions are not positive, this creates a suboptimal context, with the potential of the leader-follower connection being impaired catastrophically.

2.3.4.2 Causal relationships in leadership processes

The figure below displays how in this process the variables: leader, follower, traits, skills, attitudes, behaviour and situational variables interact. In this diagram by Yukl[272] (Figure 17) the mutual influence of all elements on other elements meets in the nucleus node 'influence variables.' Here leaders, followers and situational context serve as key variables; a leader who demands optimal performance by his or her followers can only achieve this

264 Bushe (2011).
265 Yukl (2010).
266 Dekker (2006a).
267 Groeneweg (1992).
268 Reason (1997).
269 Ladkin (2010).
270 Yukl (2010).
271 Ladkin (2010), p. 67.
272 Yukl (2010).

by exhibiting behaviours that fit the situational context. Yukl[273] suggests that situational variables are the basis of the primary type of leadership process, in which the leader mobilises his appropriate traits and skills, in order to exhibit his most relevant behaviours, to encourage the follower to show attitudes and behaviour, which are required to realise the desired performance outcomes.

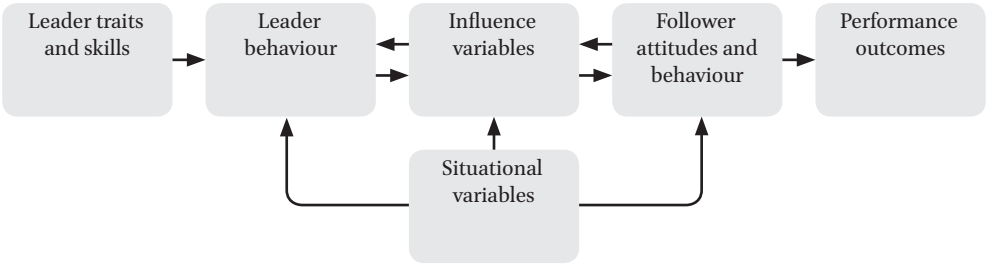


FIGURE 17 Causal relationships among the primary types of leadership processes (Yukl)

In this leadership process model, Yukl shows that leaders are not autonomous operators of their own preferred process. Their behavioural performance is restricted by their personal traits and skills. And in their attempts to achieve the desired follower behaviour, the leader depends on the specific characteristics of the situational variables (context) they are facing. For a leader, this context is only controllable to a limited degree, meaning that he or she has to be able to adapt to different, often unforeseen contextual situations. In this respect history plays a crucial role. In order to understand the actual nature of leadership applied in an operational situation, it is necessary to understand the organisational history as well as the personal histories and mutual relationships of all actors involved.

The process model as developed by Yukl represents the leadership process in general terms. In pursuance of the context of this research into the role of leaders in the prevention of safety incidents, we converted this general model by modifying the generic terminology into research-specific classifications. Therefore, we modified 'leaders' traits and skills' into 'leadership orientations', translated 'follower attitudes' and behaviour into 'risk reduction' and changed 'performance outcomes' into the outcome of the risk management process: the 'safety state of primary process.' Below, the modified, research-specific process diagram is presented (Figure 18).

273 Ibid.

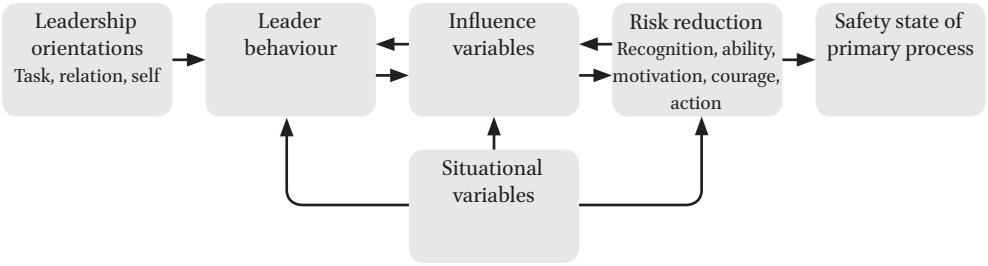


FIGURE 18 Causal relationships by leaders' influence on prevention of safety incidents

This converted version of the original process model by Yukl clarifies how leadership orientations influence leader behaviour and how risk reduction influences the prevention of safety incidents. Also, this model shows the influence of situational variables on leader behaviour, risk reduction and influence variables. Finally, the model displays the interactive relationships between influence variables and leader's behaviour, as well as influence variables with risk reduction.

2.3.5 *Behavioural motives*

In our research into what motivates leaders to behave the way they do vis-à-vis their followers, we studied the discriminating factors leading to (un)safe leadership behaviour. In order to clearly identify the discriminating factors, we considered the following leadership theories of interest: 'The Gap-Outcome-Power Model' by Leiden University, the 'Achievement Motivation Theory' by Atkinson, the 'Human Motivation Theory' by McClelland, the 'Motivational Leadership Model' by Winter and 'leadership psychopathology' by Post.

2.3.5.1 Gap-Outcome-Power Model (Leiden University)

The 'Theory of Planned Behaviour' by Ajzen[274] as described in paragraph 2.2.7.2, has been operationalised by Leiden University and labelled 'Gap-Outcome-Power' model. This model serves as one of the underpinning theories of the 'Hearts and Minds' concept as developed for Shell International Exploration and Production (Figure 19).[275] [276] This interpretation of the original model by Ajzen explicitly identifies, in addition to other parties, the role of leaders as influencers (in this model referred to as 'management') and their position in the motivating environment of actors.[277]

274 Ajzen (1991).
275 This model has been published by the Stichting Tripod Foundation in 2015.
276 Stichting Tripod Foundation (2015).
277 Van der Graaf and Hudson (2002).

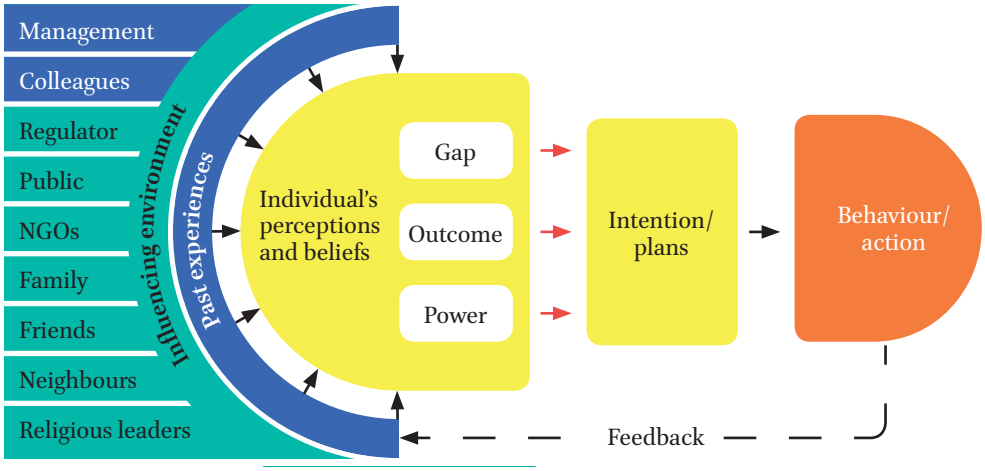


FIGURE 19 Gap-Outcome-Power Model (Leiden University)

In this model the motivating variables of an individual's perceptions and beliefs, as well as their past experiences and uncontrollable external variables created by their environment, are merged into one model. The organisational, physical and socio-psychological context in which the followers are expected to work (to execute the change process) are included. All these variables have an *influence* on the leader as well as on the follower, but not in a deterministic manner. These variables *may* alter the behavioural beliefs etc. of people, but that is not a given Newtonian logic. In this model the variables form an integrated context, which, in contrast to a deterministic 'if-then' scenario, where a variable *will determine* the outcome, result in a *probabilistic* 'if-maybe' scenario, which does not comply with predestined rules.

So, the effectiveness of this context *may* affect the actor's behavioural beliefs etc., but there is no quantitative ratio, logic, or algorithm defined, by which a calculable prediction of the influence of leaders on followers might be possible.

Followers are not in the position to modify this context. The controlling power in this context is with the leaders. It is the leader's responsibility to optimise the context of their followers. Applied to an operational setting, this theory refers, as an example, to the following possible actions by leaders: 1. Selecting and hiring the people with the 'right' attitude, 2. Convincing them of the appropriate organisation's norm with respect to risk reduction and 3. Offering them sufficient education and training facilities to enhance their skills and knowledge.

In this model, leaders are responsible for seriously considering the external variables in their strategy how to approach their followers, as these variables represent the preconditional requirements for successful operations. It also shows the dependency of followers, where it concerns performing desired behaviour. If leaders are insufficiently in control and fail to create a favourable context, followers may not perform as envisaged (Note: If-Maybe!).

Where leaders respect their roles and positions regarding the external variables, it is

very likely that their followers will act as requested and their common intended purpose will be achieved. This is what we refer to as the 'leadership process of change.' Process philosophy holds that activities take place according to certain predetermined plans, or, in case of disruption of these, alternative contingency plans are activated in order to mitigate the damage.

2.3.5.2 Achievement Motivation Theory (Atkinson)

We explored which factors are indicative in order to discriminate between different typical behaviours of leaders. In our search for relevant differences in leaders' behaviours, we consider the Achievement Motivation Theory as proposed by Atkinson to be an appropriate theoretical basis. This scholar suggests that people's motivation to select a certain path of action among a set of possible alternatives is based on their specific *motive*; their expectancy that the selected path will lead to a particular *consequence* and that following this path will result in a positive *incentive*.[278] Regarding this type of motivation, this scholar identifies two problems: 1. The possible selection of the wrong path of action and 2. The resultant of the action once it is initiated and its tendency to persist for a time in a given direction. Here the individual's motivation of why to behave in a certain way is the core of the theory. So, in the context of this research, applied to leaders, we take it that this also relates to the way leaders behave vis-à-vis their followers.

In Atkinson's 'Theory of Motivational Determinants', the motivation of people to achieve certain *goals* is related to the *risks* they dare to take in order to succeed. Atkinson suggests that people's motivation to act in a certain way is based on a specific *motive*, i.e., their *expectancy* that their acts will lead to a particular consequence and that one expects that these acts will be followed by a positive *incentive*.

Atkinson takes the position that:

> A motive is conceived as a disposition to strive for a certain kind of satisfaction, as a capacity for satisfaction in the attainment of a certain class of incentives. The names given motives – such as achievement, affiliation, power – are really the names of classes of incentives which produce essentially the same kind of satisfaction: pride in accomplishment, or the sense of belonging and being warmly received by others, or the feeling of being in control and influential.[279]

In the referred article, Atkinson claims that achievement motivation may lead to behaviour towards achieving the expected goal, but also to behaviour that aims to avoid failure.

In relation to the position of leaders and their relationship to followers, in that they aim to make the followers do what they (the leaders) want them to do (or refraining from that), it requires careful preparation of the applicable success factors by first assessing

278 Atkinson (1957).
279 Ibid., p. 360.

the actual contextual situation (who are my followers and what is their contextual situation?). This may require some thoughts about the following; does the person I want to do something understand what I ask and why I ask this; is this person supportive to me (or are we 'mental enemies'); will this person accept my request; to what type of behaviour is this person extremely sensitive; what is the persons mental state at this moment; etc.? Leaders must consider these questions or situation cues before actually approaching a follower with their request. So, in order to achieve their goals, leaders assess the risks of encountering a follower's resistance, rejection of the request, or even being ignored, by which the leaders' goals are not achieved. Atkinson conducted experiments in which he tested how the differences in strength of achievement-related motivation influence behaviour in competitive achievement situations. He concluded that, regardless of the path selected by the individual, achievement of a goal or avoidance of failure, the strength of motivation is the combination of *motive* (achievement, affiliation, or power), *expectancy* (goal-attainment or failure-avoidance) and *incentive* (what's in it for me).

Since Atkinson is not specific about the limitations of application of his theory, we argue that this theory may also be applied to people's expectations in relation to the risk reduction process and with respect to this, we suggest that leaders will be most successful in risk reduction if they show behaviour which clearly takes into account their subordinates' expectations where it concerns the consequences and incentives related to compliance with their leader's requests.

2.3.5.3 Human Motivation Theory (McClelland)

Based on Atkinson's theory, McClelland developed his motivational theory.[280] McClelland's theory also addresses three typical motivational drivers: achievement (setting and accomplish challenging goals), affiliation (wanting to belong to a group, to be liked) and power (wanting to control and influence others, like to win arguments).[281] McClelland took the position that most individuals possess and exhibit a mix of these three drivers, depending on how people are influenced by and will react on their specific situational and social context. In addition to this, McClelland suggests that often one of these drivers is exhibited as the dominant one. We take the position that these drivers apply to all people, leaders as well as followers. In this paragraph we focus on leaders as the group that exhibit their behaviours vis-à-vis their followers. Regarding different influences on risk management-related cooperation by subordinates, we suggest that the influence of leaders who predominantly exhibit 'achievement'-driven behaviours, will be different from the influence of leaders who predominantly exhibit 'affiliation'- or 'power'-driven behaviours and that this applies mutually between every different motivational driver.

Based on this achievement motivation theory of Atkinson, McClelland further developed his own motivational theory. McClelland focuses on economic growth and as a

280 There are different interpretations about the sequence in which both scholars developed their theories.
281 McClelland (1987).

consequence his work is mainly based on his experiments in relation to the commercial and economic environment. His subjects are the leaders/entrepreneurs who lead their followers to achieve economic growth as main objective.

Like Atkinson, McClelland's theory involves three types of motivational drivers: achievement (setting and accomplishing challenging goals), affiliation (wants to belong to a group, to be liked) and power (wants to control and influence others, likes to win arguments).[282] McClelland took the position that people will often exhibit a mix of these three motivational drivers, depending on how they are influenced by and react to their specific situational and social context. Additionally, he suggests that often one of these drivers is exhibited as the dominant one. In the work of McClelland, 'achievement' plays a central role. Referring to the work of Darwin, he mentions the 'desire to survive' as the principal 'need', which, in his terms, is equal to the words 'motivational motive.' He differentiates between motivation and action, because people may perform similar actions for very different motives. Eating may be motivated by being hungry, but eating chocolate or ice-cream might also be a luxury satisfier.

So, McClelland focuses on motives as the expression of one's needs, regardless of the consequential following acts. Like Atkinson, he distinguishes three motive types: achievement, affiliation and power. Which motive(s) leaders use to motivate their followers depends a great deal on the specific situational context and on what the leader perceives to be the best motive to apply in relation to the individual characteristics of his particular followers.

Research results suggest that achievement-based motivation will stimulate followers when achievement in the narrow sense (e.g., high output figures) is the objective. In the sense of economic activities, achievement as defined by the leader may serve as the principal motivator for followers to undertake certain actions. But followers may have different preferences where it concerns their motivations to satisfy the request of their leaders. Where the need of people is to be liked, accepted, or forgiven, achievement motivation will be most effective.

For people who are sensitive to a personal approach or who may easily be seduced by special rewards or a pat on the back, the affiliation motive may be more effective. Here the relationship between leader and follower may be sometimes even described as 'friendship' and the 'If you scratch my back, I'll scratch yours'-effect is the leverage for success. According to McClelland, working-affiliation-based motivation indicates a close relationship between leaders and followers.

Leaders who are concerned with controlling the means of influencing people will preferably apply the power motive type.

With reference to this motive type, McClelland writes:

> Such concern may be inferred from emotional reactions to a dominance situation (e.g., pleasure in winning or anger in losing an argument, 'statements of wanting to

282 Ibid.

> avoid weakness', etc.), from dominance activities —'disputing a position, arguing something, demanding or forcing something, trying to put a point across, giving command, trying to convince someone of something, punishing someone'—or from a description of 'an interpersonal relationship which in its execution is culturally defined as one in which a superior person having control of the means of influencing the other who is subordinate (e.g., boss-worker, judge-defendant).[283]

In this quote, McClelland clearly shows his distinction between 'motive' (pleasure in…) and 'action' (disputing…).

As the work of McClelland is about economic growth and, consequently, entrepreneurship, he prominently addresses 'risk-taking' in relation to leadership. He states that "entrepreneurship involves, by definition, taking risks of some kind."[284] Having asked business executives what their core activity is, the answer was: "We make decisions."[285] According to McClelland, this is characteristic for the role of leaders, in that they are specialised in handling situations which call for something more than routine action, which implicitly involves taking risk of some kind. The emphasis on the activity of decision-making points to the specific organisational and situational context of leaders who, in their daily operation, have to deal with the significant uncertainties where it concerns successful, undisturbed operations. McClelland summarises the entrepreneurial role as: "Decision-making under uncertainty" and that is precisely what this research is about.

Did McClelland declare business people to be gamblers? Not really. McClelland stated: "The real point is that the gambler can exercise no control over the outcome, unless he uses loaded dice, whereas the businessman can influence by his actions whether his decisions will turn out in the long run to be successful or unsuccessful."[286, 287]

With reference to McClelland, we take the position that in order to prevent operational disturbances, leaders have to pay particular attention to their organisational and situational context of which individual characteristics of their followers are an important part. We suggest that leaders who predominantly exhibit 'achievement'-driven behaviours will have different influence on the effectiveness of the risk reduction process as leaders who predominantly exhibit 'affiliation'- or 'power'-driven behaviours and that this applies mutually between every different motivational driver.

2.3.5.4 Motivational Leadership model (Winter)

In a study about personalities, Winter has discovered some particularities on people's motivational preferences, or 'motive profiles.' Like the previously referred-to scholars, in this study, Winter also refers to achievement, affiliation and power motives. He con-

283 McClelland (1967), pp. 167–168.
284 Ibid. p. 210.
285 Ibid., p. 210.
286 Ibid. p. 211.
287 Disclaimer: On this we do not necessarily agree with McClelland.

cludes that personality is a complex phenomenon; motives, cognitions, traits, as well as social context (present as well as past context) play a role. Behaviours and outcome of these can be predicted, but only in contingent (if-then) ways.[288]

According to Winter, the three motives (achievement, affiliation and power) influence personality, but skills, knowledge, individual traits and social context contribute as well. Winter claims that personality can be studied reliably and objectively without direct access. To this end he developed a testing method analysing the content of the language spoken and written by leaders. This content-analysis method comprised analysis of the same three motives as used by Atkinson and McClelland (achievement, affiliation and power). Based on his analyses of the words spoken and written by his subjects, he generated their personality profiles. In his research he discovered that power-motivated people invest much of their energy in their job and they enjoy it. In contrast, achievement-motivated people are energetic too, but seem to take less pleasure in their job. Winter explains the latter with the fact that achievement-motivated people are 'living for the job' and enter their workplace with enthusiasm and idealism. But, sooner or later, setbacks like personal conflict, production pressure, or cost overrun will appear. But achievement-motivated people are quite flexible and will use feedback from other people in order to restore performance in the best possible way to continue the job as soon as possible. Achievement-motivated people function best when they are 'in the driver's seat.' Some studies suggest that people high in achievement motivation learn such control relatively early in their childhood. This may indicate a relationship between traits and motives. About that Winter claims: "Conceptually traits involve *consistency* of publicly observable behaviour […] I believe that, while they are useful, such trait descriptions have their limits; they are certainly not a complete description of anyone's personality."[289]

Winter is not very supportive to the approach of determining someone's personality through the use of traits. To illustrate this, we refer to his finding that:

> … among extraverts, affiliation motivation (as expected) is associated with successful interpersonal relationships; among introverts, however, these relationships significantly reverse. In other words, introverts high in affiliation motivation have affiliation-related problems. Thus, traits are not the same as motives; rather, traits channel or direct the ways in which motives are expressed in particular actions – sometimes channelling them in strange directions.[290]

Regarding personalities, in addition to traits and motives, Winter also refers to social context. There he focuses on the influences by e.g., different life experiences (e.g., a soldier in a war situation versus a clerk in an office), different roles in society (politician or business person), or different living environments (village or big town). Most notably these differ-

288 Winter (1991).
289 Winter (2005), p. 567.
290 Ibid., p. 569.

ent experiences create many differences in cognitive content and style.

Winter suggests that the concerned four domains (traits, motives, cognitions and social context) constitute the four basic elements of personality. With respect to his claim that behaviour can be predicted by knowledge of these four elements, we are somewhat reserved. Referring to specific contextual situations and scenarios, Winter claims that "in such an enterprise as studying leaders at a distance, a certain sense of humility is both necessary and becoming."[291]

On this aspect Winter suggests:

> We cannot always make absolute predictions from leaders' personalities because we cannot know future situations, especially the surprising and improbable ones that they may encounter [...] we can make contingent, conditional, 'if/then' predictions: that a person of type *X* (or a person scoring high on personality variable *X*), under condition *Y*, is likely to exhibit behaviour *Z*. We cannot know everything, but we can know something.[292]

Regarding the mentioned 'surprising and improbable situations', leaders may diverge from the 'standard' behaviour they exhibit under 'standard operational conditions', where deviations of intended processes are relatively limited and safety incidents are not an issue. In the following section, some of the latter situations and some possible related diverted behaviours are discussed.

2.3.5.5 Leadership psychophysiology (Post)

When operational processes deviate from their intended paths, operational conditions descend to a 'crisis' level and everyone feels out of control, people tend to seek surety by behaving a different way than they exhibit under normal conditions, when they perceive that they are fully in control. In conjunction with this, Yukl suggests that extreme pressure on leaders to perform a difficult task or a safety emergency situation creates a situation where "... the role expectations for the leader are likely to change in a predictable manner."[293] On this phenomenon, Post has conducted some specific research. He specifically concentrated on the way certain types of leaders react when facing stressful, possibly crisis situations. With his approach he took a different, psychophysiological route to explain how and why leaders behave different when they encounter an unexpected stressful situation, one which means 'emergency!' to them.[294]

Time constraints, (perceived) urgency, ambiguity, uncertainty, uniqueness and surprise can be mentioned as contributing factors to the mental stress being generated in

291 Winter (1991), p. 579.
292 Winter (2005), p. 579.
293 Yukl (2010), p. 92.
294 Post (2004).

people who face a safety incident.

According to Post, the character of decisions made under critical conditions, e.g., during a safety incident, differs from that of the day-to-day rational routine process of decision-making under normal operational conditions. In his research, Post focused on the quality of behaviour by politicians in crises. He concludes that "the consideration of the individual is, for the most part, undifferentiated."[295] We have no reason to assume that decision-making under crisis conditions by leaders in an organisational setting is of a different nature. In this respect we also refer to the Thomas' theorem: "If people define situations as real, they are real in their consequences."[296] In his explanation of understanding behaviour under crisis conditions, Post differentiated between the roles of people and their individual personality. Post claimed that there is no one-to-one relationship between the significance of an incident (as defined above) and the amount of stress (as experienced by an individual). What threatens someone, resulting in psychological stress, may differ substantially from what threatens someone else. But the particularities of an incident are independent of individual experience.

Under stress, characteristic defence patterns intensify, thus different personality types may react differently to identical external stress-generating signals. Of special interest are the defence patterns of 'avoidance' and 'hypervigilance.' Avoidance is the result of not defining the situation as an incident or delaying taking a decision due to the inability to cope with the situation at hand. In contrast, hypervigilance is the situation where someone feels the urgency 'to do something', resulting in quick decision-taking before the situation is properly assessed.

The literature in the safety domain does not answer the question of which leaders are particularly apt to behave in a certain way – or 'why people react the way they do under particular circumstances.' But what is known, is that ambiguity seriously influences the tolerance of individuals and that this is related to personality and consequent orientation.

Research by Post has discovered that successful, but compulsive, individuals are characteristically uncomfortable with uncertainty. In ambiguous situations, they behave very differently than action-oriented people, who react more intuitively. The latter are not stressed as easily as their compulsive colleagues may be. Although an action-oriented individual may step more easily into the pitfall of hypervigilance, he or she feels uneasy when nothing is done and does not feel comfortable until 'something is done.' Under escalating conditions, it is of extreme importance to accurately assess the point at which one considers the situation to be of critical proportions and when this situation is irreversibly heading into a major incident. Here also the personality disposition of the leader plays a crucial role, as both errors in calling a non-crisis an incident as well as underestimating the criticality of an actual crisis situation may have major consequences.

A different risk where one may encounter the above-mentioned errors in decision-making, is where the problem may appear due to flawed functioning of the leader's

295 Ibid., p. 102.
296 Merton (1995), p. 380.

cognitive faculties, caused by a medical situation, e.g., due to organic brain damage. In such a case the leader's capacity to assess an escalating situation may be reduced to a level where replacing that leader becomes a, possibly uneasy, but necessary, consideration in order to prevent escalation of a threat into an incident situation.[297]

Regarding leaders in (perceived) crisis situations, Post distinguishes three personality types: compulsive, narcissistic and paranoid leaders. He argues that compulsive and narcissistic leaders are quite common. Paranoid leaders are much less apparent, but he includes this personality, because "aberrant reactions of paranoid individuals under stress can have catastrophic consequences."[298] Where individuals have compulsive, paranoid, or narcissistic personalities (as many successful leaders do), these traits can be expected to grow to extreme proportions under stress conditions.

In the following paragraph we will elaborate on the core properties of the referred personalities as presented by Post.

The compulsive personality[299]

This personality type is often found among successful leaders in executive and managerial positions, who are used to being the ones to whom people look when important decisions are to be taken. The properties that often contribute to the success of people who are identified as compulsive are: good organising capabilities, attention to detail and emphasis on rational processes. Thinking is dominant over feeling and there is a need to keep strong feelings like anxiety and anger under control. Compulsive personalities take decisions on a rational basis and try to assess and eliminate all possible risks before deriving a conclusive decision.

However, under stress conditions or, even more, in crisis situations, often there is no time to consider all possible solutions to mitigate the hazard. Then the compulsive leader, under time pressure and understanding that he is the designated person who should decide which course to take in order to resolve the situation, may mistakenly appraise the situation, resulting in a quick, but failing, remedial action. In contrast, in order to prevent quick, but wrong, decisions, compulsive leaders may become disabled and preoccupy themselves with detail; no longer overseeing the situation, they then become paralysed, resulting in indecisiveness.

Compulsive leaders, when under pressure, isolate themselves from followers in order to give themselves to think and come up with the right solution. At that time, no well-intended, or possibly useful, support from anyone is welcomed; the leader him/herself 'will lead his/her people to safety.' In general, compulsive leaders are compliant and pay respect to formal procedures. Therefore, a way of reducing the risks of the described behaviour is to prepare formal emergency procedures that will offer guidance on how to resolve different types of safety incidents. Most likely, compulsive leaders will follow

297 Post (2004).
298 Ibid., p. 106.
299 Ibid.

pre-defined recommended courses of action, because these give them the security of complying with what is expected from them. But if they are under stress and choose to refuse advice from anyone, these individuals may easily misjudge the symptoms of the accident scenario they are in. Then, unknowingly, they may trust a procedure, which does not match the actual crisis situation at hand.

The paranoid personality[300]

The core properties of paranoid personalities are: pervasive and long-standing suspicion and mistrust of people in general. Paranoids are always expecting plots and betrayal and see enemies all over the place. In part this is caused by an embellished need for autonomy; they trust nobody except themselves. Suspiciousness is the paranoid's basic theme in life. They will always seek confirmation of their own assumptions, attitudes and biases. And they are always looking for clues that confirm their own conclusions. Paranoids tend to be rigid and unwilling to compromise. When they are convinced of the existence of a certain hazard, no contradictory evidence will change their minds; what they 'see' is real. In such case, real paranoids may become hostile, defensive and stubborn and no reasonable argument will suffice to convince them of their mental flaws. In stress situations, paranoids can become dysfunctional and should be taken out of their leading position (where, in fact, they never should have been assigned to anyway). The greater the stress, the more paranoids hold to their fantasy impression of the world. Where, due to their hierarchical power positions, paranoids are considered to be influential in crisis situations, compensating measures are to be taken to prevent paranoids' actions from endangering the organisation and/or its environment.

The narcissistic personality[301]

In principle, a narcissist is a person with extreme self-confidence. These leaders can be very successful, as a mix of self-confidence and ability is a successful combination of traits. But extreme, full-blown narcissism can be inconsistent with sustained effective leadership. Leaders with a strong narcissistic personality surround themselves with followers who agree with everything they say and do whatever they want them to do. These followers are selective with respect to information to their leader, especially where they consider that this information might not be welcomed. For narcissists, their self-esteem maintenance function dominates and criticism on their actions is not accepted and may result in disciplinary consequences. A narcissist may design his/her own reality and be living completely out of the 'real world.'

Post elucidated a narcissistic person as "so vulnerable under his grandiose façade, that it is difficult for him to acknowledge ignorance and, accordingly, to accept information or constructive criticism of his ideas."[302] As these leaders are overly confident about

300 Ibid.
301 Ibid.
302 Ibid. p. 109.

the greatness of their ideas, they overestimate the probability of success for their plans. If they are in the position to take crisis-related decisions, they can be a real danger to their environment. Where there is no option to avoid narcissistic leaders as counterparts in an incident situation, one should take caution and consider to follow the advice by former US President Ronald Reagan: "Trust, but verify."[303]

Conclusively on these three personality types Post stated: "It emphasizes the point that in considering the effects of personality on crisis reactions, one must consider the interaction between different personalities in the decision-making hierarchy [...] The decision maker does not make decisions in splendid isolation but in relation to a chain of command. The interplay of personalities can influence both the information on which the decision maker acts and the manner in which his decisions are implemented."[304] This statement by Post may serve as a clear directive for the functionaries who are responsible for the design of organisations and the consequential selection and hiring of employees (this applies for leaders as well as followers).

2.3.6 *Profiling leaders*

The leadership theories as referred to in the previous sections are different in the descriptions of the discussed motivational drives. In order to deliver an unambiguous and normalised representation of these different drives, we will concur with the terminology as defined in Section 4.2.3 'Leadership characteristics'. Where applicable, we will therefore use the following terms: 'Leadership orientations', 'Task-oriented leaders', 'Relation-oriented leaders' and/or 'Self-oriented leaders.'

We elaborate on these characteristics in order to profile leaders. For each leadership characteristic, we explain: a) the leader's particular orientation, b) the leader's relevant motivational drive, and c) the specific indicators considered relevant for the particular leadership characteristic.

Below, a comparison table (Table 1) shows how the different motivational drives as mentioned by Atkinson, McClelland, Winter and Post, as previously discussed in this section, compare with these three leadership orientations.

303 Reagan (1987), p. 110.
304 Post (2004) p. 113.

Orientations	Atkinson	McClelland	Winter	Post
Task	Achievement	Achievement	Achievement	Compulsive
Relation	Affiliation	Affiliation	Affiliation	Paranoid
Self	Power	Power	Power	Narcissist

TABLE 1 Comparison of leadership characteristics versus motivational drives

The (identical) terminology as used by Atkinson, McClelland and Winter, applies to an organisational state of 'normal operations.' The terminology used by Post refers to situations where leaders are under high mental pressure or the operations are in a state of facing a (potential) major incident. These tense situations may seriously affect the way leaders behave.

Pardey explains that disorder and uncertainty are stressful and he argues:

> Crises mean that the normal order and certainty of the workplace have been disrupted and people feel that they have lost control of their own world. The result of this is anxiety which can become panic if the incident is particularly severe and/or sudden in its impact. This is when people start to behave like headless chickens – they cannot see what they should be doing or do not seem able to make sensible decisions. They have the tendency to assume that, since normality has disappeared, the normal rules no longer apply and lose any sense of direction, heading off in different directions because they do not know which way they should be heading."[305]

Also, Pardey[306] suggests that in stressful situations, when there is time pressure and limited information, leaders may change their approach and e.g., refuse to consult other people.

Post[307] elaborates on this phenomenon and distinguishes different reactions where it concerns the different leadership orientations. He argues that there are three possible behavioural reactions (see also 2.3.5.5): compulsive, paranoid, or narcissist. Based on the nature of the three different leadership orientations, we argue that, when experiencing an incident situation, Task-oriented leaders may change their behaviour as exhibited under normal operational conditions into compulsive behaviour, Relation-oriented leaders may alter their normal behaviour into a paranoid variant of behaviour and Self-oriented leaders may show the tendency to exhibit narcissistic behaviour. In the section referring to Post, we quoted his statement: "The decision maker does not make decisions in splendid isolation but in relation to a chain of command."[308] In this context Post specifically

305 Pardey (2007), p. 177.
306 Ibid.
307 Post (2004).
308 Ibid., p. 113.

mentions the influence of interaction between leader and followers under conditions of mental stress.

Stogdill claims that: "A person does not become a leader by virtue of the possession of some combination of traits … the pattern of personal characteristics of the leader must bear some relevant relationship to the characteristics, activities and goals of the followers. Thus, leadership must be conceived of in terms of the interaction of variables which are in constant flux and change."[309] In that respect, Winter proposes that personality is built from four basic elements: personal traits, motives, cognitions and cognitive constructions and social context.[310] Based on these four elements, people choose, consciously and unconsciously, what elements of which orientations they will adopt in which context. So, the behaviours exhibited by leaders are instigated by more properties than 'leadership orientations' alone. In an intervention experiment aimed at improving supervisors' effectiveness with respect to operational safety, Zohar[311] argues that improved transactional supervision enhances safety behaviour of operational employees and that transformational qualities result in incremental effects.

Horner also refers to the relativity of profiling people. He suggests that people's behaviours are dependent and therefore contingent on interaction of the leader's traits, the leaders' behaviours and the specific context of the leader. Horner supports the idea that leaders may decide to apply different leadership orientations in different situations.[312] Therefore, according to Horner, leaders' behavioural patterns are not static individual attributes, but may be applied 'as appropriate', depending on the specific organisational and situational context. But this does not imply that it is not useful to identify the predominant behavioural patterns as exhibited by leaders.

The above considerations have led to the assumption that the three leadership characteristics (Task, Relation and Self orientations) are useful distinctions for characterising the influence of leaders on the prevention of safety incidents. In the following paragraphs, leadership profiles for Task-, Relation- and Self-oriented leaders are described. Each of these descriptions include the leaders' focus, motivational drives, leadership roles and behaviour indicators.

2.3.6.1 Task-oriented leaders

Yukl[313] suggests that leaders who are Task-oriented perform their leading responsibilities primarily with a focus on activities which facilitate completion of the work in an effective and efficient way, like the coordination and facilitation of the primary processes. The Task-oriented leader is the key person for ensuring that the tasks required to achieve the organisation's objectives are performed. A Task-oriented leader concentrates on func-

309 Stogdill (1948), p. 64.
310 Winter (2005).
311 Zohar and Luria (2003).
312 Horner (1997).
313 Yukl (2010).

tions like planning, scheduling, coordinating activities and ensuring that the required supplies and equipment are provided and they render assistance where required. During routine operations, Task-oriented leaders set high, but realistic, targets. These leaders are to be considered as 'achievement-motivated' leaders.

According to Atkinson, for achievement-motivated people, the following applies: "… the attractiveness of success is a positive function of the difficulty of the task…."[314] During interaction with their followers, Task-oriented leaders primarily choose to play the roles of motivator and achiever and act as a knowledge base for their followers. Task-oriented leaders are focused on achieving satisfaction in job performance and are therefore likely to promote future task performance of their team. For instance, research by McClelland[315] shows that Task-oriented leaders are evaluated in terms of standards of excellence where intelligence and leadership capacity are concerned. In order to strive for optimal results in (non-routine) job performance, Task-oriented leaders apply their knowledge to support their team members in improving task performance.[316] Also for Task-oriented leaders, job-related knowledge and skills, if applied to helping subordinates to better perform their tasks, are a major source of personal power.[317]

Pardey claims that leadership is "… the ability to bring about movement or change in a group or organisation, when there is risk or uncertainty, by inspiring others to head in a particular direction."[318] But the world around leaders is not a static given; for instance, as Ladkin explains, the world is actually in a state of flux, changing all the time, as well as generating its innovations at a fast pace.[319] So, the Task-oriented leader is not only charged with the task to *bring about* change, he or she must also be prepared to *cope with* external changes (e.g., different requirements about products by clients, increased legislation, environmental requirements from the surrounding society, different technologies) the organisation may be facing.

In that respect, McClelland[320] takes the point of view that the Task-oriented leader's mission to optimise results implies continuously seeking more efficient and effective innovative means and methods. This means that a Task-oriented leader would not properly exercise his/her leading role by ignoring the intellectual capacity and skills of the team members. So, according to Pardey,[321] in the leader's attempts to achieve optimal results and to get commitment from followers about a plan of action, the Task-oriented leader shares his/her challenges with the followers and is truthfully interested in their ideas. As argued by McClelland, in order to prevent the occurrence of such uncontrollable situations, Task-oriented leaders put effort into assessing the risks that apply to the operations

314 Atkinson (1957), p. 362.
315 McClelland (1967).
316 Ibid.
317 Yukl (2010).
318 Pardey (2007), p. 15.
319 Ladkin (2010).
320 McClelland (1967).
321 Pardey (2007).

they lead. McClelland claims: "a great part of the efforts of business executives is directed at minimizing uncertainty."[322] McClelland[323] claims that, especially when in an entrepreneurial role, where Task-oriented leaders are relatively autonomous, they believe in taking 'moderate' risk as a function of skill not chance, and then decide about the (non-) acceptance of this in relation to the drive to achieve the organisational objectives.

As explained by Yukl,[324] in leading operations, Task-oriented leaders have one primary objective: meeting operational targets. Therefore, any unanticipated operational interruption means a critical and often uncontrollable disturbance of the leader's plans.

However, Atkinson[325] suggests that in addition to the motive to maximise performance, Task-oriented leaders also aim at operating as efficiently as possible, which implies taking risks for failure.

McClelland[326] questions whether Task-oriented leaders are really able to judge the risks they take by their decisions to consider these as acceptable. Regarding this, he refers to the work of Sutton,[327] who claims that: "… there is a strong tendency among businessmen to emphasize that their decisions are based on 'facts' and thus to make favourable outcomes the consequences of perspicacity and 'judgement' rather than good fortune…."

The people running the primary operational processes, the leader's team, know their daily processes and they have their personal perception about the accompanying risks for unanticipated incidents. These people are physically in the best position to recognise and understand these risks. Through their operational knowledge and skills, they are also the people who know how to prevent these risks from escalating into incidents, resulting in personal injury, asset damage, or loss of organisational reputation.

For that reason, a Task-oriented leader typically respects the risk assessment of the team and, as referred to by Van Kampen et al.,[328] motivates them to intervene when they identify risks, which they consider to have the potential to create unanticipated process disruptions.[329] The Task-oriented leader will then balance the risks and the primary operational targets and take a decision on which path to follow. In some cases, e.g., where there is no agreement between the different actors involved, such decision may be based on the leader's intuition.[330, 331, 332]

In order to achieve his/her goals, a Task-oriented leader must sometimes be flexible

322 McClelland (1967), pp. 210.
323 Ibid., pp. 207–214.
324 Yukl (2010).
325 Atkinson (1957).
326 McClelland (1967).
327 Sutton (1954), p. 23.
328 Van Kampen, Van der Beek, Steijn, Groeneweg and Guldenmund (2017).
329 Bennis (1989).
330 In the context of this research, we consider the following definition by Michie (in Van den Herik, 2016) most applicable: "Intuition is simply a name for rule-based behaviour where the rules are not accessible for consciousness."
331 Van den Herik (2016).
332 Sutton (1954).

concerning compliance with procedures or protocols; however, that is inherent to the position and the nature of Task-oriented leaders and their moderate risk appetite: "Making decisions." [333, 334, 335] In this respect, Bennis takes the point of view that: "Your (read: the leader's) jobs charter must allow you to take risks, make mistakes, use your creativity to the hilt and encourage those who work with you to do the same."[336]

But the above-mentioned individual considerations, assessment of risk and consequential decisions by the Task-oriented leader are not only economically driven. The leader's obligations also include legal accountabilities, as well as a moral responsibility for the safety and well-being of the team.[337, 338, 339, 340, 341, 342, 343] Implicitly Task-oriented leaders carry the responsibility of identifying and assessing risks that might threaten their people and, where these risks are not shown to be within acceptable limits, ensuring improvements, especially where it concerns the quality "... to which changes (i.e., to working methods, organisational structure or staffing resources) are carried out, by taking into consideration any potential consequences...".[344]

Summarising, quoting McClelland: "Task-oriented leaders will choose an expert over a friend."[345]

The job-related properties of Task-oriented leaders as described above, are specifically valid during 'normal operations.' The tasks and responsibilities described above may be considered as natural parts of their preferred way of achieving an organisation's objectives. However, Post (ref. 2.3.5.5) argues that, when Task-oriented leaders face serious critical conditions and experience high levels of mental stress during the fulfilment of their tasks, they may modify their normal Task-oriented operational mode and escape into a compulsive type of behaviour.[346] The leader then moves away from an interactive communication style, to a strict and directive communication style.

333 Dekker (2016), p. 59.
334 McClelland (1967), p. 210.
335 Yukl (2010), p. 22.
336 Bennis (1989), p. 2.
337 Arbeidsomstandighedenwet (2004).
338 BRZO (1999).
339 Wet klachten en geschillen in de zorg (2016).
340 Mijnbouwwet (2003).
341 Spoorwegwet (2005).
342 Pardey (2007).
343 Gabriel (2015).
344 Van Kampen, Van der Beek, Steijn, Groeneweg and Guldenmund (2017), p. 212.
345 McClelland (1967), p. 232.
346 Post (2004).

2.3.6.2 Relation-oriented leaders

Pardey suggests that Relation-oriented leaders "… empathize with others, identify with their feelings and are concerned how their actions affect others."[347]

In research by McClelland, Relation-oriented leaders are considered to be 'affiliation-motivated.' In an explanation, this theorist describes affiliation-motivated people as "… people who are concerned over establishing, maintaining, or restoring a positive affective relationship with another person. This relationship is most adequately described by the word 'friendship.'"[348] But according to McClelland, these friendly leaders "… tend to have subordinates who feel that they have little responsibility, believe that organisational procedures are not clear and have little pride in their work group."[349] Based on this connotation, one might expect that Relation-oriented people, because they like "… warm, close relationships with other people …",[350] are less interested in economic results. Although this was not anticipated by the researchers, the results of research by McClelland et al., show that Relation-oriented people proved to have an unexpected positive effect on measures of economic development indeed.[351] According to McClelland,[352] contrary to Task-oriented leaders, Relation-oriented leaders dislike uncertainty and are risk averse; Relation-oriented leaders 'prefer to walk on the safe side.' This risk-avoiding behaviour of Relation-oriented leaders is also shown by reluctance to take necessary, but unpopular decisions. But leaders who primarily want to be liked and always want to stay on good terms with everybody may easily be tempted to making exceptions for the particular needs of individuals. As McClelland claims, then "… the whole system will break down."[353] According to McClelland, this kind of behaviour may confuse team members and create uncertainty about the mutual relationships between the leader and team members. This may especially affect the level of trust by followers vis-à-vis their leader, which is fatal for mutual relations. Relation-oriented leaders favour collaboration over competition and, quoting McClelland: "Relation-oriented leaders will choose a friend over an expert."[354]

This coincides with results from other research (known as the 'Michigan' and 'Ohio State' leadership studies) and suggestions by Yukl that trust and confidence, acting friendly and considerate, trying to understand the problems of subordinates, supporting subordinates in their professional development, keeping them informed, appreciating their ideas, allowing them a sufficient level of autonomy and showing recognition for subordinates' contributions and accomplishments were mentioned as supporting behav-

347 Pardey (2007), p. 56.
348 McClelland (1967), p. 160.
349 McClelland and Burnham (1976), p. 20.
350 McClelland (1967), p. 161.
351 Ibid.
352 Ibid.
353 McClelland and Burnham (1976), p. 15.
354 McClelland (1967), p. 232.

iour that were correlated with *effective* leadership.[355] According to Yukl,[356] Relation-oriented leaders focus on good social interactions; their predominant approach to their followers is 'supportive and helpful.' Yukl summarises the core duties of Relation-oriented leaders as follows: "Supporting, developing and recognizing are key Relation-oriented behaviours."[357] Also, Yukl argues that the other side of the coin is that Relation-oriented leaders tend to show favouritism to team members who are known as being their personal friends.[358] With reference to this, Yukl argues that it is not desirable for a leader to have a very strong Relation orientation, but the reverse is also true. A leader who is weakly Relation-oriented may be too introverted and shy to make the necessary connections with his/her followers and other parties with which a leader is required to communicate to ensure a successful operational result. Regarding this, Yukl[359] concludes that the optimal Relation orientation is 'moderately weak', rather than either strong or very weak.

In line with the latter, Likert proposed that: "… a manager should treat each subordinate in a supportive way that will build and maintain the person's sense of personal worth and importance."[360] Summarising different research results, Yukl argues that: "… increases in Relation-oriented leadership behaviour usually resulted in higher subordinate satisfaction and productivity."[361]

In addition to this discussion about the strength of the orientation, Bennis[362] and Pardey[363] mention three important, different properties which should be carefully managed: honesty, personal integrity and fairness. These apply especially to Relation-oriented leaders, because these leaders base their success or failure a great deal on their social skills; when these three properties are lacking, the leader and the team are in deep trouble. Pardey and Bryden both suggest that the reason why these properties are so important is because these properties underpin an important element of Relation-oriented leadership: *trust*.[364, 365]

Bennis[366] claims that trust is manageable and its main determinant is 'constancy'; people want to know where their leaders stand and what they stand for.

Within the context of this research, the requirement of mutual trust between leaders and followers touches on a specific topic: leaders rendering trust to general employees to be authorised to act without consultation if deemed necessary for safety reasons. In ad-

355 Yukl (2010).
356 Ibid.
357 Ibid., p. 130.
358 Ibid., p. 60.
359 Ibid.
360 Ibid., p. 107.
361 Ibid., p. 111.
362 Bennis (1989).
363 Pardey (2007).
364 Ibid.
365 Bryden, Flin, Hudson, Vuijk and Van Der Graaf (2006).
366 Bennis (1989).

dition to the perspectives of, for instance, Hopkins,[367] Pardey,[368] and Leistikow,[369] safety legislation[370] is clear about the fact that leaders are criminally liable in cases where safety incidents occur. However, as Weick[371] argues, our perception of possible scenarios of risk before an incident has materialised, is constrained by the limitations of our imagination, which is substantially steered by individual experience and memory.

Moreover, Ale[372] argues that risk acceptability is a complex issue and, in principle, a political one. Therefore, leaders who trust their team members, share their responsibility for incident prevention with their followers and delegate the authority to intervene, run certain accountability-related legal risks. Thus by sharing this responsibility, Relation-oriented leaders show personal courage and face the following two challenges: 1. These leaders dare to take the risk of being criticised by their superiors (and third parties) in case an operator's decision to interrupt the primary operational process is, afterwards, considered unjustifiable; and 2. Although their responsibilities and accountability are not reduced, these leaders dare to rely on their subordinates, who are hierarchically on a lower level, but who, by their leader, are considered experts in their trade. Due to their predominantly socially angled behaviour, Relation-oriented leaders are considered to be able to cope with exposure to these challenges.

With respect to this, reference is made to the concept of High Reliable Organizing (HRO). In HRO, mutual trust and cooperation of different disciplines and organisational levels are considered basic requirements for the reliability of operations. One of the basic principles of HRO is "sensitivity to operations."[373]

Hopkins extends this by arguing that members of organisations should be: "sensitive to the experience of frontline operators, encouraging them to speak up."[374] In this principle, the leader's trust is embedded in the quality and integrity of operational workers. In organisations facing safety-critical processes, disruptions of the primary process sometimes do not allow for time-consuming consultations. In critical situations, where an unexpected trigger initiates a safety incident in an acute manner, operators' attention to safety should not be limited to 'speaking up': in those cases, they must act and sometimes interruption of the primary operational process is the only option to prevent a safety incident to occur. With respect to those situations, 'intervene' is a better description of the operators' duty than 'speaking up.'

Taking into consideration how Relation-oriented leaders are described here, we suggest that Relation-oriented leaders can also be considered as leaders who empower their followers to take autonomous courageous decisions, including, if considered required by

367 Hopkins (2008).
368 Pardey (2007).
369 Leistikow (2010).
370 Arbeidsomstandighedenwet (2004).
371 Weick (2005).
372 Ale (2009).
373 Weick and Sutcliffe (2007), pp. 12–14.
374 Hopkins (2008), p. 113.

these followers, shutting down the primary operational process. Relation-oriented leaders are responsible for (the consequences of) all decisions taken by their team members and, when required, they should defend them to anyone and in every place. Relation-oriented leaders will do so. It is this moral standing of Relation-oriented leaders, along with their social interest, that sets these leaders apart from other people.

As Gabriel suggests: "Followers expect leaders to be competent just as they expect professionals and others; but they also expect leaders to provide moral leadership."[375]

The above description of Relation-oriented leaders applies specifically to their behaviours as exhibited during 'normal operations.' The way predominantly social people deal with operational tasks, responsibilities and followers, may be considered as their preferred way of achieving the organisation's objectives with respect for their team members as prime priority.

However, according to Post (ref. 2.3.5.5),[376] when Relation-oriented leaders face serious critical conditions and experience high mental stress during the fulfilment of their tasks, they may modify their social, Relation-oriented operational mode and escape into a paranoid type of behaviour.

2.3.6.3 Self-oriented leaders

As argued by McClelland,[377] Self-oriented leaders (by this theorist referred to as 'power-motivated') are concerned with the control of the means of influencing other persons. Dominance over situations (e.g., pleasure in winning or anger in losing an argument, statements of wanting to avoid weakness) or activities (e.g., disputing a position, arguing something, demanding or forcing something, giving a command, trying to convince someone of something, punishing someone) plays a central role in the practice of Self-oriented leaders. Research as referred to by McClelland shows that Self-oriented (power-motivated) leaders are not significantly related to economic development. But without power, there is no movement and since the primary objective of a leader is 'to attain change', some power needs to be applied in all cases. McClelland refers to 'the socialized face of power' and argues that the application of power "… must be disciplined and controlled so that it is directed toward the benefit of the institution as a whole and not toward the manager's personal aggrandizement."[378] In his research data, McClelland found ample evidence that individuals who show no sign of inhibition or self-control exercise their power impulsively and are often rude to other people and the like. This is the type of leader who is considered a threat where it concerns the responsible operation of the primary processes of an organisation. To identify the contrasting views of power-motivated (Self-oriented) and affiliation-motivated (Relation-oriented) people, Mc-

375 Gabriel (2015), p. 316.
376 Post (2004).
377 McClelland (1967).
378 McClelland and Burnham (1976), p. 4.

Clelland uses the terms "ego" and "alter."[379] These words clearly emphasise the opposite characteristics of Self-oriented and Relation-oriented people. According to McClelland and Burnham, the more effective leaders show more Self- than Relation orientation and they take the position that "… the bogeyman of authoritarianism has been wrongly used to downplay the importance of power in management."[380] In an explanation, McClelland claims that a Self-oriented leader, because he delivers clarity to the team about what is required and what he want his followers to do, creates a better morale in subordinates than the 'friendly', Relation-oriented leader, who is vaguer in this respect; Self-oriented leaders apply clear rules universally. But this does not imply approval for dictatorial behaviour directed to aggrandisement of the leader him/herself.[381]

According to Winter: "Successful leaders and managers must use power – to influence others, to monitor results and to sanction performance; but this power must be exercised in 'responsible' ways that involve ethical standards, accountability for consequences and a concern for effects on subordinates and peers."[382]

Pardey[383] suggests that Self-oriented leaders focus on their individual feelings, have a sense of autonomy and concentrate on their own needs. And according to a taxonomy developed by French and Raven,[384] the type of power predominantly used by Self-oriented leaders is referred to as 'coercive power.'

Yukl[385] puts this in perspective of the general role of leaders: to create change, one needs the application of power. However, as Yukl claims, there are different types and degrees of power and which type a leader applies to what degree depends on a complex set of factors, e.g., the context in which leadership is being exercised, the personal traits of leader and follower(s), the relationship between the parties and the specific activity at hand. Yukl[386] claims that leaders' coercive power is based on authority over punishments, which varies greatly across different types of organisations. Compared to two centuries ago, the use of coercive power has declined, but there are still sectors (e.g., the military, mining, aviation, marine, industrial operations, etc.) where discipline is considered as an important aspect for achieving operational goals in a safe and responsible way.[387] About these traditional/formal situations, Yukl argues that: "Coercive power is invoked by a threat or warning that the target person will suffer undesirable consequences for non-compliance with a request, rule, or policy."[388] With reference to the degree of coercive power, Yukl suggests that the lateral relationship (read: hierarchical distance)

379 McClelland (1967), p. 171.
380 McClelland and Burnham (1976), p. 24.
381 Ibid.
382 Winter (1991), p. 77.
383 Pardey (2007).
384 French John Jr and Raven (1959).
385 Yukl (2010).
386 Ibid.
387 Probably there is a relationship between the type of operation and the associated relative high safety risks.
388 Yukl (2010), p. 206.

between leader and follower might be of influence; where followers are dependent on their leaders for career development, more power is accepted as, for instance between two leaders, working in different departments and being mutually dependent.

Traditionally, organisations are built as abstract hierarchical constructions, with the most empowered person, the 'boss', at the top of the pyramid. Depending on their hierarchical positions, leaders are granted more or less hierarchical power over more or less followers and the level on the pyramid determines the extent of authority of leaders over their followers. In exercising their authority, leaders use their preferred type and degree of individual power and Self-oriented leaders typically prefer to apply a strong degree of power.

Nevicka et al.[389] argue that: "… the insatiable need for glory might lead narcissistic leaders to pursue unrealistic projects and risky investments, or even display unethical and counterproductive work behaviour …" and that "… narcissistic CEOs were found to make riskier decisions that result in greater volatility in organisational results …." They also claim that narcissistic leaders, in addition to having negative characteristics like overly positive self-views and perceptions of superiority over others, may initially show positive behaviours, such as charm, confidence, humour and extraversion but these initial positive impressions do not seem to endure. Power distance and personal contact between narcissistic leaders and their followers seem to be influential factors. Only followers who had relatively fewer opportunities to observe their leaders perceived those leaders as being more effective. These observations were absent in followers who had better opportunities to observe their leaders. According to Nevicka et al., professionalism and organisational experience is also important for a leader's functioning.

Focusing on the effect of Self orientation on the relationship between leaders and followers, Ladkin[390] proposes that leaders must remain in their particular 'identity orbit' in order to remain viable as leaders for particular groups. If leaders act in a too Self-oriented manner, do not respect the link between their point of view and that of their followers, they run the risk of moving too far away from their 'identity orbit' and might lose the required authority to function as leader. This scholar refers to this effect as 'lack of reversibility', using the following words: "'Reversibility' suggests that 'leaders' know who they are through the eyes of their 'followers' and, likewise, 'followers' can only know themselves as 'followers' through the eyes of their 'leaders.' When these perceptions jar against deeply held ego identities, the leader-follower connection can be severed."[391] Where Self-oriented leaders do not care for their followers' 'identity orbit'; they walk in their own direction and often too far away and therefore trust will evaporate and they lose grip on the people they are supposed to lead.

In conclusion, it should be clear that the above descriptions of Self-oriented leaders apply specifically to their behaviours as exhibited during 'normal operations', and these

389 Nevicka, Van Vianen, De Hoogh and Voorn (2018), pp. 703–723.
390 Ladkin (2010), p. 67.
391 Ibid., p. 67.

leaders predominantly deal with their operational tasks, responsibilities and followers.

For Self-oriented leaders, this is the preferred way of achieving the organisation's objectives. And to reach their goal, they apply the type and amount of power they feel is required. But power has to be applied in a controlled way and being in the powerful position also holds the risk that these Self-oriented leaders exhibit too little inhibition. In such cases, the hierarchical authority of a Self-oriented leader could inadvertently lead to behaviour with a priority for achieving their personal objectives. In relation to this, Post[392] argues that, when Self-oriented leaders are facing serious critical conditions and experience high mental stress during the fulfilment of their tasks, they may lose their controlled Self-oriented operational behaviour and escape into a form of narcissistic leadership.

Rosenthal and Pittinsky[393] argue that the psychological underpinnings of narcissistic leaders might include arrogance, feelings of inferiority, an insatiable need for recognition and superiority, hypersensitivity and anger, lack of empathy, amorality, irrationality and inflexibility and paranoia. In serious critical conditions, these behavioural properties will not be helpful to prevent escalation.

2.3.7 *Summary*

In these sections, we elaborated on the concept of leadership. We proposed to consider leadership as a social construct and expanded on the leadership process, in which we discussed leadership behaviours and how the different leadership variables may interact. The descriptions of the three different leadership orientations as discussed in these paragraphs, present the 'pure nature' of these orientations. But no one is 100% Task, Relation-, or Self-oriented.[394] In that respect Kotter[395] suggests that effective leaders probably use a mix of different types of power. The resulting leader is a mix of the three orientations, showing a predominant one. But this dominance may change due to external situational influences. As Yukl argues: "Where there is extreme pressure to perform a difficult task or to survive in a hostile environment, the role expectations for the leader are likely to change in a predictable way."[396] Supporting Yukl, Post specified this by suggesting that leaders' behaviour as usually exhibited under 'normal' operational conditions may change into a compulsive, paranoid, or narcissistic type of behaviour.

The main objective of this research is to study the relationship between leaders' behaviours and the prevention of safety incidents. By finalising these paragraphs about leadership, leaders have been profiled in a way that they can be recognized as Task, relations-, or Self-oriented. In our research we will employ these three orientations to establish whether and if so, in what way, leaders of certain behavioural orientations indeed influence the prevention of safety incidents.

392 Post (2004).
393 Rosenthal and Pittinsky (2006).
394 Dweck (2012).
395 Kotter (1982).
396 Yukl (2010), p. 92.

2.4 Operational context

Safety incidents arise in a complex environment, where organisational, situational, physical and socio-psychological circumstances sometimes interact in an unforeseen way. In the following sections we will elucidate some salient aspects of this context. First, we present the organisational frameworks (in legal as well as operational terms) in which primary processes operate. We then give a (very limited) overview of case histories, where primary (typically) processes deviated from their intended courses and 'derailed'.

2.4.1 *Organisational frameworks*

Organisations operate in two significant and different contextual frameworks: an external *legal* framework and an internal *operational* framework.

De Vries describes an approach which connects the two frameworks by introduction of the concept of 'vulnerability.'[397] In his work he argues that the meticulously regulated world we live in is not as safe as we would like. There are still 'unknown unknowns', safety risks, which organisations encounter in their daily operations and which are not covered by legislation.[398] In order to prevent business interruptions, organisations take measures upon discovery of these new risks even before the law forces them to take preventive action. Only later, after the 'unknown unknowns' have become 'known knowns', legislators react on these 'new' risks by the development of new regulations.[399] This is an interactive process and intertwines the two frameworks in which leaders of organisations have to find their way.

2.4.1.1 The legal framework

Leaders, by law as well as morally, are ultimately responsible and considered accountable for the occurrence of adverse events and consequences of safety incidents.[400, 401, 402]

But is that a reasonable requirement? Are leaders actually capable and sufficiently informed to enable them to prevent safety incidents? Do they, in case of unconfirmed weak signals of unsafety, want or dare to intervene in seemingly smooth-running production processes?

Rasmussen suggests that: "In spite of all efforts to design safer systems, we still witness severe, large-scale accidents."[403] The Netherlands, the research area of this study, is not an exception to that: safety incidents, albeit irregularly keep occurring.[404] Apparently,

397 De Vries, Verhoeven and Boeckhout (2014).
398 Ibid.
399 Ayres and Braithwaite (1992).
400 Braut and Lindøe (2010).
401 Eisenberg (1989).
402 Leistikow (2010).
403 Rasmussen (1997), p. 183.
404 Onderzoeksraad voor Veiligheid (2013d).

many organisations are not sufficiently in control of their operational processes. Incident analyses show that often leadership plays a prominent role in the cause of safety incidents. In order to protect leaders from legal proceedings and prosecution, organisations should make all possible efforts to ensure an effective conduct of state-of-the-art risk management methods and techniques.[405, 406, 407, 408]

The legal framework defines obligations, responsibilities and accountabilities from an external, governmental point of view. This section suggests that in the 1980s an intended deregulation of legislation created a legislative vacuum, which has been filled by extensive, newly developed accreditation and certification rules. We take the position that the legal transformation process has not resulted in a reduction of the gap between the 'paper world' and the 'real world.' Often, compliance with legislation is limited to a level where leaders of organisations deem this necessary to keep their 'licences to operate.'[409] Also, we argue that, due to the increased complexity of primary processes, the current practice of self-regulation and compliance provides insufficient reason to rely on the self-cleaning capacity of organisations.[410]

In every socio-cultural environment, organisations have to deal with society's and political expectations where it concerns the prevention of safety incidents. In order to regulate that interactive process, a legal framework governs the way organisations manage their safety risks. In the countries where the observed safety incidents occurred (the Netherlands, United Kingdom and the United States of America) the legal systems contain rules and regulations governing the responsibility for the prevention of accidents in organisations (safety regulations). All of the organised operational processes referred to are subject to the jurisdiction of legal frameworks, like for occupational safety, the Arbeidsomstandighedenwet, which is based on the European OSH Framework Directive 89/391/EEC and similar legislative frameworks concerning the quality of occupational safety management systems (e.g., the Nederlands Technische Afspraak (NTA 8620:2016, 'Specification of a safety management system for major accident hazards'), which aim to prevent safety incidents in the different sectors subject to this study.[411, 412, 413, 414, 415]

In this respect, the health care sector takes a special position; besides managing safety risks to health care workers (occupational safety), managing the safety risks to hospital patients is also regulated. To that purpose, specific legislation has been developed. The 'Wet kwaliteit, klachten en geschillen zorg' (law on quality, complaints and healthcare

405 Onderzoeksraad voor Veiligheid (2007).
406 Onderzoeksraad voor Veiligheid (2008b).
407 Onderzoeksraad voor Veiligheid (2012).
408 Onderzoeksraad voor Veiligheid (2013c).
409 Kluin (2014).
410 Erp, Huisman, Bunt and Ponsaers (2008).
411 Arbeidsomstandighedenwet (1980).
412 BRZO (1999).
413 Spoorwegwet (2005).
414 EU OSH Framework Directive 89/391/EEC (1989).
415 NEN (2016).

disputes) is the central part of that legislation.[416] In addition, the sector has developed a specific standard concerning patient safety management systems (NEN 8009:2018, 'Safety management system for hospitals and institutions that provide hospital care').[417] Also the health care sector itself develops and issues professional guidelines on an ongoing basis. Until 1999 the health care sector was rather passive with respect to patient safety, but the publication of the report 'To Err is Human' served as a wake-up call.[418] Since then, the sector has caught up and at present health care-related legislation and patient safety systems are of an innovative nature.[419]

Addicted to bureaucracy

In the 1930s, Heinrich[420] proposed that the organisation of the responsibility for safety should follow a similar hierarchical structure to the way responsibilities for the primary production process are organised. That proposal has been followed by many organisations and this approach is still reflected in current health and safety legislation of many countries.

Roughly 50 years later, Bennis predicted the end of 'bureaucracy as we know it.' He claimed that hierarchical structures will be replaced by new social systems better suited to the demands of the twentieth century industrialisation, because the 'Heinrich way of organisation' will be out of joint with contemporary realities then.[421] However, in his book *Safety Management, A Human Approach* (2001), Petersen explains that the typical present-day safety programs still follow the pyramidal-hierarchical organisation as proposed by Heinrich over 70 years ago.[422]

In this respect, it is interesting to notice that Bennis' vision, which predicted rapid change, growth in size and complexity requiring diverse highly specialised ability, was quite correct, but his claim that the predicted changes would lead to the end of bureaucracy has not been realised. Indeed, already in the early 1970s, Lord Robens in the UK proposed replacing prescriptive legislation with an all-encompassing requirement that employers ensure the safety risks of workers 'as low as reasonably practicable' (ALARP). This proposal has been accepted by the regulators in the UK and subsequently enacted in many other countries.[423] In 1980 health and safety legislation in the European Community member states was generalised from prescriptive to goal-setting type regulations. Throughout the European Community, this has resulted in replacing old prescriptive legislation with new, goal-setting legislation.[424] Nevertheless, Bennis' predictions did not come true; bureaucra-

416 Wet klachten en geschillen in de zorg (2016).
417 NEN (2018).
418 Brown and Patterson (2001).
419 Leistikow (2010).
420 Heinrich (1941).
421 Bennis (1989).
422 Petersen (2001).
423 Hopkins (2006).
424 Arbeidsomstandighedenwet (1980).

cy in the regulation of safety has not been reduced at all. On the contrary: since the early 1980s, a clear tendency towards the proliferation of formal law is observed.[425] Prescriptive text has been replaced by e.g., requirements to set performance criteria, which give room for interpretation and are therefore hard to operationalise univocally.

According to Hopkins, there is a difference regarding the type of decision in relation to the level of detail of regulations. The dichotomy that exists is that on a non-operational level (a.k.a. 'blunt end'), decisions are taken based on risk analysis and that on an operational level (a.k.a. 'sharp end'), decisions are taken based on rule-compliance.[426] Consequently, operational people need clear specific rules in order to know what to do to ensure continuation of the primary process. But these prescriptive instructions have been withdrawn and the transfer to goal-setting regulations has created uncertainty and unexpected room for individual preferred solutions of safety issues. As a reflex to this unclear situation, the desire appeared to eliminate the indistinctness and regain clear criteria. Thus, private organisations and industrial sectoral associations rehabilitated old prescriptive rules, which had been declared void by the government.[427, 428]

We wondered whether an elementary transformation of the European legal system as described above had influenced the organisations' focus on safety-related subjects. And we assumed that, in case this is true, it could have caused certain fluctuations in the literature about risk, safety and the legal discipline. In order to verify that, we generated a n-gram visualisation of the frequency of word-use in the English language during the period from the beginning of the 19th century until the year 2000. In Figure 20 below, the frequency of the use of some key terms, which are considered relevant in this context are visualised.

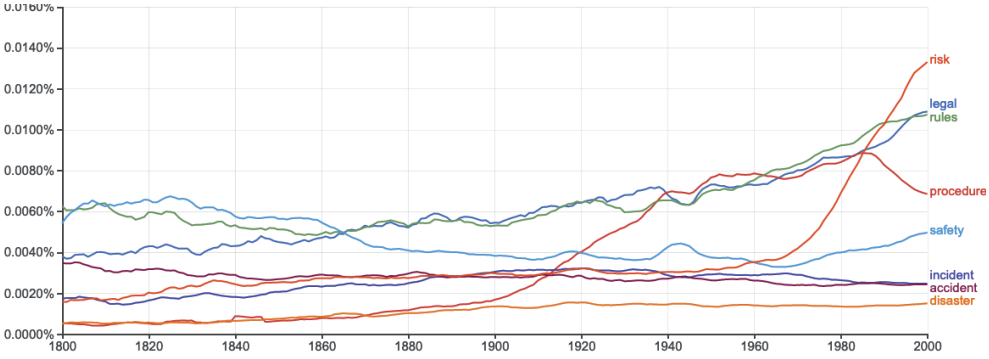


FIGURE 20 Word-use of risk management related terms in literature

The referred transformation in European safety legislation from prescriptive into goal-setting regulations took place in the early 1980s; nevertheless, the increase of use of

425 Teubner (1987).
426 Hopkins (2011).
427 Peuscher and Groeneweg (2012).
428 Walker, Throndsen, Reeves, Hudson, Croes, Dahl-Hansen, Stadler and Winters (2010).

the terms 'legal' and 'rules' continued until the year 2000 at the same pace as happened in the preceding 100 years. Since the 19th century, the use of the term 'procedures' has also shown a similar increase. But in the 1980s this steady increase reversed, resulting in a steep decrease in the use of 'procedures.' The fact that this decrease coincides with the withdrawal of many prescriptive procedures from the European legislation is probably no coincidence. Since the 1970s, an increase in use of the term 'safety' is observed and also the use of the term 'risk' shows a steep increase since then. Regarding these terms, an ongoing increase in focus is recognised. Of special interest is our observation that none of the mentioned fluctuations in the use of the referred terms has had a significant effect on the use of the terms 'incident', 'accident', or 'disaster.'

We conclude that deregulation has resulted in a steep decrease in procedures, but it has not stopped the steady increase in rules and legislation. Also, a consistent increase in focus on risk and safety is visible. But despite the observed fluctuations in literature, we did not observe any influence where it concerns the words 'incident', 'accident' and/or 'disaster.'

The European drive away from prescriptive to goal-setting legislation may have reduced the use of procedures, but it also created a boost on a secondary level of juridification, which possesses a quasi-legislative character. This concerns new rules related to e.g., certification and accreditation of goods and services. Part of that change was the obligation for organisations to acquire health and safety-related support from accredited independent enterprises (Arbodiensten). This requirement generated new standards in order to enable certification of these health and safety service providers.[429] Consequently, the governmental requirements for the development and certification of safety management systems and safety cases created a formal position for private certification bureaus (a.k.a. independent bodies) in an attractive new market place.[430] Tangible certification requirements and other measurable performance indicators have been developed and these have more than replaced the void prescriptive governmental regulations. We illustrate this statement with some examples:

Nowadays all machinery, instrumentation and materials must be CE-certified, technical staff are required to be NVQ certified, health care workers are registered in a national (BIG) register, health care centres like hospitals and nursing homes are certified (e.g., HKZ, Joint Commission International) and many workers have attended compulsory basic safety or in-house emergency services (BHV) training courses, for which attendance is proven by the stamps in their 'Personal Safety Logbooks.' The company's safety achievements may be established by measuring the achieved level on the culture ladder.[431, 432, 433, 434, 435]

Even a dentist is allowed to install dental implants only if these implants are CE-certi-

429 Gerlings and Hale (1991).
430 Zwetsloot, Hale and Zwanikken (2011).
431 Ahaus (2008).
432 Biesaart (2010).
433 Soree (2007).
434 Sreenivasan, Benjamin and Price (2003).
435 Zwetsloot, Bezemer and De Hoog (2012).

fied, which should warrant that the implant meets the essential requirements for safety, effectiveness and health.[436] The above examples are images of the paper world mankind has created.

A paper world

For regulators as well as operating organisations, clarity has now returned: safety performance has returned to paper! So, it has become auditable again; stamps and certificates serve as proof of being safe. This is exactly what leaders need in order to obtain the comfortable feeling of control.[437, 438]

But history has proven that that is a false feeling of comfort, as reality shows a different picture; in all sectors referred to in this dissertation, efforts to reduce safety risks by accreditation and certification systems have not been effective.[439, 440, 441, 442, 443, 444, 445, 446, 447, 448]

Kluin identified that organisations clearly understand that compliance with regulations is a necessity to maintain their licences to operate, but she also indicates that the observed compliance is an optic phenomenon only, which is not equal to effective risk control.[449] So, the bureaucratic reflex and subsequent certification and internal juridification drives after the transfer from a prescriptive to a goal-setting regime may have delivered the desired clarity on paper, yet to date, it has not led to the desired level of operational risk control.[450] Apparently, the paper world gives people a feel-good experience. However, with awareness of its actual limited effects on risk reduction, the challenge is to find different ways to convince people, leaders and followers that, in order to improve risk reduction, a different type of attention is needed.[451]

Inspectorates

Governmental inspectorates are aware of that reality and try to keep an eye on what happens in day-to-day life in operational processes. Policing governmental departments

436 Verdonschot (2008).
437 When asked to pinpoint his USP (Unique Selling Proposition), the manager of a safety training centre answered: "We facilitate the manager's night rest!" (Personal communication, 2002).
438 Groeneweg, Hudson, Vandevis and Lancioni (2010).
439 Onderzoeksraad voor Veiligheid (2005).
440 Onderzoeksraad voor Veiligheid (2007).
441 Onderzoeksraad voor Veiligheid (2008b).
442 Onderzoeksraad voor Veiligheid (2008a).
443 Onderzoeksraad voor Veiligheid (2011).
444 Onderzoeksraad voor Veiligheid (2012).
445 Onderzoeksraad voor Veiligheid (2013a).
446 Onderzoeksraad voor Veiligheid (2013b).
447 Onderzoeksraad voor Veiligheid (2013c).
448 Onderzoeksraad voor Veiligheid (2015).
449 Kluin (2014).
450 Here we refer to the results as presented in the n-gram (Figure 20).
451 Bieder and Bourrier (2013).

conduct inspections and audits to remind organisations of their duties. But the effectiveness of these inspections and audits is limited. The fields to be inspected are too wide, technologies are too complex and innovations are developing quickly and on a continuous basis.[452] The quantities and competences of inspectors are far too limited to ensure that all accidents are prevented.[453]

Therefore, it is not realistic to expect that rules and regulations be fully enforced. Full coverage is impossible and, from a preventive point of view, it is not realistic to expect sufficient capacity in governmental inspectorates to ensure the prevention of all types of safety incidents. Compliance depends a great deal on the leaders and the professional experts who reside inside the organisations where safety risks are present and who know how to control their safety-critical processes.

In addition, the technology behind these processes develops in a fast pace and contains, also due to the protection of intellectual property, more and more unique and complex features. Also, in the present competitive environment, organisations tend to shield off the particularities of their innovative findings. In that setting it is unrealistic to expect that governmental inspectorates are capable of identifying every detail of hazardous primary processes and its ensuing safety risks.

In reaction to losing governmental prescriptive guidance, some sectors have developed sector-specific risk management systems, which organisations/members of the sector's professional association are bound to comply with. These systems address sector-related safety and operational issues and sector-wide comparison of compliance levels stimulates organisations to become 'best in class.' In this way, organisations obtain/maintain their licences to operate by convincing the authorities that the safety risks of the intended operation are managed according to their own sector standards and that these risks do not exceed the ALARP[454] level. The development of these systems is a clear example of how deregulation has triggered a shift in the supervising role from governmental inspectorates to private organisations.

However, like in other situations described above, it is noticed that supervising authorities shift their focus to the non-operational level by imposing additional guidance. This guidance primarily amounts to further sets of rules about how decisions are to be made in complex situations.[455] But, how are inspectorates dealing with inherent 'uncertainty'?

Concerning this phenomenon, the European Commission has issued clear legislation. This refers to the so-called 'precautionary principle', which is to be applied in cases where organisations are not able to assess safety, environmental and health risks with a sufficient degree of exactitude. Although most publications show that this European legislation refers to environmental protection, this legislation is not limited to this domain

452 Bratspies (2011).
453 Popma (2011).
454 As Low As Reasonably Practicable.
455 Hopkins (2011).

only and safety and health are indeed mentioned, but not as explicitly as the environmental related text.[456]

The concept of 'uncertainty' has not yet been addressed widely; nevertheless, increased complexity of primary processes supports the idea that uncertainty will be subject to future discussions between inspectorates and leaders of organisations and in future even may be applied to elucidate, defend, or accept the development of safety incidents.

The law and the role of leaders

Realistically spoken, where it concerns the prevention of safety incidents, compliance with legislation is not considered a 'silver bullet'; the effectiveness of risk control merely depends on the way the organisation itself is taking care of their primary processes.[457] Moreover, not all decision-making can be converted into procedures and there will always be situations which are not formally regulated or where quick decisions are needed in order to remain safe and where individuals need to trust their own expertise to assess operational safety risks and act on their own account.[458, 459]

In the end, where it concerns the undisturbed continuity of production, the organisation itself is the primary stakeholder. Inside organisations reside vocational expertise, operational skills and knowledge of the primary processes, with their embedded hazards. This is where the leaders on all levels appear as the individuals responsible for optimally meeting the legal 'duty of care.'[460]

The next section will discuss the operational contextual situation in which leaders are expected to fulfil this obligation.

2.4.1.2 The operational framework

The previous section discussed the 'paper world'; this section is about dealing with the 'real world.'

The operational framework defines tasks, responsibilities, authorities and interrelations of the members of the organisation from an internal point of view, supported by the shareholders of the organisation. If an organisation has assigned accountabilities to the right, most competent people, it has a preventive effect for safety.[461] Here, continuity of the primary process and prevention of operational disturbances are the central themes.[462, 463]

456 European Commission (2000).
457 Erp, Huisman, Bunt and Ponsaers (2008).
458 Hopkins (2011).
459 Weick and Sutcliffe (2007).
460 Eisenberg (1989).
461 Wetenschappelijke Raad voor het Regeringsbeleid (2008).
462 Groeneweg (1992).
463 Muller E.R. (2012a) .

The real world

For reasons of efficiency and effectiveness, activities take place in an organised form, called a *system* or *organisation*. Each system has its specific goals and objectives, like making profit, healing ill people, or transporting people or cargo from A to B.[464] Safety risks are inevitable side effects of these goals.[465] Fischhoff argues that "hazards begin with the human need the technology is designed to satisfy and develop over time."[466] Perrow[467] argues that most high-risk systems have some special characteristics that make accidents inevitable, even *normal*. Moreover, he states that for safety reasons certain technologies should be abandoned, but that is impossible, because "we have built much of our society around them."

In this simultaneously stimulating and sometimes constraining operational environment, people conduct a balancing act in finding an incident-free way to achieve their goals and objectives. Many times, we embrace the pros and compromise the cons of something, simply because we like or need it; generating electrical power pollutes the atmosphere, exploring hydrocarbons depletes oil and gas reservoirs, oil tanks emit poisoning vapours, trains collide and health care can be fatal to hospital patients, etc.

Operational disturbances (unintended mishaps in an intended operational process) may, if safety risks are not identified and sufficiently controlled, evolve into events with (potentially) disastrous consequences.[468]

Leaders in organisations direct their subordinates in the desired direction in order to accomplish the intended organisational goals. By law, the task of the leader is also to ensure that operational disturbances that have potential for safety incidents to occur are prevented.[469] But since, according to Beck, in the classical industrial society the 'logic' of wealth production dominates the 'logic' of risk production, the letter of law does not always suffice to motivate people where it concerns compliance.[470] Organisations operate in an environment of incompatibilities; people, planet and profit are competitive concepts and sometimes complying with safety regulations may conflict with these priorities.[471] In such situations it is not always easy for people, on managerial, on tactical, as well as on operational levels, to prioritise safety over other operational aspects.[472]

According to risk management theory, human error plays an important role in the causation of accidents.[473] The contextual situation in which people conduct their occupational activities is of important influence on the probability that these people may err.[474]

464 Hale and Glendon (1987).
465 Beck (1986).
466 Fischhoff and Lichtenstein (1984), p. 10.
467 Perrow (1999), p. 4.
468 Reason (1997)
469 Ibid.
470 Beck (1986).
471 Kluin (2014).
472 Erp, Huisman, Bunt and Ponsaers (2008), ibid.
473 Groeneweg (1992).
474 Rasmussen (1997).

In many cases, people work under unfavourable contextual situations and may be tempted to err and thereby contribute to the occurrence of a major incident. Consequently, it is the role of the leaders to create and maintain favourable contextual situations in order to reduce the probability of human error to a minimum. But causation of safety incidents is much more complex than a combination of good and wrong human acts resulting in success and/or failure. Where we are fairly well able to investigate and analyse the causes of individual accidents, we do not yet know how to manage the risks that may lead to a major incident.[475] In order to enhance understanding of the safety incident causation process, in the next sections, relevant key factors in incident causation are discussed.

2.4.1.3 The primary process

The primary process of an organisation is its 'reason to be.' It is the way one works towards predetermined economic or social added value. In the Oxford dictionary a 'process' is defined as 'a series of actions or steps taken in order to achieve a particular end'.[476] Also, a process means 'change' and/or 'creation.' In the context of this study, the 'primary process' encompasses the activities required to generate value to all stakeholders concerned. However, apart from this intended positive effect, a primary process may generate unwanted safety hazards. The primary process is considered to be the place where hazardous energy, or sufficient cause is 'waiting to escape' in an uncontrolled manner.[477] These hazards can be considered by-products that need to be controlled to prevent a safety incident and its consequential loss, damage and/or injury. Risk reduction measures, such as a safe design, risk identification, risk analysis procedures (e.g., HAZID, HAZAN and HAZOPS), inspections, audits and preventive maintenance, are developed to ensure that trapped energy will not escape in an uncontrolled way and cause damage or injury. People are also instructed and trained to operate the primary process according to Standard Operating Procedures (SOP), and are prepared to recognise and manage operational disturbances through contingency planning and emergency procedures.

In this study, which focuses on the sectors of oil and gas, tank storage, hospitals, rail and general infra and general industry, the following processes are examples of 'primary processes': drilling wells to explore oil and/or natural gas reserves, storage of flammable fluids, surgery and administering of medication to hospital patients, track and time control of trains, construction of rail systems and conducting infrastructural and steel construction work. In relation to safety incidents causation, these processes are considered 'risk generators.' Organisations undertake risk management activities to ensure the safety of their respective primary processes. The next sections will explain what is meant by the term 'safety.'

475 Weick (1988).
476 Oxford University Press (1989).
477 Hopkins (2014).

2.4.1.4 Examples of derailed primary processes

This research is about leadership in organisations where serious safety incidents are considered imaginable, or have even taken place already. The following sections list some scene-setting, and illustrative examples of major incidents which have occurred in the sectors covered by this research. These major incidents have been selected according to the following criteria: 1) the variety of these specific domains, 2) repetitive nature of the domain concerned, and 3) relative high community impact.

Safety risks are only related to the specific primary processes in a specific business sector, and not to the geographical area in which the organisations are operating. We made this choice because some of the examples are well-known internationally, and are illustrative as relevant major incidents in this research. Each of the examples shows a state of crisis, either due to singular severe disasters, or multiple, widespread, individual cases. These major incidents meant 'crisis' for both the organisations involved, and the authorities concerned. In general, each of the described cases show how seemingly controlled operations in well respected and safety-concerned organisations have led to major incidents. In each case, a certain severity threshold has been exceeded, causing community interest, press coverage and, consequently, collateral damage to reputation of the organisations involved. Before these incidents occurred, nobody expected these to happen; everyone was convinced that their operation was safe.

The examples are depicted sector-by-sector in the following order: tank storage, hospitals, oil and gas, rail infrastructure, the process industry and general infrastructure.

Tank storage

On December 11, 2005, the town of Buncefield (UK) faced a series of explosions at the nearby hydrocarbon storage facilities. The extremely strong explosions were noticed by the British Geological Survey and recorded as an earthquake measured as 2.4 on the Richter scale. The explosions were reported as audible in France, Belgium and the Netherlands. As a result, 43 people were injured and there was a massive amount of material damage.[478]

During the year 2011, a tank storage terminal in the Rotterdam area (NL) became subject to intensive inspection by different inspectorates due to non-reporting of accidental chemical emissions to the environment. During the inspections, many violations of environmental and safety regulations were found. As a result, the terminal was shut down, employees were laid off and the terminal went broke.[479] Due to a huge financial injection from the owners, the terminal resurrected and was re-started after more than a year under different management; the leaders of the tank terminal were removed and a team of new leaders introduced.

Shortly after the terminal ceased operations, the Health and Safety Inspectorate ordered inspection of 91 different tank farms, randomly selected throughout the sector. At

478 Buncefield Major Incident Investigation Board (2008).
479 Onderzoeksraad voor Veiligheid (2013a).

73 sites a total of 323 violations of environmental and health and safety legislation were detected.[480] In reaction to this, legislation, as well as inspections, were intensified.[481]

Hospitals

Major incidents in industrial and transport sectors show precise numbers where it concerns casualties and injured people. Due to the different nature of the health care profession, the extreme volume of events and the lack of public records, it is not possible to precisely quantify the number of major incidents for this sector. However, in the mid-1990s, extensive studies were conducted in the USA (Colorado, Utah and New York) showing that in the USA, 44,000 (1997 extrapolation based on figures from a Colorado and Utah study) to 98,000 (1997 extrapolation based on figures from a New York study) people die each year as a result of preventable medical errors in hospitals.[482]

The attention to these situations raised serious attention in the year 1999 when the Committee on the Quality of Health Care in America of the Institute of Medicine (appointed in 1998) issued their report 'To Err is Human; Building a Safer Health Care System'. The report marked the completion of a project aimed at the examination of the issues and gave recommendations for rigorous changes in American health care.[483] The report refers to the Colorado, Utah and New York studies, as well as to three medical error cases where patients did not survive their hospital treatments, which made the headlines in the national press. 'To Err is Human' can be considered the book that increased interest in health care safety on a global scale. In order to identify the severity of the problem of medical error in the United States, the book compares the annual amount of fatal occupational accidents (6,000) with the estimated annual number of people dying in or outside hospitals as a result of medication errors alone (7,000).[484]

In 2001, the committee issued a second report, titled 'Crossing the Quality Chasm, a New Health System for the 21st Century'. Where 'To Err is Human' focused on patient safety only, this second report focused more broadly on how the health care delivery system can be designed to innovate and improve care. This report relates to the purpose and aims of the health care system, how hospital patients and their clinicians should relate and how care processes can be designed to optimise responsiveness to patient needs.[485]

The publication of 'To Err is Human' has triggered a response where worldwide health care institutions have extrapolated the American data to their local situations, followed by investigating the actual national numbers of 'preventable deaths' in their own health care systems.

In the Netherlands in the year 2004, 6,000 hospital patients experienced permanent

480 Rijkswaterstaat (2013).
481 Ministerie van Infrastructuur en Milieu (2013).
482 Gawande, Thomas, Zinner and Brennan (1999).
483 Institute of Medicine (1999).
484 Ibid.
485 Institute of Medicine (2001).

health damage by preventable medical errors.[486] A study by EMGO NIVEL reported that in the same year, 1.735 people died as a result of preventable medical errors in hospitals in the Netherlands.[487] Successive studies show that this number increased slightly to 1.960 (in the year 2008) and then decreased to 968 casualties in the period from April 2011 to April 2012.[488, 489] It is suggested that this reduction by 54% was the result of the introduction of a national patient safety campaign (VMS). During the period of April 2015 to April 2016, the reported number of casualties increased insignificantly to 1.035.[490] There is no unambiguous information publicly available about the causality of these deaths and/or about the causality of other deaths not classified as 'preventable.'

Process industry

On June 1, 1974, a chemical plant at Flixborough (UK) was severely damaged by a large explosion caused by leaking cyclohexane. 28 Workers were killed and 36 people injured.[491] The disaster happened one day after the first European Loss Prevention Symposium.[492]

On March 23, 2005, at a hydrocarbons refinery in Texas City (US), a vapour cloud explosion occurred. 15 people were killed, over 170 people were injured and huge damage was caused.[493]

On January 5, 2011, at Moerdijk (NL), the site of a chemical packing company burned down completely. The fire and the way the fire brigade combatted it, resulted in enormous environmental pollution. After the fire, the buildings on the site were totally burned down. There were no casualties. The company went broke.[494]

Oil and gas industry

In March 1980, the semi-submersible accommodation platform Alexander Kielland, located in the Norwegian Ekofisk field, about 400 kilometres east of Scotland, capsized. As a result, 123 crewmembers drowned; only 89 of 212 workers survived the accident.[495, 496]

In the evening of July 6, 1988, the oil and gas industry was struck by an explosion and consecutive fire on the Piper Alpha offshore production platform, located 193 kilometres North East of Aberdeen (UK); as a result, 167 oilfield workers died.[497]

On May 21, 2005, at Warffum (NL) a storage tank containing natural gas condensate

486 Van Velthoven (2008).
487 De Bruijne, Zegers, Hoonhout and Wagner (2007).
488 Langelaan, Baines, Broekens, Siemerink, Steeg, Asscheman, De Bruijne and Wagner (2010).
489 Langelaan M., Baines, Broekens, Hammink, Schilp, Verweij, Asscheman and Wagner (2013).
490 Langelaan, Broekens, de Bruijne, de Groot, Moesker, Porte, Schutijser, Singotani, Smits and Zwaan (2017).
491 Venart (2004).
492 Swuste (2022), p. 183.
493 Hopkins (2008).
494 Onderzoeksraad voor Veiligheid (2012).
495 Braut and Lindøe (2010).
496 Moan (1981).
497 Cullen (1990).

exploded during welding work; as a result, 2 technicians died.[498]

On April 20, 2010, the well blew out on the semi-submersible drilling rig Deepwater Horizon in the Gulf of Mexico. The unit caught fire and sunk. As a result, 11 oil workers went down with the sinking rig and drowned. The well spilled 4.9 million barrels of crude oil into the sea, polluting the water and the Texas coast line, destroying the local fishing industry at the coast of the Galveston and Houston area.[499]

Rail infrastructure

On January 8, 1962, near the village of Harmelen (NL), two passenger trains collided head-on in thick fog. As a consequence, 93 people died and 52 people were injured.[500] This railway accident served as the trigger to install automatic brake control systems (ATB) in all trains in the Netherlands.

On November 30, 1992, a passenger train derailed in the vicinity of Hoofddorp (NL). As a result, five passengers died, more than 30 passengers were injured and there was massive material damage. This railway accident served as one of the triggers to install a National Railway Accident Investigation Board, the predecessor of the Dutch Safety Board.[501]

On April 21, 2012, two passenger trains collided head-on in the vicinity of Amsterdam Central Station. As a result of that, one passenger died. This accident initiated an extensive political debate about the safety of railway traffic. [502]

General infrastructure

On October 21, 2010, in Rotterdam, a concrete floor of a high-rise building under construction collapsed due to lack of stability in the temporarily support scaffolding under the floor being fabricated. During the building process, the scaffolding was not constructed as per the design. Five people were seriously injured and the material damage was extensive.

On May 27, 2017, part of a parking garage at Eindhoven airport collapsed one month before the building was planned to be opened. Deviation from the standard design of the floor construction decreased the structural integrity of the floors. Expansion of the floor elements due to high ambient temperature resulted in an overload of the floor sections and the consequent collapse. This incident resulted in massive damage to material and the company's reputation. No personal injury was reported.

On May 27, 2017, a road construction worker fell from a viaduct in Amstelveen (NL). The day before the incident, the outline of the fall protection boarding had been changed. This created a situation where workers had to position themselves outside the protected

498 Onderzoeksraad voor Veiligheid (2007).
499 White, Hsing, Cho, Shank, Cordes, Quattrini, Nelson, Camilli, Demopoulos, German, Brooks, Roberts, Shedd, Reddy and Fisher (2012).
500 Raad voor de Transportveiligheid (1999).
501 Hansen (2012).
502 Onderzoeksraad voor Veiligheid (2013c).

area in order to do their work. The victim died due to the injuries caused by the fall.

In this chapter the theories, concepts and operational context regarding the core aspects of this research, risks, safety and leadership, have been discussed. Next, we will explain the scope, research queries, design and methodology of the empirical research in order to discover the resolution of the principal query of this research; if and if so, in what way, to what extent leaders can help to prevent of safety incidents.