Towards Sustainable Safety and Performance in Organisations

Total Respect Management as a Design for Pursuing and Achieving Excellence in Organisations

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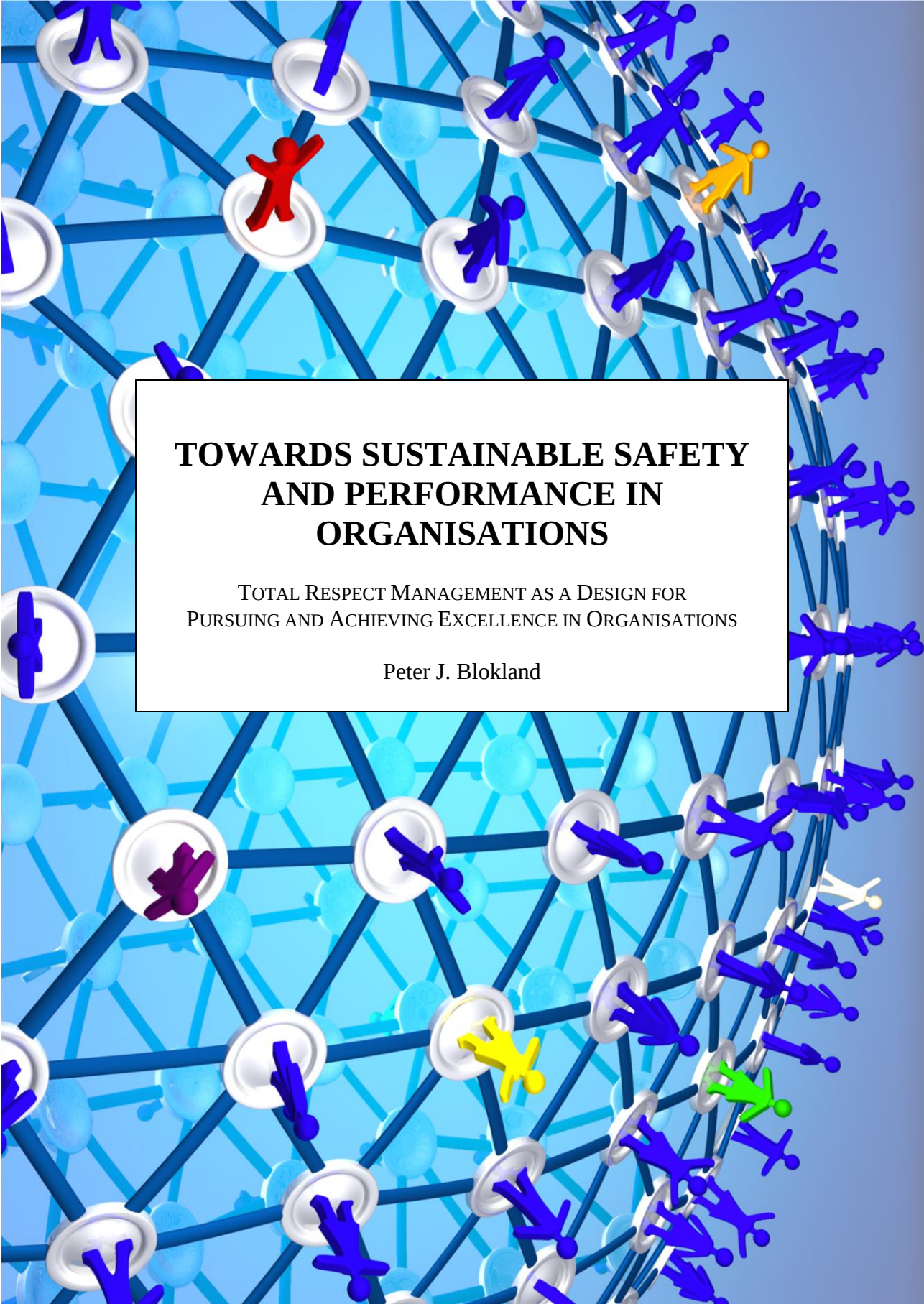

TOWARDS SUSTAINABLE SAFETY AND PERFORMANCE IN ORGANISATIONS

TOTAL RESPECT MANAGEMENT AS A DESIGN FOR PURSUING AND ACHIEVING EXCELLENCE IN ORGANISATIONS

Peter J. Blokland

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DISSERTATION

For the purpose of obtaining the degree of doctor

at Delft University of Technology

by the authority of the Rector Magnificus prof.dr.ir. T.H.J.J. van der Hagen

Chair of the Board of Doctorates

to be defended publicly on

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by

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PROEFSCHRIFT

ter verkrijging van de graad van doctor aan de

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in het openbaar te verdedigen op

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Table of Contents 7

Summary

Safety is crucial for sustainable growth in organisations and vital for societal progress. Yet, when considering “safety”, one is often confronted with the opposite of what safety is, with a focus on events and occurrences that generate bad consequences. Decisions and actions are ever so often based on past experiences of things that went wrong, making safety habitually reactive. Safety in organisations is directly related to systems that bring about events happening or not happening. It is frequently the case that one reacts to those symptoms, as the solution seems obvious, and immediate action offers a quick relief of the problem symptom. A systemic approach precludes solely reaction to symptoms of events happening, but instead seeks to discover the underlying systems, structures and their associated mental models, in order to understand how the whole system produces its results (wanted and unwanted). Such an approach is necessary, because we live in a VUCA (Volatile, Uncertain, Complex and Ambiguous) world. As a result, organisations in the 21st century wrestle with novel challenges, which are no longer manageable and controllable with the same paradigms and mental models that governed previous centuries. In this thesis I argue that mental models are important human factors. They are the sources of systems, and therefore determine what happens in organisations and society as a whole.

Consequently, the following general research question needs to be addressed: “How can organisations proactively generate and improve safety and performance in a volatile, uncertain, complex and ambiguous environment, taking into account sustainability, human factors and mental models?”

This research is based on the idea of a design research, where the methodology to pursue and achieve safety and performance proactively is to be seen as the design. In this case, the design consists of appropriate mental models, processes and activities that help organisations to pursue excellence.

How one understands and conceptualizes the notions of risk, safety, security, and performance are fundamental mental models. People have an intuitive understanding of these concepts. But how one regards these words determines how one deals with them. Hence, based on an etymological and etiological study of the concepts of risk and safety, and the definition of risk proposed by the ISO 31000 guidance standard, an innovative semantic and ontological foundation for safety and security science is proposed. This foundation provides coherent, standardized notions and definitions of the constructs risk, safety, security and performance,

centred on an inclusive understanding of the term “objectives”, to be used as guiding mental models in the design.

But what is the significance of mental models for upholding safety in organisations? Risk, safety and security have become ever more important and are also vital to enhance sustainability. The key in achieving safety proactively depends on one’s quality of perception, where the quality of perception should be understood as the level of deviation between reality itself and the perception (mental model) of that reality by an individual or group of people. In our ever more complex and connected world, the safety of systems depends on the awareness and understanding of the interactions and performance of the much smaller sub-systems. Individual behaviours result from individual mental models that generate the gain of achieving and safeguarding objectives, but they also bring about unwanted consequences, causing loss. A proactive way to reach safety of systems is therefore to focus on the performance of the sub-systems at ever deeper levels of detail within the concerned socio-technical systems and determine how mental models affect risk, safety and performance. Implementing appropriate empowering mental models, as well as alleviating harmful ideas, allows to achieve and safeguard objectives, generating safety proactively and eliminating unwanted events. Therefore, to achieve safety and to attain sustainable safe performance, understanding and managing mental models in organisations is of paramount importance.

Changing mental models is difficult. The more important they are, the more resistance will be encountered. So, how to change mental models in organizations to proactively improve safety and performance? Mastering mental models in organisations is the fundamental purpose of the design. Generating, adjusting and managing mental models involves a systemic approach, based on dialogue, in order to improve the quality of perceptions in organisations. This requires a systemic view, leadership, leadership skills that enhance dialogue, and the ability to develop a shared vision, mission and ambition, determining what is important and valuable. It allows for aligning individual mental models with those that should govern the system. In doing so, it is possible to create well-aligned corporate cultures that create and protect value and that generate sustainable safe performance.

This thesis develops Total Respect Management (TR^3M) as a design that acts through an innovative, systemic, organisational culture alignment model. It involves systems thinking abilities, leadership skills and acts as a process to align

mental models and objectives with the purpose of the organisation. Furthermore, besides enhancing systems thinking capabilities and leadership skills (directed towards dialogue), ISO 31000 and its guidance is used as a practical tool to undertake and support this alignment process. This makes it possible to generate safe performances in organizations in a sustainable way through continuous improvement. Altogether, these elements define the TR³M design as a concept, set of mental models, a methodology, and a systemic management system. As such, TR³M acts as a design to reach safety and performance in organisations proactively. Unlike many other management systems, the TR³M methodology covers the aspects of leadership, management and continuous improvement in a holistic, systemic and integrated way, linking risk, safety and performance with the individual, organisational and societal objectives to pursue an organisational mission in an innovative, corporate socially responsible manner.

But how to implement this pro-active safety management design and improve the performance of organizations of any size or sector, operating in a volatile, uncertain, complex and ambiguous environment? Since TR³M is a holistic and systemic approach, it will likely not work as well as intended and expected whenever parts of the design are not fully implemented. It involves new paradigms, a lot of change and needs education of those who are going to use the design. When executed in the appropriate order, i.e., to start with increasing systems thinking and leadership skills, then implementing ISO 31000 and finally focus on continuous improvement, the accompanying mental models and increased quality of perception should generate the systems needed to reach success.

How would one know whether a TR³M implementation works? Measuring results should indicate its success. But how can safety instantly and continuously be measured in a standardised way, independent of the type or size of the organisation? For decades, scholars have been looking at ways to capture the level of safety in organisations, creating complicated measuring systems, capturing a multitude of parameters that have been determined by analysing organisations and their mishaps. But until now, no system is capable of exactly and continuously indicating a quantified level of safety of an organisation. However, starting with the clear and coherent definitions of safety and unsafety, proposed in this thesis, and a clear notion of what unsafety represents in socio- technical systems, combined with the use of a multicriteria model, using specific loss and impact categories combined with impact and severity levels, it is possible to create an aggregated model that can provide a clear and instant indication of levels of safety and unsafety

in organisations, indifferent from their size, sector or industry. As such, this innovative measuring system acts as an important feedback loop for the TR³M design, increasing the quality of perception and discovering effects of the much smaller sub-systems, long before they cause harm.

Samenvatting

Veiligheid is cruciaal voor duurzame groei in organisaties en van vitaal belang voor maatschappelijke vooruitgang. Toch wordt men bij het beschouwen van "veiligheid" vaak geconfronteerd met het tegenovergestelde van wat veiligheid is, met een focus op gebeurtenissen die nare gevolgen hebben. Beslissingen en acties zijn altijd gebaseerd op ervaringen uit het verleden van zaken die fout zijn gegaan, waardoor veiligheid doorgaans reactief is. Veiligheid in organisaties is direct gerelateerd aan systemen die gebeurtenissen tot stand brengen die al dan niet plaats grijpen. Het is vaak zo dat men op die symptomen reageert, omdat de oplossing voor de hand lijkt te liggen en onmiddellijke actie een snelle verlichting van het probleemsymptoom biedt. Een systemische benadering sluit echter reactie alleen op basis van symptomen van gebeurtenissen uit, maar probeert in plaats daarvan de onderliggende systemen, structuren en hun bijbehorende mentale modellen te ontdekken, om te begrijpen hoe het hele systeem zijn resultaten produceert (gewenste en ongewenste). Dergelijke benadering is noodzakelijk omdat we vandaag in een VUCA (Volatiele, Onzekere, Complexe en Ambigue) wereld leven. Als gevolg hiervan worstelen organisaties in de 21e eeuw met nieuwe uitdagingen die niet langer beheersbaar en controleerbaar zijn met dezelfde paradigma's en mentale modellen die vorige eeuwen beheersten. In deze thesis argumenteer ik dat mentale modellen belangrijke menselijke factoren zijn. Het zijn de bronnen van systemen en daarom bepalen ze wat er gebeurt in organisaties en de samenleving als geheel.

Daarom moet de volgende algemene onderzoeksvraag worden beantwoord: "Hoe kunnen organisaties proactief veiligheid en prestaties genereren en verbeteren in een vluchtige, onzekere, complexe en dubbelzinnige omgeving, rekening houdend met duurzaamheid, menselijke factoren en mentale modellen?"

Dit onderzoek is gebaseerd op het idee van een ontwerp-onderzoek, waarbij de methodologie om veiligheid en prestaties proactief na te streven en te bereiken moet worden gezien als het ontwerp. In dit geval bestaat het ontwerp uit geschikte mentale modellen, processen en activiteiten die organisaties helpen om uitmuntendheid na te streven.

Hoe men de begrippen risico, veiligheid, beveiliging en prestaties begrijpt en conceptualiseert, zijn fundamentele mentale modellen. Mensen hebben een intuïtief besef van deze begrippen. Maar hoe men deze woorden beschouwt, bepaalt hoe men ermee omgaat. Daarom wordt op basis van een etymologische en

etiologische studie van de concepten risico en veiligheid, en de definitie van risico, zoals door ISO 31000 voorgesteld, een innovatieve semantische en ontologische basis voor veiligheids- en beveiligingswetenschappen voorgesteld. Deze bevat een coherente, gestandaardiseerde interpretatie en definities van de constructen risico, veiligheid, beveiliging en prestaties, gebaseerd op een inclusief begrip van de term "doelstellingen" en te gebruiken als leidende mentale modellen in het ontwerp.

Maar wat is de betekenis van mentale modellen voor het handhaven van veiligheid in organisaties? Risico, veiligheid en beveiliging zijn steeds belangrijker geworden en zijn ook van vitaal belang om duurzaamheid te verbeteren. De sleutel tot het proactief bereiken van veiligheid hangt af van iemands kwaliteit van perceptie, waarbij de kwaliteit van perceptie moet worden begrepen als het niveau van afwijking tussen de realiteit zelf en de perceptie (mentaal model) van die realiteit door een individu of groep mensen. In onze steeds complexere en meer verbonden wereld hangt de veiligheid van systemen af van het bewustzijn en begrip van de interacties en prestaties van de veel kleinere subsystemen. Individueel gedrag is het resultaat van individuele mentale modellen die de winst genereren van het bereiken en beschermen van doelstellingen, maar ze brengen ook ongewenste gevolgen met zich mee, waardoor verlies ontstaat. Een proactieve manier om de veiligheid van systemen te bereiken, is daarom om zich te concentreren op de prestaties van de subsystemen op steeds diepere detailniveaus binnen de betrokken socio-technische systemen en te bepalen hoe mentale modellen risico's, veiligheid en prestaties beïnvloeden. Het implementeren van geschikte ondersteunende mentale modellen, evenals het verminderen van schadelijke ideeën, maakt het mogelijk om doelstellingen te bereiken en te beschermen, proactief veiligheid te genereren en ongewenste gebeurtenissen te elimineren. Om veilig te zijn en duurzame veilige prestaties te bereiken, is het begrijpen en beheren van mentale modellen in organisaties daarom van het grootste belang.

Het veranderen van mentale modellen is moeilijk. Hoe belangrijker ze zijn, hoe meer weerstand er zal worden ondervonden. Dus, hoe kan men mentale modellen in organisaties veranderen om proactief de veiligheid en prestaties te verbeteren? Het beheersen van mentale modellen in organisaties is het fundamentele doel van het ontwerp. Het genereren, aanpassen en beheren van mentale modellen omvat een systemische aanpak, gebaseerd op dialoog, om de kwaliteit van de percepties in organisaties te verbeteren. Dit vereist een systemische visie, leiderschap, leiderschapsvaardigheden die de dialoog bevorderen en het vermogen om een

gedeelde visie, missie en ambitie te ontwikkelen, die bepalen wat belangrijk en waardevol is. Het maakt het mogelijk om individuele mentale modellen af te stemmen op die ideeën die het systeem moeten aansturen. Daarbij is het mogelijk om goed op elkaar afgestemde bedrijfsculturen op te bouwen die waarde creëren en beschermen en die daardoor duurzame veilige prestaties genereren.

Deze thesis ontwikkelt Total Respect Management (TR^3M) als een ontwerp dat werkt via een innovatief, systemisch, organisatiecultuur en alignment model. Het omvat systeemdenken, leiderschapsvaardigheden en een proces om mentale modellen en doelstellingen af te stemmen op het doel van de organisatie. Bovendien, naast het verhogen van het systemisch denken en het verbeteren van leiderschapsvaardigheden (gericht op dialoog), wordt ISO 31000 en zijn richtlijnen gebruikt als een praktisch hulpmiddel om dit afstemmingsproces uit te voeren en te ondersteunen. Dit laat toe om in organisaties op duurzame wijze veilige prestaties te genereren door middel van continue verbetering. Al met al definiëren deze elementen het TR^3M-ontwerp als een concept, een reeks mentale modellen, een methodologie en een systemisch managementsysteem. TR^3M fungeert daarom als een ontwerp om proactief veiligheid en prestaties in organisaties te bereiken. In tegenstelling tot veel andere managementsystemen, omvat de TR^3M-methodologie de aspecten van leiderschap, management en continue verbetering op een holistische, systemische en geïntegreerde manier, waarbij risico's, veiligheid en prestaties worden gekoppeld aan de individuele, organisatorische en maatschappelijke doelstellingen om een organisatorische missie na te streven op een innovatieve, maatschappelijk verantwoorde manier.

Maar hoe dit proactieve veiligheidsbeheerontwerp te implementeren en de prestaties van organisaties van elke omvang of sector te verbeteren, die actief zijn in een vluchtige, onzekere, complexe en dubbelzinnige omgeving? Omdat TR^3M een holistische en systemische benadering is zal het waarschijnlijk niet zo goed werken als bedoeld en verwacht wanneer delen van het ontwerp niet volledig geïmplementeerd worden. Het gaat om nieuwe paradigma's, veel verandering en heeft onderricht nodig van degenen die het ontwerp gaan gebruiken. Wanneer het in de juiste volgorde wordt uitgevoerd, d.w.z. eerst het verbeteren van systeemdenken en leiderschapsvaardigheden, vervolgens het implementeren van ISO 31000 en ten slotte zich richten op continue verbetering, dan moeten de bijbehorende mentale modellen de systemen genereren die nodig zijn om succes te bereiken.

Hoe kan men weten of een TR³M-implementatie werkt? Het meten van resultaten moet het succes ervan aangeven. Maar kan veiligheid wel direct en continu op een gestandaardiseerde manier worden gemeten, onafhankelijk van het type of de grootte van de organisatie? Al tientallen jaren zoeken wetenschappers naar manieren om het veiligheidsniveau in organisaties te bepalen, waarbij ze ingewikkelde meetsystemen creëren en een veelheid aan parameters vast leggen, die gekozen worden door het bestuderen van organisaties, en het analyseren van hun ongelukken. Maar tot nu toe is geen enkel systeem in staat om precies en continu een gekwantificeerd veiligheidsniveau van een organisatie aan te geven. Echter, met de duidelijke en coherente definities van veiligheid en onveiligheid, voorgesteld in dit proefschrift, is het mogelijk om een geaggregeerd model te creëren dat een duidelijke en onmiddellijke indicatie kan geven van de niveaus van veiligheid en onveiligheid in organisaties, onafhankelijk van hun grootte, sector of industrie. Dit kan door een duidelijk idee van wat veiligheid en onveiligheid betekenen in socio-technische systemen, te combineren met het gebruik van een multicriteriamodel dat gebruik maakt van specifieke verlies- en impactcategorieën in combinatie met impact- en ernstniveaus. Als zodanig fungeert dit innovatieve meetsysteem als een belangrijke feedbacklus voor het TR³M-ontwerp, waardoor de kwaliteit van de perceptie wordt verhoogd en effecten van de veel kleinere subsystemen worden ontdekt, lang voordat ze schade veroorzaken.

Foreword

If someone would have told me ten years ago that I would make a PhD study at TUDelft, I would probably think this person to be completely out of his mind. At that time, the possibility of doing such a study had never crossed my mind, and to even think about starting such an endeavour seemed impossible. My childhood dream was to become a Formula One driver, and as that seemed out of reach, I settled for a career in the military as a fighter pilot. Although I obtained a master's degree at the Royal Military Academy in Brussels, these are aspirations and professions very far away from an academic career. As such, my career lies behind me and this effort is more a conclusion of that career than a start.

In fact, I learned a lot as a pilot, an instructor, a commanding officer, an aircraft accident investigator and aviation safety specialist. Also, during my second career, as a trainer/coach, I gathered valuable practical information that led to this study. This career guided me in discovering the concept of risk in a very personal way, mainly looking at the upside of risk in my efforts to reach my objectives. However, also the downside of risk became very clear early on in my job as a fighter pilot, as several of my colleagues and friends died in the many aircraft accidents the Air Force endured in the last decades of the twentieth century. So, both dimensions of risk are important and can't, and shouldn't, be separated from one another.

Therefore, this study is not meant to give my career a boost, or to start a new chapter in the world of academics. It is more the consequence of a moral obligation to share the knowledge and insights I gained, and that can have the potential of creating a better, a safer, and more sustainable world.

In the end, this document is mainly about what I have observed, reflected upon, discussed about, and studied. Also, my personal mental models have been explored and held against the light of an academic study. In the end I learned a lot in that research and found the logic in what initially was more an intuitive feeling about safety and performance, what this work is about and what this study tries to convey.

Many academics will have different mental models of the concepts risk, safety and performance that I have tried to understand, and that is entirely OK. It is not a matter of who is right or wrong. Different perceptions exist, but it doesn't mean they tell a different story. It is the same story but viewed from a different angle. As such, this work is just a gift to the reader who has an open mind and is ready to explore different viewpoints. It is meant for those who are open to see the possibility of considering different perceptions of the same reality.

I wish you, the reader, the best of luck and success, and I hope that reading this document isn't excessively boring and that, in the end, you will not consider it a waste of your time in doing so. Have fun!

Peter

INTRODUCTION

THE SPEED OF CHANGE

AND

THE NEED FOR CHANGE

1. Introduction

1.1. General view

In the past decades, the world has seen a constantly increasing growth causing drastic changes at an ever-faster rate. The rhythm of this growth is easy to discern in the huge increase in world population and its associated effects. It took many thousands of years to reach a total of 1 billion people in 1804, and it took another 123 years to get to 2 billion in 1927. However, 33 years later, in 1960, the mark of 3 billion was already reached, and 14 years later a population of 4 billion people became a fact. Yet, it took another 13 years to attain the number of 5 billion persons and 12 years to get to 6 billion inhabitants of planet Earth in 1999. Although the increase in the speed of growth diminishes, population growth continues at a steady pace. In 2011, the mark of 7 billion individuals on Earth was reached, and in 2022 a total of 8 billion people inhabiting our planet is to be attained.

(Source https://www.worldometers.info/).

This sustained population growth, its associated socio-economic development and related effects, has led to global and regional problems, which are becoming increasingly prominent today (Liu et al. 2022). Furthermore, recent analysis examining trends in technology, the economy and the labour force, shows that the world of work is changing. Based on an analysis of trends in the work, a study has predicted that as technology reduces the need for workers to complete routine manual tasks, workers will spend more time focusing on people, solving more strategic problems and thinking creatively. Therefore, as well as deep and broad knowledge in key disciplines, one will need a range of skills and capabilities, including creative, critical thinking and problem solving, in order to thrive in the future world (Lamb et al., 2017). For example, the innovation rate in information management is high. And innovation and creativity can lead to new tools and services. However, there is no innovation without risk. Proposing something different and new, whether in information management or in other domains, may become an unexpected success, or may not work as anticipated, could be criticized, not be supported, or even fail (Heye, 2006).

As a result of this rapid pace of change, organisations in the 21st century wrestle with various revolutionary trends: accelerating product and technological change, global competition, deregulation, demographic changes, and a drift into a service society and information age. The workforce has changed dramatically in terms of age, gender, ethnic and racial composition, family structure, and job expectations. Consequently, such social developments have had significant impacts on the nature and operations of organisations. (Chew & Entrekin, 2004)

In the article "The fourth industrial revolution: What it means, How to respond", Schwab (2015) states that compared with previous industrial revolutions, this fourth industrial revolution is evolving at an exponential rather than a linear pace. The author also indicates that it is disrupting almost every industry in every country, where the breadth and depth of the changes announce the transformation of entire systems of production, management and governance. As such, it is clear that a transition is ongoing in almost every aspect of life. (Schwab, 2015)

Transitions, in their literal sense, refer to the process of change from one state to another via a period of nonlinear disruptive change. Such systemic change, by definition, is the result of an interplay of a variety of changes at different levels and in different domains that somehow interact and reinforce each other to produce a fundamental qualitative change in a societal system. The notion of transitions, present in many scientific disciplines for more than a century, in general, thus refers to a qualitative change in the state of a complex system. Also, the term sustainability transitions is increasingly used to refer to large-scale societal changes, deemed necessary to solve "grand societal challenges." (Loorbach et al., 2017)

For the past two decades, sustainability science, a new research field and discipline in its own right (Spangenberg, 2011), has focused on transforming how science is conducted to create new knowledge to progress the sustainability agenda. Sustainability introduces ethical principles of achieving equity between present and future generations. It means a just society, a sound environment and a healthy economy, and is not intended to sustain practices, industries and organisations that are harmful to these three requirements. Corporations are important players in the sustainability scene. Therefore, creating a sustainable society must involve changes to corporations, as well to other social institutions (Diesendorf, 1999). It is not enough, however, to do science differently. Realizing sustainability goals also requires changing how decisions are made, and how they draw on scientific and other knowledge. Today, sustainability is not solely about profit for the shareholders of a corporation, but about value for all stakeholders, including society. As a result, sometimes apparently opposing or conflicting objectives need to be balanced. To do this, science needs to be positioned differently in the world, through integrating new ways of knowing into new ways of making decisions and acting across all spheres of social, economic, and political life (Wyborn et al., 2019).

1.2. The need for new paradigms

The above observations regarding the level of growth and change in society reached today, indicate a number of present and future challenges that humanity faces. They also make clear that these challenges are no longer manageable and controllable with the same paradigms that governed previous centuries. Hence, there is a need for

new insights and ways of thinking with which sustainable solutions can be formulated to tackle the social, organizational and societal issues individuals, organizations and society as a whole face in the twenty-first century.

In their book "*Total Respect Management, excellent leidinggeven voor de toekomst*", Blokland and Reniers (2013) state that today, we live in a world where connections and interactions between people, organizations and society branch out worldwide and where events can have an instantaneous and global effect. For example, on the 23rd of March 2021, early in the morning local time, the Ever Given container ship, a 400 meter long giant, blocked maritime traffic in the Suez Canal. A clear sign of the importance of this route in the organization of the global energy and commercial goods supply chain was the next day's 4% rise in crude oil prices amidst fears that the Suez Canal could be closed for a long time, a worrisome scenario. Five days later, on March 28, 369 ships were queuing to pass through the Suez Canal, with a daily estimate of USD 9.6 billion in merchandise held up (de Bodt et al., 2021). As such, this simple incident, where nobody got hurt, impacted the global economy and logistics worldwide, with effects that ripple on even up to the moment of this writing.

In recent years and months, the interconnectivity and interdependence of people, organisations and societies in a globalised world has become crystal clear. Globalised travel and human interaction caused the dissemination of the SARS-CoV-2 virus. What started as a local contamination has spread in no time across the globe, impacting all aspects of life and society. Furthermore, the conflict in Ukraine, besides the political, social and environmental consequences for that region, caused a global impact on supply chains of energy, food or other production goods in various regions of the world, causing a rising inflation, economic impact and even famine in certain regions of the world. Sooner or later individuals, organisations and even whole societies are impacted by the consequences of such events and their domino effects.

Everything is connected, information spreads faster than a wildfire, and what is to be considered right and good today, turns out to be considered wrong or mediocre tomorrow. Everything is changing at an ever-increasing pace and the world is falling from one crisis into another, because, in general, people don't look at the bigger picture and do not anticipate enough. Short-term visions prevail over the long-term perspective, so that one is only busy fighting fires and ultimately there is no time and resources left to tackle the root causes. Even when ambitious goals, such as the United Nations Global Goals, or the European Union Climate Change objectives, seem to have a long-term perspective, they rarely deliver the needed drastic changes in attitude and behaviour of individuals and organisations when daily life concerns

take over. Due to the craving for short-term profit, sustainable solutions and investments with a focus on the future, requiring investment without immediate profit, have fewer chances. This is how the future is compromised and much of it has to do with inadequate models and methods by which one approaches today's reality. The world is evolving and needs new perspectives that can evolve along with the rhythm of progressive (and sometimes revolutionary) change. (Blokland & Reniers, 2013)

At first sight, the challenges posed by the global population growth and rapid change are immense and seem insurmountable. However, Schwab states that the preceding industrial revolutions raised global income levels and quality of life, and he also points out that, in the same way, this fourth industrial revolution has the same potential to improve life for populations around the world. (Schwab, 2015). However, to improve life for populations around the world, new perspectives and ways of doing things are necessary to make that potential come true.

Although each industrial revolution is often considered a separate event, together they can be better understood as a series of events building upon innovations of the previous revolution and leading to more advanced forms of production. The speed and measure of the changes coming about by the fourth industrial revolution are not to be ignored. These changes will bring about shifts in power, shifts in wealth, and knowledge. Only in being knowledgeable about these changes and the speed in which this is occurring can we ensure that advances in knowledge and technology reach all and benefit all. (Xu et al., 2018)

1.3. A new paradigm for safety

Improving life for populations all over the world, also means to increase safety. Safety is indispensable for a company's sustainable growth (Koo & Ki, 2020) and therefore it is also vital for societal growth. However, when considering the subject "safety", one is often, if not always, confronted with the opposite of what safety is. Talking about safety often starts with the things one doesn't want, mentioning the negative effects of events that can or will affect one's own or other objectives. It never starts with what "safety" ultimately is supposed to be, other than the absence of what one doesn't want to happen. It is a fundamental flaw in safety science that needs to be addressed to make further progress in this field of study (Blokland & Reniers, 2013).

While, in general, safety issues are under control as a result of ongoing efforts, fast changing realities make safety concepts based on reacting on events and statistical data less appropriate, as new risk sources arise due to changing circumstances. Instead, finding approaches to reach safety proactively, and maintain adequate

safety levels in a sustainable way, is a challenge society faces today, as demand for more and sustainable safety persistently grows. Global connectedness results in global challenges and an ever-faster pace of change which impacts many sectors and industries who all suffer the same consequences of volatility, uncertainty, complexity and ambiguity (VUCA[1]). For instance, what would have happened to the Ever Given in the Suez Canal when those responsible for the safety of the ship had fully understood the reality of a sandstorm in combination of a super container vessel and narrow water conditions? And what would have happened when they would have fully considered the possible consequences of their choice of continuing operations in the adverse conditions and things going wrong? Maybe they would have decided otherwise. But, Lebedev et al. (2021) mention in their article "Could the accident of "Ever Given" have been avoided in the Suez Canal?", that calculations showing the effect of such winds on a ship have not been identified in scientific literature, although considerable attention is paid to the effects of strong winds and sand storms on railway transports, building structures and windmills. But while ships have passed the Suez Canal in sandstorms before, container ships are a relatively young class of ships and the Ever Given is one of the largest in its class. This provided for a new reality, not experienced before. As such, the accident of the Ever Given was not anticipated and waiting to happen in a world that is still reacting to events instead of foreseeing them.

Safety, how it is often seen today, is still aimed at preventing events and occurrences that generate bad consequences. Decisions and actions are often, if not always, based on past experiences of the things that went wrong. Therefore, dealing with safety is often reactive, focussing on unsafe issues and happenings, putting barriers around the possible causes and consequences of a lack of safety. Accordingly, safety is regularly regarded as a burden for decision-makers, as they have to deal with the "barriers" and other kinds of "restrictions" when trying to achieve something, as they are the ones that need to take the risk to make things happen. As a consequence, a reactive and negative focus on safety could lead to conflicting objectives between what the decision-maker wants and what safety requires. Additionally, focusing on

1 'VUCA' or 'VUCA world' was an acronym coined in the late 1990s by the United States Army War College to describe the post-Cold War environment, however, it remains as relevant today in the context of modern-day organizations. The term stands for, Volatility, Uncertainty, Complexity, and Ambiguity, words that effectively define and assess the work environments of future ready organizations today. 'Volatility' stands for the increasing size, pace, and nature of the changes being faced by organizations. 'Uncertainty' signifies the lack of information, or the inability to predict issues and events of the future. 'Complexity' highlights the interconnectedness of interacting forces affecting organizations and 'Ambiguity' is defined by unclear causal relationships and difficulty in teasing out issues. The core characteristics of VUCA are driving major strategic and leadership decisions in organizations. (Dhir, 2019)

what one doesn't want doesn't necessarily mean that one achieves what one actually wants. This is also true for achieving sustainable safety. With a negative focus on safety, one is less unsafe at best.

Similar to safety, risk is often approached from a negative viewpoint. Then it is considered the opposite of safety or a synonym of danger. Yet, recent understanding sees this differently. This negative focus, in general, also relies on learning from past experiences to build the barriers and take the measures to prevent bad things from happening. However, relying on the past to predict the future becomes ever more difficult and increasingly unreliable due to the rising pace and scope of change. Therefore, in order to be able to progress, it is clear that safety and risk are to be approached from a more positive viewpoint. Instead of avoiding what one doesn't want, it is necessary to focus on what one needs and aims for. Hence, it requires a shift from an events driven risk and safety management, which is mainly based on probabilities of negative consequences, towards an objectives focused risk, safety and performance approach, based on the consideration of positive effects, while also keeping an eye on events, negative effects and likelihoods when pursuing those positive effects.

It is how Schwab describes the challenges of the Fourth Industrial Revolution: "Neither technology nor the disruption that comes with it is an exogenous force over which humans have no control. All of us are responsible for guiding its evolution, in the decisions we make on a daily basis as citizens, consumers, and investors. We should thus grasp the opportunity and power we have to shape the Fourth Industrial Revolution and direct it toward a future that reflects our common objectives and values." (Schwab, 2015)

While the Fourth Industrial Revolution and associated VUCA conditions result from an ever faster evolving world, individuals and organisations have to deal with the consequences of those conditions and the ever faster and more significant changes they impose. It means that organisations operate in ever more complex socio-technical systems, while organisations also become ever more complex themselves.

Complex systems are to be recognised by the following characteristics:

These systems involve large numbers of interacting elements, and the interactions are nonlinear. Minor changes can produce disproportionately major consequences, because complex systems are dynamic and the whole is greater than the sum of its parts. Solutions can't be imposed, they arise from the circumstances, which is frequently referred to as emergence. Complex systems have a history, and the past is integrated with the present; the elements evolve with one another and with the environment, and evolution is irreversible.

Though complex systems may, in retrospect, appear to be ordered and predictable, hindsight does not lead to foresight, because the external conditions and systems constantly change. Unlike ordered systems (where the system constrains the agents), or chaotic systems (where there are no constraints), in a complex system the agents and the system constrain one another, especially over time. This means that one cannot forecast or predict what will happen (Snowden & Boone, 2007).

Consequently, organisations require appropriate knowledge and tools to cope with the reality of operating in the volatile and complex environment of the VUCA world. This will also be necessary to maintain or improve organisational safety and performance in such conditions. Because of these rapidly changing, unpredictable conditions, it seems problematic, or even inappropriate, to base these tools on past experiences. Hence, new and more pro-active ways to generate safety and performance in organisations, and society as a whole, will be required.

1.4. Overall aim

Institutional reforms, technological evolutions, increasing attention for sustainable solutions and rapidly changing market demands, impact the safety of organisations in many ways at an overarching level. However, this is a level on which organisations have a limited impact upon. Nevertheless, it is paramount that organisations of any size or sector improve their safety and performance to cope with the challenges of the Fourth Industrial Revolution and the increasing or even urgent demand for sustainability. Consequently, it is our purpose to study and determine how safety and performance can be improved and maintained in a sustainable way through a proactive approach towards safety and performance of organisations themselves.

In that regard, according to Mathis & Galloway (2013), learning how to transformational enhance systems, performance, and culture from within, is where true sustainability lies. Therefore, the overall aim of this research project is to develop and implement a systemic and integrated approach, a design, which proactively achieves safety and excellent performance in organisations. This design should be applicable to any organisation in any sector, to enable the realisation of safety and excellent performance in a proactive, innovative and socially responsible, sustainable way.

This leads to the following preliminary question:

"How can organisations of any size or sector proactively pursue and achieve safety & performance in a volatile, uncertain, complex and ambiguous environment."

2. Research concept

This research is based on the idea of a design research, where the methodology to pursue and achieve safety & performance proactively is to be seen as the design. The concept of design research is evolving through the literature, on-line discussions, and conferences. These discussions, in general, revolve around defining what research is and where it belongs in design education and practice. The verb design comes from the Latin root "designare", meaning to specify and the noun comes from the root "signum", meaning sign or specification. As such, design is an activity for planning and implementing new products and services, which includes the by-products of the processes involved. (Frankel & Racine, 2010)

Furthermore Bayazit (2004) states:

- Design research tries to answer the obligations of design to the humanities:
- Design research is concerned with the physical embodiment of man-made things, how these things perform their jobs, and how they work.
- Design research is concerned with construction as a human activity, how designers work, how they think, and how they carry out design activity.
- Design research is concerned with what is achieved at the end of a purposeful design activity, how an artificial thing appears, and what it means.
- Design research is concerned with the embodiment of configurations.
- Design research is a systematic search and acquisition of knowledge related to design and design activity.

In their article "Demystifying Design Research: Design is not Research, Research is Design", Trygve and Haakon Faste state the following regarding design research: "Research is generally defined as a systematic investigation that establishes novel facts, solves new or existing problems, proves new ideas, or develops new theories. It is primarily associated with the search for knowledge, especially in the sciences and technological fields. Design, in contrast, deals with the act of planning and communicating a course of action to others, usually through the creative exploration of an area of interest. Charles Eames defined design as "A plan for arranging elements in such a way as to best accomplish a particular purpose." (Neuhart et al. 1989). The term "design research" combines these two reasonably well-understood areas of practice, research and design, resulting in a seemingly meaningful merger roughly equivalent to the investigation of knowledge through purposeful design." (Faste & Faste, 2012)

Design research, in general, is an emergent field of study. There is debate as to which research approaches are valid and productive, and in continuation the criteria by which design research should be evaluated are also contested. However, the main criterion for a research approach is ultimately that it should generate knowledge about the field of inquiry (Dalsgaard, 2010). Brandt & Binder (2007) argue that the knowledge that springs from experimental design research inquiries should be of a type that makes it accessible to, and arguable among peers: "… knowledge production in experimental design research involves a traceable genealogy, an intervention in the world and the articulation of an argument for others to engage with." (Dalsgaard, 2010)

The discussion on research on, in and through design (Frayling, 1994), has inspired and challenged design researchers to position research more clearly in relation to design practice, and it has opened a venue for design research where a designerly engagement becomes a relevant vehicle for the production of knowledge. In design research it is not the purpose to make finished designs for their own good. The design typically defines an area of exploration, setting goals for what is to be achieved by the design, but leaving it open how this is accomplished. (Brandt & Binder, 2007)

In his article "Investigating Design: A Review of Forty Years of Design Research", Bayazit (2004) offers the definition of L. Bruce Archer (1981): "Design research is the systematic inquiry whose goal is knowledge of, or in, the embodiment of configuration, composition, structure, purpose, value, and meaning in man-made things and systems". It is also how this research is viewed and approached.

In this study, the area of exploration of knowledge and the goals (purpose and value) to be achieved by the design are clear. The concepts "Safety" and "Performance" are to be researched and these are also the goals that need to be achieved by the design (man-made system) in a proactive and sustainable way. To accomplish this aim, new paradigms are needed, and it will be necessary to challenge existing ideas and convictions regarding safety and performance, while providing new ways on how to look at and deal with safety and performance in organisations of any size or sector. As such, the methodology of a design research is considered to be an adequate way of generating the knowledge, composition, structure, purpose and value of a design that proactively generates safety and performance in organisations.

Obviously, in order to be successful, a design needs to be implemented and implementing the design will require change in organisations. Also, the VUCA world requires socio-technical systems to manage change. Hence, the ability to change becomes ever more important for any type of organisation/socio-technical system. Consequently, the capability to manage change needs to be an important

part of the design. It is argued that any change characterised by complexity and interaction should be managed as a whole and therefore it is suggested that a holistic perspective is needed (Cao & McHugh, 2005). Systems thinking looks at the whole of a system and offers such holistic perspective. Accordingly, in order to cope with change and to incorporate sustainability, also a holistic / systemic view on the concepts risk, safety and performance in organisations needs to be developed.

3. A systems thinking perspective as a foundation for the development of the Design

3.1. A systems thinking perspective on socio-technical systems in the 21st Century

In the larger part of the 20th Century, the levels of change and complexity in socio-technical systems were low, and consequently, complexity was not so much an issue. However, in the introduction it was made clear that with the rapid development of digital technology and the increasing connectedness of socio-technical systems, this has changed. Hence, the 21st century can be seen as being the century of complexity, because complexity of the socio-technical environment in which one lives and works, has reached such a level that it is becoming problematic. Complexity impacts all aspects of life, as it is a property of open systems that involves a large number of diverse, interacting components. The examples of the Ever Given accident and the dissemination of the SARS-CoV-2 virus show that in a connected and dynamic world a single decision by one or a few persons can have a global impact due to the domino effects of a single event. In these cases, the domino effects caused the disruption of worldwide logistic chains or the infection of whole populations, resulting in huge economic difficulties and severe global health issues. Complex systems are characterised by the fact that they generate uncertainty, as the components, often called agents, have a certain degree of autonomy and a particular and changing degree of self-organisation, generating emergent behaviour. Also, the current transition from an industrial to an information society shows a very steep increase in social complexity[2] due to the spread of digital technology and the resulting connectivity. Therefore, complexity has become an inherent property of ever more systems that constitute the environment in which people live and work. (Rzevski, 2015)

In 1993 Donella Meadows drafted the book "Thinking in systems"[3]. In the introduction of that book, Meadows states: "As our world continues to change rapidly and becomes more complex, systems thinking will help us manage, adapt

[2] In sociology, social complexity is a conceptual framework used in the analysis of society. Contemporary definitions of complexity in the sciences are found in relation to systems theory, in which a phenomenon under study has many parts and many possible arrangements of the relationships between those parts. At the same time, what is complex and what is simple is relative and may change with time. Current usage of the term "complexity" in the field of sociology typically refers specifically to theories of society as a complex adaptive system. However, social complexity and its emergent properties are central recurring themes throughout the historical development of social thought and the study of social change. (Source Wikipedia)

[3] This book was not published at that time and Donella Meadows died unexpectedly in 2001 with the book still unfinished. In 2008 her colleagues of the Sustainability Institute published her manuscript posthumously (Diana Wright (editor), 2008).

and see the wide range of choices we have before us. It is a way of thinking that gives us the freedom to identify root causes of problems and see new opportunities." (Meadows, 2008)

The distinction of systems thinking is its focus on the whole and the use of a methodology to synthesize separate findings into a coherent whole. It is far more critical than the ability to generate information from different perspectives. Classical science is preoccupied with independent variables. It assumes that the whole is nothing but the sum of the parts. Accordingly, to understand the behaviour of a system one needs only to address the impact of each independent variable on that system. It is the essence of analytical thinking. However, increasingly it is clear that the independent variables are no longer independent, and that analytical thinking is no longer effective. (Garajedaghi, 2011).

In his article "Criteria of systems thinking", Capra (1985) explains that the first aspect of systems thinking concerns the relationship between the part and the whole. The whole, as this term is used in systems thinking, indicates the fact that a system will always consist of sub-systems and will likewise always be a part of encompassing systems. Looking at the whole of an issue then means to zoom out, both in time and space, to see the relevant systems, the elements (parts) that explain the behaviour of the concerned system, which is then the whole.

He also expounds that for systems thinking the parts can only be understood through the behaviour and dynamics of the whole and raises the question: "If everything is connected to everything else, how can one ever hope to understand anything?". As this would imply that, because everything is connected to everything, to explain any one of them would require the understanding of all the others which is obviously impossible. Yet, Capra indicates that there's such a thing as approximate knowledge. If one is satisfied with an approximate understanding of a system, one can describe selected sub-systems, neglecting others that are less relevant (Capra, 1985). As such, an important, even crucial, aspect of systems thinking is to find the relevant systems (elements/parts) to be included in the whole of a system and determine the dynamics between those parts that explain the behaviour of the whole.

Safety in organisations is directly related to events happening or not happening. When these events show visible symptoms, it is often the case that one reacts to those symptoms, as the solution seems obvious and immediate action offers a quick relief of the problem symptom. However, this often diverts attention away from the real fundamental source of the problem. Efforts spent only treat the symptom, but not

the underlying causes, often leading to systemic archetypes[4] called "fixes that fail", "shifting the burden" or "addiction" (Senge et al., 1994). For instance, to cope with the strong winds and the effect it had on the Ever Given, the Egyptian pilot decided to increase the speed of this super container ship to increase responsivity and have a better control over the ship's movements. However, due to the proximity of the bank, a so-called "bank effect" occurred, generating a yawing moment, pushing the bow away from the bank of the canal, causing the ship to get out of control and deviate from its course, ending up with the bow wedged in the other bank and the stern nearly touching the opposing bank of the canal. Not taking the whole into account caused this accident to happen, as only a single parameter, deemed independent, was considered by the pilot (Baric et al., 2021). A systemic approach precludes solely reaction to symptoms of events happening, but instead seeks to discover the underlying systems, structures and their associated mental models[5], in order to understand how the whole system produces its results (wanted and unwanted). Because, in order to change results, it is not enough and often wrong, to directly react to the visible aspects of events happening. Reacting to these events via their visible symptoms, which are generated by underlying systems, can even aggravate situations and problems. When one reacts to symptoms, fundamental dynamics of those systems remain intact, the unwanted events will happen again, and resources are spent without solving the issue. As such, a reactive approach, solely based on the visible aspects of events doesn't lead to lasting effects or sustainable results. For example, in the case of the Ever Given, the pilot failed to "zoom out" to take the "whole" of the parts "weather", "ship" and "canal" into account, missing the important aspect of a possible "bank effect". Most likely, this

[4] Using system dynamics, one can start to identify and visually describe general patterns that are repeated in widely different contexts. System dynamicists and systems thinkers have observed some of these common dynamics and defined a set of "system archetypes" that can be applied to multiple different scenarios. System archetypes are visual descriptions of generic, recurring system structures in the form of Causal Loop Diagrams. There is no definitive list of system archetypes; there is a broad list of eight to twelve core archetypes, but some even argue that four archetypes can explain all the other archetypes. (Branz et.al, 2021)

[5] Mental models are mental representations, images, in one's brain and how people understand the universe and everything in it. Not only do mental models shape what one thinks and how one understands, but they shape the connections and opportunities that one sees. Mental models are how people simplify complexity, why someone considers some things more relevant than others, and how one reasons. A mental model is simply a representation of what something is or of how something works. One cannot keep all of the details of the universe in one's brain, so individuals use models to simplify or generalise the complex world into understandable and organizable chunks. As such, mental models are individual representations of reality. As such, mental models are the end results of perceptions and are the output of linguistic comprehensions. They are what underlie thinking and reasoning. And, thinking and reasoning is what manipulates mental models. (Senge, 1990, Johnson-Laird, 2001, 2004)

phenomenon was not part of the mental model of the pilot in command at the moment of his decision to speed up.

A systems thinking approach entails a whole system to be taken into account and acts on those elements in the system that generate fundamental and sustainable change. This, in order to spark the concerned socio-technical systems to produce and achieve their specific goals safely. When safety and corporate social responsibility are important to an organisation, associated values and their supporting beliefs, need to be embedded and become deeply rooted into the organisational culture. Such a situation can only materialize when the mental models – how people, from top to bottom, perceive reality – including well founded paradigms, present in the organisation, are aligned with these values and beliefs. The reason is that these mental models will determine how systems will be structured, how they function and how they eventually produce outcomes and results.

3.2. How to intervene in and change complex socio-technical systems

When aiming for a proactive, innovative, socially responsible and sustainable way to get results, it is necessary to reach sustainable transformations of socio-technical systems. In their article "Leverage points for sustainability transformation", Abson et al. (2017) point out, that despite a substantial focus on sustainability issues in both science and politics, humanity remains on largely unsustainable development trajectories, due to interventions that target highly tangible, but essentially weak leverage points. Therefore, there is an urgent need to focus on less noticeable but potentially far more effective areas of intervention. One could argue this is also the case for organisations. Many organisations are still more reacting to events that are known and have already happened in the past. Hence, in order to become more proactive regarding safety and performance, organisations also need to undergo sustainable transformations. According to Abson et al. (2017), the answer is to be found in a systems thinking approach focusing on transformational interventions and leverage points as boundary objects for genuinely transformational sustainability science.

The concept of leverage points offers great potential to consider how one can intervene in systems to create transformations for sustainability. Donella Meadows' notion of leverage points has much to contribute to sustainability science. It was first offered as a metaphor and heuristic framework for conceptualizing the potential different interventions in complex systems to generate systemic change. (Leventon et al., 2021)

Leverage points are places (positions, items, elements, characteristics, …) within a complex system (an organisation, an economy, a community, an ecosystem, …)

where a small shift in one element can produce big changes in everything. Leverage points are not intuitive. Or if they are, one intuitively uses them backward, systemically worsening whatever problem one is solving. (Meadows, 1999)

Using leverage points backwards can happen when the whole is not considered, or when cause and effect are separated in time and space. Also, events may have different effects and the order of importance may shift in time. Furthermore, cause and effect can replace one another, generating specific dynamics. As such, removing an initial cause will not necessarily remove the effect (Garajedaghi, 2011).

For instance, human activity is causing an increasing level of CO2 in the Earth's atmosphere, generating a change in Earth's climate. One of the effects of this change is a rise in average temperatures and changing precipitations all over the globe. As a result, forests are drying out and in turn more easily catch fire. Even when the human activity, causing the climate change in the first place, is diminished, this new dynamic, which was an effect, in turn becomes a cause for climate change. Forest fires also increase the level of CO2 in the atmosphere and on top of that also diminish the ability to capture this carbon dioxide, aggravating the situation even more.

Besides the already mentioned systemic archetypes such as "fixes that fail", "shifting the burden" or "addiction", another well-known backwards use of a leverage point has been identified as the archetype called "tragedy of the commons". It is the case when the use of a common resource provides for success, but sooner or later the resource will be become depleted, collapses or will cause side effects that counter the desired result of using the resource in the first place, causing huge problems. As an example, one can mention the use of fossil fuels to drive the economy and all of its unwanted side effects, causing huge damage to economic systems all over the world as a result of the natural disasters that result from the climate change, which is one of the consequences of the excessive use of fossil fuels to drive the economy.

In her article "Leverage points: Places to intervene in a system", Meadows (1999) proposes and explains a list of elements of systems that can be used to intervene for change. She also indicates that it is dangerous to generalize about them. It is not a recipe for finding leverage points but rather a way to think more fundamentally about where to intervene when changing systems. Her list of leverage points, the places to intervene in a system, in increasing order of effectiveness, is as follows:

3.2.1. Constants, parameters, numbers of items

Parameters, such as numbers of accidents, Lost Time Injury Rates (LTIR), and other factors often used in safety science, can be important, especially in the short term, but they rarely change any behaviour.

3.2.2. The size of buffers and other stabilizing stocks, relative to their flows

Inventories, back-ups, buffers, can be powerful means to leverage outcomes, but, in general, they are physical items that are not so easy to change. Examples of stocks are, for instance, using land that can be flooded to cope for excessive rainfall. Or, the use of buffer tanks, or reserve stocks in production processes, to cope with the variabilities in the production flow.

3.2.3. The structure of material stocks and flows

Also, the physical arrangement of stocks and flows can be a leverage point. For example, how production lines are shaped or how safety arrangements are physically placed can influence the outcome of safety and performance issues in organisations.

3.2.4. The lengths of delays, relative to the rate of system changes

Delays in feedback loops are critical determinants of system behaviour. They cause a system to oscillate when there's a delay in getting the feedback information or also when a response is delayed. Oscillations can be critical and even cause irreversible damage. Therefore, adapting the delay in a feedback loop, relative to the rate of system change, can have big effects. But things take as long as they take, and often it is easier to slow down the change rate. For instance, the rapid changes in corporations and society today, require much quicker reactions to what is happening, even to the extend that anticipation is needed to avoid jeopardy.

3.2.5. The strength of negative feedback loops, relative to the impacts they are trying to correct against.

Negative feedback loops in systems are omnipresent. One can find them in nature and humans invent them as controls to keep system states within safe boundaries. Negative feedback loops need goals, monitoring and signalling devices to detect deviations from the goal and a response mechanism. A most common example of a negative feedback loop is a thermostat keeping a space or device at the desired temperature. Complex systems usually have several negative feedback loops in order to self-correct their states. The strength of negative feedback loops is important relative to the impact it is designed to correct. In safety, these negative feedback loops may be inactive much, if not all of the time. As an example, one can think about the devices often installed to counter fire, such as fire extinguishers or sprinkler systems. But their presence is often critical to the long-term health of the system. A big mistake is to strip these "emergency" response systems when they appear (excessively) costly and when they are not used.

3.2.6. The gain around driving positive feedback loops

Negative feedback loops are self-correcting, but positive feedback loops are self-reinforcing. The more they work, the more they gain power to work some more. They are sources of growth. However, sooner or later a negative feedback will kick in. When unchecked, positive feedback loops will erode or explode. Being able to control the gain of a positive feedback loop in a system is generally more powerful than strengthening the corresponding negative feedback loops. As an example, one can think of fire retardants, slowing down or blocking the progress of a fire that is building up.

3.2.7. The structure of information flows

Missing feedback is one of the most common causes of system malfunction. Badly crafted information flows lead to a lack of feedback opportunities. Restoring feedback at the right time and place, in a compelling form, is what creates a strong leverage point. For instance, how would a chemical plant function without the permanent feedback to its control rooms? A malfunction on this level can easily develop into a catastrophe.

3.2.8. The rules of the system

The rules of a system define its scope, boundaries and its degrees of freedom. Constitutions are strong examples of social rules. Physical laws are absolute rules. Laws, institutions, punishments, incentives and agreements are progressively weaker rules. Rules have a huge impact on the functioning of systems. These are high leverage points when one has power over them. As an example, one can think of speed limits in traffic, destined to keep people safe.

3.2.9. The power to add, change, evolve, or self-organise system structure

Charles Darwin already knew: “It is not the strongest of the species, nor the most intelligent that survives. It is the one that is the most adaptable to change.” Biological systems have the power of evolution and human systems have the ability to innovate. This ability is often called self-organisation. It means changing any aspect of a system with the previous leverage points. It is the strongest form of system resilience. A system can evolve and survive almost every change by changing itself. Any system that cannot self-evolve is doomed over the long term. The intervention point is obvious, but unpopular: Encouraging variability and experimentation and diversity (biological, cultural, social, market, …) is often counterintuitive.

3.2.10. The goals of the system

The goal (purpose) of a system is a leverage point superior to the self-organising ability of a system. A goal defines a system. In the same way a negative feedback loop is centred around a goal, this is the same for a system. While, the goals of the different negative feedback loops are obvious, system goals are larger and less obvious. These are really high leverage points, as they drive the entire system.

3.2.11. The mindset or paradigm out of which the system – its goals, structure rules, delays, parameters, arise.

Paradigms (mental models) are the sources of systems. They generate the system goals, the information flows, feedback loops, stocks, flows and everything else about a system. Mental models are harder to change than anything else about a system. As such, it isn't obvious that it is high in the list. However, there's nothing physical or expensive or even slow in paradigm change. For an individual it can happen in milliseconds. It only requires a new way of seeing. Yet, for societies that is another matter, as they will resist challenges to their paradigms harder than they resist anything else. To change paradigms, one needs to point out the anomalies and failures of the "old" paradigm and commit loudly and with assurance to the "new" one, working with open minded people. Meadows warns not to waste time with the reactionaries. It is obvious that climate change, and how people look at it, is a nice example of this high leverage point. A well-known Dutch football player once said: "you will only see it when you will understand it". A mental model can be so strong that people even can't see the obvious, as long as their understanding (mental model) of the subject hasn't changed. When old mental models generate powerful and successful goals that drive a successful system, it is counterintuitive and very hard to change them.

3.2.12. The power to transcend paradigms

There's one leverage point that is even higher than changing a paradigm. It is the ability to stay unattached of paradigms, realizing that no paradigm is true and that any mental model is only a limited understanding of the parts of an immense universe, far beyond any human comprehension.

3.3. Intervening in organisations to achieve, maintain and improve safety and performance

Surely, exceptions can be found to every of the above-mentioned leverage points, as they can move up and down the ranking of importance. Also, according to Meadows, the higher the ranking, the more the system will resist changing it. This is probably why today a large part of action in safety science is still based on the

numbers and parameters that a safety system gathers, trying to predict a future that is changing even before the numbers have been gathered and analysed.

It is obvious that building a design that aims to change systems to become more proactive about safety and performance ideally takes into account all places to intervene in the system and needs to comply with the higher-level leverage points. As such, it seems logic to begin with the highest of them all, transcending paradigms to get a better understanding of reality.

But Meadows is also clear about the effort needed to reach such change. She points out that there are no cheap tickets to mastery. High level leverage points are not easily accessible, even if one knows where they are and how to push them. The higher the leverage point, the stronger the resistance to change will be. Therefore, the most difficult part might be to strategically and profoundly letting go of the ideas and paradigms that actually rule the systems.

4. Research questions

4.1. Purpose of the design

As described in the introduction, organisations operate in a highly complex environment and are subject to constant change, involving economic, institutional, technical and organisational factors. Also, organisations themselves become more and more complex in their functioning, forming complex socio-technical systems. Furthermore, the interconnectedness of organisations and society today, require ever more attention to sustainability and other ethical issues. The importance of the human factor in safety and performance has since long been recognised. However, the increasing pace of change and level of complexity also requires the human factor to adapt to new situations and a changing environment in a sustainable way. Therefore, a systemic and an integrated approach to proactively pursue and reach performance, safety and Corporate Social Responsibility (CSR) in organisations and teams is what is assumed to be needed to cope with the current complex reality of rapid change and increasing numbers of possibilities.

Hence, the objective of this research is to develop and study a design, based on the leverage points indicated by Meadows. The purpose of the design itself is to achieve sustainable safety and performance in organisations proactively in order to cope with the VUCA environment organisations operate in. Consequently, the following **general research question** needs to be addressed:

"How can organisations proactively generate and improve safety and performance
in a volatile, uncertain, complex and ambiguous environment,
taking into account sustainability, human factors and mental models?"

4.2. Risk, Safety & Performance

According to Meadows (1999), the highest possible leverage point is the ability to stay unattached of paradigms. A paradigm is a standard, perspective, or set of ideas. Paradigms are ways of looking at something. The concept paradigm is often used in the academic, scientific, and corporate worlds. They are strong mental models that govern the way of thinking about a subject. This is also true for the concepts risk, safety and performance. How one regards these concepts will determine how one deals with these notions. Risk, safety and performance are at the heart of this study and constitute the goal of the design.

As a consequence, it is important to be clear what these concepts comprise and how they need to be understood. Today, different perceptions of these concepts exist despite varying efforts to grasp what these notions comprise. Also, in science there

are discussions and ongoing attempts to standardise how these ideas can be looked at.

When discussing the concepts of risk, safety, security and performance, people have an intuitive understanding of what these notions mean, and, to a certain level, this understanding is universal. However, when delving into the real sense of these concepts, one is likely to fall into semantic debates and ontological discussions, as a wide range of perceptions of these constructs exist. For this research, it is important to have a clear understanding of these constructs. For this, it is necessary to let go of old paradigms regarding risk, safety and performance and build a sound and coherent foundation on which the design can be based. Thus, it is essential to discover and explain the similarities and differences behind the perceptions of these concepts, to come to a fundamental understanding of risk, safety, security and performance, proposing a semantic and ontological underpinning, based on an etymological and etiological study of the concepts of risk and safety that can be used as a foundation for safety and security science, theoretically allowing for an increasingly more precise understanding and measurement of (un)safety across the whole range of individuals, sectors and organizations, or even society as a whole.

This reasoning leads to sub question 1:

"How to understand and conceptualize the notions of risk, safety, security, and performance?"

4.3. Mental models

Other strong leverage points are the mental models that govern organisational systems. They determine the individual, team and organisational goals and drive the systems that pursue those goals. When a design has the purpose to change systems, it is a leverage point that can't be ignored. In the past one hundred years, concepts such as risk, safety and security have become ever more important, and they represent a growing concern in our society. These constructs are also important subjects of study to enhance sustainability. During the past fifty years, safety science has gradually developed as an independent field of science. In this period, different concepts, theories, models and research traditions have emerged, each with its specific perspective. Safety science is now focused on finding ways to proactively achieve safety versus reaching safety in a reactive way. This increasing awareness and search for proactiveness can be found and presented when viewed in the light of systems thinking and leverage points, where increasing awareness and proactiveness can be seen as digging deeper into higher levels of leverage points, discovering how systems are governed by the mental models that are present in organisations. It offers a way forward in understanding, and proactively managing,

risk, safety, security and sustainable performance, in organizations and ultimately in society as a whole.

Consequently, this leads to sub question 2:

"What is the significance of mental models for upholding safety in organisations?"

4.4. Changing mental models in organisations

Ultimately, the highest leverage point is the ability to change existing mental models. When looking at socio-technical systems from a systems thinking and systemic perspective, it becomes clear that mental models govern the behaviours and determine the achievements of socio- technical systems. This is also the case for individuals, being systems themselves and, as such, being elements of those socio-technical systems. Individual behaviours result from individual perceptions (mental models). These individual behaviours ideally generate the desired outcomes of a socio-technical system and create value. However, at the same time, mental models and the associated individual behaviour also bring about unwanted consequences, destroying or diminishing value. For example, one could think of the organisation that requires strict adherence to standardised procedures. This should be the general idea throughout the organisation. However, it is possible that someone, possibly coming from a different corporate culture, has the idea that different ways of executing tasks are equally valid, or that cutting corners could save time and effort. The resulting behaviour of these ideas could then lead to an inadequate execution of the procedures and tasks, possibly resulting in disaster. Therefore, to achieve safety and to attain sustainable safe performance, understanding and managing mental models in organisations is of paramount importance. Consequently, in organisations and society, one needs to generate the required mental models that create successes and, at the same time, avoid or eliminate damaging perceptions and ideas in order to protect the created value. Because, by changing the mental models, ethical and societal goals can become incorporated in any organisation, regardless of its size or sector. By changing mental models, it is possible to fundamentally change the socio-technical systems that organisations are. Only by changing the mental models of people in organisations, behaviours will effortlessly change in a sustainable way. Because, when these mental models are inspiring and clear, the system will adapt itself automatically according to these new mental models, generating new and adapted behaviour. Think of the person that has an unhealthy lifestyle and doesn't care about it, but who is suddenly confronted with a life-threatening event as a result of this particular lifestyle. Confronted with one's mortality, the new perception this person gets then often fundamentally changes the behaviour of this individual, to generate a new and much healthier lifestyle. By changing mental models,

organisations of any size or sector will become proactively and sustainably safe and high performing. At least, that is the principle on which the design will be based.

Accordingly, an important issue to be solved for constructing the design is sub question 3:

"How to change mental models in organisations to proactively improve safety and performance?"

4.5. Building and implementing the design

When the questions above have been answered, a design can be proposed and developed that is capable of changing mental models in organisations of any size or sector, building a system that proactively generates safety and performance in a sustainable way. Yet, it is not enough to build a design. It also needs to be clear how to implement and use it before it can be brought to success. The elements of the design should be made clear, and one also needs to understand the interactions of its elements.

Therefore, one also needs an answer to the following sub question 4:

"How to implement pro-active safety management and improve the performance of organizations of any size or sector, operating in a volatile, uncertain, complex and ambiguous environment?"

4.6. Measuring results of implementing the design

Having a specific design, and implementing it, is how safety and performance can be achieved proactively. At least, that is the hypothesis. However, the question remains whether the design and its implementation will actually improve safety and performance in organisations. Therefore, it is also necessary to be able to measure its impact. Performance management and measurement are already well-developed aspects of managing organisations. Organizational performance can be measured in several ways, resulting in many different and subjective interpretations of how well an organisation performs (Cristian & Monica, 2017). Because, although the concept of organizational performance is very common in the literature, it is a difficult construct to define, due to the multitude of meanings and perspectives from which it can be seen. Therefore, there is no universally accepted definition of this concept nor a generally accepted tool for measuring organizational performance (Gavrea et al., 2011). The same is true for measuring safety. Many ways are possible to measure safety in various types of organisations. However, one of the major challenges in safety science is to develop methodologies and systems that are able to proactively capture and recognise situations and patterns that have the potential to provoke

severe accidents. This instead of being obliged to use reactive approaches, such as learning from safety statistics or accident investigations when incidents, mishaps and disasters already occurred (Swuste et al., 2016). Most indicators and certainly the most reliable one's are lagging, telling the story long after events took place. Accordingly, increasingly more organisations are looking for more proactive methods in measuring and achieving safety performance. As a result, in recent years, important efforts have been undertaken to improve the understanding of safety culture and safety climate and how to measure these concepts in organisations, for instance in the process industry and at chemical plants. Likewise, substantial efforts have been made to determine and develop a wide range of leading and lagging safety indicators that can reflect and predict safety performance. While developing leading indicators and making culture measurements are helpful, they both measure safety conditions indirectly. Because, an organisational culture or climate can be regarded as a specific indicator of a possible future performance, in the same way leading safety indicators aim to predict the future. Yet, few tools are currently available for the instant measuring of actual safety conditions and performance in organisations, providing information that allows for benchmarking between different sectors and industries. Nevertheless, when safety, and its opposite "unsafety", are carefully defined, it becomes imaginable to develop tools that instantly measure the safety performances and actual safety situations in organisations so that they can be used for benchmarking regardless of sector or industry. (Blokland & Reniers, 2019). Risk, safety and performance indicators are closely related, but so far, there's no universal way on how to look at them.

This leads to the following sub question 5:

"How can safety instantly and continuously be measured in a standardised way, independent of the type or size of the organisation?"

5. Structure of the thesis

This thesis consists of three parts. In the introductory part, an analysis and vision on the current situation in organisations, and society as a whole, has been developed, leading to the identification of a requirement for organisations to become more proactive regarding their performance and safety. The introduction also presents how this requirement can be researched by a design research and how this need can be fulfilled by a design. In order to create and develop this design, the introductory part also offers a series of questions that need to be answered in order for the development, implementation and use of the design to be successful.

Part 1 consists of the answers to these sub questions. All of them have been treated by the means of dedicated publications. Sub questions 1 to 3 have been handled in three concept papers[6] that form the heart of this thesis.

Part 2 completes the thesis with a discussion of the proposed design and its answers to the different sub research questions. It also offers reflections and conclusions regarding the general research question. Furthermore, it will also provide an overview of all related publications and offer ideas for future research on this topic.

[6] All of these concept papers were published in the MDPI Journal "Sustainability" because sustainability is a core concern in this thesis.

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PART 1

CONCEPTS, QUESTIONS AND ANSWERS

Chapter 1[7]

"How to understand and conceptualize the notions of risk, safety, security, and performance?"

1. Introduction

Standardization in industries is an important aspect of sharing information and facilitating cooperation. When one talks about safety, security, risk, or performance, everyone understands what is being talked about. There is no one who does not grasp what the words mean in one's own perception and how they can be understood. However, when opening a discussion on what these concepts really are and how one should study or deal with them, it is most likely ending up in ontological and semantic debates due to different experiences, views, perceptions, and understanding. Even though much research has been devoted to studies of safety, the concept in itself is undertheorized [1].

Companies in industrial parks are not only connected by mutual interests such as technological similarities, logistics advantages, and the like, but they are also linked through the responsibility of obtaining and sustaining safety and security standards as well.

For instance, Chemical Industrial Parks are an important element of the development and economic growth in countries worldwide. They benefit from a common infrastructure, minimal utilities costs, the presence of complementary products and services, functioning as force multipliers on the surrounding region. When properly managed, they bring the benefit of scale economies and bring benefits to the region—the more standardized, the greater these benefits.

However, at the same time, these parks are high-risk areas, often showing great vulnerabilities and the potential for domino effects when things go wrong. As such, accident prevention and emergency response are crucial capabilities in securing the economic benefits these clusters generate. Similar to the importance of standardization of products and services for economic growth, it is important to have a common understanding of concepts such as safety and security to maximize efficiency and effectiveness in preventing disaster and facilitating health, safety, and the protection of the environment [2–4].

Consequently, cooperation on topics concerning safety and security is highly relevant. Therefore, in industrial parks, it is important that managers from different

[7] This chapter has been published before as the concept paper "An Ontological and Semantic Foundation for Safety and Security Science" (Blokland & Reniers)
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companies belonging to the park have the same understanding of the concepts of risk, safety, and security. Because, only when a shared understanding of these concepts is present, organizations belonging to industrial parks are able to truly and optimally cooperate in the field of risk, safety, and security [5,6].

Risk and safety are often proposed as being antonyms, but more and more understanding grows that this is only partially true and not in line with the most modern, more encompassing views on risk and safety. Risk can also be considered as something that is positive, and the common idea of expressing risk using probabilities is too narrow [1,7–11]. Likewise, safety and security are often seen as being completely different fields of expertise and study that are separate from each other, while other views might more underline the similarities that are to be found between the two concepts and how they can be regarded as being synonyms [12].

Science, including the domain of risk and safety, is served with clear and commonly agreed-upon definitions of concepts, and well-defined parameters, since having these precise definitions of concepts and parameters allows for standardization, enhancing communication, and allowing for an unambiguous sharing of knowledge. As Brazma (2001) says: *"Our ability to combine information from independent experiments depends on the use of standards analogous to manufacturing standards, needed for fitting parts from different manufacturers"* [13].

Standardization in science, in its turn, allows for a more exact measurement of observations, and this opens the opportunity of increasing the accuracy of analysis, which then can be used to develop more sound theories and practices. However, when studying in the field of safety science (a relatively young field of science), it is hard to find clear-cut definitions that indisputably link safety, security, performance, and risk. When reviewing the safety science literature, the question "what is safety" is answered in many ways, and it is very hard to find a clear definition of its opposite, which we could also name 'unsafety'.

Although the field of safety science is relatively novel as a separate and independent domain of study, many theories, models, and metaphors have already been proposed, attempting to describe what safety is and how it can be achieved. Often these theories are drawn from the investigation of—and lessons learned from—catastrophes and disasters. As such, these theories are often justified by explaining how these mishaps came about. Therefore, in general, efforts to improve the safety of systems have mostly been driven by hindsight, both in research and in practice [14]. Most problematic is that safety is mostly defined by its opposite, for instance, as being the antonym of risk.

As a consequence, looking at the concepts of risk, safety, and security in scientific literature shows that there is no truly commonly accepted and widely used semantic foundation to be used in safety and security science, providing common, unambiguous, clear, and standardized definitions. Likewise, such a survey also

confirms that there is a lack of standardization when it comes to defining the opposite, the antonyms that indicate a lack of safety or security. Terms like accident, incident, mishap, disaster, and catastrophe are often used, indicating losses. Therefore, these words could be considered being the opposite of safety. Unfortunately, they all have different and sometimes specific meanings depending on the persons or fields of knowledge that use these commonly employed words. They are often more related to the level of consequences than associated with the nature or origin of the losses incurred.

As such, it is very difficult to benchmark safety performance in industrial parks and compare safety performance in an objective way.

For the antonym of security, it is even worse to find a commonly used word covering the subject. A short survey on the internet to find the antonym for the word security brings about the following words: "break", "disagreement", "endangerment", "harm", "hurt", "injury", "danger", "insecurity", "peril", "trouble", "uncertainty", "worry"; all words that are equally valid to describe "unsafety". When looking up the meaning of the word insecurity in the Cambridge dictionary, the first meaning that is proposed is "a feeling of lacking confidence and not being sure of your own abilities or of whether people like you", "a lack of confidence". This is hardly what people generally think of when talking about security issues in safety and security science today. A second possible meaning seems to be closer to the subject we are currently talking about: "the quality of not being safe or strong"; "a lack of safety". Here, as well, it is difficult to make a distinction between safety and security.

A perfect word to indicate a lack of safety would be "unsafety", and for the antonym of security, "unsecurity" is a clear option, although both terms are less used in scientific literature, as is indicated in the following Table 1.

Table 1. Number of hits per concept regarding "Risk" and "Safety" on Google Scholar *.

Concept	Number of Hits	Concept	Number of Hits
Risk	4,770,000	Uncertainty	3,930,000
Safety	3,450,000	Unsafety	8800
Security	3,290,000	Unsecurity	40,800
Accident	3,110,000	Insecurity	1,090,000
Incident	3,160,000	Mishap	77,500
Disaster	2,800,000	Catastrophe	899,000
Hazard	3,340,000	Danger	2,770,000
Injury	1,900,000	Loss	5,810,000

* Google Scholar search results—27 March 2018.

Furthermore, in different languages, there is only one word that is used for safety and for security, e.g., in Italian, Spanish, German, Chinese, and Russian, which are also languages used around the globe. It seems that more clarity about both concepts is indeed needed in general and in scientific literature in particular.

So, how do these concepts relate to each other? How can a modern view on risk, safety, and security help in understanding and in dealing with the issues related to these concepts? How can it impact safety and security in industrial parks? These are the questions this chapter tries to tackle by looking at the historical evolution these concepts have endured. As a consequence, this paper proposes a set of fundamental definitions of the concepts "risk", "safety" and "security", where the similarities and differences become immediately apparent. From a scientific perspective, these definitions and how these concepts are linked, intend to provide a semantic and also an ontological foundation for safety and security science.

In Section 2, we will discuss and elaborate on the evolving perceptions regarding risk, safety, and security based on a concise etymological and etiological study of these concepts. Built on the findings of this study, we will propose an ontological and semantic foundation for safety science in Section 3, followed by a discussion in Section 4 and our conclusions in Section 5.

2. Evolving Perceptions Regarding Safety (Science), Risk (Management) and Security

Safety, security, and risk, but also performance, are concepts that are becoming increasingly more important in our complex and fast changing society. From a broad perspective, the concepts of risk and safety are tightly coupled and have known similar evolutions in their development and in how people understood these concepts. Also, the evolution of how people have dealt with risk and safety is very much comparable. Safety and risk are often perceived in a similar way and are regularly used as antonyms. Approached from this limited perspective, risky often means unsafe and safe often means without or protected from risk (as indicated in many dictionary definitions of safety). However, in recent years, different perspectives have emerged, where risk and safety are not necessarily opposing concepts. Moreover, when looking at the past, one can see that ideas about safety and risk have evolved in a very analogous way and for comparable reasons, expanding the view on these concepts. Therefore, it is interesting to have a closer look at these two concepts and discover their etymology and its etiology.

2.1. A Historical Perspective on Risk Management, the Etymology of Risk and Its Etiology

2.1.1. Ancient Times

For thousands of years, people considered much of what happened to them as the will and acts of the gods [15]. So, the general idea was that whatever one tried, things finally happened by the will of the gods, and there was nothing to do about it but to accept it.

However, this doesn't mean that concepts of risk and safety were strange to people. In their article "Risk analysis and risk management: an historical perspective", Covello and Mumpower [16] describe how, in the Tigris-Euphrates valley, about 3200 B.C., a group of people, called the Asipu, already offered consultancy services related to risk and safety. The Asipu would analyse and interpret alternative options regarding important decisions to be taken and, "guided by the gods", would recommend the most favourable options to pursue. In fact, they even made their final reports etched on clay tablets. As such, these reports indicate the first recorded form of risk analysis in the history of men [17,18].

2.1.2. The Renaissance and Modern Time Period

Essentially, the concept of risk as we generally use it today saw its appearance with the rise of commerce in the colonial era during the Renaissance, a moment in time where science started to challenge the superstitious beliefs associated with religion. It was a time of an expanding world and trade of new and scarce products

transported overseas, which created a new reality. Trade overseas to distant destinations and far away countries was a high-risk endeavour. Huge profits were anticipated, but also equally huge losses were possible.
It is this economic factor that made people become more aware of the concept of managing risks, where the uncertainty regarding gain or loss was very high, and the level of consequences could be immense. Soon, the insurance industry emerged as an effort to manage risk in commerce, covering for possible losses and the consequences of unfortunate events. Wealth was no longer the privilege of the happy few but could be earned by investing in trade and making the right decisions. [15,16] Nevertheless, it took until the work of Pascal in the 17th Century to see sudden progress in the understanding of risk and decision making based on numbers.

2.1.3. Twentieth Century

Although the etymological roots of the term risk, in the way that many people understand it today, can be traced back as far as the late Middle Ages, and despite the fact that its practical use emerged during the colonial age, the more modern concepts of risk appeared only gradually, with the transition from a traditional to a modern society. With larger and ever more complex technology systems emerging after the Second World War (e.g., nuclear installations and general aviation), the focus on probability and risk increased and supported a scientific, mathematically based approach toward risk and risk assessment [19].
Later in the twentieth century, with standards of living quickly rising after World War II, other objectives also became important and the concept of managing risk expanded from a mathematically-based approach to include also more qualitative methods, in order to be able to deal with the achievement of non-financial objectives and to cope with uncertainties that were less easy to quantify. Hence, the origins of operational risk management can be traced back to the discipline of safety engineering, which in turn, is mainly concerned with the physical harm that may occur as a result of improper equipment or operator performance [20]. Furthermore, the decade of the 1970s was a period of heightened public concern about the effects of technology on the environment, mainly regarding health hazards, such as the effects of asbestos or other chemical substances. This concern further increased government attention for risk assessment and risk management regarding health safety issues [21].
Continuing losses, injuries, and casualties in peacetime operations and exercises, due to accidents, also triggered the US Armed Forces and NASA to develop risk management towards a more comprehensive approach, called Operational Risk Management (ORM) [22–24]. They proposed a set of principles, a process, and specific guidelines on how to deal with risk in operations, adapting the world of risk

management to the human factor involved in day-to-day operations. However, by the end of the century, further development of the concept of operational risk management expanded the view on risk from a purely loss-and-probability perspective to a more systemic view, shifting attention from the probability of loss to the likelihood of achieving goals. As such, no longer solely focusing on the prevention of loss.

In the same period of time, due to scandals such as the Barings Bank (1995), the dot.com bubble (1997–2001), and the ENRON Corporation (2001), people became more and more concerned with the management of risk and the good ethical practices in managing organizations, complying with legal and legislative requirements. The idea of risk is closely connected with the human aspiration to control the future, and the idea of 'risk society' [25] might suggest a world becoming more hazardous, but this is not necessarily so. Rather, it is a society increasingly preoccupied with the future (and also with the safety of that future), which generates risk awareness [26,27]. However, at that time, the focus was still exclusively on the negative impact of risk at an organizational level, and operational risk scarcely existed as a category of practitioner thinking at the beginning of the 1990s. Nevertheless, by the end of that decade, regulators, financial institutions, and practitioners could talk of little else [28].

As such, it is to be noted that the first risk-related national standard, the Norsk Standard NS5814:1991 concerning risk analysis, was only published in 1991, soon followed by other risk-related standards. For instance, IEC/IEC 300-3-9:1995 regarding the risk analysis of technology systems, or BSI PD 6668:2000 regarding the risk elements of corporate governance [20,29–31]. In this timeframe, risk management standards were also developed by the United States Armed Forces, providing a more comprehensive approach to manage (operational) risks, also aimed at achieving objectives safely (e.g., Air Force Pamphlet 91-2015—Operational Risk Management (ORM), Guidelines and tools—1 July 1998) [32].

2.1.4. Twenty-First Century

The changes that gradually emerged during the last quarter of the 20th century persisted, and an increased understanding of the concept of risk started to grow as modern risk management evolved substantially due to a number of factors, such as the rise of knowledge-intensive work, an expanding view on stakeholders, a growing importance of project management, the expanded use of technology, increased competitive pressure, increased complexity, globalization, and continuing change [20].

This growing concern and increasing awareness regarding risk management at the turn of this century led to the development of a whole range of additional risk management standards. These standards were issued by governments (Canada in

1997, United Kingdom 2000, Japan 2001, and Australia/New Zealand 2004), international institutions (IEEE-USA 2001, CEI/IEC-CH 2001), or professional organizations (IRM/ALARM/AIRMIC-UK 2002, APM-UK 2004, PMI-USA 2004) [33–41]. Each of these standards, coming from different perspectives and fields of knowledge, reflect an increased understanding of risk and risk management, proposing different definitions of risk and comparable processes to manage risks. At that moment in time, a shift occurred from a purely negative view on risk, still expressed in the definitions of some of those (older) standards (CAN/CSA-Q850-97:1997 and IEEE 1540:2001), to more neutral or even very broad definitions of risk in the more modern standards [32,36]. Another remarkable aspect of the "newer" definitions of risk is the fact that risk is more explicitly linked to objectives and that the effects of uncertainties on objectives (consequences) can be positive, negative, or both [20].

The beginning of this century is also characterized by international legislation putting a greater emphasis on transparency (e.g., Seveso III), collaboration, inspection, and moral values. This all driven by societal pressure due to increased connections between citizens.

Also, in the first decade of this century, and due to a number of scandals—similar to ENRON—there was ever-increasing attention for corporate governance and the role of operational risk management. This resulted in the first internationally used comprehensive corporate standard on risk management, the COSO Enterprise Risk Management Integrated Framework (2004) [42,43]. Enterprise Risk Management (ERM), similar to ORM in the military and aviation sectors, is the more organization-wide approach that is needed to cope with the complex realities and awareness of risks for the corporate world in the 21st century. This methodology stands in stark contrast to the segregated silo approach that is mainly occupied with the assessment of some well-defined risks, for instance in engineering, or when only looking at the financial aspects of risk in corporations, focusing on probabilities and a limited range of consequences, hence possibly under- or overestimating risks to the entity as a whole [44].

However, the COSO ERM framework, which was mainly developed as an auditing tool to check compliance, failed during the 2008 financial crisis because organizations implementing ERM would still follow the reductionist approach of treating complex matters, such as Collateralized Debt Obligations (CDO's), as being the simple stocks and bonds, these organizations were used to. It caused the financial institutions to completely lose their ability to assess the involved risks, and the failure showed the need for a truly system-dynamics approach to ERM [45]. Hence, the International Standardization Organization (ISO) set out to establish a working group of risk management professionals to achieve consistency and reliability in risk management, by creating a standard that would be applicable to all forms of risk

and to all kinds of organizations, creating a standardized foundation for risk management [46–49].

Purdy (2010) states that "Little real progress could be made with the ISO standard until all agreed on a definition of risk that arose from a clear and common understanding of what risk is and how it occurs." The working group arrived at: "risk is the effect of uncertainty on objectives". This definition of risk reveals more clearly that managing risk is merely a process of optimization that facilitates the achievement of objectives. Risk treatment is then about changing the magnitude and likelihood of consequences (effects), both positive and negative, to achieve a net growth of gains (value creation) and the maintaining or achievement of objectives—objectives being understood in the broadest sense of the word. Controls are then the outcomes of risk treatment decisions, in which the purpose is to modify risk [49].

The specific way in which risk is regarded by the ISO 31000 standard also broadens the understanding and attention of risk management towards performance instead of solely focusing on compliance or the prevention of loss. Lalonde and Boiral (2012) state that "*although this approach may seem relatively conventional, the standard does succeed in integrating into a single concise and practical model a considerable amount of knowledge, accumulated from research on multiple aspects of the field, which is widely scattered in the literature and thus difficult to consider*" [50].

The latest changes in the practical understanding of risk and risk management in different sectors and industries have been issued in updates of the COSO and ISO standards. In 2017, the revised COSO framework, called "COSO Enterprise Risk Management—Integrating with Strategy and Performance", was issued, putting emphasis on the alignment of objectives with the corporate mission, vision, and core values. In 2018, ISO issued a revised version of the ISO 31000 standard. However, to the best of the authors' knowledge and understanding, these new versions do not add any new insight to the understanding of the concept of risk, which was not already found in the first version of the ISO standard [51,52].

This overview of the evolution of the concept of risk and risk management is far from complete. Other interesting overviews and reflections on the concept of "risk" can, for instance, be found in Rechard (1999) and Aven (2012) [9,53]. Nevertheless, this and other overviews of historical and recent development trends on risk and risk management indicate a tendency towards more overall, general, holistic concepts, capable of assessing and managing decision problems, crossing traditional scientific disciplines and areas and opening up for new ways of describing/measuring uncertainties other than probability [9].

2.2. Evolving Awareness in Safety Science

Surprisingly less attention has been given to the history of safety science, compared to risk and the other sciences. The oversight may stem from a common assumption

that safety is a composite of engineering, biomedicine, public health, and, more recently, environmental studies [54]. As such, the following sections only try to give an indication of how and why the perceptions regarding safety, and the insights in safety through science, changed over time.

2.2.1. Time Period from the Industrial Revolution Till World War II

Safety science, similarly to risk management, originated because of a need to cope with uncertain profit, the failure of maintaining possession of valuable assets, and the injury or loss of workforce, particularly of losses due to accidents. Therefore, in safety science, scholars have always been searching for a fundamental understanding of why and how accidents happen. In the same way that expanding views impacted the etymology of the concepts of risk and risk management, an ever-increasing awareness and knowledge regarding the concepts of safety and safety management has also impacted the etymology of safety and thinking in safety science.

The industrial revolution and the appearance and use of new technologies, such as steam engines and weaving machines, provoked reoccurring and severe accidents, damaging valuable assets, causing severe casualties and injuries to workers. In the beginning, these accidents are just seen as setbacks, caused by workers' behaviour and part of the business. However, during the second industrial revolution, which mainly took place in Europe and North America starting at the end of the 19th Century, ongoing mechanization and new technological developments were used to develop new industries. With the advent of mass production and production engineering, productivity substantially increased. As a result, life was getting better, incomes were rising, and mortality was declining [55]. These rapid economical, technological, and social changes also triggered the dawn of safety as a science, when occupational safety was developing into a professional field.

Accidents have always been a problem. Yet they did not appear as a major economic and health issue until the early 1800s when the declining death rate from infectious diseases shifted attention to other causes of mortality [54]. Because accidents in a production line are costly, not only due to the casualties and lost workforce, but also because of the loss in production and production capacity, this was a real burden on the profitability of these new factories. At that time, these accidents were responsible for high mortality in the industrial world, leading to a bad reputation. Due to the rising prosperity, this was no longer acceptable or taken for granted. Accidents were no longer considered to be acts of (the) God(s), but man-made, and could be prevented [56].

So, from the start, awareness about risk and safety and ideas governing risk management, safety management, and safety science were triggered by the likelihood of bad things happening, impacting on the profitability of endeavours

related to new emerging sectors such as worldwide trade and mass production. Both approaches (managing risk and managing safety) tried to accommodate for losses that impacted profitability. Risk, as such, became the domain of insurers and the start of a whole financial industry to cope with possible financial losses. Likewise, safety science started with focusing on accidents, injuries, and casualties, how they came about, and what could be done to prevent these mishaps from happening. In fact, in both illustrations of risk and safety, the attention of practitioners drifted away from what people really wanted or needed, which was safeguarding and achieving the objectives of higher financial profit and increased production figures.

One of the first theories concerning safety is about accident proneness. The term accident proneness was coined by psychological research workers in 1926 [57]. According to this theory, some people were considered to be more likely to have accidents than others [58]. Kerr (1957) [59] defines it as follows: "Accident proneness is the constitutional (i.e., permanent) tendency within the organism to engage in unsafe behaviour within some stated field of vocational activity". However, the accident proneness theory only looks at one possible cause of accidents and, therefore, cannot explain accidents in a general manner. It has, therefore, been abandoned.

In the same timeframe, Heinrich observed production facilities to discover trends and patterns in occupational accidents, resulting in Heinrich's pyramid or triangle [60]. Even today, his conclusions are used as a basis to measure and predict safety in organizations, by parameters such as LTIR (Lost Time Injury Rates) or time without mishaps. Heinrich also proposed his domino theory on accident causation when studying the cost of accidents and the impact of safety on efficiency, opening up the perspective to the role of management in accident prevention [61]. Heinrich's domino theory became a basis for many other studies on accident causation and the role of management in accident prevention, dominating the world of safety practitioners well beyond World War II [62].

2.2.2. Time Period of the Sixties, Seventies, and Eighties

Heinrich's research and work was the foundation for many other researchers, also incorporating the role of management in their models. For instance, Petersen (1971) [63] developed a model based on "unsafe acts" and "unsafe conditions", and Weaver (1971) and Bird (1974) [64,65] updated the domino model with more emphasis on the role of management [62,66].

At the beginning of the second half of the twentieth century, Gibson (1961) and Haddon (1970) focused on the causation of injuries, discovering and proposing a formula for injury prevention [67,68]. This shift in focus caused safety science to look at engineering as a way to reduce injuries, leading to safety belts, bumpers, and many other devices capable of absorbing or deflecting energy [54]. In this period of

time, also the introduction of the "hazard"–"barrier"–"target" model and analysis tools, such as Failure Mode and Effect Analysis (FMEA), Hazard and Operability Analysis (HAZOP), the Energy Analysis approach are to be noted [66].
Similar to the evolutions in risk management, safety science further evolved as a result of unfortunate events, such as a series of accidents that had a huge impact on society. Names such as Flixborough (1 June 1974), Seveso (10 July 1976), and Three Miles Island (28 March 1979) are ingrained in the history of safety science, resulting in a broader perspective on safety and the advent of more safety regulations. The increased awareness about safety is reflected in increasing political attention for safety-related issues and an increase in associated regulations. It is also clearly demonstrated by the advent of a number of safety-related scientific journals in the last quarter of the twentieth century. As a result of the investigations of these accidents, the awareness of safety practitioners expands from the role of management to interactions in the entire socio-technical system.

2.2.3. More Major Accidents and Disasters in the 1980s

The socio-technical concept arose in 1949 [69]. However, at that time and in the early fifties, the societal climate was negative towards socio-technical innovation. This climate would only become positive thirty years later [70]. Again, similar to the development of risk management and operational risk, safety science took up this wider organizational perspective on safety issues as from the early eighties. For example, Rasmussen's taxonomy concerning human error per skill-, rule- and knowledge-based mistakes, in conjunction with the interaction with technology and its signals, signs, and symbols, expanded the ideas on Human Factors, behaviour, and performance. This was exemplified by what happened at Three Miles Island [71]. At the same time, further advances in technology also made safety engineering an indispensable part of safety science, with the development of safety equipment such as safety belts and air bags.
Another result of analysing the Three Miles Island accident, amongst others, is Charles Perrow's book, Normal Accidents (1984) [72], in which the "normal accident theory" (NAT) is proposed. It has been particularly influential among researchers concerned with understanding the organizational origins of disasters and the strategies that might be used to make organizations safer [68].
Safety science further developed in the past thirty years as a result of another series of significant accidents and important disasters, such as the disasters of Mexico City (20 November 1984), Bhopal (2–3 December 1984), Challenger (28 January, 1986), Tsjernobyl (26 April 1986), and The Herald of Free Enterprise (6 March 1987), to name some of the most important ones. Each of these accidents show the complexity of socio-technical systems. As a result, scholars try to model systems in order to

predict their behaviour. Building on the work of Rasmussen (1983), Reason (1990) proposes the Generic Error Modelling System (GEMS), later to become known as the Swiss Cheese model (of defences) [73–76]. Other models that build on the human factor approach are, for instance, the Software-Hardware-Environment-Liveware-Liveware (SHELL) model [77], or the Human Factors and Classification System (HFACS) [78], building on the work of Reason.

2.2.4. The Last Thirty Years

By the end of that disastrous eighty's decade, people also looked at human factors and behaviour, by introducing the notion of safety culture. According to Cooper (2002) [79], "*the term safety culture first appeared in the 1987 OECD Nuclear Agency Report on the 1986 Chernobyl disaster* [80]. *It is loosely used to describe the corporate atmosphere or culture in which safety is understood to be, and is accepted as, top priority"* [81]. A more specific approach is the concept of Just Culture, coined by Dekker [82,83]. Furthermore, the concepts of 'High Reliability Organizations' [84–86] and 'Resilience Engineering' [14,87] were introduced, looking at the whole organization. Recent years have seen a whole range of models that try to model the taxonomy and structure of accidents. Examples are the Systems Theoretic Accident Modelling and Processes model (STAMP) by Leveson [88] and the Functional Resonance Analysis Method (FRAM) by Hollnagel [89]. The most remarkable distinction is that FRAM is focused on safety instead of unsafety, going beyond the failure concept and the concepts of barriers and controls, aiming at the day-to-day performance [89]. This is remarkable because the idea is a result of finding ways to achieve safety proactively. In his article, 'Is safety a subject for science', Hollnagel indicates the difficulty in changing the mindset of the safety science community from what is going wrong to what is going right. An idea further developed with the advent of the concepts of Safety-I and Safety-II [90,91].[8]

In summary, the new millennium, in the same way as risk management, safety science expanded into a more systemic/holistic view with the advent of concepts such as Resilience Engineering [12], High Reliability Organizations [84], Safety-I and Safety-II [91], and Total Respect Management [92–95]. Ever more, these modern concepts in safety are focusing on what people want, what their objectives are, and how to achieve them instead of solely trying to avoid bad things from happening. Likewise, scientists are increasingly looking for significant leading indicators in order to be more proactive in avoiding accidents and achieving what is planned for. The concepts, therefore, also evolved from a purely negative view on risk and safety towards a more encompassing, expanded view, also considering the positive sides of risk and

[8] Safety-I has been defined as a state where "as few things as possible go wrong" in a system. The Safety-II perspective focuses on ensuring "as many things as possible go well" in the system.

safety. Regarding safety, you could even say that, now, the focus is more on safety instead of exclusively concentrating on unsafety.

2.2.5. A Drastic Change in the Perception of Security

Until the last quarter of the twentieth century, security has been the realm of the protection of valuable assets and persons, guarding these assets and individuals from damage, injury, or being taken away by unauthorized persons. In essence, security was a matter of the national security services to protect national assets and VIPs against actions of foreign nations. It was also a concern of large corporations against actions of competitors, or it was a worry of wealthy individuals against the actions of criminals. It was not a main concern for the public at large.

This started to change in the second half of the twentieth century, where security was no longer solely needed to protect national interest or assets of wealthy people but also to counter deliberate and sometimes indiscriminate violence against randomly chosen targets resulting from actions related with local or global ethnic, social, and political movements and conditions. Actions of these movements range from guerrilla warfare, via selective and individualized acts of violence that can be qualified as terrorism, to categorical, indiscriminate terrorism, mainly targeted at local, mostly government-related institutions and individuals [96].

A key event, changing the perception of the world on terrorism and security were the so-called terrorist attacks of September 11th, 2001. Before 9/11, terrorism research was the exclusive domain of non-academic "security experts" and political scientists, of which only a limited number were interested in social-science theory [96]. Up until 9/11, one could say that terrorism was a more or less confined, local, and regional phenomenon of social and political differences, and that, in general, people had a choice whether or not to go to those countries or areas that suffered from these acts of violence. The economic impact of these so-called terrorist actions remained rather local or regional at best, mainly having an adverse effect on tourism and the local or regional economy. However, the message of 9/11 was that terrorism could happen anywhere and to anyone, and as such, security also became everyone's concern worldwide. The impact was immediate, affecting travel and commerce worldwide, resulting in global economic and psychological effects.

Another aspect that generates increased interest in security is the invention of the world wide web and the increasing interconnectedness of information technology. Together with the advent of global connectedness and the increasing use of information technology touching on all facets of human life, the illicit use of information technology became more and more an issue, leading to the specific field of cybersecurity. At first, this was a concern for large institutions and states, as, for instance, in recent years, there has been an increase in both the frequency and seriousness of cyberattacks targeting critical infrastructures [97]. Nowadays,

cybersecurity is also becoming ever more an issue of importance for individuals with the arrival of malware, ransomware, and phishing, aimed at individuals and this with criminal intent.
Today, virtually no one is secure against acts of violence, terrorism, and cybercrime. In a way, one could say that international terrorism and cybercrime have lifted the importance of security in society in the past decades. Not only because events related to unsecurity became a global risk and everyone's concern but also because of the immense economic impact terrorism and cybercrime potentially have on society.

2.3. Advanced Perspectives on Risk and Safety

Looking at this historical overview of risk, safety, and security, one can see that these concepts and their understanding have evolved over periods of time, expanding awareness, triggered by times of perceived hardship. Actually, these concepts are culminating in more advanced and more holistic perspectives that are very similar, as both risk and safety include positive and negative outcomes to be managed in order to reach an optimum situation. As such, taking risk is aimed to increase value, and safety is reached when it is likely that this value will be secured by excellent performance (Safety II thinking). Likewise, running risk is the possibility of losing value, and unsafety is to be expected when it is likely this value will be lost due to all kinds of hazards and threats (Safety I thinking). Both parts are important and connected in a holistic view on risk, safety, security, and performance.

2.4. Quality of Perception

Risk, safety, and security are complex matters because, even for just one individual, it is very difficult, if not impossible, to discover or take all concerned objectives, all effects, and all uncertainties occurring at a given moment into account. Furthermore, irrespective of the actual conditions and possible future outcomes, risk, safety, and security will always be a construct in people's minds. Every individual has different sets of objectives, or value the same objectives differently, creating different perceptions of the same reality. This also impacts people in an emotional way and determines the mental models with which they perceive reality. Hence, what is to be considered safe and secure for one individual, organization, or society, can be very unsafe to another, when objectives are different or when they are valued differently in equal circumstances. This is also the case in industrial parks, where levels of awareness and importance of safety vary from one organization to another.
Reality, in itself, will always need an interpretation, and therefore, can only be perceived according to the mental models present in the minds of those assessing the situation. So, there will always be a remaining level of uncertainty and residual lack of understanding related to risk, safety, and security. Consequently, the

perceptions and mental models of the moment are also to be taken into account when studying risk, safety, and security. As such, organizations with a lower sense of awareness regarding safety and security and with less attention for risk and risk management could present an additional hazard to other organizations within the same industrial park.

Safety science should, therefore, aim for the highest possible quality of perception and methods to develop this quality of perception, where the deviation between reality itself, as it is, and the perception of that reality is the lowest possible. It is the ever-continuing difference and discussion between constructivism and positivism, studying reality or the perception of that reality when socio-technical systems are concerned. However, both approaches can start from the same fundamental ontological and semantic foundation.

3. Understanding and Defining Risk, (Un)Safety and (Un)Security, Proposing an Ontological and Semantic Foundation for Safety and Security Science

As Möller, Hansson, and Peterson [1] mention, the concepts we need to define come in clusters of closely related concepts. Any serious work on definitions should start with a careful investigation of the relevant cluster, in order to determine if and how the concepts can be defined in terms of each other, and on the basis of that, which concept should be chosen as the primary definiendum.

3.1. The Importance of Standardization and Commonly Agreed-Upon Definitions of Concepts

As indicated earlier, science is served with clear and commonly agreed-upon definitions of concepts and well-defined parameters. Having these precise definitions of concepts and parameters allows for standardization, enhancing communication, and allowing for an unambiguous sharing of knowledge and comparison of scientific results. Brazma, a life science researcher, formulates it as follows: *"To obtain new insights and knowledge, huge amounts of information from experiments need to be transformed into executive summaries. To be able to do this, the information needs to meet certain criteria. First, it should include the elements that are essential to understand the phenomena that are investigated. One will need to know what units are used to express measurements. Second, the information should be presented in a way it can be parsed by a computer program correctly, pulling out the relevant descriptions in the correct semantic fields and standard names should be used to describe common properties. Finally, the information should meet with high quality standards to be usable in new contexts. This needs a formal language, and therefore controlled vocabularies and ontologies should be used."* [13]

When concepts can be defined in different ways, giving different meanings to the same concepts, it is much harder to share knowledge and handle large amounts of data because, each time they are used, the concepts and their interpretation need to be explained over and over again. Consequently, these different explanations can also lead to misunderstanding and flawed conclusions when the concepts are changing, not clear, and/or ambiguously defined. As such, it is very likely that a lack of standardization hampers progress in science.

3.2. Foundations and Philosophies of Science

As it is the purpose to provide a fundamental way of looking at the concepts of risk and safety, it should not matter from which perspective this foundation is regarded and, therefore, should cater to whatever viewpoint one has on science. The proposed foundation should, as such, be equally available for any scholar or academic,

independent from the scientific approach or philosophy one adheres to and is why this chapter does not wish to expand on the differing viewpoints on science or take any position in this debate. Any true foundation should be able to be inclusive in that regard, and we believe that the proposed foundation remains valid irrespective of the chosen scientific philosophy, as it can be used for either a qualitative or a quantitative approach. Also, the observations concerning the historical evolution of the understanding of the concepts of risk and safety can be seen as an inductive way of reasoning to come to the findings of the ontological and semantic foundation. While, at the same time, it is also possible to regard the proposed foundation as the result of deductive reasoning, starting from the etymological overview on risk and safety and the chosen definition of risk.

3.3. A Semantic Foundation for Risk

Semantics is the linguistic and philosophical study of meaning, in language, programming languages, formal logic, and semiotics. It is concerned with the relationship between signifiers—like words, phrases, signs, and symbols—and what they stand for, their denotation.

While standard definitions for safety and security are lacking, this is not so for the concept of risk. Regarding the concept of "risk", many opinions and definitions exist, for instance, the Society for Risk Analysis Glossary alone offers at least seven different qualitative definitions for risk, expressing different views on this concept. Unfortunately, they are not always aligned with, nor fitting the proposed ontology.

For instance:

"Risk is the possibility of an unfortunate occurrence".

It indicates a limited and exclusive negative view on risk, a view that is not consistent with the recent development and understanding of the concept "risk" in the twenty-first century, as demonstrated in the etymological and etiological overview.

Or also:

"Risk is uncertainty about and severity of the consequences of an activity with respect to something that humans value".

While this definition is already more aligned with the proposed ontology, it is still inadequate, as it is an incomplete definition because uncertainty in the concept of risk is not restricted to the severity of the consequences. Also, the uncertainties regarding possible events, the nature of the consequences, and even uncertainties regarding the objectives themselves are all elements that matter in understanding risk. Furthermore, effects (consequences) can also result from situations and are not limited to the consequences of activities.

However, an encompassing internationally agreed upon and standardized definition

is available that fits with the proposed ontology, providing a solution to the non-inclusivity of many available definitions of risk. The International Organization for Standardization (ISO) is an independent, non-governmental international organization with a membership of 161 national standards bodies. Through its members, it brings together experts from all over the world (from both industry and the academic world) to share knowledge and develop voluntary, consensus-based, market-relevant International Standards that support innovation and provide solutions to global challenges (ISO). Due to the way ISO standards are developed, it can be considered as a very stringent way to develop knowledge that also has a high level of acceptance worldwide.

ISO 31000 is the current standard on risk management, and it is adopted by an ever-increasing number of nations (via their national standardization bodies), making it a truly worldwide used and known standard. ISO 31000 defines risk as follows: *"Risk is the Effect of Uncertainty on Objectives".*

This definition is arguably the only worldwide officially accepted, known, and used standardized definition of risk. It is challenging, concise, but, at the same time, also covering all possible types of risk when each part of the definition is understood in its most encompassing way. It would be conceivable to find an easier wording for this definition (e.g., risk is an uncertain effect on objectives), but this would not necessarily be a better one.

The ISO 31000 definition of risk has the merit that it fits with the proposed ontological foundation. The effect of uncertainty stands for the uncertain future where anything can happen (e.g., events and consequences) and links this notion with the essential element of value represented by the concepts "effect" (positive, negative or both) and "objectives". As such, it embraces the three essential elements that are needed for risk to exist (conditio sine qua non).

Furthermore, it incorporates these elements in the most concise yet encompassing form. As indicated before, these essential elements are "objectives", "uncertainty", and "effect". All three elements need to be present and are indispensable. Leave one of these elements out and the word risk no longer has meaning. Risk will always be some sort of function in relation to these three elements. One could compare it with the same way in which fire needs "fuel" (objectives), "heat" (effects), and "oxygen" (uncertainty) for fire (risk) to exist. No fuel, not enough heat, or no oxygen, and it is impossible to have a fire. Also, similar to risk, the presence of fire can have an effect that is positive, negative, or both. The same way as with fire, risk needs to be managed carefully to reach an optimum effect on objectives.

Taking the proposed ontology and definition of risk as a reference allows us to define safety and security and their antonyms in an analogous, unambiguous, and encompassing way. Risk and safety—where safety needs to be understood in a

broad perspective including security—are tightly related, and the meaning and understanding of these two concepts have evolved in similar ways. The understanding expanded from a purely negative loss perspective towards a more encompassing and inclusive point of view, including the actual performance related to objectives. Today, according to ISO 31000:2018, it is clear that the effect of uncertainty can be negative (loss), positive (gain), or both. Also, in safety science, it becomes increasingly clearer that the domain of safety does not only cover the situation of being protected against loss (Safety-I) but that it also includes the condition where a positive/excellent performance makes achieving and maintaining objectives more certain (Safety-II) [89].

As such, safety and security are no longer concepts that are solely described in negative terms, such as being vulnerable to or protected against negative things happening. Today, risk, safety, and security can also be linked to what one actually wants or needs and how to get it, instead of solely being concerned with what one does not want. It is this most obvious part, "the objectives", that is often forgotten in many definitions and concepts.

It has to be stressed again that none of the earlier developed concepts and theories regarding safety, security, and risk are to be dismissed, because each of them holds the truth of the perspective and awareness of its timeframe and field of knowledge. However, today, a holistic view on risk and safety exists. Hence, the proposed foundation is semantically based on the definitions used in the inclusive ISO 31000 (2009/2018) standard. Consequently, it is meant to expand the vision on the concepts of risk, safety, and security, and to tie them together in a semantic and ontological way to form a basic theory from which these concepts can be studied, expectantly leading to the generation of new insights and methods to deal with safety, security, and risk in ever more proactive ways.

3.4. Ontological Foundation of Risk, Safety, and Security

Ontology is the philosophical study of the nature of being, becoming, existence, or reality, as well as the basic categories of being and their relations. Ontology often deals with questions concerning what entities exist and how such entities may be grouped, related within a hierarchy, and subdivided according to similarities and differences. There is an extensive amount of literature available regarding the different perspectives on ontologies and how to engineer them. However, this is beyond the scope of this paper. The way we intend it to be is that an ontology is a set of concepts and categories in a subject area or domain that shows their properties and the relations between them. It is a particular theory about the nature of being or the kinds of things that have existence. Keet (2018) formulates it as follows: *"ontologies provide an application-independent representation of a specific subject domain, i.e., in principle, regardless the particular application. Or, phrased positively: (re)usable by*

multiple applications." [98] The definitions of the terms risk, safety, and security vary widely in different contexts and technical communities. As indicated before, many scholars have discussed this topic and provided their input on how to understand these constructs. All of these attempts to come to a standardized understanding are valid when consistent with the perspective from which they were drafted. However, most of these definitions are related to the sector or subject domain they belong to, and it is questionable whether a universal and general definition is already available that is valid in any domain, circumstance, or situation. Furthermore, as was already mentioned above, in some languages, the same word is used for both safety and security. However, even in languages that offer two distinct words, the meaning of each term varies considerably from one context to another [95]. Moreover, when talking about safety and security, people actually mean their opposites, which could be named 'unsafety' and 'unsecurity'. This lack of a consistent and unified perspective on the concepts of risk, safety, and security makes measurement or comparison very difficult. Because, when there is no commonly accepted way to define risk, safety, or security, and its opposite, it becomes very difficult to measure and compare the level of (un)safety/(un)security of situations and organizations in an unambiguous or objective manner. Certainly, this will not be the case amongst different industries, sectors, or societies, or even the different organizations that belong to the same industrial park.

Also, it is more difficult to think of proactive solutions that generate safety and/or security instead of solely developing reactive methods that prevent unsafety and unsecurity. As such, one misses the opportunity to improve safety and security performance proactively and by design, by acting before anything bad has happened. While safety and security both deal with risk [97], the question can be asked how all of these concepts are linked?

Risk, safety, and security are concerned with things that matter and that have significance or certain value to people and mankind. As such, this is a commonality between these concepts, and, therefore, the primary definiendum for this ontology is the concept "objective", which can be defined as follows:

"Objectives are those matters, tangible and intangible, what individuals, organizations and societies (as groups of individuals) want, need, pursue, try to obtain or aim for. Objectives can also be conditions, situations or possessions that have already been established or acquired and that are, or have been, maintained as a purpose, wanted state or needed condition, whether consciously and deliberately expressed or unconsciously and un-deliberately present".

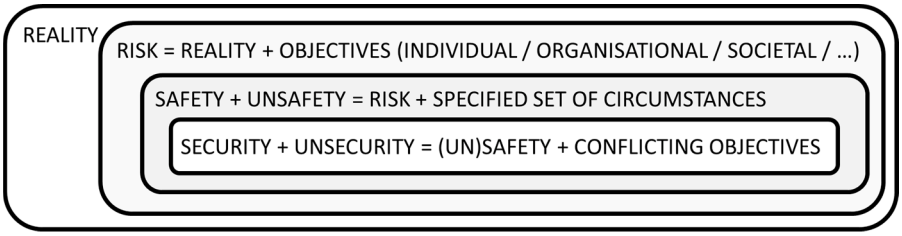
What one "wants or needs", anything that can be considered as some sort of value, can be considered being one's "objectives", with the concept "objective" understood in its most encompassing way. As such, this idea is in line with the more modern ideas on risk, as referenced in the introduction, where risk is also linked to what humans value [11]. It is why the ISO 31000 definition of risk is a good starting point for our

ontological and semantic foundation.

At the heart of this proposed foundation and the definition of risk, lies the concept of objectives. This, in contrast with a more traditional view of risk, being considered mainly the domain of uncertainty. This is, of course, true when a limited view on risk is adopted, where only a very limited range of objectives is considered in isolation, such as in finance or engineering. However, it is a view that no longer fits with today's complex reality and its multitude of intertwined objectives that play a role in Enterprise Risk Management or the safety and security of industrial parks. Risk only exists when objectives are linked and exposed to a defined reality. The concept of objectives is herewith to be understood in its most encompassing way, as expressed in the proposed definition. As such, at the core of risk, the principal part of its definiens is the encompassing concept of objectives.

However, risk is always concerned with the future, and the future is uncertain, as it is always — to a certain degree — uncertain what will happen in the future. Often, it is also uncertain how this uncertainty (uncertain events) can affect the objectives that are linked and exposed to a certain reality. This combination of uncertainties and effects is what can be called the effect of uncertainty, which in the end can be positive, negative, or both. Because both good and bad things can happen (even simultaneously), creating effects that affect the involved objectives. As such, risk can be seen as being the effect of uncertainty on objectives.

Figure 1 attempts to capture this central ontological base from which also a semantic foundation for safety and security is drafted. Figure 1a represents a defined reality (say the environment of an industrial park) at a given moment (T), including all of its future possibilities, where Figure 1b is the reflection of the result of that same reality when action or a lack of action has led to an actual result in time (same industrial park at time T+1).



(**a**)

(**b**)

Figure 1. (**a**) Proposed basic ontology for risk, safety, and security at time T; (**b**) proposed basic ontology for risk, safety, and security at time T+1.

The proposed ontology tries to give an overview of how risk, safety, security, and performance can be regarded and how they fit together in a timeline. It starts from a very broad perspective on reality as it is (to be seen as possible sets of circumstances) at a certain moment in time (T), including all of the possible future states of that reality. This reality is to be seen as the cosmos where everything is possible and where the future is less than 100% certain. When objectives are linked and exposed to that reality, risk arises.

3.5. Linking and Differentiating Risk and Safety

The link between risk and safety can be seen as follows: risk, in order to exist, requires the presence of a possible reality (set of circumstances) that can affect involved objectives. As such, all three of the following elements: "objectives", "effects" that can affect those objectives, and "uncertainty", related to both the objectives and the effects, need to exist to have risk.

In industrial parks, for instance, industrial processes often work with hazardous substances. When these substances escape the intended environment of the process, this can cause (substantial) loss and damage within or even beyond the industrial park. Therefore, the containment of the hazardous substance is an important objective. As a result, there's also the risk of the loss of containment of hazardous substances due to uncertain events, causing uncertain effects, where such loss would immediately interfere with a number of other objectives, such as the health and wellbeing of personnel, preservation of assets, and many more.

Safety (including security), although in a way related to uncertainty, mainly concerns the objectives and the effects that can affect the concerned objectives when a specified set of circumstances is known or determined. By itself, safety (including unsafety) is the same as risk, but with less emphasis on uncertainty and more attention to the possible effects that can be linked with an actual situation. When conditions are such that the likelihood of loss of containment is very low, it is obvious that regarding the hazardous substance, the condition is safe. But when the conditions are such that

loss of containment is imminent, the situation is unsafe. Understanding risk and safety (including security) then both require the understanding of the objectives involved, the possible effects that can affect these objectives, the likelihood of occurrence of these effects, and the level of impact—and its associated likelihood—of these effects. The only difference is that risk deals with a possible future state of reality, while safety is more concerned with the actual conditions and effects of a specific set of circumstances. In other words, one could say that the (level of) risk at a certain moment is the (level of) safety of the next moment, when the related uncertainty has transpired into the certainty of actual conditions, linking the objectives with the actual effects of a present situation/ set of circumstances. When these effects are mainly positive, they enhance safety, providing support for the objectives involved. While the negative effects degrade safety, or increase unsafety, as they subtract value from present and future objectives. As such, the ontological relationship and hierarchy between reality and risk is clear. When no (subjective or objective) value can be attributed to reality, there is nothing at risk, and questions on safety and security are irrelevant because objectives are absent. There is no risk. Anything that happens is just an event.

REALITY + OBJECTIVES → RISK

Risk is always related to a future state, hence the presence of uncertainty. When risk is considered in a concrete and specified set of circumstances with its specific objectives (value) at a given time (T), "risk" becomes the related "safety", including "unsafety". The specific objectives that are likely to be obtained and safeguarded (likelihood of value obtained and kept) can be considered (being) safe(ty). Unsafe(ty) is to be used for those specific objectives that are likely not to be safeguarded or obtained (likelihood of value lost). As such, the relationship and hierarchy between risk and safety is established.

RISK + SPECIFIED SET OF CIRCUMSTANCES → SAFETY + UNSAFETY

3.6. Linking and Differentiating Safety and Security

So far, safety and security have been regarded in the same way. However, what is the distinction between these two similar yet different concepts? What are the common elements that make security the same as safety, and what is the distinction between these two words that possibly separates them? In essence, as indicated in several languages all over the world, security can be regarded as a subset of safety. As such, security requires additional elements to be distinguished from safety when safety is regarded in a narrow perspective (i.e., excluding security issues).

3.6.1. A Distinction on the Level of "Objectives"

A way to look at the difference between safety and security, on a fundamental level, is to have a look at the concerned objectives because a typical aspect of a security setting is the involvement of multiple parties (with a minimum of two). By itself, different perceptions come into play when more than one party is present. Accordingly, different objectives also become involved. One of the parties will try to maintain and protect a set of objectives, where one or more opposing parties will have different opinions on those objectives, as they intentionally will try to affect these objectives in a negative way (which is a positive effect for the opposing party). When looking at security situations from this perspective, it becomes clear that security issues can be regarded as situations or sets of circumstances where different, non-aligned objectives of stakeholders conflict with each other. (*A stakeholder is a person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity*—ISO 31000 definition).

Supposed that objectives can point in a defined direction (e.g., objective A in Figure 2) and that (non)alignment of objectives could be determined in a geometrical way, the difference between safety and security can then be determined by measuring the level of non-alignment of objectives of the different parties involved. Once the non-alignment of objectives becomes more than 90◦ (supposing fully aligned objectives are at a 0° deviation of each other), it is apparent that these objectives are conflicting (e.g., objective C in Figure 2), and achieving the objective of one party could cause negative effects on the objectives of the other party (A). Therefore, one could argue that in security management, discovering the presence of different, opposing, or non-aligned objectives is crucial.

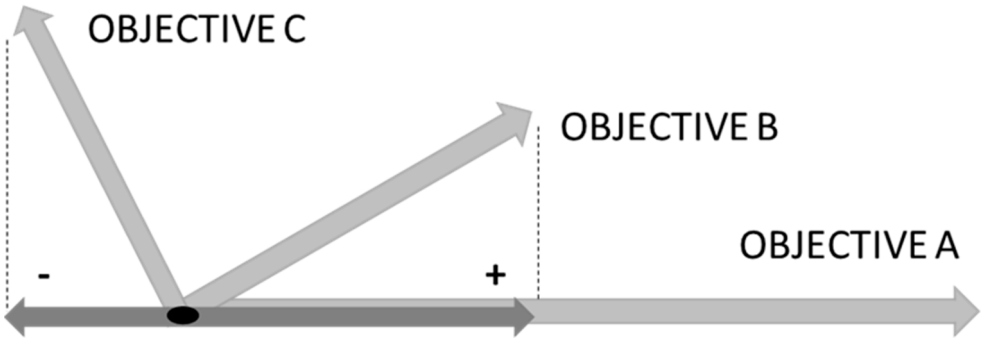


Figure 2. (Non)aligned objectives.

This is conceptually clear; however, it might be very difficult to operationalize. For instance, someone who wants to work faster for the organization he works for, but therewith acting unsafe, might perceive his actions aligned with the operational

objectives of the organization, but they are not, as these actions are not aligned with the organizations' safety objectives. In such a case, it would be hard to determine the "degree of deflection" presented by the situation. In any case, it can be argued that even when the deviation is more than 90° (meaning that an opposing component between the objectives exists), since there's no intention to cause a loss, this kind of situation is to be considered belonging to the domain of safety instead of security. As such, it seems that intentionality is also a governing factor in security. But the presence of conflicting objectives is the distinguishing factor.
A level of distinction between safety and security, therefore, also can be found in the level of alignment of objectives of individuals, organizations, or societies.

3.6.2. A Distinction on the Level of "Effect"

In managing risk, risk professionals mainly try to determine the level of risk when risks have been identified. But the assessment of the nature of risk is also a very important element to take into account in managing risk and, therefore, also in determining and managing safety.
The level of risk can be understood as being the level of the impact of effects on objectives (negative and positive) in combination with their related level of uncertainty. It is often expressed in the form of a combination of probabilities and consequences. The nature of risk, on the other hand, is more linked to the sources of risk and how these risks emerge and develop. In the ISO Guide 73, a risk source is defined as being an element that, alone or in combination, can give rise to risk [99]. It is in the understanding of possible risk sources that the difference between safety and security can be found.
When continuing on the proposed ontology, the necessary elements of risk and the definition of risk source in ISO Guide 73, safety can be seen as "a condition or set of circumstances, where the combination of likelihood and negative effects of uncertainty on objectives is low". When safety is regarded in a very general way, security then is just a sub-set of safety because when the likelihood of negative effects of uncertainty on objectives is low, this also means that a secure(d) condition or set of circumstances exists.
As such, a distinction between safety and security can also be revealed when looking at the "effects" on objectives, introducing the idea that effects can be regarded as being "intentional" or "unintentional" (accidental). When negative effects on objectives are "intentional", it is appropriate and correct to use the term (un)security instead of speaking of (un)safety. Consequently, it would also be inappropriate to use the term "security" when the effects involved are "unintentional".
As an example, one could consider the situation in an industrial park where people are not supposed to trespass on one of the compounds. While an intentional, but unauthorized ingress on the compound to cause damage or get unauthorized

information (conflicting and opposing objectives) can be seen as a security issue, the ingress by a person aiming for a shortcut, without the explicit intention to enter any of the installations (not aligned objective at +/−90◦), can be seen as a safety issue.

3.6.3. A Distinction on the Level of "Uncertainty"

Also, a distinction on the level of uncertainty can be made. Safety science and safety management often depend on statistical data in order to develop theories and decide upon safety measures. The nature of unintentional effects makes it so that the same events repeat themselves in different situations and circumstances. Furthermore, any individual can be taken into account for objectives that are very much aligned, such as keeping one's physical integrity. This provides for a vast amount of data that can be used to build theories and consider measures.

Unfortunately, in security issues, the intentional nature and the non-alignment of objectives makes it so that each time, repeated attempts are made to invent new tactics and techniques to achieve the non-aligned objectives, making it much more difficult to build on statistical data to determine specific uncertainties.

To conclude, when a specified set of circumstances also contains conflicting objectives, safety and unsafety can also be regarded as being "security" and "unsecurity" for those risks related to the conflicting objectives. Hence, also the relationship and hierarchy between safety (including unsafety) and security (including unsecurity) can be established.

SAFETY + UNSAFETY + CONFLICTING OBJECTIVES → SECURITY + UNSECURITY

3.7. Linking and Differentiating Safety and Performance

Finally, when time has expired and an actual situation (T+1) exists, safety and unsafety are mirrored and expressed by the results of an actual performance. Hence, any performance indicator can be seen as being a lagging safety or security indicator for the objective(s) it covers.

Surely, the same performance indicators can also be leading (safety) indicators, as they correspondingly reflect a certain situation at a defined moment. As such, they are also risk indicators that can give warnings or signs of possible future levels of safety. It all depends on which position on a timeline one considers the risk–safety–performance continuum, as these three elements are always simultaneously present regarding the objectives one holds.

For instance, a well-designed and adequately maintained installation, operating with an experienced and well-trained crew (performance), will certainly have a positive effect on the situation regarding the objective of containment of hazardous substances (risk), therefore also safeguarding other objectives and increasing the

level of safety (safety). Likewise, suitable protective gear and training offer the potential to limit the effects of a loss of containment, adding to the level of safety. Both "risk controls" influence the risk, safety, and ultimately also performance when everything functions as intended and no losses are to be noticed.
When societal objectives are taken into account in addition to individual and corporate goals, this will lead to a more sustainable performance and social responsibility. As such, risk is a leading indicator for safety, safety is a leading indicator for performance, and finally, performance becomes a leading indicator for sustainability and corporate social responsibility (CSR) when individual, corporate, and societal objectives are taken into account in a balanced way.

3.8. An Inclusive Ontology

Due to the fact that this proposed ontological foundation is based on an encompassing definition of objectives, it is independent of any category of objectives and, therefore, covers any type of risk or safety domain.

3.9. Definitions for Safety and Security Science based on the Definition of Risk Proposed in the ISO31000 Guidance Standard

Let us look back at the definition of risk according to ISO31000:
"Risk is the effect of uncertainty on objectives"

It fits with the three aspects that are needed to have risk:

- Objectives
- Effects on objectives
- Uncertainty related to these effects and the objectives themselves

The semantic foundation can be seen as follows: risk is an uncertain effect on objectives, while safety is a possible and likely result of that uncertain effect in specified circumstances. It is why both concepts have evolved over time in similar ways and at a comparable timing. People want to take risks and be safe at the same time. They do not want to run risks, and they also want to avoid unsafety. Both are important and possible at the same time.
Risk management, in a way, started closely related with gambling activities. Professional poker players know that they do not win by chance or as a result of acts from the gods, but through carefully gathering information and analysing/considering options based on that knowledge. It allows them to increase the quality of their perception and the probability that they make the right decision to support their aim of winning the game. They do it by taking more risk (aiming for higher gain) when it is appropriate to do so and limit the risks they take and run

(limiting the amount of possible gain and loss) when it is the wiser decision, each time counting on the fact that the risk run for the decisions they take is low. However, they will only be safe when the game is over, and the profit has been paid. In the same way, an industrial installation will only be safe when the right decisions have been made, over and over again. As such, safety and risk are the same, where risk, and how it is managed, determines the future of one's safety and performance.
Based on the definition of "objectives" proposed in paragraph of Section 3.4, the following distinguishing definitions regarding safety and security can be presented:

3.9.1. Safety/Unsafety

- *Safe(ty) (broad perspective, including security) = "the condition/set of circumstances where the combination of likelihood and negative effects on objectives is Low"*
- *Safe(ty) (narrow perspective) = "the condition/set of circumstances where the combination of likelihood and unintentional negative effects on objectives is Low"*
- *Unsafe(ty) = "the condition/set of circumstances where the combination of likelihood and negative effects on objectives is High"*

3.9.2. Security/Unsecurity

- *Secur(e)(ity) = "the condition/set of circumstances where the combination of likelihood and intentional negative effects on objectives is Low"*
- *Unsecur(e)(ity) = "the condition/set of circumstances where the combination of likelihood and intentional negative effects on objectives is High"*

Including the alignment perspective into the above proposed definition for security and unsecure(ty), it could also be envisaged as follows:

- *Secur(e)(ity) = "the condition/set of circumstances where the alignment of objectives is high and where the combination of likelihood and intentional negative effects on objectives is Low"*
- *Unsecur(e)(ity) = "the conditions/set of circumstances where the alignment of objectives is low and where the combination of likelihood and intentional negative effects on objectives is High"*

3.9.3. Alternative Formulation (Safety II Perspective)

- *Safety (broad perspective) = "the condition/set of circumstances where the combination of likelihood and positive effects on objectives is High"*
- *Unsafe(ty) = "the condition/set of circumstances where the combination of likelihood and positive effects on objectives is Low"*
- *Unsecur(e)(ity) = "the conditions/set of circumstances where the alignment of objectives is low and where the combination of likelihood and intentional positive effects on objectives is Low"*

- *Security = "the condition/set of circumstances where the alignment of objectives is high and where the combination of likelihood and intentional positive effects on objectives is High"*

3.9.4. Other Related Definitions

- *Performance = the condition or set of circumstances resulting from positive and negative effects on objectives.*
- *Excellence = the condition or set of circumstances that improves the positive effects and reduces the negative effects on objectives.*
- *Failure = the condition or set of circumstances where the negative effects on objectives are high.*
- *Success = the condition or set of circumstances where the positive effects on objectives are high.*

4. Discussion

As it is the purpose to provide a fundamental way of looking at the concepts of risk and safety, it should not matter from which perspective this foundation is regarded and, therefore, should cater to whatever viewpoint one has on science. The proposed foundation should, as such, be equally available for any scholar or academic, independent from the scientific approach or philosophy one adheres to. It is why this chapter does not wish to expand on the differing viewpoints on science or take any position in this debate. Any true foundation should be able to be inclusive in that regard, and we believe that the proposed foundation remains valid irrespective of the chosen scientific philosophy, as it can be used for either a qualitative or a quantitative approach. Also, the observations concerning the historical evolution of the understanding of the concepts risk and safety can be seen as an inductive way of reasoning to come to the findings of the ontological and semantic foundation. While, at the same time, it is also possible to regard the proposed foundation as the result of deductive reasoning, starting from the etymological overview on risk and safety and the chosen definition of risk.

We are well aware of the fact that many different ontological and semantic foundations for safety science can be developed when different approaches and other specific viewpoints are used. Therefore, this chapter is also intended to stimulate thought and discussion on these fundamental concepts in order to learn and progress in understanding. As Aven declares, such discussion is considered to be very important for the development of the risk and safety science fields [6].

The proposed perspective on risk and safety, working with the notion of objectives, allows us to understand and work with the most important factors of influence. Amongst others, it permits to build systems that can measure safety instantly and holistically, or better said to measure 'unsafety' instantly and holistically because measuring safety would require knowing all objectives present in a system and its sub-systems. This is impossible, because most of the time, people are not aware of all of their objectives, and organizations are unable to know all the objectives of all their stakeholders. On the other hand, it is much easier to discover unsafety because when an objective has failed and has incurred negative effects, it is likely to trigger a reaction, even when the "loss" is rather insignificant. Consequently, to measure perceived unsafety, it is sufficient to capture all occurrences of negatively affected objectives, something that is aimed for in some of the highest risk and performing organizations, for instance, airline corporations, aircraft carriers, or nuclear installations.

In 1999, Rochlin stated the following: *"As is the case for risk, safety may also be defined formally or technically in terms of minimizing errors and measurable consequences, but it is more appropriate to adopt the principle used by Slovic in his social studies of risk and note*

that safety does not exist 'out there' independent of our minds and culture, ready to be measured, but as a constructed human concept, more easily judged than defined" [100]. Noticing unsafety will, therefore, always depend on what is regarded as unsafe by the beholder. As such, measuring unsafety will always require an effort to increase awareness of the objectives that matter when a positivist approach is concerned.

The adage "safety first", seen from a traditional safety perspective, is a falsehood, stretching the truth. When safety is the prevention of bad things happening, this credo is a real showstopper, as the safest thing to do for avoiding losses is to do nothing and prevent any activity. This hardly matches with the sometimes-hazardous operations in industrial parks. However, when you look at this motto from a fresh, modern, and open-minded perspective, it becomes a helpful mental model in achieving safety proactively. "Safety first", then, means to achieve and protect objectives as a priority, aiming at a successful performance (Safety II) and calling to action instead of promoting inaction. When this is the governing paradigm, it will also become possible to be the first in safety, managing both the positive and negative effects of the risks encountered, aiming at excellence because safety performance will also become an objective to be achieved and safe-guarded [95]. As such, a focus on safety will also translate to a focus on performance, creating better results for those industrial parks that adopt this inclusive paradigm regarding safety and performance.

5. Conclusions

In this chapter, we presented the controversial opinions on the concepts of risk, safety, and security, and we also reflected upon their antonyms. Subsequently, we conducted an etymological and etiological overview of risk and safety and expounded on how the awareness regarding these concepts grew due to repetitive adverse effects on objectives and the efforts of mankind, looking for ways to understand and cope with what had happened. We also indicated how the meaning and understanding of the concepts changed as a result of this increased awareness and specified their similarities and differences. Accordingly, we proposed an ontological and semantic foundation for safety and security science, introducing a definition of "objectives" as the core of these concepts and of the definitions regarding (un)safety and (un)security. It is our conviction that these definitions can help in improving the safety and sustainable, socially responsible performance of industrial parks. We also believe that this foundation can be used in a general and universal way, providing a common understanding of these very important topics. Furthermore, the proposed ontology can provide a basis for future research and the development of concepts that generate safety, security, and sustainability in industrial parks or otherwise, instead of merely preventing unsafety and unsecurity, as often is the case.

However, the authors of this paper understand that other viewpoints on these topics exist and can be adhered to, as in the end, the concepts of risk, safety, security, performance, and sustainability are human constructs that can be approached from different perspectives and with different mindsets. As such, this paper aims at providing a coherent point of view on these topics, to facilitate cooperation on these subjects, aiming for sustainable performance in industrial parks.

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Chapter 2[9]

"What is the significance of mental models for upholding safety in organisations?"

1. Introduction

1.1. Purpose of this chapter

Every element and part of the universe can be regarded as a system. When humans and technology are involved, one can also look at these elements as being socio-technical systems (STS). These systems range from very simple to ultra-complex. Hence, the purpose of this chapter is to look at safety from a systems thinking perspective and to indicate how such a perspective can be used to consider safety and sustainability issues today.

1.2. Systems

Meadows describes a system as a set of things—people, cells, components, molecules, and so on—interconnected in such a way that they produce their own pattern of behaviour over time. A system may be buffeted, constricted, triggered, or driven by outside forces. But the system's response to these forces is characteristic of itself and seldom simple. As such, a system can be defined as "an interconnected set of elements that is coherently organised in a way that achieves something" [1]. Consequently, a system consists of three kind of things: "elements", "interconnections" and a "function" or "purpose".

1.3. Systems Thinking

Arnold and Wade state that "systems thinking" was coined by Richmond in 1987 [2]. However, the origins and use of the term "systems thinking" are to be found much earlier. Richmond defines systems thinking as the art and science of making reliable inferences about the behaviour of systems by developing an increasingly deep understanding of their underlying structure [3]. Others say that systems thinking is a method of considering reality in a way that helps in getting a better understanding of systems and that allows to work with systems to influence the quality of life [4]. Many other definitions exist, but it is essential that system thinkers look at whole systems and their elements. This allows them to increase their ability to understand the "elements", see "interconnections" between these elements and ask

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"what-if" questions about possible future behaviours of systems. This insight in systems then permits them to be resourceful about system redesign [1]. Hence, systems thinking provides options to transform systems in such ways that they will behave as desired, generating wanted outcomes and creating intended value.

Systems thinking and systems engineering are different concepts. Systems engineering focuses on how to design, integrate, and manage complex systems over their life cycles, while systems thinking is a way of looking at reality, a language and a set of tools to understand systems. As such, at its core, systems engineering utilizes systems thinking tenets. Furthermore, systems thinking recognizes that relationships between a system's components and the environment are as important (in terms of system behaviour) as the components themselves. It looks at, and determines, feedback loops, considers emergent properties and complexity, takes into account hierarchies and self-organisation, and tries to understand the dynamics and their (un)intended consequences [5].

Systems thinking is rooted in general systems theory (GST) and systems dynamics (SD). General systems theory was introduced by von Bertalanffy more than 50 years ago [6]. It is an interdisciplinary practice that describes systems with their interacting components, applicable to biology, cybernetics and many other fields of science. GST is a solution to problems posed by an increasingly more complex and connected world, where traditional modes of thinking fail whenever large numbers of elements and processes interact [7]. Systems dynamics, on the other hand, was founded in 1956 by Jay Forrester at MIT. He recognised the need for better ways of understanding social systems, to improve them in the same way people use engineering to improve mechanical systems [8]. As such, systems thinking has been applied to a wide range of fields and disciplines, as it has the ability to solve complex problems that are not solvable using conventional reductionist thinking [6].

1.4. Four Levels of Thinking

Systems thinking comprises different levels of thinking. First, there is the level that deals with the basic information or data of events. It concerns, for instance, "what happened", "where", "when", "how" and "who". These are the directly observable facts, the collectable data, concerning an event. However, a richer picture can be drawn from a deeper level of thinking when the data are combined across a larger time frame, revealing patterns and trends of events. Searching for common cause effect relationships can then help in trying to explain what the causes behind these patterns and trends are. Nevertheless, a much deeper level of thinking is to reflect on how the interplay of different factors brings about the outcomes that can be observed. The critical issue at this level of thinking is to understand how these factors interact, to see the system and its elements behind the patterns and how interactions are structured. Still, there's another, much deeper level of thinking that hardly ever

comes to the surface. This represents the "mental models" of individuals and organisations that influence why things should or do work, or should not or do not work [9].

Mental models reflect the beliefs, values and assumptions that individuals or organisations hold. They underlie the reasons why and how things are done. However, mental models generally remain obscure, limiting the collective understanding of issues and, hence, when not aligned, reducing meaningful communications and the development of shared visions and common action [10].

Each level of thinking has its importance and provides answers to questions. Nevertheless, it is possible to see these different and increasingly deeper levels of thinking as an indication of the ever-increasing awareness and understanding of (socio-technical) systems.

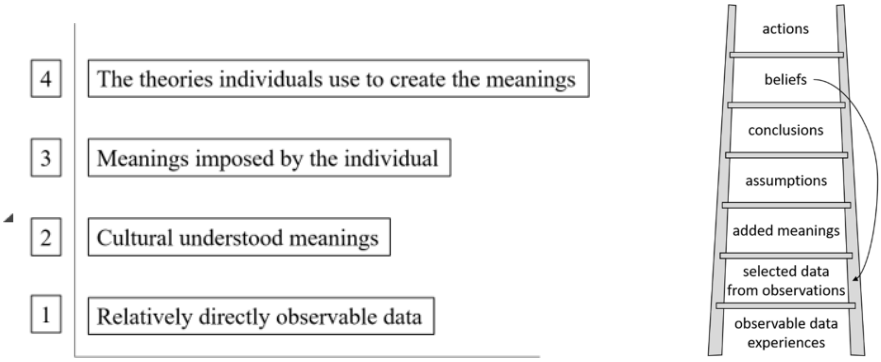
1.5. Mental Models and the Ladder of Inference

The concept of mental models goes back to antiquity, but the phrase was coined by Scottish psychologist Kenneth Craik in the 1940s. It has since been used by cognitive psychologists, cognitive scientists, and gradually by managers. In cognition, the term refers to both the semi-permanent tacit "maps" of the world which people hold in their long-term memory, and the short-term perceptions which people build up as part of their everyday reasoning process. According to some cognitive theorists, changes in short-term everyday mental models, accumulating over time, will gradually be reflected in changes in long-term deep-seated beliefs [11].

Reality, as one perceives it, is just an image in one's mind. It is the result of a whole set of mental models that consciously and subconsciously influence what one observes. Reality, as it is, is significantly more complex than what the human mind can process and comprehend at any given moment.

In their paper "Neural substrates of cognitive capacity limitations", Buschman et al. state: "Despite the remarkable power and flexibility of human cognition, our working memory—the "online" workspace that most cognitive mechanisms depend upon—is surprisingly limited. An average adult human has a capacity to retain only four items at a given time." [12].

Therefore, in order for the human mind to deal with reality, individuals must conceptualise reality by using more abstract notions. This leads to concepts that can have different meanings and that can apply to different situations. Many of these thoughts are learned at an early age and become taken for granted. They turn out to be obvious and concrete, not abstract and questionable. It leads to the so-called "ladder of inference" (see Figure 1). This is what all human beings go through in order to make sense of their world and in order to act [11,13,14].



(a) **(b)**

Figure 1. Ladder of inference according to (**a**) Argyris [13,14] and (**b**) Senge [15].

The ladder of inference (Figure 1) is a common mental pathway of increasing abstraction, often leading to misguided beliefs. The only visible parts are the directly observable elements, which are the data at the bottom of the ladder and the actions resulting from decisions at the top of the ladder. These actions are the result of self-generating beliefs which remain largely untested. One adopts those beliefs because they are based on conclusions which are inferred from what one observes, added to past experiences [11]. The whole process of added meaning, building assumptions, inferences and beliefs, shapes the mental models one holds. It also determines which added meaning is retained, what assumptions are used, how conclusions are drawn and what beliefs will govern one's actions.

As such, the ladder of inference is a reinforcing feedback loop (as shown in Figure 1), enforcing the mental models (meanings) at each level of the ladder. As a result, mental models are internal and incomplete, inconsistent representations of an external reality. They are context-dependant, can be very individual or shared and can change over time through experience and learning [16,17].

Safety, whether at an individual level, in organisations or at a societal level, is a result of the many decisions and actions taken at each moment in time. These decisions and actions are the result of the existing ladders of inference that are present at the decision-making level (individual, organisational and societal). This is why mental models influence and shape the systems that are at the origin of wanted and unwanted events happening for individuals, organisations or society as a whole.

1.6. The Systems Thinking Iceberg and Increasing Levels of Awareness

To provide for an inclusive (re)view of the increasing awareness among scientists regarding the concept of safety, and to understand the evolution of the leading perceptions in safety and security science over time, it is suitable to approach these

concepts from a systems thinking perspective. As indicated in Section 1.3., systems thinking comprises four levels of thinking, each level digging deeper in the understanding of the behaviour of systems and the outcomes they produce. This evolution in increasing awareness is also to be found in the evolution of the concepts governing the ideas and approaches used in the pursuit of safety.

As a starting point for this systems thinking approach, the image of an iceberg, as shown in Figure 2, is helpful. It is often used as a metaphor for a system and its consequences.

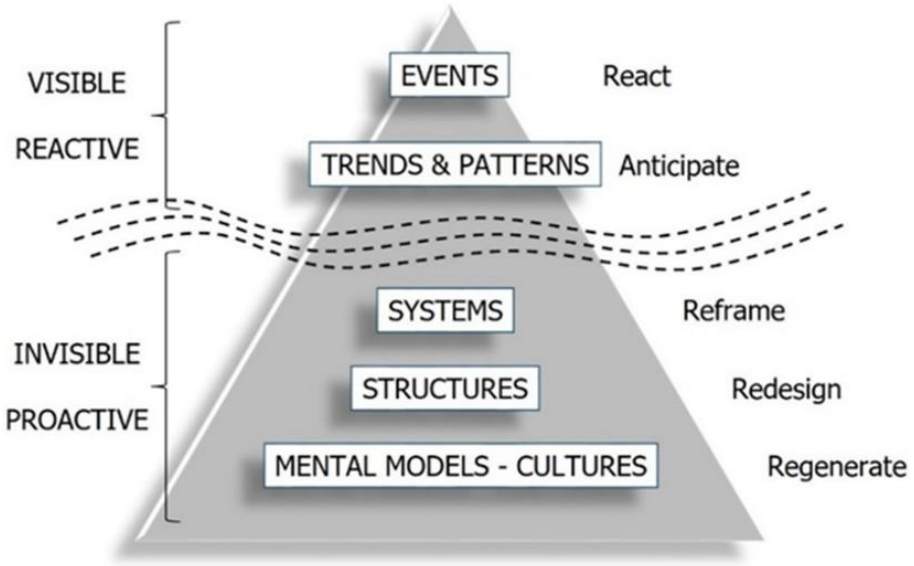


Figure 2. Systems thinking iceberg based on Bryan et al. [18].

At first, one can see the tip of the iceberg. This represents the events that occur day-to-day as a result of things happening or not happening. These visible cues at the "event" level might include failures, losses, but also the signs of created value and successes. In the case of unfortunate events, the normal reaction is to address these problem-related events on the spot and fix the issues one confronts (i.e., those one can see). Unfortunately, the effort, energy, and resources used in directly reacting to events do little or nothing to fix the fundamental causes of the problems that lie under the surface, at the base of the figurative iceberg. If one cannot address the root causes of these events, a cyclical process occurs, whereby the same problems continue to emerge regardless of how often one addresses them. The systems thinking approach suggests that interventions should be made at the root-cause level instead of just dealing with the events and symptoms one observes [19,20].

It is unclear who first adopted this iceberg metaphor in systems thinking, and

different representations have been used in the past. A representation of the model that can help in getting this general view is the systems thinking iceberg model proposed by Bryan et al. [18]. This model provides a visual representation of a layered methodology to discover deeper levels of understanding and awareness. It also proposes ways on how to act at each level of awareness. In essence, the purpose of managing risk and safety is to create socio-technical systems that generate wanted events and eliminate or avoid unwanted events. It is what is immediately visible, and these are the discernible symptoms of the (sub)system(s) at work.

2. Increasing Awareness in Managing Safety

The following sections are a concise overview of how safety science has evolved over the past 100 years, where scientists and safety practitioners discovered ever deeper layers of awareness and understanding of symptoms, patterns of events, systems, structures of systems, and finally of the mental models that are responsible for the creation of (un)wanted events.

2.1. The Objective of Profit (Creation of Value) and Preventing Loss of Value—Symptoms of Systems at Work

Both risk and safety are related sciences and started as fields of interest because systems produced outcomes that held the prospect of being very valuable, but at the same time they were also very vulnerable to losses. In both cases systems aimed at profit. For instance, trade overseas (risk and insurance) and industrialisation (health and safety) were very uncertain regarding the realisation of the wanted events (profit) and a high probability of loss (of investment and human lives) was present. Lost cargo or lost workforce were the visible events of the systems of overseas trade or industrialisation and these events required solutions in order to maintain desired profit levels. When these events are noticed, it may become clear that they repeat themselves in some way. As a consequence, it is possible to discover patterns and trends related to these events and one can act anticipating these events. This is the easiest level to work with and it is also at this easy-to-perceive level of awareness of systems that safety science and risk management originated. For risk in overseas trades, the answer was insurance. For safety in the early industries, for instance, the response was that less "accident-prone" people were required. One took actions that only dealt with the symptoms, but at that time, no solutions for the more fundamental causes of the unwanted events were envisioned. Still today, some risk and safety practitioners are driven by the visible facts that are directly observed and that are gathered in statistical data.

In their search for safety in the beginning of the past century, specialists tried to find and understand these symptoms, looking for trends or delineating recognisable patterns related to the events observed, in order to discover causal relationships and produce better predictions, allowing to prepare for these negative effects or prevent the events from happening again.

2.2. Trends and Patterns

When events are observed over a longer period of time, trends become visible when these events reproduce themselves in similar ways. At that time, the common approach to safety was to look at events such as loss of life, injury, harm, damage, or any other event generating negative effects, looking for ways to understand, predict and prevent these bad things from happening by analysing trends of unwanted

events and their negative effects. As an example, the accident proneness theory [21], Heinrich's accident pyramid [22], or Rasmussen's skill- and knowledge-based approach [23] can be seen as a result of that approach and its level of awareness and understanding.

2.3. Systems

A further step in increasing awareness regarding accidents is becoming aware of the systems that produce reoccurring unwanted events. It is what every accident investigation tries to achieve, i.e., reach understanding regarding how bad things came about, in order to find ways to prevent them from happening again. When the system is understood, it is possible to proactively alter the system, so it does not produce or cause the same unwanted events again. Through history, scholars have been searching for ways to explain why unwanted events happen and how disasters can be predicted, trying to discover and describe the system(s) that is (are) behind the occurrence of unwanted events and major accidents. One of the first to develop a theory on accident causation was Heinrich with his domino theory [24], providing categories for the elements of the system that are involved in the creation of accidents, using the metaphor of domino blocks to represent the subsystems. As such, triggered by higher values of objectives, scholars were digging deeper in the iceberg and becoming more aware of accident causation. Furthermore, Perrow's Normal Accident Theory (NAT) regarding tightly coupled and complex systems [25] and Rasmussen's Brownian movements model [26,27] can be seen as such efforts.

2.4. From Systems towards the Elements and Structures of Systems

Other, more encompassing concepts have also left their hallmark on safety science, looking at safety from a broader perspective, touching on the systems, structures and even mental models of socio-technical systems. This is done not necessarily to explain and predict but aiming at the intended outcome of resilience and high reliability to thwart misfortune.

Resilience theory is a multifaceted field of study that has already existed for many decades in different fields of science. It has been addressed by social workers, psychologists, sociologists, educators and many others. In short, resilience theory addresses the strengths that people and systems demonstrate that enable them to rise above adversity [28]. When applied to people and their environments, "resilience" is fundamentally a metaphor. Its roots are in the sciences of physics and mathematics, as the term was originally used to describe the capacity of a material or system to return to equilibrium after a displacement [29].

High reliability organisations (HROs) exhibit a strong sense of mission and operational goals, stressing not only the objectives of providing a ready capacity for production and service but an equal commitment to reliability in operations, and a

readiness to assure investment in reliability enhancing technology, processes and personnel resources [30]. As such, HROs are a way to determine which elements in a system can help in becoming safer. Most of the time, these elements will also allow to increase the performance. In a sense, HROs are in fact high performing organisations (HPOs).
However, in their article "Beyond Normal Accidents and High Reliability Organizations: The Need for an Alternative Approach to Safety in Complex Systems", Marais et al. [31] stated that:

"The two prevailing organizational approaches to safety, Normal Accidents and HROs, both limit the progress that can be made toward achieving highly safe systems by too narrowly defining the problem and the potential solutions", and that they believe that "a systems approach to safety would allow building safety into socio-technical systems more effectively and provide higher confidence than is currently possible for complex, high-risk systems".

Therefore, in order to be able to predict or to obtain more understanding and control vis-à-vis the systems involved in bad things that are happening, scientists dig ever deeper in the systemic iceberg in their efforts. This time, to determine the structure of the systems involved, aiming at getting a clearer view of the structures and the dynamics that are at the genesis of accidents.

2.5. Structures of Systems

The structures of systems are to be understood as being the elements of a whole together with the types of connections that exist between those elements. Recent years have seen a whole range of models that try to model and determine the structures of systems that generate unwanted events, searching for the elements that populate the system and trying to determine and understand how these elements interact, thus creating the dynamics that generate accidents. Some examples are the Systems-Theoretic Accident Model and Process (STAMP) [32], the Functional Resonance Analysis Method (FRAM) [33] or more recently the SAfety FRactal ANalysis (SAFRAN) method [34]. More widely used, there is also the Swiss Cheese model [35,36] and the models that build on the same human factor approach, for instance, the Software-Hardware-Environment-Liveware-Liveware (SHELL) model [37], or the Human Factors and Classification System (HFACS) [38], just to name a few. Furthermore, theories regarding "safety culture" could also be promoted as an example of looking at systems, how they are structured and how systems generate safety or not.

2.6. Mental Models

Finally, scientists and practitioners also aim at developing an understanding of how

the mental models that generate systems and their structures can be controlled and managed, in order to design methods with which systems proactively emerge, consequently generating safety and preventing unwanted events. Mental models are often described as paradigms, mindsets, beliefs, assumptions, cultural narratives, norms, expectations, or simply perceptions [20]. An example of mental models capable of generating safety is the concept of "just culture" [39,40]. This concept aims at restoring the mindset of trust and accountability in organisations. Trust and accountability are two powerful mental models, facilitating communication, reporting and a proactive behaviour towards safety and performance, that are capable of generating systems that are different from the systems where these characteristics are not shared on an organisational scale [41].

In fact, only insight in and knowledge of the mental models present in a system provide the basis for understanding how fundamental changes can be made in order to proactively obtain more safety and performance [15]. Regeneration of mental models, redesign of structures and the reframing of systems are the needed changes for improving socio-technical systems towards desired and sustainable results [42].

3. A Fundamental Understanding and Approach for Safety in Socio-Technical Systems

3.1. A proactive approach towards safety

Safety is often defined as a dynamic non-event and mostly explained by the events that violated that state of dynamic non-events [43]. The problem with this approach is that it only covers the domain of unsafety and leaves any interpretation of safety open. When safety thinking is linked with dynamic non-events, it solely focusses on preventing bad things from happening. But is this the right approach in pursuing safety? The paradox in this approach is that something needs to happen before action is taken. When safety increases, and safety is defined in a negative way, a safe situation will lead to nothing significant happening. When this situation continues, the efforts to maintain safety at a desired level will come under pressure, as the effort will not be justified by things happening. Absence of happenings will result in a reduction of efforts, which will then lead to a reduction in resilience and reliability, making something unwanted happening more likely [44].
So, is turning away from unsafety the same as aiming for safety? When one considers a situation of 100% safety, is this a situation where nothing is happening? This seems an impossible assumption. There will always be something happening, events and consequences (positive effects on objectives) one desires and events and consequences (negative effects on objectives) one does not want. Both are important from a modern safety perspective. Moreover, understanding and managing the governing mental models about risk, safety and performance is important. So, what is particularly needed for safety to emerge, exist and persist?

3.2. A Modern Perspective on Risk, Safety and Performance

A modern perspective on risk, safety, and performance looks at the whole picture. It starts with whatever people, organisations and societies want. What are the objectives that are valued, needed and important to be safe? Safety should in the first place be concerned with making sure these valuable, needed and important objectives are pursued, achieved and secured. It is making certain that excellent performance is attained when pursuing and safeguarding objectives, and that health and wellbeing will be assured in all circumstances [45]. Hollnagel [44] refers to this as Safety I and Safety II, where Safety I is the traditional approach of avoiding losses due to the factors negatively affecting objectives. Safety II, on the other hand, is related to the variability in performances when pursuing or protecting objectives. In our view, this is how safety and safety science should evolve. It is about both the absence of losses (low unsafety), the presence of pursued, achieved and safeguarded objectives (high safety) [45] and the mental models that are at the genesis of the systems that generate wanted and/or undesirable outcomes.
Leveson indicates that "safety" is an emergent property of systems, not a component

property [32]. It means that safety is not inherent to systems, but rather something that needs to be consciously and persistently pursued, achieved and safeguarded. In a systemic perspective, systems are parts of larger systems and consist of smaller subsystems. As such, a component of a system is to be considered as a system itself, having a specific purpose different from the objective of the overarching system. Each of these (sub)systems is subjected to a specific set of risk sources that can affect those more individual objectives that also need to be safe to maintain the performance of the higher-order system(s).

A way to represent this approach and sense of risk, safety and performance, is by depicting a set of risks related to a particular objective of a (sub)system (Figure 3). Risk, as defined by ISO 31000, is "the effect of uncertainty on objectives" [46,47], and it is also stated that an effect is "a deviation from what is expected" [48]. In general, people have expectations regarding objectives, and they rest on the mental models they carry, reflected in the ambitions and the attributed values these prospects carry. As Slovic states: "Risk does not exist out there, independent of our minds and cultures, waiting to be measured. Instead, human beings have invented the concept 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 objective risk" [49]. From Slovic's statement, one can understand that risk is an individual construct, differing from one person to another because different people have different objectives and possibly value the same objectives differently. However, when one can determine the objective of a system component and make an abstraction of individual expectations and their attributed values, one could start considering a more objective approach to risk and safety that is tied to a well-determined objective, independent of the beholder and their expectations. Although this seems to be aligned with a traditional view on risk and the management of risk, it is not. Because a traditional approach will only look at the negative effects that can affect the concerned objective, judged from the governing individual, corporate or societal mental models. This is also true for objectives one is not aware of. On the other hand, with the proposed approach, risk still needs to materialise as a construct. Because only when an expected or desired value and its corresponding (perceived) likelihood are attached to an objective will it become real. In essence, this is the risk one is willing to take. It is the positive value attributed to that objective.

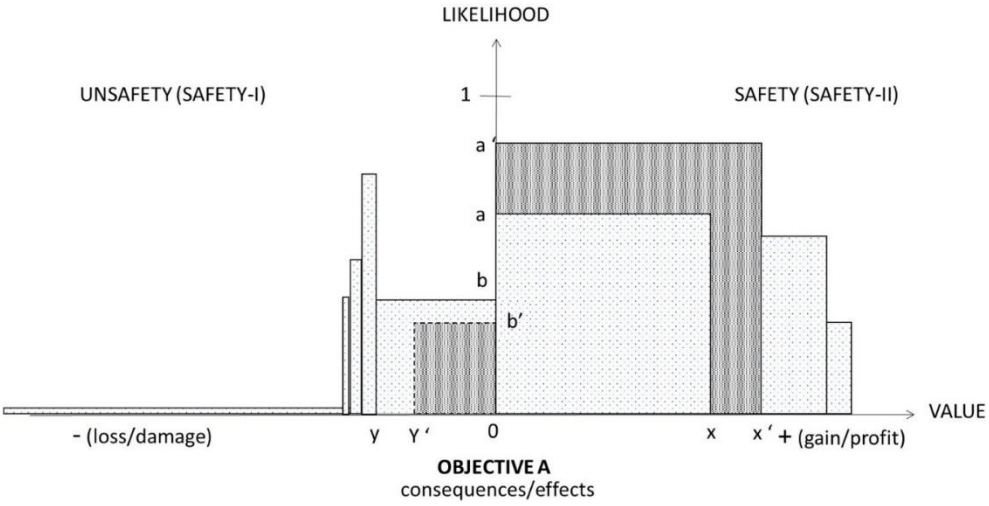


Figure 3. Risk, unsafety and safety [46].

According to one of the most used risk management standards, risk is the effect of uncertainty on objectives (ISO 31000). It is stated that this effect can be positive, negative or both. In practice, when considered over a period of time, objectives mostly undergo both kinds of effect. When an objective is clear, it is possible in some way to determine an associated value, and an according likelihood of achieving this value, to it. In Figure 3, these expected or desired values are related to "x" and "a". At this point, there's no 100% certainty regarding achieving this value, so risk is involved. When taking the risk of pursuing this objective, which means taking action aiming to achieve the objective, the expected value (level of safety or gain) "x" related to objective A is supposed to have a likelihood of "a" to be achieved. At the same time, a negative value (level of unsafety or loss) of "y" is also directly to be expected with a likelihood of "b" for the risks run, i.e., the negative effects that can directly prevent the achievement of the objective and their associated loss. At a first glance, the decision to pursue and maintain the objective will then be determined by the relative sizes of the two surfaces "ax" and "by". When this balance is positive, it is considered worthwhile and safe to proceed and act. Most of the time, this balance and action concerning objectives is based on the individual mental models (values and convictions) of the decision-makers involved when pursuing objectives individually, in organisations or society as a whole.

Traditionally, risk and safety practitioners, as well as scientists, have looked at the left-hand side of the graph (Safety-I), where it is important to reduce the likelihood b to b' and reduce the consequences y to y'. With a better understanding of the system(s) that can influence the safety of objective A, traditional risk and safety would also be interested in finding as much as possible about all the other possible negative effects

on the objective A, trying to eliminate and/or reduce these effects and their associated likelihoods. Discovering the various risk sources that, alone or in combination, can create such effects is then paramount. Most of all, the high impact, low probability events (HILP, or Type II) have stimulated safety scientists to search for the holy grail of finding the systems and structures that allow preventing these catastrophes from happening. However, very limited research is performed concerning the mental models that create and govern such systems.

With new insights in managing risk and safety, expressed in modern standards and theories such as ISO 31000 and Safety-II, the right-hand side of the graph also becomes involved. Managing risk and increasing safety then also means to take those measures that increase the value x to x' and likelihood a to a', while also decreasing the value y to y' and the corresponding likelihood b to b'. As such, these alterations can be seen as primary effects of uncertainty on objectives.

Systems always act in larger overarching systems and are comprised of smaller sub-systems, each of them with a specific purpose and outcome. Even the smallest systems can fail and produce unwanted outcomes, creating adverse effects for the larger encompassing systems. This is also an effect of uncertainty on objectives.

4. Discussion

4.1. Taking Risk and Running Risk

As the history of safety science shows [45], in one's mind, connections are easily made between both sides of the risk and safety graph. Scholars pursue ways to improve safety, but they have always been concerned with the reduction of unsafety. This happens because both sides of risk (negative and positive) and safety (Safety-I and Safety-II) exist from the moment a certain value or importance is attached to an objective. When the total value of that objective is perceived to be uncertain, it is considered as taking risk when pursuing this objective. Taking risk, therefore, actually signifies trying to create or obtain the expected or desired value attributed to that objective.

However, in taking action to pursue an objective—and not taking action is also to be understood as taking action—the objective and its value will also be linked to different risk sources that can generate positive and negative effects, adding or subtracting value of the objective. These are the risks one runs. Taking risk is active, deliberate and in the pursuit of value, but running risks is passive, un-deliberate and with the prospect of loss. Because certain people are afraid of these losses, they immediately think of the possible losses when thinking of taking risk, they focus on the loss instead of considering the possible gains when the outcome of an endeavour is uncertain; they have a so-called risk-averse attitude. Other people, with a focus on gain, have a rather risk-seeking attitude, even if most people have a so-called risk-tolerant attitude. These attitudes result from the mental models (meanings, assumptions, conclusions and beliefs) generated through the ladders of inference one holds.

4.2. Proactively Generating Safety

Risk, safety and performance are related to objectives (what is valuable and valued by someone) at a given time. For risk, this lies in the future, for safety it is about a present situation and performance is about what has already happened and lies in the past [45].

Taking risks is all about pursuing uncertain objectives. This can be done by expressing an ambition and determining the level of risk one expects to take (corresponding to surface x.a in Figure 3), by articulating an expected level of value (x) and an expected level of likelihood (a) regarding achieving or maintaining that objective. In that way, a basic level of safety at the component level is established. Running a risk (surface b.y in Figure 3) is the cost or losses likely to be incurred when pursuing an objective, which can be considered a basic level of unsafety [45]. The establishment of these basic levels of safety and unsafety provides a starting point allowing to identify risk sources and their effects—both positive and negative—related to this specific objective. Combined with the associated likelihoods of those possible effects, a more comprehensive level of safety (creation of value) and

unsafety (loss of value) can be determined, reflected by the additional surfaces on the graph in Figure 3.

Managing the level of safety can then typically consist of taking measures that improve the basic level of safety by increasing the performance regarding the concerned objective, by adding value and increasing likelihood on the safety side or reducing loss and likelihood on the unsafety side of the graph. This can happen by increasing the actual value ($x \rightarrow x'$) and/or likelihood of realisation ($a \rightarrow a'$) of the positive effects on objectives, which will then increase the level of safety. One can also take action in reducing the value ($y \rightarrow y'$) and likelihood ($b \rightarrow b'$) of the negative effects related to the concerned objective, decreasing the level of unsafety.

However, even for a single objective many risk sources and their associated effects can affect the end result of an actual case, which can be seen as the actual performance of the system in pursuing, achieving or safeguarding its objective. Each action taken (and no action is also considered a type of action) will create a new basic level of risk, safety and performance, adding, subtracting and changing the different risk sources and their associated effects influencing both sides of the graph. These actions (as a result of generated mental models) create a new level of safety with a new balance between the positive and negative effects of uncertainty on the concerned objective. When the actual performance of the system meets the desired level of performance, an objective can be considered as being safe or safeguarded. However, when the desired safety and unsafety levels are not reached, the objective is to be considered as a failed objective.

4.3. The Illusion of Cause-Effect Prediction and Accident Prevention

In safety science, many scholars are looking for ways to predict and prevent accidents. Most certainly this is the case for the high impact and low probability (HILP) events that can have a huge impact on society. It is the consequence of Safety-I thinking, where negative effects of uncertainty on objectives are seen to be related to cause-effect relations, looking for fixed systemic connections between risk sources and consequences. It is a line of thinking (mental model) aiming at the capability for accidents to be forecasted and to prevent them from happening. It is part of the "barrier" and "scenario thinking" methods that are still popular ways to deal with safety in organisations today. While it is possible to think of possible and plausible cause-effect relationships in simple and complicated systems, this is no longer possible for the complex socio-technical systems in today's society. Complex and chaotic contexts are unordered—there is no immediately apparent relationship between cause and effect, and the way forward is determined based on emerging patterns. Furthermore, a complex system has the following characteristics [50–52]:

- It involves large numbers of interacting elements;
- The interactions are nonlinear, and minor changes can produce

disproportionately major consequences;
- The system is dynamic, the whole is greater than the sum of its parts, and solutions cannot be imposed; rather, they arise from the circumstances. This is frequently referred to as emergence;
- The system has a history, and the past is integrated with the present; the elements evolve with one another and with the environment, and evolution is irreversible.

Though a complex system may, in retrospect, appear to be ordered and predictable, hindsight does not lead to foresight because the external conditions and systems constantly change.

Unlike in ordered systems (where the system constrains the agents), or chaotic systems (where there are no constraints), in a complex system the agents and the system constrain one another, especially over time. This means that one cannot forecast or predict what will happen [51].

There are cause-and-effect relationships between the agents in complex systems, but both the number of agents and the number of relationships defy categorization or analytic techniques. Therefore, emergent patterns can be perceived but not predicted [52].

Consequently, as indicated earlier, safety is an emergent property of complex systems and needs to be achieved over and over again. It is not a static situation but a set of dynamic circumstances, where the objectives of sub-systems need to be aligned and ever again achieved to create the desired level of safety. Therefore, the only way to envisage the future correctly is to shape it in the way it is looked-for, by adapting and aligning mental models through dialogue and learning on an individual, corporate and societal level, creating actions that generate safety and safeguard objectives on a continuing basis. It is the only way to achieve and maintain an adequate and sustainable level of safety in complex socio-technical systems.

4.4. Total Respect Management

A modern systems thinking perspective on safety that fits with this representation and a model to generate and achieve sustainable safety in a proactive way that is proposed is what is called Total Respect Management (TR^3M). Respect, in the way this word is intended to be used for this model, is an expression originally derived from the Latin word "respectus". In its turn, "respectus" comes from the verb "respicere", which means "to look again", "to look back at", "to regard", "to review", or "to consider someone or something". In other words, the original meaning of the word "respect" holds the connotation of giving someone or something one's appropriate and dedicated attention in order to have a better view on the matter or give it some thought, particularly to come to a better understanding. When used in the context of Total Respect Management, this is exactly how the word

"respect" needs to be understood [50,52]. As much as possible, the corresponding sub-systems of socio-technical systems and their objectives need to be known and understood by giving them the appropriate level of attention. For TR^{3}M, this means respecting people (individual objectives and mental models) by developing leadership, respecting profit (corporate objectives and corporate mental models) by managing risk and respecting the planet (societal objectives and societal mental models), aiming for excellence and sustainability. As such, TR^{3}M aims at promoting a systems thinking approach, developing leadership to align mental models, implementing risk management according to ISO 31000 and a continuous improvement of inadequate sub-systems. It builds on the generation of trust and accountability in order to proactively influence safety and performance, as trust is an important precondition to facilitate the process of proactively changing and aligning mental models in organisations [53].

4.5. The Swiss Cheese Metaphor Revisited

The reason for this "respect" for systems and their sub-systems is the conviction that there is no common structure to (all) "accidents" (See also Section 4.3). They cannot be predicted when complexity is such that not all cause effect relations can be understood and managed anymore. Or, at least, it is the conviction that such a complex structure is beyond the actual means of comprehension of mankind. Alternatively, at best, for less complex systems, this notion exists at a very general level, not very well suited for an unquestionable prediction of future accidents. This is also a way in which one has to look at the Swiss Cheese metaphor. When picturing some Swiss cheese, people imagine a block of cheese with holes in it. In this metaphor, in the way one can see it, the whole block of cheese is a reflection of reality and of the performance of a socio-technical system and its sub-systems, created and governed by its associated mental models. The cheese itself can be understood as everything that goes well. It relates to the objectives that have been achieved and which are safeguarded. Hence, the cheese stands for the objectives where the value achieved and safeguarded in the Safety-II domain of the graph in Figure 3 is dominant. The cheese therefore represents the achieved and safeguarded objectives. On the other hand, the holes in the cheese are the sub-systems of which the objectives have not been achieved or safeguarded, and this mainly concerns those objectives where the loss of value, represented by the unsafety (Safety-I) side of the graph in Figure 3, prevails. These are the objectives that have failed. As such, these are the different reasons which contribute to phenomena going drastically wrong when they become connected (thus, the holes in the cheese represent Safety-I). The model's hypothesis is that one can never know with complete certainty which sub-systems will fail at a given time or why and how these failed objectives will become connected in a cause-effect relationship at a given time, thus causing a catastrophic failure of the whole overarching system.

Each hole in the cheese is to be regarded as a "failed" objective and it therefore creates unsafety. To understand how to view this model, it is important to remember that reality is dynamic and that conditions change from one moment to another. It is supposed that holes grow and shrink, and this will happen at random. This process means that this Swiss cheese is dynamic. One has to picture a Swiss cheese of which the holes constantly change in positions and dimensions, and this does not happen in a predictable way. In his book *Managing the risks of organisational accidents* [35], Reason states:

Although the model shows the defensive layers and their associated 'holes' as being fixed and static, in reality they are in constant flux. The Swiss cheese metaphor is best presented by a moving picture, with each defensive layer coming in and out of the frame according to local conditions. [. . .] Similarly, the holes within each layer could be seen as shifting around, coming and going, shrinking and expanding in response to operator actions and local demands."

Although the idea of layers of protection, by putting barriers or fences around the holes, is useful to a certain extent, it only works for Safety-I. Therefore, the TR^{3}M model also focusses on successful performance as an element of safety. The aim of performance is to achieve objectives and maintain, as much as reasonably possible, the objectives safeguarded. As such, performance stands for the whole cheese, or the whole concerned socio-technical system and the aim is excellence (safe performance), where the holes are as little and few as possible and value is maximised.
The way TR^{3}M approaches the Swiss Cheese metaphor is by stating that each of the holes is a subsystem of which the specific objectives have failed (latent conditions) and that failures of achieving or maintaining these objectives can be seen as accidents on their own. One could say it is about slicing the cheese in little pieces and consider each piece as an entire block of cheese, whereby a hole through the cheese is considered an accident. These "accidents", or failed/failing objectives (unsafe performance), result from systems (risk sources) shaped and maintained by the mental models existing in, or surrounding, the concerned socio-technical system. In fact, it is just the level of importance and number of objectives involved that differentiate the catastrophic "accidents" from these incidents and their corresponding, apparently "less important", holes. In general, it is only when the holes represent important objectives they are seen as real accidents and considered worth investigating. However, each one of the holes (objectives in a broad sense) is meaningful and needs one's respect. Hence the name Total Respect Management [54].

4.6. Quality of Perception

The key to achieving safety proactively depends on one's quality of perception, where the quality of perception should be understood as the level of deviation (gap) between reality and the perception (mental model) of that reality. When this gap is small, there is a high quality of perception, but when ignorance makes the gap bigger, there is a lower quality of perception. It means that increasing the awareness, knowledge and understanding of objectives involved in a socio-technical system, its subsystems and encompassing systems (context) is crucial in generating safety. How are the objectives possibly impacted by events or conditions? What are the consequences of failure or success of these objectives? How well are these objectives aligned? These are essential questions to be asked. When the quality of perception is high, this will have its consequences on the mental models present in the system, as these mental models will be better aligned with reality, allowing for better decisions, increased safe performance and less unsafe performance.

4.7. A Broad Perspective on Safety

In a traditional context, risk and risk management are more concerned with finance and profit, where safety is more worried about health and injury and security is troubled by possessions, opposing interest, power and human life. However, many different categories of objectives exist and every one of them has to be taken into account to determine and generate safety proactively. An aircraft crash or a similar important accident, in the processing industry for instance, has an impact on many important objectives. These objectives range from very specific and individual goals to very general and societal aspirations. They also cover different dimensions, for instance, individual objectives regarding life and health, or financial objectives of the organisation regarding profit and continuity of operations, or objectives regarding our environment on a societal level, and so on. The more objectives that are impacted by the negative effects of uncertainty and the more valuable they are, the more they will be perceived as an accident. One only has to think of the countless individual, organisational and societal objectives which were impacted by the Fukushima disaster. It is the range, the number and the importance of those goals that caught everybody's attention and which will remain in the memory of mankind. Nevertheless, this accident only happened because of some latent conditions that existed in the nuclear plant and in the organisation operating the plant; the protective measures, equipment and procedures in place did not achieve the objectives they were intended or designed for. These were the existing holes in the system nobody was aware of, or no one bothered to take action against, due to the governing mental models in this socio-technical system. They did not seem important until they were joined by the circumstances and the failure of other objectives, which proved to be crucial at that moment [54].

Risk, safety or security, in this sense, are nothing more than possible conditions of one's objectives and the performance regarding those objectives at a given (future) time, representing a reflection of a possible (future) reality. The better this future reality can be imagined, the more it can be shaped to the desires and needs of the beholders by taking the right decisions at the appropriate time. This can only come about when different viewpoints can be paired and aligned with the common objectives to create common and aligned mental models that fit with reality and generate systems producing safety proactively.

4.8. Some Examples of Mental Models Influencing Safety, Security and Performance

A first example of a mental model that positively impacts safety and performance at a very general level is a concept (or an idea, conviction, mindset, and so on) that is at the core of aviation safety. It generates a high level of detailed reporting of incidents and is responsible for huge efforts made in accident investigation. It is the very simple belief that it is crucial to learn from the mistakes of others because one will never live long enough to make all mistakes oneself. This mental model works, since mistakes in aviation often have a deadly outcome impacting many important objectives. It is only because of these huge efforts in reporting and analysing incidents and accidents that knowledge and understanding increase in such ways that it allows to reach the very high standards of safety and performance currently achieved in the aviation industry.

Another idea (or belief, concept, conviction, and so on) is the mindset focused on always holding the stair railing when ascending or descending stairways or ladders. In some organisations, often in the petrochemical industry, this mental model is so ingrained that it has become an attitude and even a habit. It is impossible to know how many accidents have been prevented by this very simple organisational, yet individual, mental model. However, thousands of people get injured every year, and some killed, by either careless behaviour, or by faulty architectural features that contribute to these accidents [55].

Mental models play a role in causal relationships, as can be found in investigations of notorious accidents. In their paper "The accident of m/v Herald of Free Enterprise", Goulielmos and Goulielmos state the following:

"This was for the ship to do the crossing at the least possible time reducing time at the port as a rule. Moreover, two written instructions were issued in 1986 showing a pressure for the earlier sailing of the ship from Zeebrugge (as ships delayed in Dover as a rule), by 15 min, management asking for exerting pressure, especially on Chief Mate, for this end. The company had passed the culture of the urgency of sailing without this being supported by any marketing survey and as happened at the expense of safety."

Knowing that the ship sailed off without verifying the closure of the bow doors, which directly caused the ship to sink, it can be argued that a different mental model, not putting the emphasis on time pressure, but on safety and following procedures instead, could have created a different system, with a different outcome [56].
Similar flaws can be discovered in relation to the Fukushina nuclear disaster. Hasegawa [57] states, amongst others, the following reasons for this tragedy:

"A series of "unexpected situations" which the executive members of TEPCO have sought to explain should be re-termed a series of "underestimations" by the company and the government. First, the height of the tsunami was underestimated by TEPCO and the Japanese Nuclear Safety Commission (JNSC). Even though some researchers gave scientific warnings of a 15.7-m tsunami in May 2008, both TEPCO and JNSC neglected this warning. So, the plant remained designed to withstand a 5.7-m tsunami according to the 2002 estimation. On 11 March 2011, a tsunami with a height of 14–15 m at its maximum hit and flowed beyond the 10-m elevation of basement, flooding to a depth of over 5 m. Second, Japanese power companies and government agencies had not expected any possibility of lengthy "station blackouts," the total loss of AC power of the station, especially caused by a large-scale natural disaster, earthquake, tsunami or flood. But the blackout occurred with the result that all cooling functions were lost. Authorities expected that in the case of a station blackout, external power would be recovered within 30 min. This expectation was formed without sufficient basis thereby dismissing the need to prepare for the possibility of a lengthy period of no AC power."

It is clear that "unexpected situations" is a sign of possibly flawed mental models of TEPCO and the government agencies, indicating at least a low quality of perception, not taking into account scientific warnings. Or even worse, it could also be an indication of a deliberate underestimation of possible events, with a priority for profitability as a governing mental model, leading to the latent failed objectives of protection against flooding and the availability of AC power. What would have happened if other governing mental models had been in place? For instance, the mental model that it is wise to listen to scientists and heed their advice.
When mental models are different in different groups of people (societies), they can generate conflicting objectives. When this happens, security issues will arise. As an example, one only has to think of the governing mental models in a democratic open society, where equal rights, gender equality and women's empowerment are very important aspects of life that possibly conflict with differing viewpoints ruling different societies. When these conflicts are very outspoken, terrorist action can be expected, as has been the case with Al Qaeda or the Islamic State of Iraq and Syria (ISIS). Likewise, there are the different mental models that go along with political systems, which can also cause deliberate the harmful action of one group of people against another one, not adhering to the same values and belief systems (mental

models). Understanding these governing mental models and their associated objectives provides information and directions on how to deal with these related security issues.

An example of the influence of one simple mental model on the performance of a complex socio-technical system can be found in the book "The Power of Habit". In this book, Duhigg tells the story of the Aluminium Company of America (Alcoa) and how in 1987, at a time when Alcoa was struggling, a new CEO was appointed. Paul O'Neal, the new CEO, drastically changed Alcoa's performance by focussing on one simple idea regarding safety. This mental model was "zero injuries". His ambition was to make Alcoa the safest company in America by reducing Alcoa's injury rate. At that time, this was something unheard of in the corporate world and at the beginning this approach was met with a lot of scepticism. But within a year, Alcoa's profits would hit a record high and by the time O'Neal retired in 2000, the company's annual net income was five times larger than before he arrived [58].

4.9. Mental Models and a Sustainable World

Safety is closely linked with sustainability. In a certain way they are almost synonyms. Safety is about achieving, maintaining and protecting what is valuable and important. How can something be safe when it is not sustainable or how can something be sustainable when it is not safe? Societal mental models governing sustainability are to be found in domains such as climate change, corporate social responsibility or world peace. Examples can, for instance, be found in the United Nations Global Compact principles (specific mental models) for corporate sustainability. One can read on the UN website: "By incorporating the Ten Principles of the UN Global Compact into strategies, policies and procedures, and establishing a culture of integrity, companies are not only upholding their basic responsibilities to people and planet, but also setting the stage for long-term success" [59].

5. Challenges and Further Research

While the idea of working with mental models seems easy and simple, it is not. As indicated earlier, mental models result from individual ladders of inference and are different from one person to another. These individual mental models govern the behaviour of people and, as a consequence, also the behaviour of organisations and ultimately society as a whole. Alignment of individual mental models in organisations and society is therefore an important challenge that needs to be addressed when aiming to implement organisational or societal mental models. This aspect of working with mental models is something to address in another paper and certainly is a possible way forward in the search for proactive and sustainable safety.

6. Conclusions

In our ever more complex and connected world, the safety of systems depends on the interactions and performance of the much smaller sub-systems. A proactive way to reach safety of systems is therefore to focus on the performance of the sub-systems at ever deeper levels of detail within the concerned system. It would therefore be interesting to study how mental models and these smaller subsystems relate and how they determine risk, safety and performance in the concerned socio-technical systems. Discovering appropriate empowering mental models, as well as relevant harmful mental models, would then allow to work with mental models that generate safety and eliminate unwanted events. This should be made possible at an individual, corporate and societal level, to create an environment where people can be safe in any aspect of life.

To be able to do so, it is of the utmost importance to organise and structure dialogue to create and disseminate the corresponding mental models that generate and allow for this dedicated focus and attention to detail (the role of leadership). At the same time, it is important to discover how the sub-systems interact and create value or produce unwanted events that can be avoided (the role of risk management). As such, it is necessary to simultaneously consider risk, safety (and security) and performance of even the smallest sub-systems and aim to reduce the number of failed objectives by continuous improvement, creating and maintaining safety in a sustainable way (the role of excellence).

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Chapter 3[10]

"How to change mental models in organizations to proactively improve safety and performance?"

1. Introduction

1.1. Context

This chapter is the content of a concept paper that is the third article in a row, with each step building further on a concept on achieving safety and performance in organisations proactively. These articles have been written in a way that they can stand alone. However, together, they form a concept answering three questions from the same coherent perspective on risk, safety and performance:

- How can risk, safety and performance be understood?
- How can risk, safety and performance be regarded from a systemic perspective?
- How can safety and performance be achieved proactively?

Together, the answers presented in these articles provide the perspectives and the mental models that help proactively achieve safety and performance in organisations.

As such, these articles contain the building blocks of a concept, an approach, we have named "Total Respect Management". It is a systemic and integrated methodology useful in leading and managing any organisation in a volatile, uncertain, complex and ambiguous environment. This third article ties everything together and provides a brief view on what Total Respect Management entails.

1.2. A Systemic Perspective and Integrated Solution

In our article "Safety Science, a Systems Thinking Perspective: From Events to Mental Models and Sustainable Safety"(2020), we concluded the following:

"In our ever more complex and connected world, the safety of systems depends on the interactions and performance of the much smaller sub-systems. A proactive way to reach safety of systems is therefore to focus on the performance of the sub-systems at ever deeper levels of detail within the concerned system. It would therefore be interesting to study how mental models and these smaller subsystems relate and

[10] This chapter has been published before as a concept paper "Achieving Organisational Alignment, Safety and Sustainable Performance in Organisations" (Blokland & Reniers, 2021)
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how they affect risk, safety and performance in the concerned socio-technical systems. Discovering appropriate empowering mental models, as well as finding relevant harmful mental models, would then allow to work with and develop mental models that generate safety and eliminate unwanted events. This should be made possible at an individual, corporate and societal level, to create an environment where people can be safe in any aspect of life.

To be able to do so, it is of the utmost importance to organise and structure dialogue to create and disseminate the corresponding mental models that generate and allow for this dedicated focus and attention to detail (the role of leadership). At the same time, it is important to discover how the sub-systems interact and create value or produce unwanted events that can be avoided (the role of risk management). Hence, it is necessary to simultaneously consider risk, safety (including security) and performance of even the smallest sub-systems and aim to reduce the number of failed objectives by continuous improvement, creating and maintaining safety in a sustainable way (the role of excellence)" [1].

In this third concept paper, we consider the different aspects of this conclusion, reflect on the role of mental models and establish ways to work with them.

- What are the challenges and the possible solutions when working with mental models?
- What about the mental models related to risk, safety and performance?
- How can safety and excellent performance in organisations be achieved?

To build further on our conclusions, we look at concepts such as "leadership" and "alignment" to propose our own "Dynamic Cultural Alignment" and "Dynamic Organisational Alignment" models. Subsequently, we elaborate on how this model can be used as an instrument to create an aligned organisational culture, focussing on risk, safety and performance and working by means of dialogue, attention to detail, continuous learning and dedicated improvement, using the guidance contained in ISO 31000 as a practical tool.

1.3. Practical Approach of This Paper

First, we make clear how safety and performance can (and should) be understood in this context of organisational alignment, safety and performance and why leadership skills are of paramount importance.

Next, we expound upon the role of leadership in establishing alignment through determining and developing mental models in organisations, focussed on objectives and their achievement, and subsequently, we illuminate how the alignment of these mental models can be envisioned.

Finally, we explain how ISO 31000 [2,3] can be used as a tool in aligning mental

models and in structuring dialogue in organisations, how this increases one's quality of perception for better decision making and how this leads to continuous improvement. As such, ISO 31000 serves as a tool in achieving the desired alignment, the required focus and dedicated attention to detail, delivering the continuous improvement needed to reach safety and excellent performance proactively.

2. The Importance of Mental Models in Achieving Safety and Performance in Socio-Technical Systems

2.1 Systems, Mental Models and Levels of Perspective

Meadows described a system as a set of things—people, cells, molecules, etc.—interconnected in such way that they produce their own pattern of behaviour over time. She also stated that a system can be buffeted, constricted, triggered or driven by outside forces. However, the system's response to these forces is characteristic of itself, and that response is seldom simple in the real world [4].

The consequence of this statement is that different systems—and certainly socio-technical systems—react differently to similar events, causing different results. When these results are "unwanted", the best solution is not necessarily reactively putting barriers around the events to contain them but rather changing the system in a proactive way so that it produces different, "wanted" results instead of the "unwanted" outcomes.

Kim [5] states that systemic structures generate patterns and events (Figure 1) but are very difficult to see.

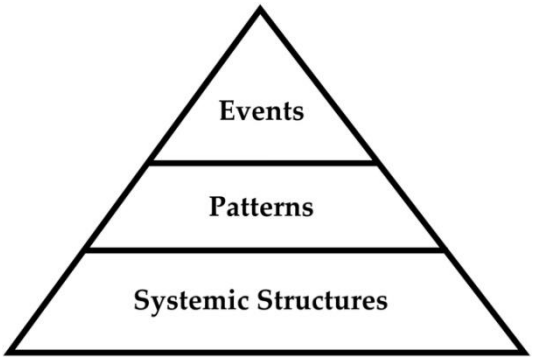

Figure 1. Systemic structures [5].

Kim also declared that a richer insight into systems can be gained by adding two more levels of perspective: mental models and vision. According to Kim, mental models are the beliefs and assumptions one holds about how the world works and, as such, they are the systemic structure generators. Vision, in his view, is seen as the picture of what one wants for the future, and it is the guiding force that determines the mental models one holds as important when pursuing goals. He proclaimed that the levels of perspective framework (Figure 2) can help go beyond responding only to events and can begin looking for actions with a higher leverage and that each level offers a distinctive mode of action.

The most basic mode of action is "reactive" to counter events. More leverage is obtained when discovering patterns and when "adapting" to accommodate what is happening. A higher action mode is to act on the level of the "systemic structures", for instance by redesign, reorganisation, reengineering, etc., and to be "creative" in doing so. However, successfully altering systemic structures often requires a higher leverage action mode and a change in mental imagination of what the new structures ought to be and what is to be changed. Therefore, the action mode becomes "reflective", questioning one's assumptions and building new mental models. According to Kim, the highest leverage is achieved on the level of "vision".

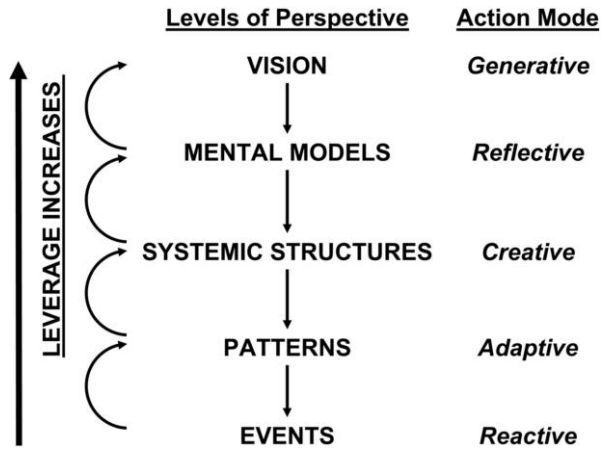

Figure 2. Levels of perspective [5].

However, changing mental models is a difficult and painful process, as mental models are the results of many years of experience and are difficult to alter. However, at the level of "vision", new ideas can be envisioned, and the action mode becomes generative, bringing about matters that did not exist before.

According to Jones et al. [6], people's ability to see and represent the world accurately is limited and unique to each individual. Therefore, mental models are incomplete and inconsistent images and interpretations that are context dependent. These mental models can change corresponding to specific situations at hand, adapting to continually changing circumstances and evolving through learning over time.

Although it is clear that a higher level of perspective offers the possibility of higher leverage, Kim [5] also indicates that not every issue needs a higher level of perspective to obtain a high leverage. There is the possibility of high leverage at every level of perspective, as this depends entirely on the issue at hand. For example,

when a fire breaks out, it is best first to react very quickly to this event and to only seek higher levels of perspective and be more proactive in preventing fires breaking out afterwards.

Senge [7,8] stated the following: "the problems with mental models lie not in whether they are right or wrong. By definition, all models are simplifications. The problems with mental models arise when they become implicit, when they exist below the level of aware- ness and remain unexamined. Deeply entrenched mental models can impede learning and can overwhelm even the best systemic insights." Nevertheless, bringing mental models to the surface and challenge them opens up opportunities and can accelerate learning.

2.2 Mental Models of Risk and Safety

How one perceives the concepts "risk" and "safety" can also be based on deeply entrenched mental models that possibly impede learning. For example, for some people, these concepts are considered antonyms, while others in past decennia have expanded their view on this matter.

Since the end of the previous century, these conceptions have seen an evolution in the ways we look at them, for example, as expressed in the ideas by Möller et al. [9], stating that safety is more than the antonym of risk, or by Slovic and Peters [10], who point out the importance of individual perceptions when dealing with risk. Furthermore, there are concepts such as Safety-I and Safety-II [11], where Hollnagel indicated that things going right is the larger part of safety but that this is rarely considered. In recent years, many scholars have approached these subjects from different angles, not necessarily coming to similar conclusions. More particularly, the introduction of a new (standardised) definition of risk a decade ago in the ISO 31000 standard has caused a lot of turmoil and discussion, dividing the world of risk specialists into believers and opposing non-believers that seem to dismiss this newer and broader definition of risk.

ISO 31000 defines risk as the "effect" of "uncertainty" on "objectives". According to the ISO, an effect is a deviation from "the expected" and uncertainty is a state of (even partial) deficiency of information related to the understanding or knowledge of an event, its consequences or its likelihood. However, the ISO does not define the term "objectives", and this is problematic, as this definition is only valid when the concept "objectives" is understood in its most encompassing sense. However, when one understands "objectives" being anything of value, anything a (sub)system needs or wants, one could say that this is the shortest and, at the same time, most complete definition of risk possible, as it incorporates all three elements that define risk in a most concise way. Anything added makes the definition more specific and less general and consequently subtracts from its meaning. Risk and "objectives",

"uncertainty" and "effect" can be considered similar to fire, which needs "fuel", "oxygen" and a certain level of "heat" to exist. When leaving one of these three elements out, there is no risk. When an uncertain effect does not affect any objective, it is simply the probability of an event having likely consequences because no value is attributed to this event. When viewed this way, one can say that the ISO 31000 definition is an expansion of the traditional perspective on risk, including specifically the objectives at risk. Therefore, one could say that the intrinsic and expected value of an objective is now also incorporated in this broader definition, allowing us to include the possibility of both positive and negative effects on objectives, something that is missing in a traditional view on risk. Although one can argue otherwise, there is always room for improvement regarding a specific objective, opening up the positive side of risk.

As such, "the effect of uncertainty on objectives" (risk) is what can be considered the likelihood of an event combined with its likely associated consequences that can either be beneficial or detrimental to an objective or that can even be both at the same time. The question is not which mental model is right or wrong, but foremost what can be learned from a new and expanded mental model regarding the concept risk that mainly focusses on objectives rather than purely on uncertainties.

In his article "The risk game", Slovic [12] already noticed that traditional approaches to risk assessment and risk management, where risk is viewed as an objective function of probability and adverse consequences of adverse events that can be objectively quantified, was insufficient, arguing for a new approach and highlighting the subjective and value laden nature of risk and its impact on decision making [13]. In his view, risk does not exist "out there", independent from our minds and cultures, waiting to be measured [14]. He stated that humans invented the concept of risk to help them understand and cope with the uncertainties of life. Indeed, risk is about what humans value and each human values things differently. As such, the ISO definition of risk responds very well to the concerns expressed by Slovic.

For example, take a group of people going for a hike in the mountains. A traditional risk perspective focuses on possible events and, amongst others, evaluates the risk of falling rocks and the likelihood of impacting the group of people with all or some of its possible consequences. For a traditional approach to risk assessment, the risk is the same for every individual in the group, as they are all in the same situation. Traditional approaches do not consider the personal objectives of each member in the group because it is very difficult to know how every individual values their own "health and safety". However, then, without knowing this value, the considered risk is just the probability of an event, and because the expectation is that rocks should not fall down on a group of people, every outcome is regarded as a negative

outcome, as, generally, it is assumed that everyone values their health and physical integrity in the same way. However, arguably, this is not the real risk every individual takes or runs. With a focus on "objectives", another, more diverse picture presents itself. Maybe there is a person in the group that has no objectives at all, no desires, no goals and no needs. This person could not care less what happens and does not care about life or death or injury. What is the real risk to this person? Maybe there is a person in the group that has a very imminent death wish because life is not what this person wants? Do these people run the same risk as a person that is looking forward to meeting their loved ones at the end of their journey? The value attached to the objective "life" determines the risk much more than any probability of an adverse event. Without these individual objectives, it is not risk that one deals with but just the probability of an (adverse) outcome that can be valued differently by different people. ISO 31000 defining risk as "the effect of uncertainty on objectives" provides a different, expanded view on the issue. Phrased in another (longer) way, one could also say that risk is that which makes maintaining and achieving one's objective(s) uncertain because objectives and how they are valued matter in determining what risks are. The effect of uncertainty is about the things that could or could not happen and, as a result, impact one's objectives. It means that the possible consequences of these rather expected or unexpected events influence the actual outcome of one's objectives. Therefore, risk, in a sense, is a possible deviation of expected results regarding objectives. Of course, this deviation can be positive, negative or even both, depending on what objectives one considers, which time frame one observes, and which value is expected because risk is a complex matter, related to an unknown future, concerning all of one's objectives. These objectives can be not only conscious and explicit but also unconscious and implied.

For instance, one could consider two people, both playing the lottery. Both invest exactly the same amount of money, for example, EUR or USD 1000. A traditional perspective on risk calculates exactly what the risk is. The probabilities are known, and the value is also a given. However, is this the correct risk for both people, and is it really the same? This is impossible to know without further investigation because one does not know the value that the amount of money represents for that person. One also does not know the objectives that are involved in this situation for both people. What if one of those people is a multi-millionaire, for which EUR 1000 is just a number and of insignificant value. The risk is mostly positive because missing this amount of money does not mean much as no other objective is affected by the outcome of the event, while only winning is significant enough to make a difference. In essence, for this person, the risk is low, as the probability of gain is also very low. However, what would be the case for a person that invested all of their possessions in hopes of winning? Surely, for this person, a lot of his objectives are affected by the outcome of the event, making a huge difference between winning or

losing. The risk for this person is mostly negative because the odds are not that good and losing that money can make a huge difference while winning can also make a huge difference, but this is highly unlikely. As such, the risk for this person is high, although the value of the money and the probabilities related to the event and its direct consequences are exactly the same for both people. Nonetheless, the risk for both is entirely different because the number and importance of the objectives that are affected by the end result are distinct. This example makes it clear that risk is, in the first place, about the objectives that can be affected and much less about the uncertainties involved, although both are important.

This approach towards risk and risk management, focused on objectives, is different from the traditional way, focused on uncertainties and probabilities. It requires a different way of assessing and dealing with risk. It is a different mental model concerning risk that also opens up a wider perspective on safety and performance when objectives are at the core of their definitions.

2.3 Looking at Risk Is Looking Proactively at Safety and Performance

How one looks at things is how one perceives reality and determines one's mental models. As such, one also develops mental models of the concepts "safety" and "performance".

In 1999, Rochlin stated the following:

> "*As is* the *case for risk, safety may also be defined formally or technically in terms of minimizing errors and measurable consequences, but it is more appropriate to adopt the principle used by Slovic in his social studies of risk and note that safety does not exist 'out there' independent of our minds and culture, ready to be measured, but as a constructed human concept, more easily judged than defined*" [15].

Le Coze stated that

> *"One of the major challenges in safety science is to develop methodologies and systems that are able to proactively capture and recognise situations and patterns that have the potential to provoke severe accidents. This instead of being obliged to use reactive approaches, such as learning from accident investigations when disasters already occurred" [16].*

In systems thinking, it is important to zoom out and to see how elements are linked or related and how they influence each other. It offers insight into what the dynamics are and how a system behaves. It is widely understood that risk and safety are related, and that safety and performance are related. When looking at risk, safety and performance from a holistic "objectives" perspective, it becomes clear that risk, safety and performance are concepts dealing with the same thing: objectives.

Concerning the concept risk, this has been made clear by the ISO definition of risk. However, safety is also a concept that is linked to one's objectives. Positive effects of uncertainty on one's objectives are in general considered to improve one's safety (Safety II thinking). Additionally, negative effects of uncertainty on one's objectives are usually judged as being more unsafe (Safety I thinking). Similarly, the resulting value attributed to one's objectives is what characterises one's performance. When the effects of uncertainty and all other actions undertaken to reach, achieve or maintain an objective provide a negative deviation of the expected value of this objective, this is normally considered a bad performance, whereas a positive effect on those objectives is deemed a good performance. Looking at risk, safety and performance in this way and linking this with a time perspective, one could say that the state of one's objectives at a certain time determines one's risk, safety and performance (Figure 3).

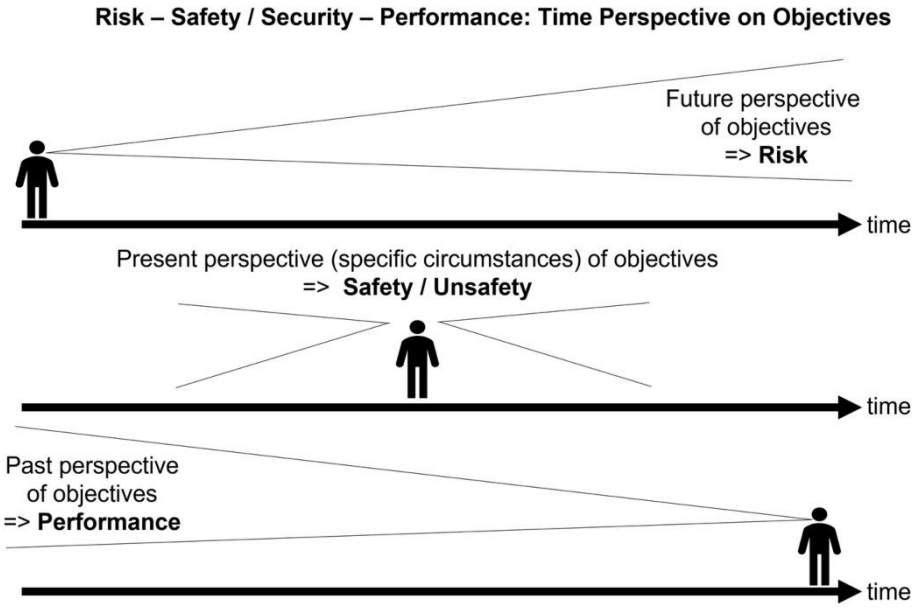

Figure 3. Time perspective on objectives.

The possible (uncertain) effects on objectives seen in the future create and determine one's risk. The possible (uncertain or not) effects on one's actual objectives in the present characterises one's safety. Finally, the actual effects on one's objectives (in the past) defines one's performance. In other words, risk, safety (in its most encompassing sense, including security) and performance are the same thing: the status of the effects on one's objectives. The only difference is the time perspective that these different concepts represent [17].

Risk, safety and performance require a focus on objectives, being clear about what they are, how they can be valued and knowing how they can be managed. The ISO definition of risk immediately provides which elements need to be considered. First, there are the "objectives" themselves, and only then, there are the "effects" of "uncertainty" that can affect those objectives that can be treated and optimised.

Looking at objectives from different time perspectives to reflect risk, safety and performance and to understand that these concepts are fundamentally the same thing is a fundamental mental model and starting point for this concept paper. Positive effects increase safety and performance, and negative effects decrease safety and performance. However, the future makes these effects always uncertain, corresponding to the effect of uncertainty, whether these effects are perceived or not.

3. The Systemic and Integrated Perspective of the Cynefin Framework

3.1. Five Domains That Define One's Quality of Perception

"Systemic" indicates a holistic view on reality. "Integrated" on the other hand means that various parts or aspects of an approach are linked and coordinated. The Cynefin framework, displayed in Figure 4, is a way to approach reality in both a systemic and an integrated way, delivering a clear view on one's environment in its largest sense (which is the means the Welsh word Cynefin) and how to deal with this reality. As such, it offers insight into the methodologies needed to improve or alter the mental models related to one's reality.

In a way, this model describes the different states of one's quality of perception, meaning how well one understands a situation one is in and how well one's mental models coincide with that specific reality. The framework distinguishes between order and disorder and uses these distinctions to match problems and their contexts with methods, tools and techniques that lead to solutions. While organisations seek order, stability and predictability, they also need a level of flexibility, adaptability and innovation to cope with an ever faster changing society and its reality. Cynefin helps in interpreting this reality and offers how to cope with this [18].

The framework divides reality in four specific domains. Each domain relates to the degree of complexity and the understanding of the reality one finds oneself in. The Cynefin framework's value resides in the fact that it prescribes a set of behaviours and practices that are appropriate for a given domain. For example, it provides insight on how to think and act in order to move from complete ignorance (no mental model of the situation) and chaos (very confusing and jumbled mental models) towards the full understanding (clear, sharp and correct mental models) of reality in the simple domain. In essence, applying the steps in different domains, going from chaos towards simplicity, is about learning and adapting one's mental models, which in turn helps increase one's "quality of perception". One can only perceive the reality one is confronted with, and thinking and acting in accordance with the different domains is appropriate and needed to increase awareness and understanding to achieve higher levels of perception.

3.2. The Importance of Leadership and Leadership Skills in Dealing with Mental Models

Another insight that the Cynefin framework offers is the kind of leadership behaviour fitting the different domains of the framework in order to obtain the best possible results of the actions taken. The model can be understood as follows (Figure 4).

The domains to the left of the model are referred to as being the "unordered" domains (complex and chaos), while the two domains to the right are also referred

to as "ordered" (complicated and simple), where a certain order can be established [19].

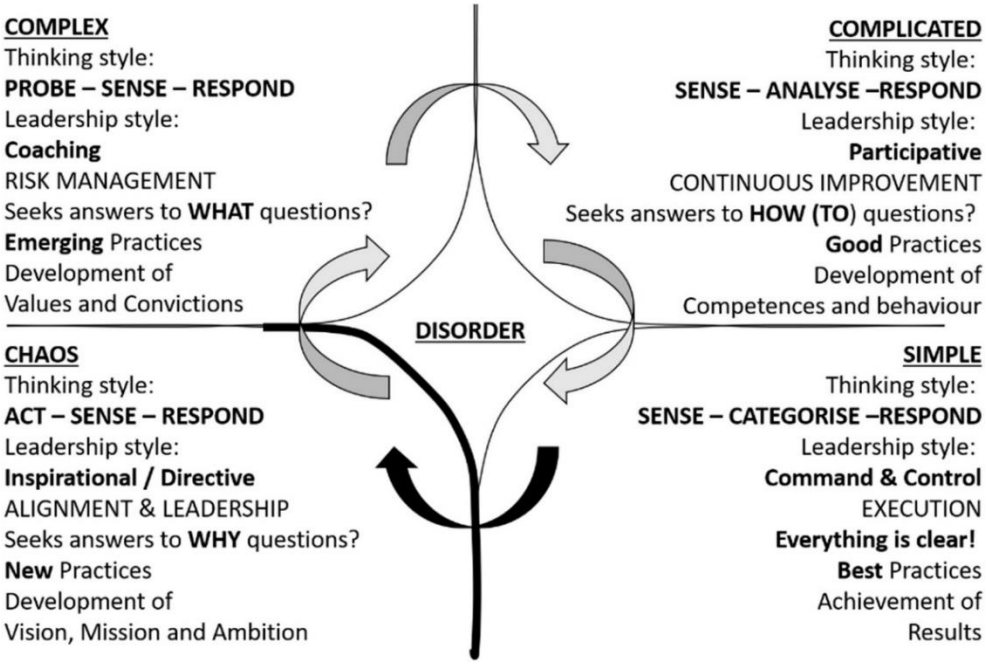

Figure 4. Cynefin framework (inspired by [19]).

Each domain is linked to the level of awareness and understanding of reality it represents, ranging from a complete lack of knowledge and understanding in the domain of so-called "chaos" to broad knowledge and understanding in the "simple" domain, after passing the complex and complicated domains, where knowledge and understanding is still lacking and where one still needs to learn. In the simple domain, everything is clear. Cause–effect relationships are fully known and understood. It is where the best practices reside. However, this is only the last phase of a learning process and often impossible to reach when situations are Volatile, Uncertain, Complex and Ambiguous (VUCA) due to the continuing change that organisations and society face today.

When one is unaware of things or unknowledgeable about matters, according to Snowden, one finds oneself in the domain of "chaos". In this domain, one is unable to establish any cause–effect relationship, not even after events take place. Chaos first requires one to "act" upon events and, then to "sense" what happens and consequently to "respond" with appropriate actions to what occurred. In chaos, charismatic or directive leadership is needed to create a purpose (objective) and a direction to proceed in because, in chaos, one requires clear concepts (vision) and

directions (purpose/objectives) in order to create structure and meaning. As soon as clear concepts and direction are established, one has to deal with the complexities that surround these objectives (risk). This requires a different attitude as one creates a form of order in chaos. It allows us to learn things and to move towards the complex domain. Here, one has to deal with the cause–effect relationships that could not be established beforehand, but which can be distinguished and studied afterwards when the effect of uncertainty on objectives turned into a performance that can be observed and investigated. In the complex domain, it is important to "probe" first, then to "sense" and finally to "respond" to what one has sensed. This typically is the domain of risk management, where the effect of uncertainty on objectives can be envisaged and where different scenarios or options can be identified and developed. In the complex domain, leadership is more of the supportive kind (paternal/matriarchal), focused on coaching and development, facilitating the exploration of new ideas, possibilities and innovation. This allows one to develop and move from the complex domain towards the complicated domain, as a sense of order emerges [19].

The right approach in the complex domain establishes order and leads to the "complicated" domain. Here, relationships between cause and effect are still not always very clear, but with some effort, they can be determined and studied before they produce outcomes. Once in the complicated domain, the approach should be "sensed", "analysed" and "responded to". Here, one requires less attention in the form of coaching, but gradually, as one's self-leadership develops, there is a need for support and possibility participation in decision making itself. Therefore, in the complicated domain, a participative leadership style is a most appropriate way to conduct leadership. It is where analysis and evaluation of options and situations provide the possibility to continuously improve. Finally, one arrives at the lowest degree of (perceived) complexity in the "simple" domain. This domain is characterised by the fact that cause–effect relationships are "one on one", easy to discern, known and understood. In the simple domain, the appropriate way to approach situations is to "sense", "categorise" and "respond". Therefore, in the simple domain, command and control are appropriate. Simple concepts neither allow for much room for interpretation nor provide the freedom the other domains offer [19].

A fifth domain, named "disorder", is meant for moments and situations where one cannot clearly determine in which of the four domains one resides [19].

The different reasoning-in-action strategies summarised above underscore the capacity to continuously sense or monitor reality. In the ordered domains, this involves monitoring and feedback of fact-based-information, allowing for continuous improvement. In the unordered domains, this requires the capability to

gather information and to discover events and patterns early enough so that a response to these new perceptions can be set up and attempted. Ideally, organisations discern these patterns while they are still small and emerging [20,21].

It needs to be stressed that the different domains relate to how well one knows and understands the matters one is dealing with. It is obvious that the more "VUCA" matters are, the more they are complex or even chaotic. However, even when matters are simple for one person, they can still be chaotic or complex for people with a lesser quality of perception regarding those matters. What is "simple" for specialists can be very "complex" for laymen. In Table 1, the insights the model offers are summarised.

Table 1. Cynefin domains and their features.

Action in the Different Domains and Their Features				
	Chaos	**Complex**	**Complicated**	**Simple**
Cause-effect relationship	No idea about it	Only established afterwards	Established beforehand, after analysis	Easily established beforehand
Thinking style	Act–Sense–Respond	Probe–Sense–Respond	Sense–Analyse–Respond	Sense–Categorise–Respond
Leadership style	Inspirational or Directive	Coaching	Participative	Command & Control
Practices	New	Emerging	Good	Best
Logical levels development	Vision–Mission–Ambition	Values & Convictions	Competences & Behaviour	Environment–Context
Main concern	Alignment & Leadership	Risk & Management	Continuous Improvement	Execution & Results

As mentioned earlier, learning and development dictate one's state of mind and the domain one is in, which is related to a situation one is in. The model also shows that leaders play an important role in the process of learning and increasing one's quality of perception because leaders help people develop and improve their quality of perception using appropriate methods of reasoning and adopting the corresponding leadership styles for the people they lead, taking into account the domain these people find themselves in. Adequately adopting these different leadership styles requires a variety of leadership skills, ranging from developing a vision to which everyone can relate to a wide range of communication skills in dealing with the different levels of the quality of perception that exists in organisations.

In his article "What leaders really do" Kotter stated the following:

"Leadership and management are two distinctive and complementary systems of action. Each has its own function and characteristic activities. Both are necessary for success in an increasingly complex and volatile (business) environment. Leading an organisation to constructive change begins by setting a direction—developing a vision of the future (often the distant future) along with strategies for producing the changes needed to achieve that vision" [22].

To put it clearly, "Leadership is creating a world to which people want to belong". This quote by Gilles Pajou indicates what leadership really is about, which is creating an image of the future where people can relate to and for which they are willing to abandon the "world" they are currently in [23].

Another perspective on leadership is offered by Nicholls [24]. He stated that there are three fundamentally different perspectives of leadership. He defined these as Meta, Macro and Micro.

Meta leadership creates a "movement" in a broad general direction (such as clean energy, human rights or glasnost); it links individuals, through the leader's vision, to the environment. It is the overarching vision that inspires and creates followers.

Macro leadership is the next step and is fulfilled in two ways: pathfinding and culture- building. Pathfinding can be seen as finding the way to the successful future that is envisioned. Culture-building can then be regarded as drawing people into a purposeful organisation, traveling along the chosen path and exploiting the opportunities that arise. Macro leadership influences individuals by linking them to the entity—be it the whole organisation or just a division, department or team—by giving answers to questions such as the following: What is our purpose or goal? What is my part in the story? What is in it for me? What is expected of me? Why should I commit myself and make an effort? In the process, the leader creates committed members of the organisation contributing to the cause.

Micro leadership on the other hand is about the choice of leadership style to create an efficient working atmosphere and to obtain the cooperation necessary in finishing the job by adjusting one's style to directing people in organisations in the accomplishment of a specific job or task. On a micro level, leadership involves considering one's individual state and capabilities with respect to the perceptual filters and motivations of one's collaborators in order to define and achieve specific objectives in a particular environmental context.

One could say that meta leadership is required to allow people to leave the domain of chaos and that macro leadership is necessary to make sense of our VUCA world in the complex domain, but micro leadership is required at each of the perceptual domains that the Cynefin framework offers, related to the quality of perception one

has at a specific moment and for the specific task executed to reach the destination that is envisioned "If the leadership style is correctly attuned, people perform willingly in an efficient working atmosphere, creating a world to which people want to belong" [24]. It involves a mixture of all three different perspectives on leadership and their associated aptitudes.

4. Organisational Alignment

4.1. The Importance of (Organisational) Alignment

"To have your ducks in a row", "To put all the wood behind one arrow", "Getting everyone on the same page", and *"Putting all noses in the same direction"*: there are many expressions that indicate what alignment is about and what its purpose is. It is about bundling and streamlining ideas (mental models) and efforts in order to get better results. Thus, organisational alignment is the degree to which an organisation's design, strategy and culture cooperate to achieve the same desired goals [25]. Organisational alignment is an inward-looking process that is crucial for organisational effectiveness [26]. Studies have revealed that the structural alignment of an organisation depends in part on the extent to which the objectives of the organisation are made clear to employees, as it helps to align their own goals with those of the organisation, facilitating the achievement of these overall goals. Employee enhancement plays a role in this process, as it assists in achieving the objectives by providing opportunities to improve necessary skills of individuals and to improve or clarify knowledge about their individual roles and goals. As a consequence, this allows for autonomy and involvement in decision-making processes, in a group or as individuals. Leadership is also of crucial influence in developing alignment. Leaders have to make clear that their co-workers operate in accordance with the organisational objectives. Studies have also indicated that leadership is more effective when leaders provide task-oriented guidance, so people know what is expected, and when they also demonstrate interpersonal (social) support and congruent behaviour. This is also true for upper management. When these conditions are met and alignment is achieved, this is most likely to positively influence organisational commitment and organisational satisfaction (the way people feel themselves fit in organisations). The opposite is also true, where a lack of alignment generates discomfort and reduces organisational and job satisfaction [27].

The importance of alignment and, more particularly, of the alignment of visions and objectives becomes even more obvious when one considers what, in general, causes the greatest dangers for society and organisations. Different visions lead to different mental models and, as such, generate different objectives. When these objectives are conflicting, negative effects of uncertainty arise. Terrorism, for example, is a very clear illustration of non-alignment of mental models and conflicting objectives on a societal level because many terrorist objectives are exactly opposite to the societal, organisational, and individual objectives they oppose [28]. Likewise, different visions and objectives between states and unions of states have always triggered conflicts and initiated wars with all their negative effects on individual, organisational and societal aspirations. However,

also, within organisations, non-aligned or even conflicting objectives, deliberate or unconscious, are constant factors that generate effects of uncertainty on objectives (risk). They bring about adverse effects, affecting the objectives of the organisation or even society as a whole. In almost every major accident or disaster in organisations or society, non-alignment of objectives (conscious and deliberate, or unintentional and unaware) can be discovered as contributing factors. Therefore, it is of the utmost importance to align individual mental models in organisations, especially regarding vision, missions and ambitions with those of the organisation, as a first step in managing the effects of uncertainty on objectives in organisations because non-alignment of mental models and objectives is a major risk source that can and should be managed most prominently.

4.2. The Logical Levels of Awareness and Leadership

In "*Applying systems thinking to analyse and learn from events*", Leveson [29] questions i.a., the mental model that assumes that increasing the reliability of individual system components also increases safety. She stated: "*Safety and reliability are different system properties. One does not imply nor require the other. A system can be reliable and unsafe, or safe and unreliable. In some cases, these two system properties are conflicting, i.e., making the system safer may decrease reliability and enhancing reliability may decrease safety*." Giving examples of these objectives that sometimes conflict, she also stated that reliability is a component property, but that safety is not. According to Leveson, safety is a system property and that, as complexity grows in the systems we operate in, accidents caused by dysfunctional interactions among elements of the system become more likely. As such, safety needs to be managed at a systems level and not at a component level. However, this does not mean that reliability as a component property in achieving safety is unimportant. There are too many examples that show that reliability is a key component property in achieving safety and performance. However, this is the case when the objectives of those key components are aligned with the overarching systems' objectives. The ideas forwarded by Leveson, in the first place, underscore the importance of a systemic view on organisations before dealing with reliability, with a focus on the different objectives involved, their importance, how they relate and how they can be aligned.

One of the possible hierarchies that can be used to provide a quick judgement of the level of importance of an objective is the concept of the logical levels, attributed to Dilts and Bateson. Dilts [23] defined the logical levels as leadership skills in applying the concept of Bateson [30], who recognised "natural hierarchies of classification" in processes of learning, change and communication. Dilts [31,32] called logical levels "an internal hierarchy in which each level is progressively more psychologically encompassing and impactful" [33].

This means that an impact at a higher "logical level" is perceived as being more important. The scientific problem with the originally proposed logical levels is the fact that the upper levels, as defined by Dilts, are considered "spiritual" [34]. However, it is less of an objection when "spiritual" is replaced by "inspirational". The inspiration of socio-technical systems lies in their purpose and the vision, mission and ambition that determine the objectives that matter and how they can be valued.

In their article "Organizational change: A critical challenge for team effectiveness", Goodman and Loh [35] described the logical levels related to change. It provides a good basis on how an objective increases in importance when this concerns higher logical levels. The logical levels, in increasing level of importance, can be described as follows [36]:

- Environment is the lowest logical level and refers to what is outside the system: the place and time (where and when) the system pursues its objectives.
- Behaviour refers to specific actions: what each system does. This is the outward display of having successfully applied the key expected behaviours for achieving or safeguarding a particular objective.
- Capabilities are also referred to as "competencies". These are the skills, qualities
- and strategies, that characterise the system. They are how actions of the system are executed. They often need to be defined, taught and practised in order to support the achievement and safeguarding of objectives. This also includes technology and other tools that are used to conduct specific behaviour and to reach specific results.
- Values and Beliefs (rules): "Values" are what an individual or team/system holds to
- be important, so they act as the drivers for what the system does. "Beliefs" are what an individual or team holds to be true and therefore influence what the system does and how it acts.
- Identity is how a system sees itself; it consists of the core beliefs and values that define
- it, and which provide a sense of "what the system is".
- Purpose refers to the larger system of which the system is part. It connects to a wider purpose: "for whom?" or "what else?"
- Using Dilts' model of logical levels to distinguish different levels of importance in objectives therefore provides a powerful tool to determine and assess the impact of an objective on a socio-technical system. As such,

the model offers a systemic view on individuals and organisations related to the alignment of objectives. Dilts [23] states the following:

"Any system of activity is a subsystem embedded inside of another system, which is itself a subsystem embedded inside of another system, and so on. This kind of relationship between systems and subsystems naturally produces different levels or hierarchies of processes. The levels of process within a social system or organization correspond closely to the levels of perception and change that we have identified for individuals and groups—i.e., environment, behaviour, capability, beliefs and values, identity and 'spiritual'. Each level of process involves progressively more of the system. Change in identity, for instance, involves a much more pervasive change (and, consequently, more risk) than a change at a lower level. It is a much simpler issue to change something in the environment or in a specific behaviour than to change values or beliefs."

Figure 5 illustrates what Dilts declares. At each logical level, objectives can be noticed. The higher the logical level, the more important these objectives are because, the higher the logical level, the more subordinate objectives are involved at lower levels to achieve or maintain this higher level objective. This means that objectives situated at a higher logical level are more valuable.

Additionally, when systems and their objectives are not part or only partially part of the system's higher logical levels, non-alignment occurs (Figure 5). Most problematic is when this non-alignment turns into a conflict. The higher the level on which this conflict occurs, the more conflicting objectives become involved, creating more negative risks, unsafety and a lack of performance for the concerned system(s).

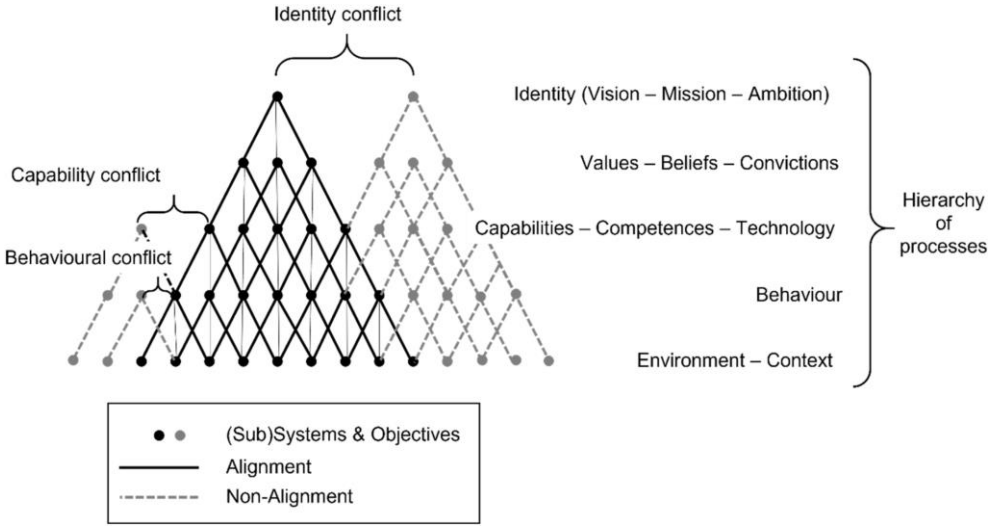

Figure 5. Logical levels—Inspired by Dilts [23].

4.3. A Dynamic Cultural Alignment Model—Flywheel of Alignment

One can also consider the hierarchy of logical levels from a "mental model" perspective and relate it to individuals and organisations. It shows how mental models can determine situations and action. How one looks at reality determines what is important not only to individuals but also to organisations. Purpose comes from a vision that translates into a mission and ambition. To become aware and to build a clear, unified and shared vision of reality therefore become of paramount importance in aligning the logical levels. This is both valid for an individual perspective as well as an organisational view on reality.

Although Dilts considers "Identity" as a separate level, one could also consider "Identity" as being the whole of all logical levels together (Figure 6). People identify themselves by their environment, where they come from (region, nationality, culture, etc.), what they do or the competences they have (e.g., being a painter, a researcher, a taxi driver, etc.). One also identifies people by the values and beliefs they adhere to (religion, politics, nutritional choices, etc.). Additionally, all of these "characteristics", at different logical levels, shape the filters with which the world is viewed. For individuals, the higher levels of awareness are difficult to become aware of. What exactly one's purpose is, how this relates to reality and how one views this reality is something one, in general, does not contemplate about. It is why people end up in situations they are not happy about, as the perceived reality of their environment does not fully correspond with these higher levels of awareness, creating a lack of alignment and generating conflicting objectives. By itself, people have different "role identities" related to what one does but one rarely discovers one's true identity, aligned with the inspiring purpose that energises and fulfils one's aspirations.

The same is true for organisations. Here, one can say that, instead of "true identity", one can consider the whole of all logical levels as being the "true culture" of the organisation. The more these levels are aligned, the easier this culture is recognised and the stronger it becomes.

Today, most successful organisations are aware of the importance of common values that are characteristic of the organisation and that need to be respected by its stakeholders. However, although shared values are very important, it is only an alignment at a lower logical level that is pursued. Shared values do not necessarily represent shared ambitions or a shared mission. In general, shared values lack the power of inspiration and should rather be a result than an aim in and of itself. Much more powerful are the shared vision, mission and ambition because, when mental models at this level of awareness are shared and recognised, they become a persistent force and guidance for all members of the organisation. This force and this guidance boost safety and performance when they are values that are

aligned with and have been recognised in the vision of the organisation [37].

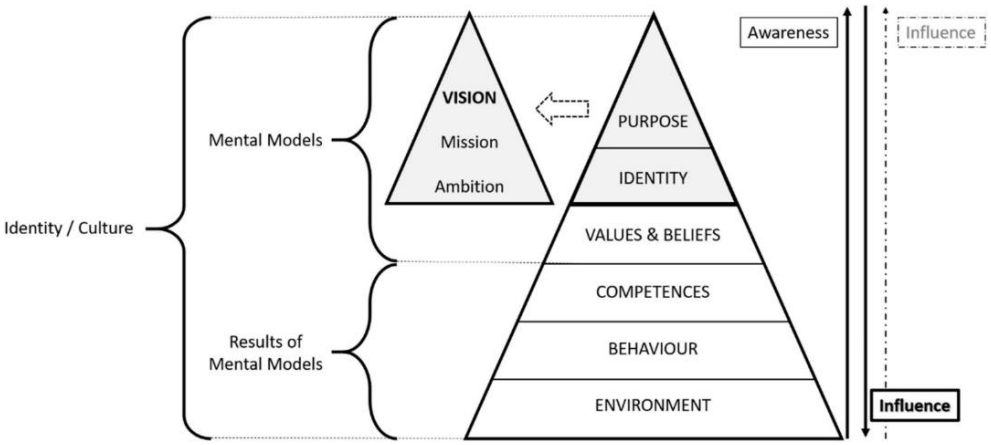

Figure 6. Based on the logical levels of awareness Inspired by Dilts [23].

Dilts also emphasises the following:

"*One of the most important aspects of effective and ecological communication and change is the congruence between the 'message' and the 'messenger.' On a personal level,a healthy and effective person is one whose own actions are aligned with his or her capabilities, beliefs, values and sense of identity or mission. A person's sense of role andidentity is a dynamic process related to several different factors*:

- One's sense of mission or purpose (which evolves with one's cycle of development in life);
- One's view or vision of the larger system in which one is a part (a "spiritual" perspective); and
- One's role in relation to the organisational and family systems in which one is a member.

The concept of different 'levels' of change provides us with a powerful road map for bringing the various dimensions of ourselves into alignment in order to realize our goalsand visions. Each of these different levels is embodied through successively deeper and broader organizations of 'neural circuitry.' As one moves from the simple perception of the environment, for instance, to the activation of behaviour within that environment, more commitment of one's mind and body must be mobilized" [38].

As indicated earlier, the key to successful change and organisational alignment is aninspiring vision. A vision of the past, present and future reveals a path to a better future that people want to belong to. This is for individuals and organisations alike because individuals are at the core of any organisation, as it

is their mental models that shape and govern the organisation. Building a shared vision in organisations is creating a shared understanding of the deeper purpose of the organisation and its destiny because not all visions are equal. Only visions that tap into this deeper sense of purpose and that translate into the objectives of a mission and ambition fitting the organisation make this vision and purpose genuine and true. It then has the power to generate aspiration and dedication to belonging to the world envisioned. However, this vision also needs to come from the people who care for the organisation and who have a collective sense of its underlying purpose. Building a shared vision therefore is a process that requires respect, openness and dialogue at every level of the organisation. It is the construction of a common understanding of a shared map of reality and the deliberate choice of an itinerary to an inspiring and engaging destination [7,8].

The importance of developing this common purpose, where corporate goals also become personal objectives is supported by Berg. In his article "The role of personal purpose and personal goals in symbiotic visions" [39], he stated the following:

Engagement was defined by Bakker, et al., as a positive and pleased state of mind, categorized by vigour, commitment, and captivation, commonly understood to generate higher levels of energy and a strong connection to work. Boyatzis, Smith, and Beveridge also connected engagement with increased energy, focus and drive through their research on "Positive Emotional Attractors. (PEA)" They validated this theory by linking PEA to physical stimulation—identifying the physiological activation that occurs during the actual experience of an elevated state of engagement, hopefulness, and future orientation. When reaching for a personal vision one is engaged, emotionally and physically, in moving toward an overarching goal. The goal becomes meaningful and purposeful enough to impact their energy, their focus and their drive. This is also supported by the evidence that the desire to achieve one's "ought self," or the self that we feel we ought to be, is less than the desire to reach for our ideal self. When we are working to accomplish a goal or vision that is not our own, we are less driven.

Vision and how one views reality are closely related to the attitude one adopts when looking at the past, present or future. The ladder of inference (Figure 7) [7,40,41] is a common mental pathway of increasing abstraction, often leading to misguided beliefs. The only visible parts are the directly observable elements, which are the data at the bottom of the ladder and the actions resulting from decisions at the top of the ladder. These actions are the result of self-generating beliefs that remain largely untested. One adopts those beliefs because they are based on conclusions that are inferred from what one observes, added to past experiences [42]. The ladder of inference provides insight in the way people perceive reality as it is and which attitude they have developed due to this

perception. For example, when situations are perceived to be satisfactory and good enough, this focus provides evidence for this inference and anything that contradicts this conclusion is dismissed. Hence, it is difficult to create a vision of better and more, as the need for improvement is not perceived and the attitude is one of acceptance of a status quo. However, a different reality can be perceived when it is possible to establish the mental model that, within a certain context, everything can and should be improved whenever possible. In other words, there is always room for improvement, and it is also a moral obligation to pursue excellence. Elements requiring improvement are noticed and a changed attitude, with a focus on improvement, is developed. This altered attitude in its turn allows for the development of a new perception of reality. This perception creates a vision concerning the need for a better future, requiring improvement and change [37].

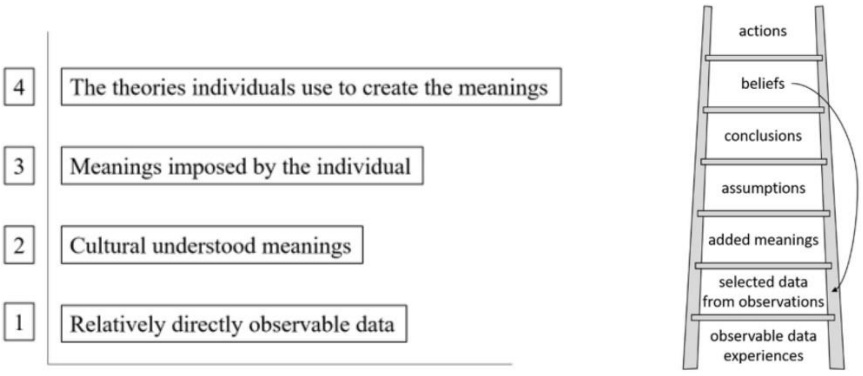

Figure 7. Ladder of inference according to (**a**) Argyris [40,41] and (**b**) Senge [8,42].

A first and crucial phase in alignment in organisations is discovering and altering individual attitudes and aligning them as much as possible with the attitude that the organisation needs. Kotter [22] stated that alignment is more of a communication challenge than a design problem. Alignment always involves talking to many individuals. This involves not only subordinates but also supervisors; peers; staff in other parts of the organisation; as well as other stakeholders, such as suppliers, government officials or customers. Anyone involved in implementing a vision and its associated strategies or who can help or impede implementation can be relevant. This is a huge communication challenge because alignment messages are not automatically accepted just because they are understood. It all depends on credibility. One has to believe the story. Credibility, amongst others, depends on the background of the person delivering the message, the content of the message itself, the communicator's reputation regarding integrity and trustworthiness, and the consistency

between words and deeds. Leaders need to "talk the walk" and most certainly "walk the talk" when they seek alignment. They are the first example. Managing organisations with design of systems and structures helps normal people complete routine jobs successfully, every day. Leadership however has a different calling. It is about achieving grand visions, which continuously involves a lot of energy. Therefore, it is the leader's duty to motivate and inspire people to energise them. This does not happen by pushing them in the right direction, as control mechanisms do, but by paying attention to fundamental human needs such as a sense of belonging, recognition and self-esteem because fulfilling these needs provide a sense of achievement, a sense of control over one's life and the power to live up to one's ideals [22]. These emotions touch people profoundly and therefore provoke powerful reactions that trigger the right attitude to expand one's reality and to understand and welcome the new reality presented by the vision of the leader.

This first crucial step in organisational alignment is represented in Figure 8a, where leaders have to confront the mental models and ladders of inference of their "followers". They have to show people a different and more inspiring reality, provoking the right attitude to embrace the vision the leader develops. It is the fundamental "why" that Sinek talks about in his book Start with why: How great leaders inspire everyone to take action [43]. Once this most difficult step is achieved, the organisational alignment can follow the hierarchy of logical levels, determining the objectives at each logical level aligned with the objectives of a higher level. Again, this is a communication challenge, where leaders need to communicate in the form of dialogue to choose the appropriate objectives people believe in. At a strategic level, this involves the mission, ambition, and values and convictions that are important to achieve what is envisioned (Figure 8b). In that regard, Canals [44] declared:

> "*Leadership development programs should either have a clear purpose in terms of their design and goals or may end up in an expensive and sometimes useless initiative that consumes people's time and resources, and may generate a cynical view of the diverging pathways between the firms' mission and the real life in the organization. Moreover, leadership programs should also help participants understand better the implications ofthe firm's mission on the different corporate policies and decisions regarding customers,people, shareholders and other stakeholders, and the corporate culture and values that should be present in making those decisions*."

What can be named a "mission" is the action required to close the gap between the current reality and the envisioned future, while the ambition translates the identity of the organisation into objectives. Surely, the ambitions of a multi-national organisation completely differs from a local SME with only a local

reach; in the same way, this is completely different from a public service or a government agency. At the operational level, these strategic objectives translate into the objectives regarding competences (including technology), behaviour and context needed to achieve the overarching objective and aligned with the higher strategic logical levels (Figure 8c). The mental models developed at the strategic level dictates what is necessary and in line with the adopted vision, mission and ambition, congruent with the values and convictions that support the vision. At each level, each step is a feedback loop in itself. The most prominent influence moves clockwise. However, a counter clockwise influence can also be present. Together, they are needed to adapt and improve where necessary and to make the alignment more powerful.

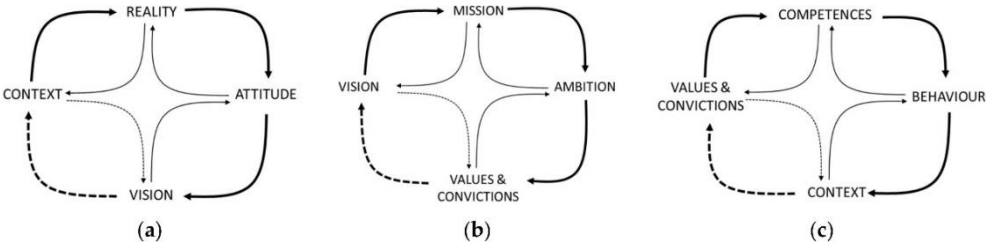

Figure 8. (**a**) Ladder of inference (Direction and orientation.), (**b**) Strategic alignment (Overarching objectives) and (**c**) Operational alignment (Specific and detailed objectives).

The loops described above form a whole. They connect the ladder of inference with the strategic component, which results in the operational component, in the form of parts of the process, creating an aligned identity and a corporate culture [37]. In essence, the three loops form an individual leadership process when each step is used to align oneself with the vision one adopts, resulting in aligned leadership, congruent with one's vision. At the same time, these steps can also be used as the levels of change to lead people in volatile, uncertain and complex situations, as all three elements together form a dynamic organisational culture alignment model, with which an organisation can align itself and its stakeholders with its vision (Figure 9). The better this alignment is executed, the stronger the corporate culture becomes, aligned with the vision, mission, ambition and values that matter. When high performance and safety are important values, this should automatically involve a specific attention to risks related to the objectives present at all logical levels of the organisation (Cfr. Section 2.3).

4.4. A Dynamic Model to Align Organisational Strategy and Culture

The flywheel of alignment is an instrument of vertical alignment in organisations, aligning individuals, and the organisation as a whole to create a

strong corporate culture. However, organisations also develop strategies to reach their aims. Both strategy and culture need to work in concert to perform well. Still, the statement "Culture eats strategy for breakfast" (attributed to Peter Drucker post-mortem 2006) indicates that a strategy chosen by higher management can easily be dismissed due to an organisational culture that is not aligned with the strategy taken. This claim also indicates that it might be meaningful to spend efforts picking or developing the right strategy to reach one's objectives and to align it as close as possible with the existing corporate culture. However, it is also possible to enhance the organisational culture to fit a desired strategy first, for instance when this is needed as a result of a merger or another crucial change in the organisation [37].

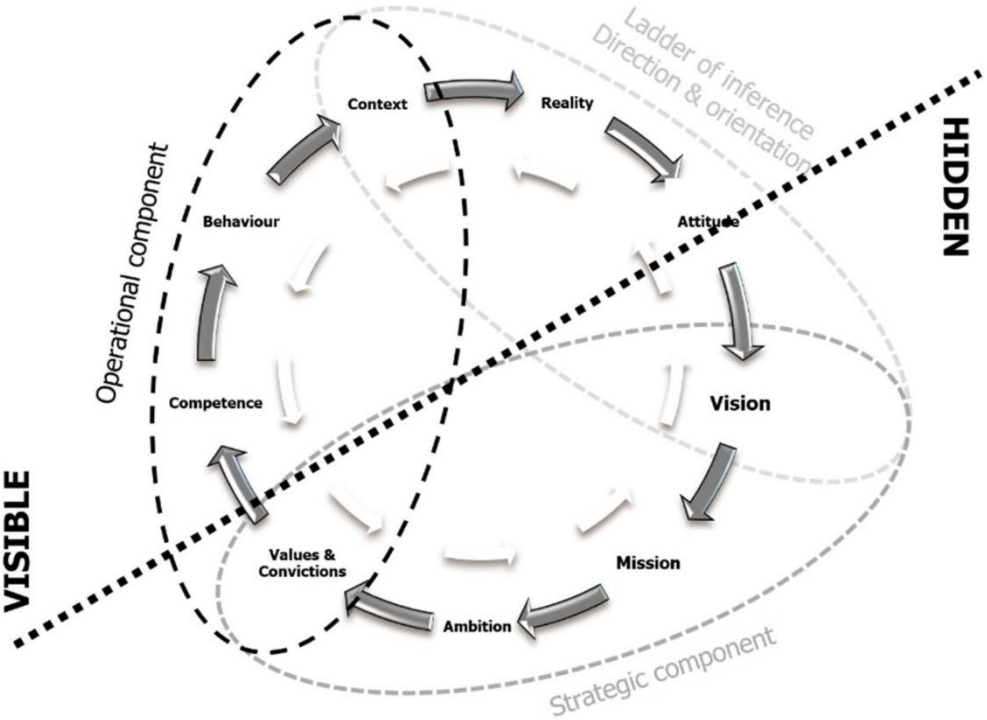

Figure 9. Dynamic cultural alignment model—flywheel of alignment [37].

In their book *Strategy synthesis*, De Wit and Meyer [45] stated that there is no such thing as a common understanding of what strategy is. They even said that a sharp definition of strategy would be misleading, as there are so many different and strongly differing opinions on most of the key issues. The presence of these conflicting views indicates that strategy cannot be summarised into a widely accepted definition. However, complexity theorists define strategy as the unfolding

of the internal and external aspects of the organisationthat result in actions in a socioeconomic context. As such, one could say that strategy consists of selected organisational arrangements an organisation needs and uses to achieve its aim. Most organisational alignment studies deal with aligning these organisational arrangements with the chosen strategy. For instance, how can IT solutions (tools) support the organisations processes or what kind of processes are necessary to achieve the strategicaims. However, these punctual alignment issues focused on strategy often miss the systemicapproach that is necessary to align these solutions to the people and the corporate culture they represent. Ideally, these organisational arrangements also fit the culture that identifies the organisation.

A model that considers this aspect of alignment is the organisational alignment model proposed by Tosti. He stated: "*The concept of alignment applies to both the external alignment of the organizations with its community, marketplace, and business environment, and the internal alignment of the organizations across the levels of administration, operations andjob. Internally the organization should be aligned around the results the organization is striving to achieve*" [46]. According to Tosti and Jackson, organisational alignment is connecting strategy, culture, processes, people, leadership and systems to best respond to the demands of the organisation. Organisational alignment requires compatibility between the strategic and cultural pathways and necessitates consistency within them (Figure 10) [47].

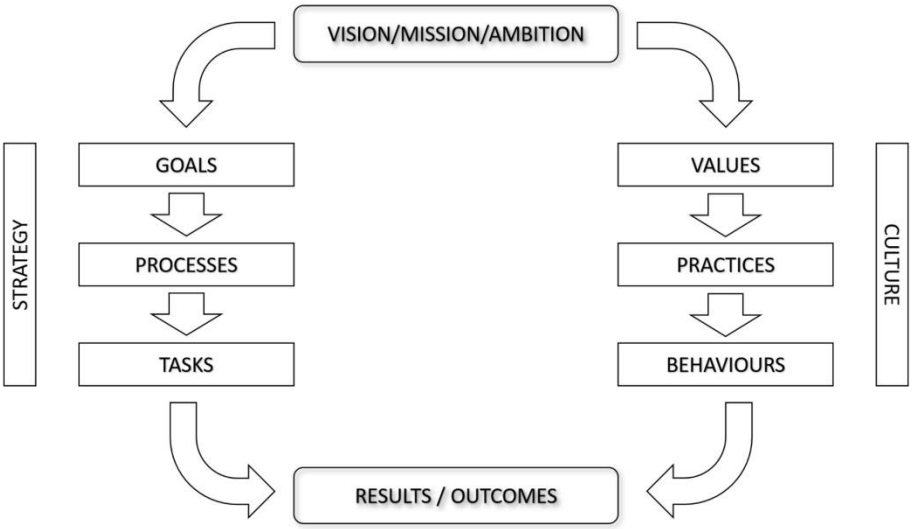

Figure 10. Organisational alignment model [46].

Amarant and Tosti [48] stated that thinking systemically, viewing performance as the result of a system is essential to performance improvement because

performance is a function of all of the systems' variables. Reducing attention to actors overlooks most important sources of performance variance that occur at other levels of the organisation. They identified three levels of organisational complexity:

- Organisational Level (Goals/Values). An organisation is a dynamic entity that must be managed and governed by people. This requires executives, functional managers and administrative systems to lead the organisation as a whole.
- Operations Level (Processes/Practices). The processes that guide people's work are intended to convert inputs into goods or services that provide customers with value. Within each process are sequences of tasks that are supported by management.
- People Level (Tasks/Behaviour). The actor is central to the system [48].

Tosti stated that results depend not only on the processes people follow but also on how one behaves when executing those processes (practices). Behavioural practices of groups and individuals can make the difference between merely adequate results and outstanding results. In the worst case, poor practices can destroy good processes. He believed that creating and maintaining a balanced and aligned organisation requires decisions about both organisational direction and intent and regarding what is important about the way it operates. This responsibility of the organisation's leadership constitutes a critical factor that needs to be considered in attempts to improve performance because they have the broadest impact on mobilising the organisation to succeed. However, there is little attempt by many organisations to ensure that these practices are aligned with the desired results [49]. Strategy is implemented tactically by making sure that the three levels of organisational complexity are vertically aligned to achieve results. This is performed to the design and execution of operational processes. This requires using the strategy and mission as a means of aligning goals and objectives, then aligning processes with those goals, and finally aligning the tasks that people perform with the processes [46].

When one combines their knowledge of the organisational alignment model and the insights of the flywheel of alignment, one can construct a dynamic organisational alignment model, as depicted in Figure 11.

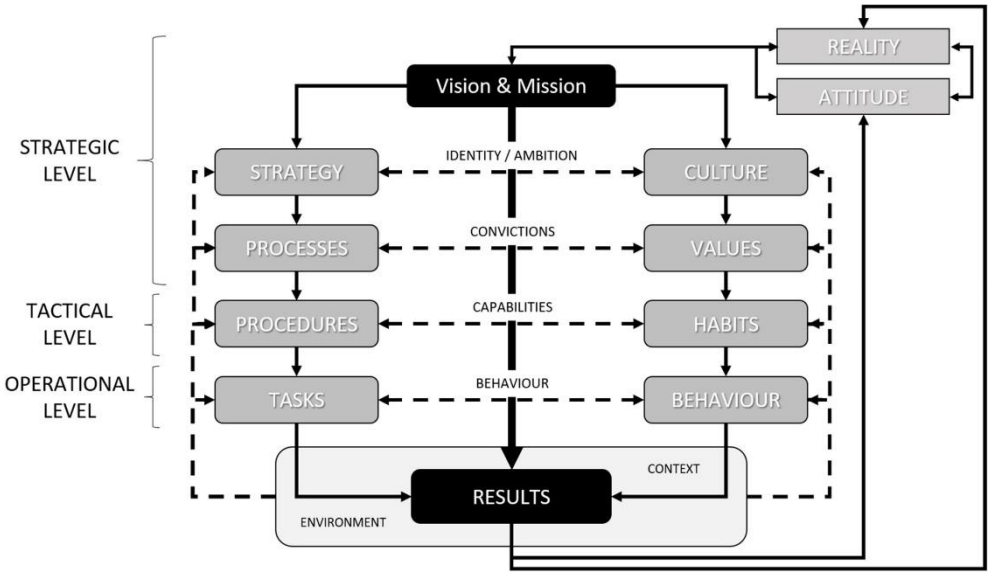

Figure 11. Dynamic organisational alignment model [50].

In the central top to bottom arrow of the model, one can find the logical levels of the individual stakeholders {XE "stakeholders"} making up the organisation. Ideally, these individual logical levels are based on a shared vision {XE "vision"} and mission {XE "mission"} , leading to individual but aligned ambitions, connecting the individual identities to a corporate identity {XE "identity"} and culture {XE "culture"} . On the right side of the model, the organisational culture is represented by all of its components, while on the left side of the diagram, the column represents the elements that make up a strategy. How stakeholders perceive their results and the organisational context and how a culture and a strategy feed into reality {XE "reality"} is represented by the closed loop of attitude and reality, explained earlier as the function of one's ladder of inference and of the flywheel of alignment. This element of attitude and perception of one's reality closes the loop connecting the actual results that are achieved in a specific organisational context, with the overall (shared) vision and mission of the organisation and its stakeholders. When vision, mission and ambition are clear and powerful, the mental model {XE "model"} is created, and alignment can start [50].

5. ISO 31000 as a Practical Tool to Reach Alignment, Safety and Performance in Organisations

5.1. Observations Regarding ISO 31000

From the beginning of this century, noteworthily, focus on risk management increased. There is a great conviction that risk management provides a fitting tool for assessing the conflicts inherent in exploring opportunities (to create value), on the one hand, and avoiding losses, accidents and disasters (to protect value), on the other [51].

In their article "Implementing Bayesian networks for ISO 31000: 2018-based maritime oil spill risk management: State-of-the-art, implementation benefits and challenges, and future research directions", Parviainen et al. [52] stated:

> "*The ISO 31000:2018 International Standard on Risk Management (ISO 2018) provides guidelines for integrated risk management for all types of organizations and is therefore in essential role in communication of academia and industry. The use of the ISO 31000:2018 standard has also been suggested as a suitable basis for the evaluation of Pollution Preparedness and Response (PPR) risk management and for dealing with uncertainties when assessing oil spill risks in industry activities. As the main focus has been on industry activities, there is a need to improve the link of the academic scientific work tothe ISO 31000:2018 standard*."

The title of the ISO 31000 standard [2,3] is "Risk management—guidelines". It is a guidance standard on how to manage risk in organisations independent of the size, sector or industry to which the organisation belongs. Unfortunately, this standard is often disputed, and it seems that it is not always properly understood by some risk specialists. Mostly, the critique is in regard to the elements of the proposed vocabulary and seems to be based on the mental models that governed risk management in the twentieth century. This mental model is based on the early developments of risk management in the financial/insurance industry, focused on loss, and the engineering world, focused on component reliability. This mental model is based on uncertainties in the form of probabilities and statistical evidence (cfr. Section 2.2). Regarding their criticism, Olechowski et al. [53] stated the following:

> "*A number of authors have critically examined the ISO 31000 standard as a whole. Aven (2011) critiques the uncertainty- and risk-related vocabulary of the standard froma reliability and safety point of view. The author argues that the guide fails to provide consistent and meaningful definitions of key concepts. In a broader critique of the standard, Leitch (2010) concludes that the standard is vague and lacks a mathematical base. He attributes the vagueness to the process, given that the standard was created from a consensus-*

based process involving people from all over the world, speaking different languages. Although it is important to conceptually examine the fundamental definitions on which the standard is built, neither of these papers involve actual evidence to evaluate the effectiveness of the ISO 31000 standard, and its potential for impact in industry."

The experts in risk assessment accustomed to this twentieth century mental model employ various, often complex, mathematical models to calculate the levels of risk for very precise and well-defined objectives related to the reliability of components of a system, where a deviation from an expected result is always negative. Seen from this twentieth century mental model regarding risk, this critique is therefore understandable and, for engineering and component reliability, the objective and the cause–effect relationships are always apparent. It is a consideration for risk on a component level. This type of risk management is the domain of experts who often work in specialised departments in organisations, often in a silo context, where risk management is separate from other departments or operations of the organisation.

However, while entirely suited to assessing the risks related to the reliability of components of a system, this mental model regarding risk is inappropriate for the VUCA world organisations operate in. This became noticeable in the second half of the twentieth century when a number of events showed the inability of these risk management silos to cope with the changing realities, and the variability and management of objectives in organisational operations. New paradigms regarding risk and risk management with a broader, more systemic focus emerged. It is a different perspective on risk, based on a different mental model, leading to concepts such as Operational Risk Management (ORM) or Enterprise Risk management (ERM) and, ultimately, ISO 31000 as an overarching set of mental models regarding the management of risk in organisations and even for society as a whole. These concepts, which are more focused on objectives involved with systems instead of the restricted view on the components of a system, also focus on the creation of value instead of solely trying to protect value, with an understanding that results can surpass expectations [17].

In the same article, Olechowski et al. [53] also stated:

"*Empirical evidence from the statistical analysis suggests that the ISO 31000 is indeed a promising guideline for the establishment of risk management in the engineering management community. Adhering to the risk management principles at a high level was found to be a significant factor in better reaching cost, schedule, technical and customertargets, in addition to achieving a more stable project execution. We believe that this provides evidence of the potential for the principles to form the basis of a project risk management body of knowledge and to have a strong impact on the professionalization ofthe risk management function*."

The twentieth century perspective comes from a risk analysis point of view. However, "risk analysis" is just a component of the system "risk assessment", which in turn is only a component of the overarching system "risk management". Looking at ISO 31000 from an analysis perspective therefore does not make sense because risk management is so much more than the analysis or assessment of risk. In fact, ISO 31000 involves even more than just management. It covers all domains of the Cynefin framework and involves leadership as much as management.

Lalonde and Boiral [54] stated:

> "*The new ISO 31000 risk management standard makes several important contributionsto a field that still has relatively few benchmarks. On the one hand, the generic nature ofthe standard may help to better identify and manage a variety of risks including threats to the environment, public health and food safety issues, threats to critical infrastructure,hazards presented by certain products, and interruption of the supply chain. This diversity of risks tends to broaden the scope of the standard's applicability to a wide range of situations and organizations. On the other hand, the standard suggests a methodical and structured approach to how to manage risks. As Purdy points out, whilethis approach may seem relatively conventional, the standard does succeed in integrating into a single concise and practical model a considerable amount of knowledge accumulated from research on multiple aspects of the field which is widely scattered in the literature and thus difficult to take into account*."

Additionally, other authors welcome this broader view on risk management. In their article "Risk management in public sector: A literature review", Ahmeti and Vladi [55] concluded:

> "*The key finding of this research was that risk management is neither an optional nor avolunteer tool in the whole management of an organization; it is a must for every type of organization if they want to assure the achievement of their strategic goals and objectives. Risk is a threat or an opportunity, which cannot be eliminated completely and requires an effective management. Accordingly, our risk attitudes and risk perceptions may be influenced by a number of factors—even if we are not aware of such an influence*."

Furthermore, in an article "Analysis of international risk management standards (advantages and disadvantages)" [56], the authors declared:

> "*In conclusion, ISO 31000, besides being a very effective tool for enterprise risk management, is also applicable as a base for more specialized standards. Consequently, it is important that these standards have the same basis or comparable to the ISO 31000 standard, especially in terms of the vocabulary and terminology used. The creation of ISO 31000 is motivated in particular by the fact that the risk management industry has always applied a variety of standards for risk management and also the terminology used*

has unmet standardisation, thus making communication of risk information more difficult. Despite the numerous of criticisms of this standard, its contribution to better risk management in the organization remains indisputable".

In contrast with the traditional risk management concepts, ISO 31000 is a truly systemic approach to risk for organisations or even individuals and society, covering the different levels of quality of perception of the Cynefin framework. It is completely different from the analytical tools based on mathematical concepts and models that are more appropriate for the complicated and simple domains, where cause–effect relationships are established and known. ISO 31000 is comprehensive and generic. Hence, it cannot be specific because specificness is opposite to comprehensiveness. The more specific one is, the less comprehensive one is. For comprehensiveness, less is more. In fact, one could see ISO 31000 as a generic and nonspecific management standard because any type of management in essence is risk management focused on a specific type of risk, covering a specific overarching objective (quality, health, environment, food safety, business continuity, etc.) which is in line with what was concluded by Ahmeti and Vladi, and Lalonde and Boiral. It is also why ISO developed new, more specific standards for specific risks, such as travel risks, legal risks or emerging risks (ISO 31022, 31030 and 31050, at the moment of this writing, all still under development).

To encompass everything therefore also involves being vague, leaving room to fill in what is necessary for the specific case it is used for. Surely, it is one of the reasons why it is not based on mathematics, as mathematics belong to the specific tools that can be used within a specific context. This perfectly fits with the ISO 31000 philosophy and principle of customisation and can perfectly be performed while adhering to the ISO 31000 guidance. ISO 31000 does not need to be "mathematical", as any mathematical tool can be used in an ISO 31000 context. This standard has a different vocation. The purpose of ISO 31000 is organising (risk) management in organisations and society in order to facilitate the use of any specific tool needed to create or protect value, whether these (mathematical or other) tools already exist or still need to be discovered because ISO 31000 plays a role at a completely different level from the tools and standards that are the bread and butter of seasoned risk professionals. Most standards are focused on how to conduct tasks related to the assessment and management of risk, while ISO 31000 deals with why it is necessary and what needs to be taken into account. As such, it is a meta standard, covering the important aspects of leadership, management and decision making based on vision and objectives, as it can be used for any objective. Whether individual, organisational or societal, all objectives can be managed by the same process. It just needs to be tailored to the circumstances for which it is needed. ISO 31000 therefore is not destined to be used by risk professionals but by any manager and by anyone

making decisions when things are not entirely clear or uncertain. This is fundamentally different from the more specific risk management standards and tools based on "mathematics" that solely concern the analysis of risks that have already been identified because this guidance standard is more appropriate for laypeople in the field of risk and risk management. It is why it needs a simple, concise and limited vocabulary regarding the concepts related to risk and risk management that are easy to be understood by people who are not highly educated risk professionals and vague enough to be comprehensive. Specific jargon is not helpful when trying to disseminate a concept throughout an organisation that everyone can relate to, as mentioned by Ahmeti and Vladi. Consequently, a limited set of definitions easily understood by everyone seems to be useful in standardising risk management in organisations and society as a whole.

5.2. ISO 31000 as a Leadership Tool for Alignment and the Management of Value in Organisations and Society

5.2.1. Purpose and Principles

The purpose of risk management is to create and protect value. To achieve this aim, ISO 31000 proposes a set of principles, a framework and a process, together with a limited number of definitions to create a standardised vocabulary regarding risk and its management. The original standard dates from 2009 and a revised version was issued in 2018. This newer version is much more concise, but unfortunately, this new version has also lost some important information. Maybe the full potential of the 2009 version was not recognised by everyone, as one of the critiques stated that this initial version was too ambitious to comply with. However, ISO 31000 is not something to comply with. It is something to align with, and that is a different story. It is one of the fundamental misunderstandings regarding this standard. One does not need to comply with ISO 31000; one needs to customise it for maximum performance, aligned with the ambitions of the organisation and tailored to its particularity, its resources and its capabilities.

The systemic nature of ISO 31000 resides in the fact that it clearly states what its purpose is (creation and protection of value) and the recommendation of a set of mental models (principles) that can generate a system that is beneficial for the management of risk and valuable to the organisation [53]. These principles (Table 2) are fundamental and need to be seen together, as it is the combination of all of the principles (mental models) together that is needed for best performance. The principles [2,3] are as follows:

Table 2. ISO 31000 principles.

2009 version	2018 version
• **Risk management creates and protects value***	**Purpose: Value creation and protection***
• Risk management is an integral part of all organisational processes	• **Integrated**
• Risk management is part of decision making**	• **Structured and comprehensive**
• Risk management explicitly addresses uncertainty**	• **Customised**
• Risk management is systematic, structured and **timely**	• **Inclusive**
• Risk management is based on the best available information	• **Dynamic**
• Risk management is tailored	• **Best available information**
• Risk management takes human and cultural factors into account	• **Human and cultural factors**
• Risk management is **transparent** and inclusive	• **Continual improvement** (risk management is continually improved through learning and experience)
• Risk management is dynamic, iterative and responsive to change	
• Risk management facilitates continual **improvement of the organisation**	

Although improvements are to be noted in the 2018 version of the standard, it is hardly the case for the way the principles have been revised. One wonders why. Was it due to the criticism encountered, a conservative reaction of practitioners, or a lack of understanding of the importance of these principles as new mental models necessary to align an organisation towards effective risk management and improved performance? A most disappointing change is the last principle, where the acknowledgement that risk management is beneficial to the whole organisation has disappeared because, as indicated by the study of Olechowski et al. [53], an effective implementation of these principles makes a positive difference for the organisation.

Altogether, the principles (old or new) form a set of basic mental models that need dissemination at all levels of the organisation. Leadership of the organisation should set an example of how to adopt these principles as individual, personal values and beliefs. It is also necessary to explain why these principles are important by indicating which organisational purpose and ambitions these values serve. They have to translate these values into personal, individual objectives and explain how

these objectives are supported by aligned goals on the lower logical levels of competences, behaviour and context, as indicated in Section 4.2 and Figures 5, 6 and 11. As such, leadership determines what is important when belonging to the organisation and how the organisation operates according to these principles. Then, it also shows how one can recognise these principles in its daily operations.

For instance:

- Why and how does managing risk create and protect value?
- What does it mean to integrate risk management in all organisational processes, and how does one recognise this?
- How does risk management deal with uncertainty, and how is this part of making decisions? How is risk management structured, and how does it support timely action when making decisions? How can it be comprehensive?
- What does it mean "best available information"? Additionally, how can the best available information be gathered timely in a structured way?
- How will the organisation customise risk management in a way that it supports its daily operations? How can one recognise risk management in its customised way? How does this principle impact the other principles, such as "being inclusive and transparent?
- How does the organisation and its leadership take the human and cultural factors into account?
- Why, how and when does the organisation make sure that an appropriate level of inclusiveness and transparency can be assured and for whom?
- Why and how is risk management dynamic, iterative and responsive to change?
- How can risk management improved and how does this positively impact the organisation?

These are just a few examples of questions for which the answers should form the starting point for developing specific objectives on the levels of competences, behaviour and context. Behaviour congruent with the leadership and translation of these answers into actual competences (including the use of technology) and specific behaviour creates a context that contains and shows all these principles, and this is what really counts when implementing ISO 31000.

In essence, when alignment around these principles takes place, they have the potential to generate a culture of openness and appropriate, effective and communication, which in turn leads to a better trust level among team members [57,58]. Church [59] noted that "*good communication is usually described as a combination of being open, honest, participative ordirect with others*." (Elements that are easier to be found in the 2009 set of principles than the amended 2018 ones). Furthermore, following these principles with congruent behaviour instils trust. Additionally, research demonstrates that trust has a positive impact on many

aspects, including job satisfaction and organisational success [60]. Anyway, these principles and their translation into concrete objectives are the foundation on which ISO 31000, its implementation and its use in organisations by means of the process should be built.

5.2.2. Framework

In 2009, the ISO defined the risk management framework as a set of components that provide the foundations and organisational arrangements for designing, implementing and monitoring, reviewing and continually improving risk management throughout the organisation [2]. In 2018, the ISO stated that framework development encompasses integrating, designing, implementing, evaluating and improving risk management across the organisation, adding the step of integration in the framework process [3]. The purpose of the risk management framework (Figure 12) is to assist the organisation in integrating risk management into significant activities and functions throughout the organisation because the effectiveness of risk management depends on its integration into the governance of the organisation, including decision making [3]. At the same time, this framework is an improvement process, improving risk management in one's organisation, and consequently, this improves its decision making and develops the organisation as a whole. It should also be the translation of the guiding principles into the specific elements of that improvement process, always starting with the commitment of top leadership, giving a mandate and showing commitment for the organisation to adopt the ISO 31000 guidance.

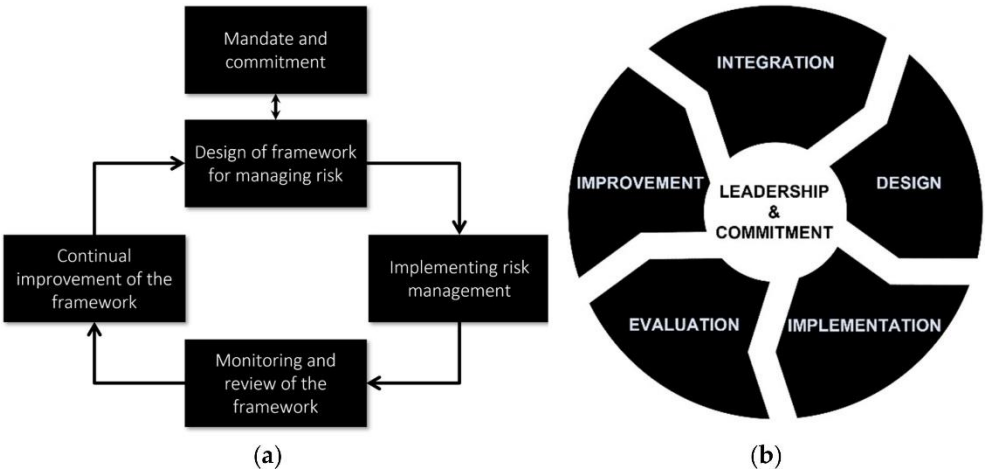

Figure 12. (**a**) ISO31000 framework (2009) and (**b**) ISO31000 framework (2018).

The initial set-up of the 2009 version clearly shows the "Plan", "Do", "Check" and

"Act" of the well-known PDCA improvement cycle (Figure 12a). The improvement to this framework in 2018 is highlighted by the emphasis on the necessity of the leadership commitment to the cause of implementing risk management throughout the organisation (Figure 12b). It is the central driving force necessary for success in this endeavour. Without it, very little is achieved. Another improvement is the step "integration" in the improvement process, as integration at all levels and all functions is an essential success factor for the implementation of ISO 31000 in organisations. As such, it needs a specific and dedicated attention. Unfortunately, often, these two elements are poorly implemented or completely missing in organisations that try to adopt ISO 31000. Amongst others, top management should demonstrate leadership and commitment by issuing a statement or policy that establishes how the organisation acts in the pursuit of its goals, ensuring that the necessary resources are allocated. Top management also needs to assign the authority, responsibility and accountability to manage risk at appropriate levels within the organisation and to be very clear about risk ownership [3].

This statement is in fact an expanded version of what can be developed to integrate the principles into the organisational culture. It is an important element of leadership communication that creates clarity regarding the organisations strategy and how it implements this strategy. Surely, this statement or policy needs to be discussed with the relevant stakeholders of the organisation, including employees, to assure alignment. Aligned with the principles, this generates trust, commitment and alignment. Research clearly shows that leadership communication practices play an integral role in developing and sustaining the employee commitment. Employee commitment is one of the most important measures of leadership success and essential for successful change. Hence, it is also crucial when implementing ISO 31000. Worker commitment reaps benefits far beyond improved organisational performance. Organisations with high trust cultures have distinct managerial communication practices that emerge to encourage organisational commitment because organisational loyalty is best nurtured when communication practices take place in an organisational culture that places high value on and engenders trust in employees [61]. Reina and Reina [62] identified communication trust as one of the four major components of cultures that embody trust in the workplace.

Furthermore, the framework can be seen as a guide to how to align the organisation with its vision, mission, ambition and strategy by determining how communication and decision making, two of the most crucial organisational processes, are developed by implementing the ISO 31000 process as an important instrument.

The "integration" step is a needed reflection on how the organisation is structured and how it operates to see and determine how the risk management process can be fitted into its daily operations. It is a preparatory step before developing a ((risk)

management) plan in the design of the framework.

The "design" part of the framework is crucial because it is the blueprint on which the organisation structures and formalises decision making and communication at all levels of the organisation. It contains the following elements:

- Understanding the organisation and its context;
- Articulating the risk management commitment;
- Assigning organisational roles, authorities, responsibilities and accountabilities;
- Allocating resources (including labour and technology); and
- Establishing communication and consultation

In essence, these steps relate to the vision, mission and ambition of the organisation, linking it to its current reality and how the organisation manages the effects of uncertainty on its objectives. In fact, it is making a plan on how to structure its management processes, decision-making and communication throughout the organisation. Every organisational objective has its related risks, and these risks need to be linked to assigned risk ownership, required resources (including time, labour and technology) and means of communication to manage them (including technology and protocols).

Once it is clear how the organisation pursues its ambitions, how it needs to be structured, who has risk ownership over what, which resources are allocated, how people communicate and use the ISO 31000 process in making decisions and how they use it to learn and improve, then another plan needs to be developed, linking the goals of the design to more specific objectives at the lower logical levels, for instance,

- How does the organisation develop and implement the competences (procedures, technology, knowledge, etc.) needed to execute the ((risk) management) plan?
- What is the expected behaviour of the members of the organisation in dealing with risk (from top to bottom)?
- Which changes in the organisational context need to be made to make things happen? How is the ISO 31000 process tailored and used at different levels, departments and operations of the organisation to facilitate and improve decision making?

These are just a few examples of questions that need a clear answer and a plan to be executed. When this plan is ready, it needs "implementation" by using wisely the allocated resources.

The true benefit of ISO 31000 is its build-in self-improvement because one of its foundations is the iterative nature of this never ending process. The implementation

of the plan and its results need constant monitoring and review because this allows us to "evaluate" and learn what is still missing, what works and what fails. As such, this knowledge provides the basis for "improvement" of all elements of the framework, including leadership commitment.

5.2.3. Process

The ISO 31000 process (Figure 13) is the actual working element of this standard. Although the principles and the framework are crucial, they only serve to make the use of the process possible and successful. The process is what has to be used by everyone whenever operations and decisions are not in the simple domain of daily routine. Even then, this process can be used to improve those daily routines, as everything that is necessary to maintain or achieve the objectives of the organisation can be monitored and reviewed by this process. In fact, it is a generic management process that can be used to manage anything when properly understood.

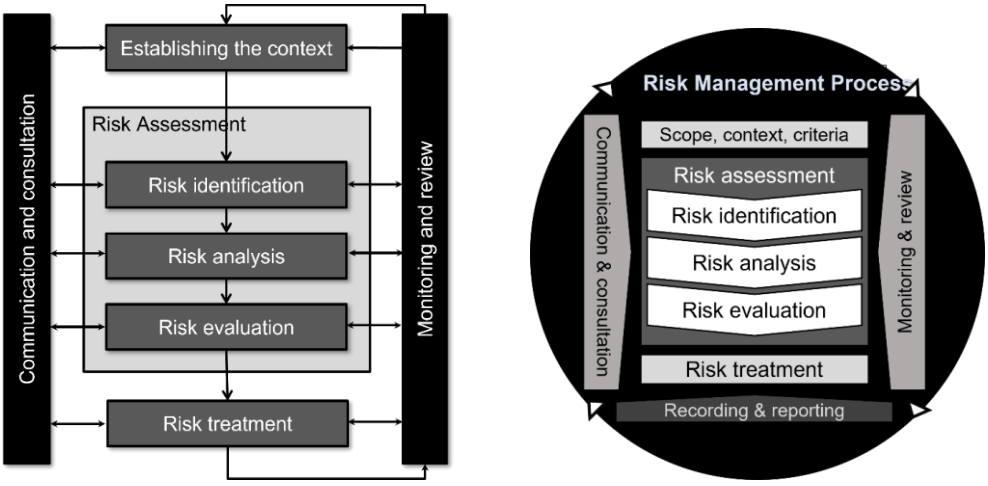

Figure 13. (**a**) ISO31000 process (2009) and (**b**) ISO31000 process (2018).

The term "risk management process", used for this universal management process, is misleading because, due to the traditional connotation linking risk only with hazards, danger and loss, one often uses it only to manage hazards and dangers. In that regard, this process is therefore often seen as another risk assessment tool and reduced to its bare minimum. Adopting a different mental model regarding risk, aligned with the ISO standard, offers a completely different use of this process and makes it possible to operate it as an instrument of organisational alignment and the management of objectives, ranging from aims related to daily routine operations to

the objectives of a change or to manage the uncertainties involved in new and innovative projects.

The main difference between the 2009 (Figure 13a) and 2018 (Figure 13b) versions of this process consists of the added aspect of recording and reporting. Otherwise, the changes are to be found in the graphic representation of the process and a different way to indicate its iterative nature. Despite the fact that recording and reporting can be very important in larger organisations, it is not always the case in smaller ones, but inherently both representations fit the process well. However, the 2009 form of the process clearly shows with arrows how the iterations can be understood. The arrows connect the essential steps of "communication & consultation" on one side, and "monitoring & review" on the other side, indicating that, at each step, it is always possible to take one or more steps back when one notices something that is not clear or missing, as at each step, feedback loops are present. This seem less obvious in the 2018 representation, possibly leading to the idea that the iteration is not only within the process but only of the process itself. As such, the 2009 representation offers a better understanding of its possibilities as an alignment tool in organisations.

Another essential piece of information that has been lost in the 2018 standard is about the understanding of the crucial part of communication and consultation in following this process. In the 2009 version, communication and consultation was defined as follows:

> "*Continual and iterative processes that an organization conducts to provide, share or obtain information and* ***to engage in dialogue with stakeholders*** *regarding the management of risk*". Where it was also specified that "*Consultation is* ***a two-way process*** *of informed communication between an organization and its stakeholders on an issue* ***prior to making a decision*** *or determining a direction on that issue*". Furthermore, it also stated that *Consultation is a process which impacts on a* ***decision through influence*** *rather than power. It is an input to decision making,* ***not joint decision making***" [2].

In the 2018 version, one can find the following description: "*Communication* ***seeksto promote awareness and understanding*** *of risk, whereas* ***consultation involves obtaining feedback and*** *information to support decision-making*". In essence, both versions of the standard try to convey the same message. However, the notion of "dialogue" seems to be lost in the new version. This could easily lead to a very formal way of communication, trying to obtain information for decision making and disseminating information in an effort to make stakeholders aware of and to let them understand the risks. As such, communication and consultation could become a top-down process, with little involvement of employees and other members of the

organisation. However, Dennis Tourish declared that

> "*Critical upward communication improves decision making in organisations. Without it, senior management teams become out of touch with the mood of their people, and underestimate or miss emerging problems in their marketplace. They are more likelyto produce strategies that are misaligned with the perceptions of their employees. The possibility of successful strategic implementation is therefore dramatically reduced. This suggests that two way communication and critical feedback is vital to organisational success*" [63].

Tourish his findings indicate the importance of conducting communication in the form of dialogue. It also emphasises the importance of trust, as one only provides critical upward communication when sufficient trust is present. This is certainly true in the context of ISO 31000 and related decision making. How one structures and applies communication in an organisation is an important way to implement and show the ISO 31000 principles. For instance, dialogue, based on inclusiveness and transparency, taking human and cultural factors into account, support the principle of using the best available information, leading to better decision making and improved performance.

Looking at the ISO 31000 process, one can distinguish three different levels requiring different participants (stakeholders) to take part in the process. "Communication & consultation" on one side and "Monitoring & review" on the other side are parts in which anyone can participate. When an organisation is open to feedback, anyone can see and report a deficiency, mistake or shortcoming regarding an objective. Likewise, anyone, at every step, can contribute by adding information to the process via the communication and consultation part. These are the steps that are ideal to obtain the best available information to feed the process because every member of the organisation and even other relevant external stakeholders, such as experts, customers, suppliers or others, can become involved.

A second level can be found in the centre of the process, it is a part of the process that can require the use of very specific tools and the involvement of experts to assess risk. It is the part that is commonly well understood by risk practitioners. It is often what is regarded, from a traditional viewpoint, as being the risk management function in organisations. Last, but most important, are the elements of the process that are directly linked to the risk owner, the manager, the team or individual who knows what is needed, required or wanted and who has the authority, the competences and the resources to take decisions in those matters. They are also the ones who can make sure the decisions regarding these matters are executed and implemented. Managers taking the risks are the ones that should start the process and who are also responsible for its execution.

Starting the process, one sets the scope of the issue at hand. This fits within a certain context (internal and external to the organisation), which determines the reality of the process. This first step of the process is also necessary to determine the specific objectives involved and to develop clear criteria for these objectives. Therefore, this first step of the process can be seen as the equivalent of the strategic part of the dynamic cultural alignment model, where the risk owner expresses his or her vision on the context, connecting this vision to the concerned objectives and provides criteria to provide a clear picture of what is important (valuable) and what needs to be achieved or maintained. It is the information needed with which the specialists can start their work. Additionally, this first step needs communication and consultation as well as monitoring and review to build a shared vision, to explain the mission and ambition to develop engaging objectives and to choose commonly understood criteria that align with the values and convictions of the organisation. It is an essential part of the ISO 31000 process, where alignment takes place in a very practical way. This can happen in any team at all levels, departments or sections of the organisation. It is a crucial step that needs to be reached before taking the process to the next stage. At the same time, it is a golden opportunity to create alignment regarding any objective of the concerned organisation. Creating clarity in this first step of the process already eliminates a lot of uncertainties and risks. It is a step where possible conflicts and their associated risks can be discovered and solved before they even exist when dialogue and trust generate mutual understanding and alignment. However, the success of this first step heavily depends on what should already be present in the statement of the leadership commitment and the content of the framework. Without this content, alignment is less certain, as the overarching vision and its related information are lacking.

Once the first step is completed, the situation can be assessed. Risk assessment is often understood as identifying hazards and finding solutions to those hazards. However, for ISO 31000, risk assessment is about finding the best way to maintain and/or achieve the objectives. For this, both positive and negative risk sources, and their possible effects on the objectives involved are important. These risk sources and their possible effects need to be identified and described. Again, the best available information is needed to accomplish this step in order to build a risk profile for the issue and the subject objectives at hand.

When a comprehensive risk profile is available, further analysis can then determine which options can be developed to achieve or maintain the concerned objectives. For simple issues, this analysis can be quick and easy. However, for larger or more complex projects, this can be a huge task using very specific tools handled by experts. Options can involve new objectives at lower logical levels. When the context and criteria (reflecting the organisational values) are clear, it is more likely that these objectives are better aligned with the organisational purpose and values.

When options have been developed, these options can then be evaluated against the criteria established in the first step of the process. The evaluation should eliminate options that do not fit with the criteria, which allows us to avoid non-aligned objectives. However, at this step, it can also become clear that the criteria should be reviewed or that new options still need to be developed when criteria are not met.

Finally, a selection needs to be made amongst the options that fit the criteria. Additionally, in this step of the process, one can further align the organisation, selecting the most appropriate option, translating this option into new objectives that need to be achieved or maintained. In this regard, the objectives concern the controls that need to be implemented to optimise the risk for the objective(s) for which the process is used in the first place.

Obviously, this process can be used for any objective. The only difference is the time and effort used to go through the process. In its shortest form, this process only takes seconds. However, when matters are complex and when many iterations are necessary. it can even take years before a solution is actually implemented. It should be the organisation's ambition to have its members always use this process when making decisions, considering what is important for the organisation as a whole.

5.2.4. Vocabulary

Many scientific articles emphasise the importance of well-taught vocabulary for students. It allows for a better understanding and leads to better performance [64]. Vocabulary knowledge is likewise multidimensional and complex in nature. An effective use of a specific vocabulary requires a combination of different types of knowledge. What is the definition of a word? How does it relate to other words? What are its specific connotations in different contexts? Particularly an abstract, conceptually sophisticated word is thought to develop incrementally over time, with students gaining additional information about a word with each meaningful, contextualised encounter with it [65]. This is certainly true for the concept risk and its related vocabulary. Consequently, when trying to align people, it is helpful to also standardise the vocabulary regarding the specific concepts used in the organisation. That is why ISO 31000 also proposes a standardised risk vocabulary.

6. Total Respect Management

6.1. Respect

Respect in the way we intend to use the word is an expression originally derived from the Latin word respectus. In its turn, respectus comes from the verb respicere, which means "to look again", "to look back at", "to regard" or "to consider someone or something". In other words, the original meaning of the word "respect" holds the connotation of giving someone or something your dedicated attention in order to obtain a better view on the matter or to give it some thought, particularly to come to a better understanding. When used in the context of Total Respect Management, this is exactly how the word "respect" needs to be understood. It is a concept indicating a very specific attitude, which is a dedicated and appropriate focus on a certain subject, person, object or situation in order to come to a deeper understanding of an issue and its context and to be capable of making the right decisions. It is a basic attitude to be developed and ingrained in an organisational culture. It is a means of leverage that leads to a better understanding of individual and organisational issues, subsequently allowing for appropriate decision-making and action in the pursuit of individual and organisational objectives [37].

Total Respect Management is abbreviated TR^{3}M, as it is about respecting people (through leadership), respecting profit (through risk management) and respecting the planet (through continuous improvement with a focus on excellence and sustainability). These three dimensions are of paramount importance for TR^{3}M in determining the mental models that should govern the organisation and its leadership.

People feel respected when they count, when they matter and when they are listened to. It is why the communication and consultation part of the ISO 31000 process is a crucial part of this process, as it allows leaders and managers to express their vision and to translate this in a mission and ambition, reflected by the objectives they pursue. The values of the organisation are then manifested by the guiding criteria set by the leadership of the organisation. At the same time, this process provides the opportunity to listen and capture people's ideas on issues that matter. At each step of the process, the appropriate stakeholders/people can be involved, creating alignment with the corporate objectives, capturing ideas and perceptions and making them feel as if they are part of decision making while increasing one's quality of perception on these matters, which in turn provides for better decision making. When properly understood, the ISO 31000 process is a structured dialogue that can be used for any issue by any leader or manager to show respect for people because, when leaders genuinely consult and communicate with the members of the organisation and take into account what they learn in the process, this generates trust and trust generates better and more accurate information. When managers and

leaders act oppositely, when they do not listen to people and do not take them seriously; thus, the opposite result follows.

Using the ISO 31000 process also results in respecting profit, as options can be weighed and the most sustainable and profitable one can be selected and improved over time, maximising the total profit over time.

Additionally, stakeholders outside the organisation are important in this process. When sustainability is an important objective and guiding mental model, options in favour of the planet can be selected, assessed and improved. Hence, attention to these aspects is also showing respect to the planet.

6.2. Total

Total Respect Management is an inclusive management philosophy and methodology with a focus on the whole. This focus leads first and foremost towards an organisational attitude, allowing businesses to align strategic objectives, strategy and culture ideally with societal needs and requirements. It is a general method to progress towards an optimal performance (or Safety-II), achieving more with less. Its philosophy is based on the fact that performance and safety are two sides of the same coin and that it is necessary to address both sides in a balanced way. It is also an integrated methodology to line up performance and performance management with the safety of core objectives of an organisation and society as a whole. In essence, TR^{3}M consists of a balanced and integrated combination of leadership (respecting people), management (respecting profit) and excellence (respecting the planet) in order to obtain a desired performance and sustainable results [37].

7. Concerns

Implementing integrated methodologies in organisations is a difficult task that requires a lot of preparation and dedication. In general, organisations look for quick fixes, an easy way out with minimum effort and maximum result. Leadership and management often look for methods that can be implemented without disturbing higher management. Unfortunately, this does not work for a "Total" concept, where each part is important and needs implementation. This means a considerable investment in time, people and money when implementing this concept, as it requires leadership development, ISO 31000 implementation and a continued effort in improving what is not great yet.

For TR³M, leadership development is crucial, aiming for level 5 leadership, as described by Collins [66]. This means, among others, the capacity to let go of one's ego; to be able to be vulnerable; and to genuinely listen to people, something that can be (very) difficult for some leaders. Additionally, a comprehensive implementation of ISO 31000, in line with its guidance, is problematic because this requires every member of the organisation to develop a certain level of comprehension of this standard and the use of its process throughout the organisation, starting with the leadership of the organisation. Often, this standard is regarded as a concern for risk managers, while it should be the concern of every leader and manager. As a result, most ISO 31000 frameworks in organisations are underdeveloped and the use of the principles as guiding mental models is lacking.

For TR³M, it is also vital that the little things matter. Attention to detail and a relentless pursuit of improvement of what can be improved concerning as much as possible objectives at all logical levels should, in the end, result in an aligned and excellent organisation, creating value for itself and its stakeholders. However, this is a level rarely achieved, as other elements of the concept are habitually missing.

It was our purpose to implement, test and measure this TR³M concept in an organisation, starting at a team level within that organisation. Unfortunately, up to now, no organisation was found willingly and audacious enough to make the investment in time and people, as these resources are often lacking. As such, the validity of this theoretical concept still needs a practical test in future research.

8. Conclusions

In this paper, we explored the consequences of a systemic approach concerning the concepts risk, safety and performance. We subsequently explored the role of leadership and the importance of alignment to propose a "Dynamic Cultural Alignment model" (Flywheel of Alignment) and a "Dynamic Organisational Alignment model", with which organisations can align its members with the vision, mission and ambition of the organisation and its strategy. We showed how the ISO 31000 principles can be used as powerful mental models to facilitate organisational alignment and consequently offered an outlook on how ISO 31000 can be used as a practical organisational alignment tool to achieve safety and performance in organisations proactively.

Finally, we briefly discussed Total Respect Management as an integrated and systemic way to achieve safety and sustainable performance in any organisation.

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Chapter 4[11]

"How to implement pro-active safety management and improve the performance of organizations of any size or sector, operating in a volatile, uncertain, complex and ambiguous environment?"

1. Design requirements

The design is destined to generate safety and performance proactively. Therefore, it needs to be able to change socio-technical systems in such a way that safety and excellent performance become at least emergent system properties at the start. Subsequently, the design, by its functioning, will require continuous improvement, to stay abreast with the VUCA world. The design also needs to fit with the ontological and semantic foundation, as expressed in Chapter 1.

This determines the following requirements:

- The design should work through the encompassing concept of objectives, the way it is proposed in the ontological and semantic foundation explained in Chapter 1, as this will allow for a clear and measurable concept of what is meant by safety and performance at an individual, team, organisational or even societal level. A clear concept avoids ambiguities and will also allow for a standardised quantification and benchmarking to compare results.
- The design should facilitate change in organisations, as this is necessary for the organisations to become agile and flexible to cope with volatility.
- The design should facilitate a dedicated attention for the effects of uncertainty on objectives, to cope with uncertainty.
- The design should facilitate dialogue in order to develop a higher quality of perception and cope with complexity.
- The design should facilitate the development of a shared vision, mission and ambitions, to reduce ambiguity.
- The design should facilitate continuous improvement to keep up with ever rising standards

In order for the design to be successful, it will be necessary to cover all of these aspects that are crucial when operating in a VUCA world and to cope with the challenges this brings. Consequently, the design should be able to have instant effect

[11] This chapter describes the design that, as a part of this study, has been expounded and published in the following book: "Safety & Performance - Total Respect Management (TR³M) - A Novel Approach to Achieve Safety and Performance Proactively in Any Organisation" (Blokland & Reniers, 2017) Nova Science Publishers, Inc. New York https://novapublishers.com/shop/safety-and-performance-total-respect-management-tr%C2%B3m-a-novel-approach-to-achieve-safety-and-performance-proactively-in-any-organisation/

in changing the system to adapt to ever-changing circumstances. Hence, it needs to incorporate and/or accommodate the abilities that involve the highest leverage points, as proposed by Meadows (1999).

1.1. Facilitating the change of mental models

The role of leadership, as a process in organisations, is to have and develop a vision, mission and ambition in order to determine objectives. In order to lead, one must know where to go. This involves creating and dealing with the mental models that are present in the organisation. Leadership in organisations concerns both the mental models at the individual, team and organisational levels, as well as the incorporation of relevant societal mental models. Furthermore, it is the role of leadership to build a team and develop a shared vision, shared mission and a shared ambition and translate this in tangible objectives, values and convictions that form the guidance for decision making.

In their book "The heart of change", Kotter & Cohen (2012) conclude the following: "The single biggest challenge in the process of change is changing people's behaviour. The key to this behavioural shift, so clear in successful transformations is less about analysis and thinking and more about seeing and feeling". They also state that emotions either undermine change (anger, pessimism, false pride, arrogance, panic, exhaustion, insecurity, …) or facilitate change (faith, trust, optimism, urgency, reality-based pride, passion, excitement, hope, enthusiasm, …). They say that successful leaders identify a problem or a solution to the problem and then they show this to people in ways that are as concrete as possible. Change leaders make their points in ways that are as emotionally engaging and compelling as can be. They show their truth in presentations or videos to get the picture clear. They do everything to shape the mental model that is needed for change. Because, what people see, the way they picture reality in their mind, their mental models, will determine how they feel, and which emotions will emerge. When these emotions are feelings of urgency, passion, pride, faith, trust, … there will be a change of heart and a transformation of behaviour that facilitates the change that is needed to keep up with the VUCA world. (Kotter & Cohen, 2012)

1.2. Facilitating the focus on the effects of uncertainty on objectives

The role of management as a complementary process to leadership, any kind of management, is achieving and safeguarding objectives, and to reduce the uncertainties that come along with these goals. It involves activities such as planning, analysis, training, monitoring, evaluation, optimalisation, control, …. Where leadership, as a process, concerns the objectives and values of the organisation, the primary task of management, as a process, is to manage the effects of uncertainty on all those objectives to obtain the best possible outcome. For top

management this will mainly involve the strategic objectives and the purpose of the organisation, but at lower levels these will be the more specific organisational goals and ambitions, translated into specific and dedicated strategies, processes, procedures, down to the daily activities of everyone involved in the creation and protection of value for the organisation. Hence, the core process for managing objectives is the process that manages anything that can affect those daily activities, procedures, processes, strategies and ambitions. They need to manage the effects of uncertainty on all of those objectives. In other words, they need to manage risk in all of its aspects, including the objectives that are at a societal level to incorporate corporate social responsibility in the daily activities and mindset of the organisation. These objectives include compliance with laws and regulations, but they should also include the higher and more ethical aspirations of a sustainable society.

1.3. Facilitating dialogue to develop the quality of perception

A leader's vision needs to be rooted in truth. Otherwise, the mission, ambition and related objectives are flawed from the start. Likewise, management decisions need to be based on the best available information and a correct assessment of conditions and circumstances. It means leaders and managers need a high quality of perception to get the best possible results. Yet, every individual has one's own mental models of what reality is, and these perceptions are by definition incomplete and distorted due the individual ladders of inference one holds. This is why there is a crucial common element (figure 1) between the processes of leadership and management, and this is the communication process. However, communication is also a very broad concept, as many forms and practices of communication exist. Organisations, in general, understand the importance of communication from a management perspective. Orders need to be communicated, reports need to be transferred, decisions need to be conveyed and so on. But this is not the level of communication which will suffice in a modern and more and more complex environment. Although these formal ways of communication are crucial to a good functioning organisation and help in increasing one's quality of perception, it doesn't necessarily help leaders and managers to develop and change their mental models. Developing mental models are best served with dialogue, a two-way communication based on mutual respect and listening before talking. The quality of perceptions of managers and leaders are a result of how well they understand the importance of dialogue and to which level they are able to adapt their mental models through systems thinking, integrated thinking and dialogue. In fact, for systems thinking and integrated thinking dialogue is also the most important tool to use.

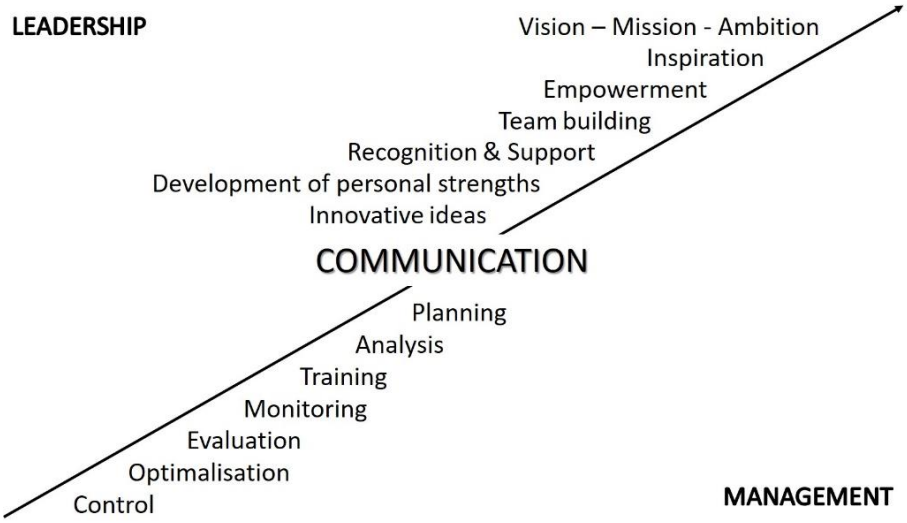

Figure 1. – Leadership, Management and Communication (Blokland & Reniers, 2017)

1.4. Facilitating the development of a shared vision, mission and ambitions

An inspiring vision, an invigorating mission and realistic ambitions are the bedrock of an organisation. These are the fundamental mental models that generate and operate the socio-technical systems that organisations are. These are the most important mental models leadership needs alignment for, as they will determine what is important, which objectives need to be pursued and how they need to be valued. When congruent, and over time, these are the mental models that will determine the organisational culture and the corporate identity. In their article "The role of communication and visual identity in modern organisations", Melewar et al. (2006) state the following: "Environmental mutations such as growing internationalisation, mergers and acquisitions, deregulation and privatisation of markets and multiple audiences, demand new tools to face such dynamics. Corporate identity arises as a potential strategic resource. … Every organisation has its identity. It articulates the corporate ethos, aims and values and presents the sense of individuality that can help the organisation within its competitive environment". They further declare that by effectively managing its corporate identity, an organisation builds understanding and commitment among its stakeholders. As such, a corporate identity, based on a shared vision, mission, ambition and values, creates the positive emotions that are needed to endure the constant change organisations face today. Furthermore, as Melewar et al. in their article affirm, this can manifest itself in attracting and retaining, employees, customers or strategic alliances, gain support of financial markets and generate a sense of purpose and direction, creating a "we-feeling" (Melewar et al., 2006). All of which are beneficial

to the safety and performance of the organisation.

1.5. Facilitating continuous improvement to pursue and maintain excellence

Continuous improvement is a specific form of innovation and change. These are the small corrections that keep the organisation and its stakeholders on track. The same way a pilot has to adjust an airplane to cope with varying circumstances and stay on course and altitude. Without continuous improvement, turns will be missed or altitude will be lost. What is excellent today will only be mediocre tomorrow. It is also a form of change that can and needs to be managed.

2. Fundamental considerations for the design and its implementation

2.1. Integrated & Systemic Approach considering the quality of perceptions

As indicated earlier, in the twenty-first century, organisations operate in an environment which becomes ever more Volatile, Uncertain, Complex and even Ambiguous (so-called VUCA). It means that, in general, organisations operate in a highly complex environment and that organisations themselves also become more and more complex in their functioning. Therefore, a systemic and an integrated approach to proactively pursue and reach performance, safety and Corporate Social Responsibility (CSR) in organisations and teams is what is assumed to be needed to cope with the current complex reality of rapid change and increasing numbers of possibilities.

A systemic approach entails a whole system to be taken into account and acts on those elements in the system that generate fundamental and sustainable change in order to spark the concerned socio-technical systems to produce and achieve their specific goals safely. When safety and corporate social responsibility are important to an organisation, associated values and their supporting beliefs, need to be embedded and become deeply rooted into the organisational culture.

Such a situation can only materialize when the mental models (including well founded paradigms) present in the organisation – how people (from top to bottom) perceive reality – are aligned with these values and beliefs. The reason is that these mental models will determine how systems will be structured, how they function and how they eventually produce outcomes and results. In that regard the most valuable instrument to influence mental models in organisations is dialogue (Senge 1990).

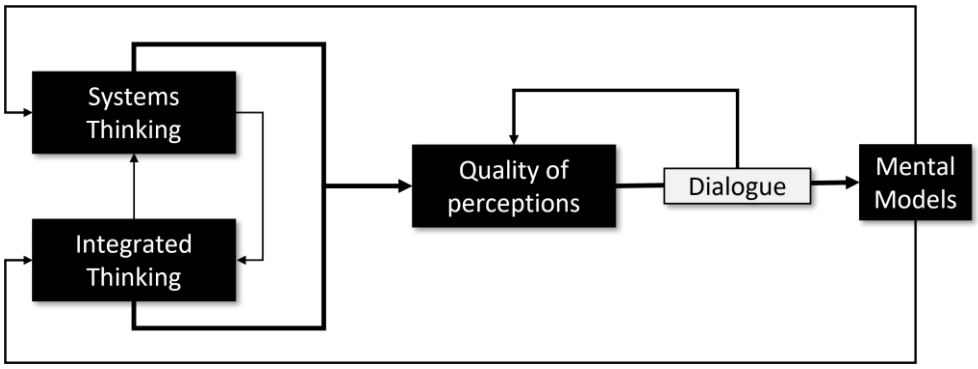

Figure 2 – Fundamentals of the design

Volatile, complex, uncertain and ambiguous issues require a broad perspective to

get a clear view on what is going on. It entails that different perspectives need to be integrated into one global vision to be able to maximally understand the issue at hand. Integrated thinking, together with the zooming in and out of systems thinking are needed to increase one's quality of perception and influence mental models in organisations. (Figure 2). Hence, the design should bank on a systemic view on issues and an integrated way of thinking, aimed at increasing one's quality of perception to align and, through dialogue, improve the mental models that govern organisations.

2.2. Fundamental 1 – A Systemic Approach

Safety in organisations is directly related to events happening or not happening. A systemic approach precludes solely reaction to symptoms of events happening, but instead seeks to discover the underlying systems, structures and their associated mental models, in order to understand how the whole system produces its results (wanted and unwanted). Because, in order to change results, it is not enough and often wrong, to directly react to the visible aspects of events happening. Reacting to these events via their visible symptoms, which are generated by underlying systems, can even aggravate situations and problems. When one reacts to symptoms, fundamental dynamics of those systems remain intact, the unwanted events will happen again, and resources are spent without solving the issue. A reactive approach, solely based on the visible aspects of events doesn't lead to lasting effects or sustainable results.

Only insight in and knowledge of the mental models present in a socio-technical system provides the basis for understanding how fundamental changes can be made in order to proactively obtain more performance and increased safety in a sustainable way (Senge 1990). Hence, regeneration of mental models, redesign of the structures of systems and reframing systems is the needed change in improving organisations towards desired and sustainable results, as presented by the systemic iceberg model in paragraph 1.6 of Chapter 2. (Bryan et al, 2006).

2.3. Fundamental 2 – An Integrated Approach

'Systemic' indicates a holistic view on reality. Integrated on the other hand means that various parts or aspects of the approach are linked and coordinated. The Cynefin framework, as displayed in paragraph 3 of Chapter 3, is a way to approach reality in both a systemic and an integrated way, delivering a clear view on one's environment in its largest sense, and how to deal with it.

The Cynefin framework can be seen as an integrated way of thinking on how to increase one's quality of perception and provides handles on how an organisation can learn, using different thinking and leadership styles, showing where to focus, to

evolve from new towards best practices. Because, today, issues, situations and circumstances are ever more variable and complex, requiring more information and better processing capacity to deal with that information. This is necessary in order to be able to fully comprehend what is going on and to take the best possible decisions.

2.4. Fundamental 3 – The Quality of Perception

An important aspect of the models displayed in Chapter 2 and Chapter 3 is how one perceives reality. A systems thinking approach tries to dive deeper into the systems thinking iceberg to increase awareness regarding a specific reality each time reaching higher levels of perception. Likewise, the Cynefin framework helps in doing the same thing, providing handles to increase insight, knowledge and understanding of a specific reality. Therefore, before explaining how to use the framework by implementing the design, it is important to underline the concept of "quality of perception", as explained in paragraph 2.4 of Chapter 1 and paragraph 4.6 of Chapter 2.

The way people experience reality is always through their individual perception of life and each individual will always have a different perception of the same set of circumstances. This is due to the fact every person has different experiences of the same reality due to varying sensorial capacities, divergent beliefs and convictions or a different focus (mental models), just to name a few of the many factors that influence perception, and which are the reason why perceptions of reality vary from one person to another. (Ladder of inference, Argyris 1982, 1985, Senge 1994)

How one perceives reality itself is always a mix of the domains as presented in the Cynefin framework, with issues reflecting varying degrees of complexity combined with different levels of knowledge and understanding. This mix is unique for every person and only depends on one's quality of perception. The closer one's perception approaches reality itself and the better understanding of one's reality, the more one moves towards the simple domain. On the other hand, the more understanding is lacking, and perception is deviating from reality, the more one digresses towards chaos. The ability to move from chaos to simplicity is what can be understood as learning. In the domain of chaos, someone has to show how to proceed and where to go. In complexity, one needs coaching and asking the right questions to probe and learn from those experiences, to move further in the right direction. When things become clearer in the complicated domain, exchanging knowledge and putting experiences together help to move forward to the simple domain, where things are clear and fully under control. The challenge in the 21st century consists in the fact that things change at an ever-increasing rate, making parts of knowledge and experience obsolete, necessitating continuous learning in all of the domains, as an

individual, but also as an organisation.

2.5. *Fundamental 4 – Objectives, risk and the learning organisation*

'Risk' means different things to different people at different times. However, as already mentioned, one of the elements characterising risks is the notion of uncertainty. Unexpected things happen and cause unexpected events. The level of uncertainty can however be very different from one set of circumstances to another. In that regard, roughly three types of uncertainties can be distinguished: uncertainties where a lot of historical data is available (type I), uncertainties where little or extremely little historical data is available (type II), and uncertainties where no historical data is available (type III).

Whereas type I negative risks usually lead to Low Impact High Probability (LIHP) events, such as most work-related accidents, for example falling, little fires, slipping, etc., type II negative risks can result in catastrophes with major consequences, often with multiple fatalities, the so-called High Impact Low Probability (HILP) events. Type II accidents do occur on a (semi-)regular basis in a worldwide perspective; large fires, large releases, explosions, toxic clouds, etc., belong to this class of accidents. Type III negative risks may transpire into 'true disasters' in terms of the loss of lives and/or in terms of economic devastation. These accidents often become part of the collective memory of humankind. Examples include disasters such as Seveso (Italy, 1976), Bhopal (India, 1985), Chernobyl (USSR, 1986), Piper Alpha (North Sea, 1988), 9/11 terrorist attacks (USA, 2001), and more recently Deepwater Horizon (Gulf of Mexico, 2010) and Fukushima (Japan, 2011). Observe that once type III risks have turned from the theoretical phase into reality, they become type II.

To prevent type I risks turning into accidents, risk management techniques and practices are widely available. Statistical and mathematical models based on past accidents can be used to predict possible future type I accidents, indicating the prevention measures that need to be taken to prevent such accidents. Type II uncertainties and related risks and accidents are much more difficult to predict. They are extremely difficult to forecast via commonly used mathematical models since the frequency, with which these events happen, is very low within one organisation and the available information is therefore not enough to be investigated via e.g., regular statistics. The errors of probability estimates are very large, and one should thus be extremely careful while using such probabilities. Hence, managing such risks is based on the scarce data that is available within the organisation, and, more generally, on a global scale, and on extrapolations, assumptions and expert opinions. Such risks are also investigated via available risk management techniques and practices, but these techniques should be used with much more caution, since the uncertainties are much higher for these types of risks than for type I risks. A lot of

risks never turn into large-scale accidents due to adequate risk management. Also, very few risks exist which turn into accidents with huge consequences. The third type of uncertainties is extremely high, and the related accidents are simply impossible to predict. No information about them is available and they are extremely rare. They cannot be predicted by past events in any way; they can only be predicted or conceived by imagination. Such accidents can also be called 'black swan accidents' (Taleb, 2007). These events can truly only be described as 'the unthinkable' (which does not mean that they cannot be thought of, but merely that people are not always capable of realising (or mentally ready to realise) that such event really may take place).

One could imagine that the "unthinkable" events and type III risks (A) are related to the domain of chaos where knowledge and understanding are so completely lacking that anything can happen, not making sense to anyone who is in chaos. This lack of knowledge and understanding makes uncertainty at such a high level that it fits with type III.

Putting things in perspective then give a grip on a situation or set of circumstances, allowing uncertainty to be reduced by learning. When a vision can be shared, things become more meaningful, allowing for information to be processed in certain ways that make sense. However, there's still a lot of uncertainty because information is still lacking. It seems obvious that type II risks (B) then belong in the complex domain, where it is still impossible to predict how things will happen, but where the investigation of events, accidents or successes, that already have happened provides for lessons learned and more information, allowing to move to the complicated domain.

In the complicated domain, experience, knowledge and understanding are already at a level that further reduces uncertainty. The available information and processing capacity becomes such that it provides the means to determine beforehand how things will evolve. It seems obvious that type I risks (C) belong to this domain, as there's still room for improvement. One can then, by using well-known techniques and skills, further reduce uncertainty and minimise the type I risks to move towards the simple domain (D).

Figure 3 is a possible representation of how types of risk can be linked to the domains of the Cynefin framework. Individual and organisational learning can be seen as follows: When one starts from a position of low variability and complexity, together with a minimum of information and/or a completely inadequate processing capacity, where even the simplest things can be perceived as being chaos, only very little information and processing capacity is needed to shift through the domains to

reach simplicity. However, figure 3 also shows that increasingly variable and complex matters will require more learning and efforts to become, if at all possible, simple. Hence, higher levels of complexity and variability will need higher levels of information and processing capacity to reach the next domains of less uncertainty. Reaching better information and more processing capacity will become more likely with the advent and increased use of artificial intelligence (AI) systems, as this will allow for quicker gathering and processing of data. Variability is not the only parameter to influence one's quality of perception, also the level of complexity of the issues at hand largely determines the amount of information and processing capacity needed to leave the domains of chaos, complexity or complicatedness to reach simplicity. It also shows that the effort needed to make matters more understandable increases with increasing complexity and variability. It is why the implementation of formal risk management practices becomes ever more important when managing organisations in a VUCA world.

Linking types of risks to the Cynefin framework allows to verify or determine what kind of management strategy is needed to deal with the concerned risk. By employing the insight Figure 3 delivers, it is thus possible for organisations and their leadership and management, to work out approaches to handle variability and information availability related to specific risk scenarios. In fact, each domain contains a certain level of uncertainty related to the perception one has and which decreases by learning. This is displayed in figure 3 below. (Blokland & Reniers, 2017)

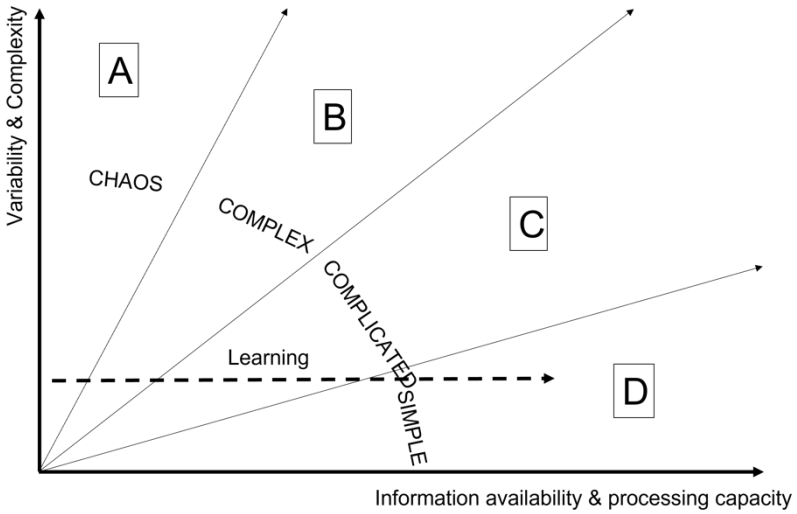

Figure 3 – The Cynefin domains, risk types and learning

In its turn, the quality of the perceptions also determines the mental models present in organisations and vice versa. As such, for a given set of circumstances, the boundaries between the domains are flexible and depend on how one perceives, learns and sees reality, as the domains and their corresponding boundaries will shift when understanding grows and mental models evolve. (Kurtz & Snowden, 2003, Blokland & Reniers, 2013)

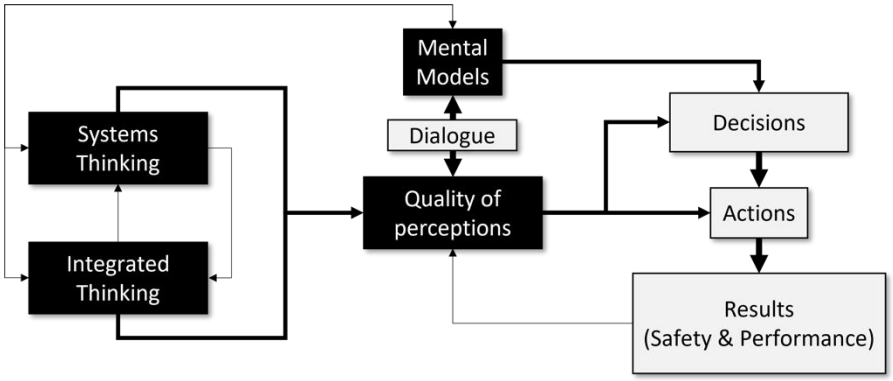

Figure 4 – A learning organisation

A systemic, integrated approach has to answer to the requirements of the different domains of the Cynefin framework. It needs to be able to handle 'Chaos', 'Complexity' and 'Complicated' issues in order to make things 'Simple' and easy to execute in day-to-day operations. Furthermore, a systems thinking lens is crucial, as it offers the highest leverage point possible, i.e., the understanding that one doesn't know reality, but only constructs mental models of everyday experiences, knowing that these mental models by default are incomplete and possibly wrong. Combined, the attitude resulting from a systemic and integrated thinking allows oneself to question one's perceptions and permits the creation and discovery of the mental models generating the systems, governing the decisions and actions that provide for safety and excellent performance (figure 4). Because, mental models will determine how systems will be structured, how they function, how they affect decisions and actions, and, eventually, how they will produce outcomes and results. Essential in working with mental models to shape systems, is to understand that the most effective instrument to change mental models, also in organisations, is dialogue (Senge 1990). Surely, there's also a feedback loop generated by the results that also feed back to the quality of perception and that can also influence the mental models that govern the complex system. Mental models in their turn will also impact the level in which systems thinking and integrated thinking will or can be applied.

3. Total Respect Management as a design

To help organisations in dealing with the challenges of the 21st Century, we are convinced Total Respect Management (TR³M), as a design, offers all the tools and practices necessary that will adequately answer to the requirements and fundamentals mentioned in the previous paragraphs.

3.1. Respect

Why "Respect"? Respect, the way it is meant to be understood, has nothing to do with hierarchy, position or deference, on the contrary. Respect, the way it is used in this context, is a concept as explained in paragraph 6.1 of Chapter 3, indicating a very specific attitude. It is a dedicated and appropriate focus/attention on a certain subject, person, object or situation, in order to come to a deeper understanding of an issue and its context, and to be capable of developing a better judgement or making better decisions. It is a basic attitude to be developed and ingrained in an organisational culture. It is a means of leverage which inspires trust, leads to a better understanding of individual and organisational issues, subsequently allowing for appropriate decision-making and action in the pursuit of individual and organisational objectives.

When does one feel truly respected? One could argue this is the case when one receives appropriate and dedicated attention from other people, enough, but not too much. This is the case when another person really wants to become aware of what another person does or says, showing empathy and understanding, without reaching a level of attention that could be considered being stalking. Likewise, this could be considered the case when individuals or institutions endeavour to understand exactly what is important, related to a subject, and act accordingly. The basic attitude which leads to this understanding and this way of acting, is what can be indicated with the word 'respect.' In essence, Total Respect Management is, as such, about respecting People, Profit and Planet. It is about understanding how the three P's of Corporate Social Responsibility (CSR) can receive sufficient dedicated attention, to get sustainable results and optimal performances. (Blokland & Reniers, 2017)

Respecting People, Profit and Planet is how one could summarize Total Respect Management as a methodology, or approach, to achieve safety and performance in a proactive way. More particular, TR³M constitutes a combination of leadership (respecting people), management (respecting profit) and excellence in the form of continuous improvement (respecting the planet) in order to get the desired levels of safety and performance. Total Respect Management is a systemic and integrated method/approach, covering all aspects of organisations. Its use is focussed on continuously enhancing one's quality of perception, by using the processes of

leadership, management and continuous improvement. Hence, it fits with the domains of the Cynefin framework and works through enhancing mental models in organisations down to the individual level.

TR³M, as a method, allows organisations to take individual and organisational perceptions from the domain of chaos, where the quality of perception is low (should this be the case), towards the simple domain, where everything is clear (whenever this is possible, because there will always be situations and conditions that are too complex and beyond full comprehension or simplification). Each step of the way, it is assumed that TR³M enables people to adapt their mental models in a desired direction, which will improve decision making and fuel progress towards a higher quality of perception. This should then provide for better decisions throughout the entire organisation, generating excellent organisational performance and increased safety. (Blokland & Reniers, 2013).

3.2. Guiding ideas for Total Respect Management

3.2.1. Accident Causation Model

The original idea at the origin of Total Respect Management emerged when using the Swiss cheese model or accident causation model (Reason, 1990, 1997, 2016), while investigating various aircraft accidents and incidents. The information obtained by the investigations was used both for accident prevention as well as for performance improvement. Because the accident causation model allows to develop a systemic view on reality. Finding which objectives have failed and why, how these objectives relate to each other, and why and how unwanted events occurred. This information allows to take informed decisions on how to prevent bad things from happening on a systemic level. Furthermore, it allows to improve situations, processes, procedures, … at an overall level. (Blokland & Reniers, 2013, 2017).

The model uses a metaphor and describes reality as a Swiss cheese (Figure 5). When picturing a Swiss cheese, people imagine a cheese with holes in it. In this metaphor, and how TR³M regards it, the cheese itself is everything that goes well (excellent performance) and the holes in the cheese are the things that don't go as planned or desired (lack of safety).

For TR³M, the cheese in the metaphor, the excellent performance, represents the explicit and implicit objectives achieved and safeguarded, related to the strategies, processes, procedures, tasks, products and services needed in achieving a satisfactory level of excellence. The holes in the cheese, lack of safety, represent the objectives that have not been achieved or are no longer safeguarded in obtaining an acceptable level of excellence.

To know the way this metaphor should be understood and how TR³M considers it,

it is important to remember that reality is dynamic, and that conditions and circumstances change from one moment to the other. It means the Swiss cheese is also dynamic and one has to picture a Swiss cheese where the holes constantly change positions and dimensions. It indicates that, at a certain time, certain objectives are achieved, but the next moment the same objectives are compromised and are no longer achieved or safeguarded.

The theory of the Swiss cheese model says that whenever these little and big holes in the cheese align themselves to make one big hole going through the cheese, an accident occurs. Accident investigation is an attempt to get a complete picture of the cheese and looks at the moment before, at and after the accident took place, discovering the holes involved in the accident and try to understand how these holes came about and how they aligned themselves to produce the unwanted outcome.

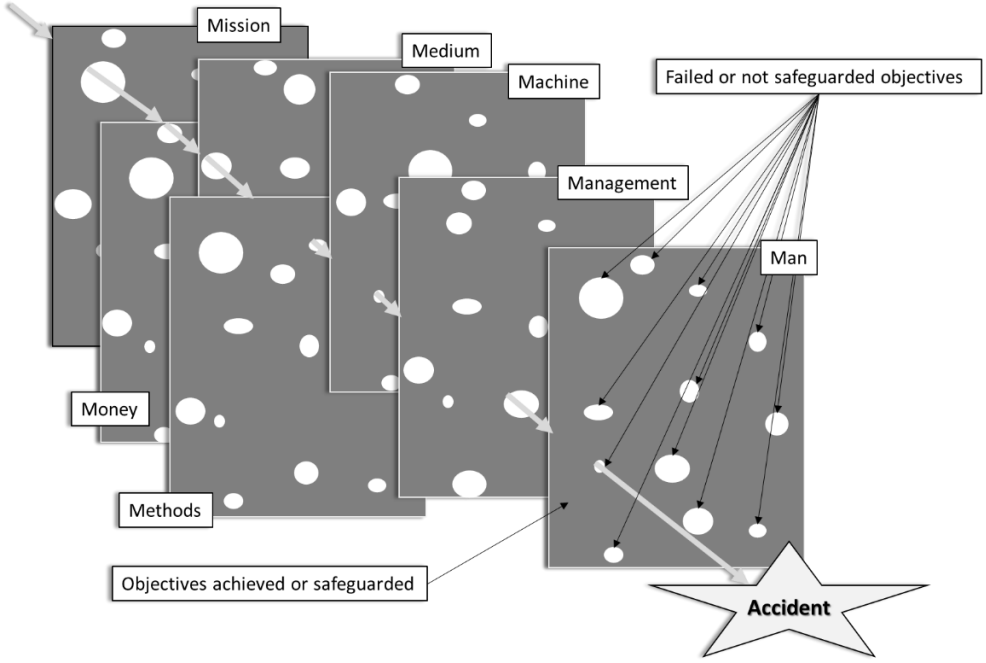

Figure 5. Swiss Cheese model (inspired by Reason, 1990)

There are always objectives which are not achieved or no longer safeguarded (even in the simple domain this occurs). But most of these shortfalls (minor incidents & accidents) are small or insignificant enough so people don't bother, and therefore don't get real dedicated attention. Other insufficiencies are present and noticed, but no one takes the effort to do something about them and finally there are the deficiencies that are noticed and where everyone tries to work around. Because, either the will, or possibility, is lacking to solve these discrepancies. These are

situations and practices what Reason calls the latent conditions, being the preconditions that provide the basic circumstances to have a noticeable accident. In his model he specifies the latent conditions as being organisational factors, unsafe supervision and preconditions to unsafe acts. Although these categories are certainly valid, the model fails to reach its full potential when the intention is to strictly adhere to a narrow interpretation of these classifications.

The way TR³M approaches the Swiss cheese metaphor, is by stating that each of these latent conditions can be seen as small accidents on their own, characterized by the objectives that are not achieved or not protected/safeguarded. It is just the level of importance and number of objectives involved that differentiates accidents to be seen as such and from being worthwhile to investigate or not. Which objectives, how bad they are impacted by events happening or present conditions, and what consequences result from the failure of these objectives, is what counts.

Objectives are linked and when one objective fails, many others can fail too, causing the very little hole in the cheese to grow. It is this interconnectedness of various objectives that makes it very difficult to predict the occurrence or outcome of an accident. Because the level of failure of one objective can influence the achievement or not of other, higher level, objectives, causing a chain of events leading to a noticeable and undesired outcome. (Heinrich, 1931)

When deficiencies (lack of safety) can be considered being accidents, these also represent a loss of performance and as a consequence a loss of potential profit or value for the individual, the organisation or society as a whole. Because, performance can also be seen as objectives achieved, creating value and profit for the organisation and its stakeholders. Performance and (un)safety belong together, you can't have one without the other. In other words, a lack of safety is a lack in performance.

The model Reason developed, makes a distinction between latent conditions and active failures and when considering human errors, both are needed for accidents to occur. For TR³M however, there is no difference between latent conditions and active failures. Both are the result of unachieved or failed objectives. However, when dealing with objectives whether individual, organisational or societal, there will always be conflicting aspirations and these conflicting goals are often the source or onset of failed or unachieved intentions. These again are the result of the mental models present in the organisation. Finding "failed" objectives offers the opportunity to reveal and deal with unsupportive mental models.

For TR³M, the Swiss cheese model fits, as a tool, in the complex domain of the Cynefin framework. The correct approach is to probe first (looking for holes), then sense (identify what is happening regarding these holes) and finally respond (assess

and treat the holes) to what one has sensed. It is why it is also perfectly suited to deal with issues of complex adaptive socio-technical systems. To facilitate the task of probing, a set of categories is proposed. In order to make things memorisable, 7 M's are used, derived from the 4/5M methodology, often used for accident investigations in aviation safety. The 4/5M methodology was initially developed in the 1960s by Kaoru Ishikawa, who pioneered quality management processes in the Kawasaki shipyards with his cause-and-effect diagram also called the "Ishikawa" or "fishbone" diagram. Using this method, managers made significant and specific advancements in quality improvement. (Liliana, 2016)

The proposed seven M's should be interpreted broadly and comprehensively, in order not to exclude possibilities:

- Mission: the mission can range from the overall mission of the organisation down to the specific tasks involved in the situation. What was/is the aim or purpose?
- Money: the resources needed, available or used to reach the aim.
- Medium: the environment (physical and other) in which the aim was or is to be pursued.
- Methods: the tools, skills, processes, procedures, tasks, etc … (to be) used in pursuing the aim.
- Machine: any kind of machinery needed or involved in pursuing the aim.
- Management: the leadership and management decisions, actions, directives, etc … to pursue the aim.
- Man: the human factors involved in pursuing the aim.

Systematically investigating these elements when pursuing objectives, also when no accident or other form of mishap took place, provides the insights to improve performance and increase safety.

3.2.2. The Concept of Unsafety

Since performance and safety belong together, it is very difficult to indicate and prove the effect of safety. What part of observed performance is actual due to safety and what part is solely a result of the performance itself? It is hard to tell. It is why safety always has a difficult task in proving itself to managers and business owners. In fact, the only thing regarding safety which can be demonstrated, is the actual lack of safety. An exact identification of safety is not possible, only unsafety can exactly be determined, for only when an accident occurs, the proof of a lack of safety is delivered. Hence the often-used credo "If you think safety is expensive, just try an accident". Unsafety is a much easier concept to verify. And this is what generally safety statistics indicate. It is not the level of safety which is reported, but the level of unsafety instead. Unsafety can be seen as being the presence of the little and

bigger "accidents" that will be reported and put into statistical evidence. In fact, the level of unsafety is the whole of small and bigger objectives that have failed.

However, even on a personal level, it is very difficult to make a list of all objectives a person has. Objectives are never isolated, and they form a very complex web of interdependent, connected, specific or less specific goals, unconscious desires or other wants and needs. Furthermore, these objectives (also on a personal level) work in concert or conflict with each other. So, it is very difficult to know if these objectives are all reached and whether they are safe or not. For organisations this difficulty is even more obvious, as the objectives of all stakeholders should be taken into account and without proper consultation and communication, stakeholder objectives often remain obscured and unaccounted for.

A moment of unsafety, however, can and should be noticed. When objectives are negatively affected and they fail, are disturbed or have not been achieved, consequences will sooner or later become noticeable and will indicate this lack of safety. But the gravity of the symptoms and consequences of affected objectives, depends on the importance of the objective that has been touched and regrettably, most of the time these losses, although noticed, are not significant enough to be investigated or even to get reported. Nevertheless, it is just at this basic level of insignificant failures, where the real level of safety can be determined. Because little insignificant losses have the potential to add up and cluster, to become bigger and more significant losses (Reason 1990, Heinrich 1931). Small deficiencies come together to become failures, until these failures are large enough to cause real trouble and reporting or investigation is needed. In the meantime, a lot of time, energy and money is lost as a consequence of these negatively affected goals.

TR^{3}M aims to respect (look again and better at) all relevant stakeholders' objectives. Although it is impossible to look at all objectives, the more these small and trivial failures can be noticed, reported upon and treated, the more it will provide the basis for an insight in the mental models present in the organisation, indicating what matters and what not. Therefore, safety and performance are a matter of how precise an organisation can detect unachieved and failed objectives of all relevant stakeholders that will provide a clear view on the level of safety in that organisation. This is what Heinrich already noticed when he formulated his law and determined his safety triangle or pyramid, as he noticed a relationship between the number of insignificant failures, significant and important accidents and catastrophes. (Heinrich 1931)

3.2.3. Changing mental models, alignment and dialogue

Today, still a lot of businesses and organisations exist that solely focus on their own objectives, ignoring or dismissing the need for corporate social responsibility. There

are still managers and leaders in organisations that mostly grew up in the previous century, where leadership and management were almost synonyms and hierarchy was really important. They grew up in a context where dialogue was not a standard practice. As a result, most organisations still focus on the acquisition of expert knowledge in very specific and narrowed down topics in order to cope with organisational challenges in a silo and stand-alone manner, lacking the integration of the non-obvious elements of the problems at hand.

This industrial view of management and leadership is no longer valid for the complex adaptive systems that organisations are today. This understanding is also inadequate in educating organisations, because it does not address the systemic nature of the complex social relationships among people who need to practice leadership today, nor does it accurately accommodate their purposes, motives, and intentions. (Rost & Barker, 2000)

Instead, policy makers in organisations will need to develop educational programs that favour the development of a systemic view, where human interactions lead to deeper understanding and handling of root causes in the issues to be addressed.

In their article on storytelling and the role of strategic leadership, Boal & Schultz (2007) state the following: "In practice, strategic leaders achieve balance in a number of different ways; as part of complex adaptive systems, they are agents that guide the interactions of other agents and transfer particular kinds of resource flows. Specifically, we argue that in creating complex adaptive organisational systems, strategic leaders channel knowledge (by altering interaction patterns) about organisational identity and vision (by promoting dialogue and organisational narratives)". In essence, storytelling (organisational narratives) is also a form of dialogue, where the leader listens to the organisation and responds to what is needed in order to achieve organisational goals. Actually, the same applies throughout the organisation for as far leadership is concerned. It means developing dialogue and narrative skills in organisations is important when dealing with complex adaptive systems.

The systemic and integrated approach which TR^{3}M proposes, starts with developing and exercising leadership in accordance with the Cynefin framework. It increases learning and organisational awareness, and, through dialogue, aligns stakeholders with the ambitions, mission and vision of the organisation by dealing with the "why" questions first (Sinek, 2009). Subsequently, the risk management process reduces uncertainty and provides an answer to what the organisation has to do in order to pursue its objectives. Finally, a process of continuous improvement determines and adapts how the organisation will act in pursuit of its goals. As such, this approach seeks to give answers to the important questions, "Why", "what" and "how (to)".

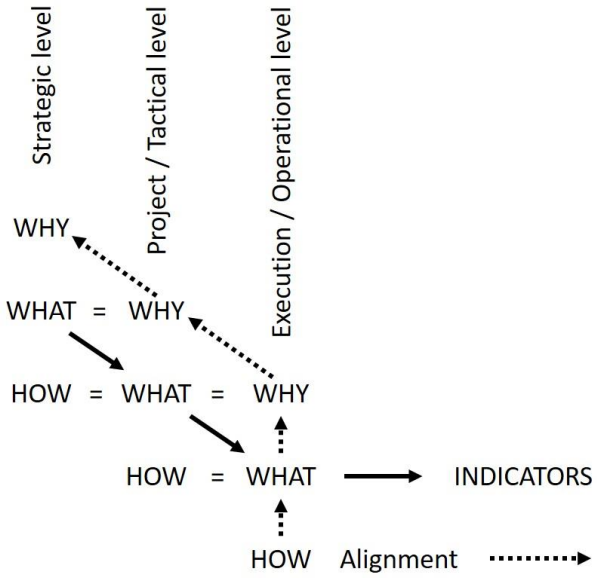

Figure 6 – Alignment between hierarchical levels

For every process and step of the way dialogue is an important tool for leaders and managers in order to exchange, adapt and align mental models in the organisation to get the level of performance and safety wanted. Each hierarchical level has its specific "Why", "What" and "How" questions and answers. At the strategic level, the "Why" question will be about the response to a vision and the overall purpose of the organisation. It is the answer to the question why the organisation exists. "What" will then concern what the organisation needs to do to fulfil its purpose. Finally, at the strategic level, answering the "How" question will be answered by a strategy to pursue the overarching goals of the organisation. At lower levels, these questions remain the same, but the answers become ever more concrete towards the operational level, where the "how" question is answered by the specific tasks and actions that get the job done. When properly aligned, the "what" questions are the answers to the "how" questions at the tactical level, while the answers to the "why" questions at the operational level are equal to the "how" answers at the strategic level. Alignment needs to ensure that all the questions are aligned and linked to the organisational purpose, as indicated in figure 6.

For example, consider a public transportation organisation in a large city. Why does it exist? It is to answer to the need for public transportation in the city. What is needed to fulfil its purpose? It needs public transportation means, such as tramlines, subways, busses and the corresponding infrastructure. How are they going to fulfil their purpose? They are going to acquire and use the means and infrastructure in

specific ways to transport people in the city. At this level, the vision, and answer to the why question, is that large cities have a need for public transportation.

At the next lower level, the vision might be that public transportation in large cities needs a subway, as an answer why the subway in the city exists. Then this leads to the next step of what is needed to have a subway and the answer is similar to the answer to the how question at the superior level, which is to acquire and use the subway in specific ways. The answer to the "How" question is a new and more detailed answer, a more specific strategy on how to build, develop and use a subway in the city as a part of the public transportation plan.

Again, the next level will be more detailed and more specific, starting with the vision that to have, develop and use a subway, one needs to acquire metro trains, build tracks and stations, etc… as an explanation why a metro station exists. These replies will also correspond to the responses to the "What" question at the higher level. Then the answer to a new "What" question will concern the building of the metro station, indicating what needs to be achieved for the metro station to exist, which should be aligned with the solutions to the "How" question of the superior level. The "How" question will again be more specific on how to achieve what needs to be done, becoming ever more detailed and specific until the level of the daily tasks and the actual execution of daily operations is reached. As such, the "Why", "What" and "How" questions, at ever deeper levels of detail, help in aligning the objectives of the organisations with more specific societal or even individual aspirations with the shared purpose of the organisation. (See also Chapter 3 figure 5)

3.3. Leadership

The core of TR³M is formed by the three processes that are aimed at respecting the three P's of CSR. Respecting "People" is the role of leadership. Leadership is the most prominent process to be used when chaos is present and, today, due to the VUCA conditions organisations operate in, chaos is something which is increasingly present in organisations and society as a whole and it needs to be dealt with. The process of leadership starts with having or developing a general and inclusive perspective on the current set of circumstances, envisioning a future reality. A comprehensive vision should then clearly show the gap between the actual situation and the envisioned future. This view will then indicate what is needed to close that gap, as this is the reason "Why" the organisation exists. What is needed, leads towards the mission. It is the action necessary to pursue this future reality and "What" it will do to close the gap. It is the organisational purpose. The vision and mission then will determine what will be of importance to execute the mission. This needs to be expressed in clear ambitions (strategic objectives) and corporate values & convictions. Together, they will determine "How" the organisational purpose will

be achieved. Ambitions are the significant goals that will determine the scope of the organisation and make clear what needs to be done and how things need to be done at the next hierarchical level. Because, clear ambitions and sound values and convictions, grounded in a broad vision and crystal-clear mission, can be translated into more specific objectives and a strategy, aligned with the corporate values, in pursuit of the specific ambitions. It is where action starts and the organisational quality of perception increases. When people in organisations can be part of the leadership process and can be part of developing a shared, unambiguous vision, mission and ambition, in line with their own aspirations, this will motivate and energise people and facilitate change. Because it will give people a sense of commitment and importance which will drive performance. Therefore, well developed strategic objectives provide for direction and lead away from chaos into the domain of complexity (Blokland & Reniers, 2013).

In his article "Two Decades of Research and Development in Transformational Leadership", Bass (1999) declares the following: "Specifically, transformational leadership is associated with behaviours defined as idealized influence (or charisma) and inspirational motivation, which are displayed when a leader envisions a desirable future and articulates how it can be reached. The leader acts as a role model, sets high standards of performance, and shows determination and confidence. Moreover, transformational leaders influence followers through intellectual stimulation, which is enacted when the leader stimulates creativity and innovation. Finally, transformational leadership is described by individualized consideration, meaning that he or she acknowledges individual differences, develops individuals on their own terms, and qualitatively transforms the reasons for interacting with others from pure self-interest to having interest for others".

In their article "Leadership in complex organisations" Marion and Uhl-Bien also state the following: "There is a rather obvious - and, we feel, interesting - relationship between complexity theory's concept of the mental models (tag) and the concept of charismatic leadership. As we stated earlier, complex systems totter on the edge of chaos, sufficiently active to be dynamic but not so active they risk continual disruption. Major change occurs when they step over that edge to a dramatically different fitness strategy. At times, such change can result from emergence and the activities of tags. That is, systems are capable of producing structures (the tag) that may perturb and alter the very system that produced it. Charismatic leaders are described as having the ability to formulate and articulate an inspirational vision. They exhibit behaviours and actions that foster the impression that they and their mission are extraordinary in such a way that they get others to rally around them. Like tags, charismatic leaders have been described as change agents."

As such, leadership is the process that is necessary for the major and many other

changes organisations endure in the ever more volatile and complex world. In advancing a vision, strategic leaders promote organizational learning and innovation as they instil meaning in followers for the roles they play in fulfilling that vision and encourage a motivated response to new situations and challenges (Boal & Schultz, 2007).

For TR³M it is essential that this form of inspirational leadership is developed throughout the organisation down to the operational level. Every department, every team in a complex organisation needs this form of leadership, where the "Why", "What" and "How" questions can get clear answers, linked to the vision, mission, ambition and values of the organisation, as these will be the guiding mental models on which the organisational culture is founded. For TR³M the leadership process is the way leaders and organisations align the logical levels, as expressed in paragraph 4.2 of Chapter 3. The process consists of the different logical levels, each time aligning the "Why", "What" and "How" answers, starting with the vision and ending at the level of environment, where the actual results and organisational performance is to be noticed.

As such, the leadership process used by TR³M, is based upon, and integrates, the ladder of inference (Argyris, 1982 and Senge 1994), the logical categories of learning and communication (Bateson, 1972), and the model of logical levels (Dilts and Epstein, 1995; Dilts, 1996; Dilts, 2000), further adapted by Blokland & Reniers in 2013 and 2017, as discussed in paragraphs 4.2 and 4.3 and displayed in figures 5 to 9 of Chapter 3. While awareness starts at the lowest logical levels of environment and behaviour, the leadership process starts with the vision one has developed. For this, it is paramount that leaders in organisations cultivate a high quality of perception to build their vision upon. As such, the process starts with integrated and systems thinking and developing an accurate vision of the circumstances the organisation is in. Because, for this process to be functional, it requires members of the organisation to adopt an open-minded attitude, being aware of the fact that different perceptions of the same reality can exist, that different insights can be valuable and that developing a shared vision on what matters is essential to make a durable change in the right direction. It is a matter of respecting people (relevant stakeholders) to obtain this level of attitude.

3.4. Risk Management

Once the leadership has determined a shared ambition, including the corporate values and convictions corresponding strategic objectives can be developed. In this phase, the management process becomes the most important aspect in leading the organisation. The fact of having objectives gives direction to the internal stakeholders. However, in a volatile, uncertain, complex and sometimes ambiguous

environment, pursuing objectives starts in the complex domain. Here, one can probe reality to identify risk sources and risks, analyse and evaluate risk and, as such, consequently, deal with the effect of uncertainty affecting the objectives, by an appropriate risk treatment. For Total Respect Management, management is about reducing the uncertainty regarding objectives and their achievement, by making sure objectives are valuable, feasible and reached. Therefore, all management should be considered as being risk management. Hence, the process to be used is the risk management process. Because it will further enhance the quality of perception, linking objectives to risk sources and their possible effects. This allows determining the optimum way in which the strategic objectives will be pursued, generating the sub-objectives at the tactical and operational levels that result from the management process. When this process is well understood, one can pursue risk and use positive risk sources to create value. While reducing the effects of negative risk sources accordingly to safeguard the objectives and their achievement. This dual approach allows to increase value gained and reduce value lost in an optimal way. In other words, the management process allows to increase the benefits and reduces losses, which results in higher value creation, respecting Profit (Blokland & Reniers, 2013). The tool associated with management and the process used by TR³M, is the ISO 31000 Risk Management process, as explained in paragraph 5.1.3 and depicted in figure 13 of Chapter 3.

3.5. Continuous Improvement & Excellence

When the management process has determined the strategy to carry out the vision, mission and ambition of the organisation, specific and more detailed objectives have to be identified and pursued by all units of the organisation. This clarity of purpose shifts perceptions from the complex into the complicated domain as a certain level of order has been achieved and people know what to do. Here, continued analysis is needed in order to understand how existing structures and systems produce the outcomes and results obtained. When sustainability is of importance, it is necessary to understand how the organisation fits into the larger perspective of its environment and what positive effects can be created to increase value, as well as which unwanted results and waste can be reduced. In this phase of development and learning, continuous improvement is the dominant process that is needed in order to obtain excellence. Systems thinking and understanding of larger complex systems is also required to improve into the right direction, taking into account the larger reality and move towards more respect for the environment and planet Earth. In this way, by learning, the quality of perception further increases to discover and develop "best practices", fitting with the ambitions, mission and vision of the organisation. Hence, TR³M leads organisations into the simple domain and towards the execution of best practices, providing for excellent and sustainable results. At

least, for as far this is possible and feasible for a given situation.

Different organisations use different methodologies, approaches and tools for implementing continuous improvement. There are many improvement methodologies. One of the best known and used improvement models today is the PDCA cycle, also called Deming cycle, PDCA stands for Plan, Do, Check and Act. DMAIC is another methodology used for improvement. The acronym stands for Define, Measure, Analyse, Improve and Control. It refers to a data-driven improvement cycle used for improving, optimising and stabilising business processes and designs. DMAIC is used, amongst others, in Six Sigma projects and problem solving (De Mast & Lokkerbol, 2012). Another interesting cycle is the OODA loop. It is a decision cycle of Observe, Orient, Decide and Act, developed by the military strategist and United States Air Force Colonel John Boyd (Angerman, 2004). Boyd applied the concept to the combat operations process, often at the strategic level in military operations. It is now also often applied to understand commercial operations and learning processes. Other improvement tools are also the EFQM quality management framework or the RADAR matrix, where RADAR stands for Results, Approach, Deploy, Assess and Refine. More models and frameworks exist and implementing continuous quality improvement methodologies can vary in different organizations. Even so, regardless of the methodology employed, every organization needs to use a proper combination and selection of quality tools, methodologies and techniques in their implementation processes. It is very important that the tools, methodologies and techniques are properly selected according to the need and demands of the team and further applied correctly to the appropriate process and approach in the organization. (Sokovic, et al., 2010)

Total Respect Management offers the KARAF model as its continuous improvement model to create excellence in organisations. This for any issue at hand, whether it is a process, service, product or person (Figure 7). KARAF is the conceptualisation of the continuous improvement process the way Major Blokland has experienced it during his military career as a Belgian Air Force pilot and NATO staff officer. It describes how military combat pilots and military planners become masters in conducting highly complex and diverse operations in modern warfare, while operating highly complex machines such as combat aircraft and command and control systems, in challenging circumstances.

The model, in a way, describes the continuous learning process to be used to master a task, procedure, process, or whatever it is that needs to be improved, and this in an ever-changing environment. At the same time, it is a possible answer to the question: “What makes people excellent?”. What is valid for individuals is often also valid for organisations as a whole. In hindsight, this model is the concept of a process

with which anything can be improved when following the steps rigorously and finding the appropriate attitude and persevere. It ranges from the tiniest thing to the most complex issue. Rigorously following the process associated with the model will always bring improvement. Maybe not immediately, but, eventually, sufficient knowledge and action will become available and make it possible to produce the desired improvement for whatever case, problem, issue or matter needed.

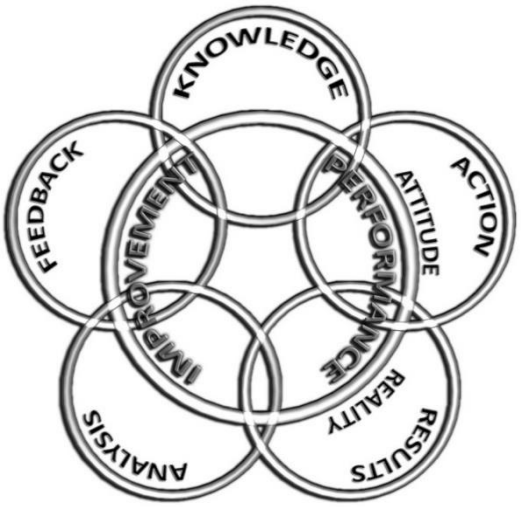

Figure 7 – KARAF model (Blokland, 2008)

The model is represented by five connected rings, linked together by an inner ring. The outer rings are the actual steps in a cyclic improvement process, being "Knowledge", "Action", "Result", "Analysis" and "Feedback", very similar to the PDCA, DMAIC and other cycles. The innovation and difference with the mentioned cycles is the presence of the inner circle, which stands for one's personal "Attitude" and "Reality", representing one's ladder of inference, the human factor in the process. At the same time, the right attitude and a high quality of perception of reality indicate the necessary conditions to be met for a successful application of the process. It can be argued that this is an important part missing in the improvement cycles more commonly in use. Because, as explained in paragraph 1.5 of Chapter 2, one's attitude and reality are related to each other via one's mental models. For instance, when the governing mental models of an organisational culture are also based on a compelling vision regarding continuous improvement, an attitude and a focus favouring improvement will create a focus, facilitating the spotting of opportunities to improve. It will also generate the necessary drive to take action to reach the desired improvement.

Regarding the elements of the model, it is important to note that there is no

beginning and ending. The cycle can be entered at any step of the way and be used in a meaningful way, depending on the Cynefin domain one is in. It only requires continuing the next steps again and again to automatically generate improvement. The inner circle drives the outer circle, and it needs a specific attitude and focus on improvement. This attitude and focus need to become part of an organisational culture and they should develop into strong mental models in people's minds. (Blokland & Reniers, 2017). The model can be explained as follows:

3.5.1. Knowledge

Knowledge should be considered in its broadest possible sense. It includes, amongst others, the programming of machines, supporting hardware and software used, or any kind of mental models, abilities or talents. It even includes all those other improvement models and their application. It is not just the information, but also the processing capacity of the available information that should be considered as being part of "knowledge" in this step.

At any given time or any given situation, a certain amount of specific knowledge regarding the subject to be improved is available. This amount can even be zero, or the information may even be wrong. Whatever the amount and the quality of information one has regarding the subject to be improved, when time is available, it is always possible to gain knowledge by any means possible. One can ask questions, consult literature, make a study or do investigations. Any method which delivers information regarding the subject can be applied. A pitfall of this step is the sense that there is more information to be gathered and studied before action can be taken. Particularly perfectionism can start a loop where new knowledge brings new questions which triggers a further search for knowledge. Consequently, a first challenge is knowing when there is enough knowledge gathered and absorbed, to be put into practice. However, when no time is available, it is possible to skip this step in the process (e.g., in case of chaos) and act.

3.5.2. Action

Action is anything one has to do or refrain from doing to improve the subject involved. The pitfall here is that the fear of failure prevents a person from taking action. Therefore, a good attitude and mental model to cherish when taking action is that there is no failure, only feedback. Even when action does not meet the anticipated requirements, it is better to do something than to do nothing. (With the remark that doing nothing can be doing something if this has been concluded to be the better option). Because doing new things will bring new experiences and further learning. The way Thomas Edison said he didn't fail. But just found 2000 ways how not to make a lightbulb. In the end, he only needed to find one to make it work.

3.5.3. Results

Whatever the case, doing nothing or doing something, there will always be results. Also, when no results are obtained, this is a result. A result is the actual situation when stepping in the process or after action has been taken. In this way there will always be results. A good thing to remember are the words often attributed to Einstein: "The definition of insanity is doing something over and over again and expecting a different result". So, when things don't go as anticipated, something needs to change. Learning and taking action is what will bring different and, eventually, better results.

3.5.4. Analysis

All steps of the process should be analysed, but the focus needs to be on how the results were obtained, which actions were (or were not) taken and how things were done. The analysis should always contain two parts. The first part concerns what went well. What part of the process gave satisfaction? Why so? Documenting what went well is an important part in the learning process and gives the basis to build confidence. The next part of this step in the process is the analysis of what went wrong or what did not work to one's full satisfaction and why. Documenting what does not work and what should be avoided or changed is also important in the learning process. It prevents making the same mistakes over and over again. At least, this will be the case when the next step (feedback) is properly executed.

3.5.5. Feedback

The final step in this cycle is feeding back into one's knowledge what has been identified during the execution of the other steps. What was helpful and what was unhelpful in the search for improvement of the treated subject? When the other steps are well documented, this is a logical and easy move to make. However, for larger organisations, this step can also involve information sessions to be conducted, sending people to training, providing proper schooling, adapting processes, strategies, technology and so on. Feedback in the sense of KARAF means to adapt and change whatever needs to be changed in one's knowledge and actions in order to reach the desired improvement.

3.5.6. KARAF and Leadership

A crucial aspect in improving things is being able to actually see the possibility of improvement. It is the start, the basic element of creating an inspiring vision, mission and ambition, even if this concerns a tiny unimportant aspect of the organisation and its endeavours. What are the issues in the team, department, organisation, or even society, which need to be improved and why do they need improvement? What

is necessary for this improvement to be accomplished and to what level is improvement needed? How will the organisation go about reaching this improvement? The clearer the answers and the more the issue is important for society, the more people will be inspired by such ambitions.

Something to consider: the KARAF model can also help construct such an inspiring statement. It starts with describing the reality the organisation is in, and stating the attitude needed to cope with this reality. Which knowledge needs to be developed? What action will be taken? Which results are expected? What will be done to analyse these results and how will the organisation learn from the feedback captured? When these thoughts can be ingrained in the corporate culture, continuous improvement to create a better world becomes a part of its identity. It will attract stakeholders, such as investors, customers or employees that also hold these values, aligning the organisation with its stakeholders. (Blokland & Reniers, 2017)

3.5.7. KARAF and ISO 31000

Just like the ISO 31000 risk management process, the KARAF model can be used in an iterative way. Moreover, when taking all the elements of the KARAF model, it largely fits with the ISO process, as can be seen in Figure 8. This should not come as a surprise, as the ISO process is also a process which incorporates continuous improvement, although they operate at different levels and not all the steps coincide. 'Reality' and 'attitude' are two components influencing the other components of the process. In a sense, this is the same for the parts "communication & consultation" and "monitoring & feedback". After all, one monitors "reality" and via "communication and consultation" one can influence mental models creating a desired attitude. Because getting the right attitude is where it starts. It influences the way 'knowledge' is gathered, how 'action' is being undertaken, how 'results' are perceived, to what extent 'analysis' will be present and finally in what manner 'feedback' is treated and executed.

Each of the elements of the model will in their turn influence 'reality.' 'Knowledge' will have an effect on one's perception and therefore on one's 'reality.' 'Action' and 'results' belong together. It is how one can change one's 'reality' for the worse or for the better. 'Analysis' will provide the information to improve one's perception of that 'reality.' Finally, when 'feedback' is taken seriously, it will alter one's 'reality' in the same way that acquiring more and better knowledge does.

In itself, 'reality' will also influence the other elements of the KARAF model, starting with one's 'attitude.' When the perception of one's 'reality' changes, one's 'attitude' will change too through the process explained in the ladder of inference. Sometimes 'attitudes' change slightly, but from time to time this can also happen in a huge way. As an example, take a person who had a heart attack due to the smoking of cigarettes

and who is faced with that 'reality.' That person will stop smoking or at least change one's 'attitude' towards smoking. However, maybe nothing changes when there's no learning or when very strong mental models about the (perceived) benefits or other justifications for smoking are present and when no change in these mental models can be obtained. Another example is the very drastic changes people undergo when submitted to specific brainwash processes, altering one's vision on 'reality,' the way it works in religious extremism or totalitarian regimes, completely changing one's 'attitude' towards society. (Blokland & Reniers, 2017)

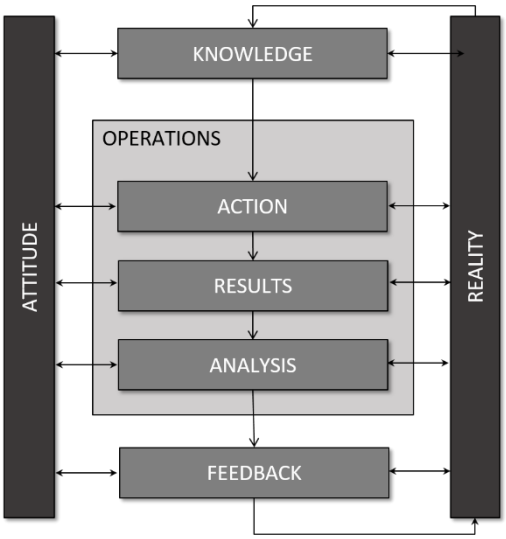

Figure 8 – KARAF and the ISO 31000 Process.

'Reality' also influences the way 'knowledge' is gathered. Sometimes, 'knowledge' is readily available and asking questions in order to improve one's 'knowledge' is commonplace. But sometimes, asking questions is not welcome or it is difficult to get accurate information, just to name a few examples on how 'reality' influences 'knowledge.' When comparing KARAF to the ISO process, it is clear that 'establishing the context' is similar to, and also a way of, getting the appropriate 'knowledge' in an organised way, in order to deal with a specific issue.

Where the ISO process proposes to 'assess' possible solutions for action, KARAF proposes 'operations' and an action to learn. The steps 'action' – 'results' – 'analysis,' however, lead to the same thing as the steps 'risk identification' – 'risk analysis' – 'risk evaluation.' Both parts will bring the information needed to improve. Therefore, the steps 'feedback' and 'risk treatment' have the same aim, namely, to improve the situation or the subject.

One's attitude will facilitate or hinder one's communication, while monitoring reality, will create the possible information where to start improvement. It is an

example of how the processes of leadership, management and excellence are intertwined and also an example that a change in perspective gives another option to approach an issue. However, these perspectives will depend on the quality of perception one has, as explained in paragraph 2.4.

KARAF process

From the above information, also a KARAF process can be drawn, depicted in Figure 9 as a dynamic system of feedback loops, influencing one's reality, perceptions and attitude, allowing to make the necessary improvements for what is not yet at the desired level and to keep what is already giving satisfaction.

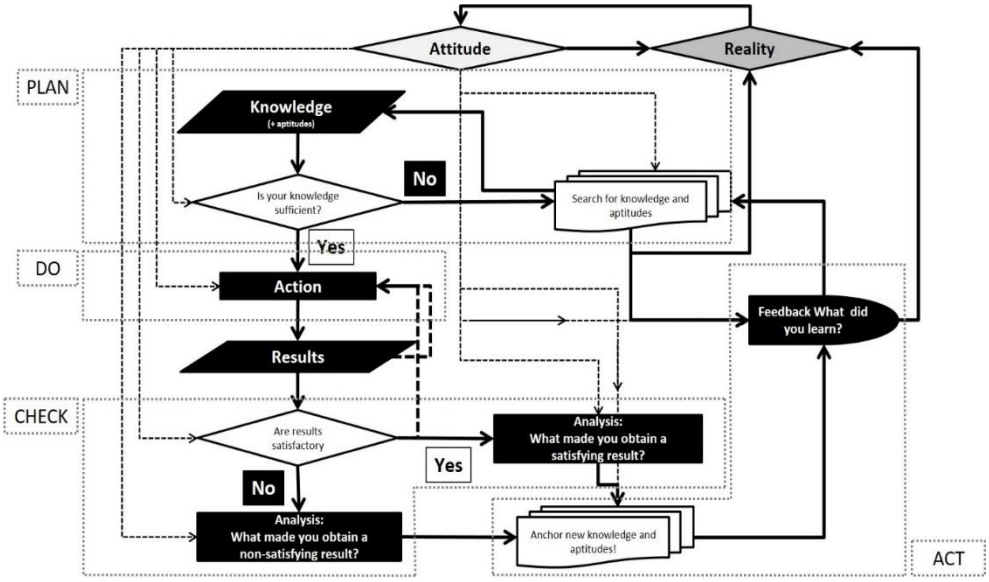

Figure 9. The KARAF Process (Blokland & Reniers, 2013)

3.5.8. Seven Domains of Excellence

Although the KARAF model and the KARAF process are intended and able to improve any kind of subject, TR³M particularly focusses on the improvement of the performance of corporate strategies, processes, procedures, tasks, as well as services and products towards excellence.

As such, the desired focus is on seven characteristics of a selected group of traits of organisational performance. Together, these characteristics indicate a certain level of excellence regarding the element that is investigated. These seven characteristics are:

- Quality: the way in which a result deviates from the expected result
- Effectiveness: the way a result suits the purpose
- Efficiency: the way a result requires resources
- Productivity: the way a result can be repeated over and over again in a defined period of time
- Ergonomics: the way a result is easy to obtain
- Ecology: the way a result is acceptable to the individual, organisation or society as a whole
- Safety: the way in which a result is the achievement of an objective creating value, or the safeguarding of objectives against deliberate harm or against the negative effects of uncertainty on objectives, preventing value to be lost

When CSR is important for the organisation, Continuous Improvement is also the process to reach sustainable results and reduce the consumption of resources to a minimum. Hence respecting the Planet. All of these characteristics influence each other in a systemic way. Therefore, attention to all of these characteristics is needed in order to improve safety and performance proactively. (Blokland & Reniers, 2013)

When the three processes (leadership, management & continuous improvement) work in concert, TR³M, as a design, is a systemic and integrated approach which permanently covers all areas of the Cynefin framework, as it totally respects all specific requirements of these areas. Consequently, TR³M respects People, Profit and Planet to reach safe and sustainable results.

4. Implementing the TR³M design

In their study "Implementing strategies successfully", Aaltonen & Ikävalko, (2002) state that organizations seem to have difficulties in implementing their strategies due to a number of problems: e.g. weak management roles in implementation, a lack of communication, lacking a commitment to the strategy, unawareness or misunderstanding of the strategy, unaligned organizational systems and resources, poor coordination and sharing of responsibilities, inadequate capabilities, competing activities and uncontrollable environmental factors.

Furthermore, they found that a considerable number of interviewees linked the problems of strategy implementation with communication. A common concern was the creation of shared understanding of strategy among the organizational members. The amount of strategic communication in the majority of the organizations was mostly in the form of top-down communication, using a large quantity of both written and oral communication. However, Aaltonen & Ikävalko noticed a great volume of information does not guarantee understanding, which was the concern of many interviewees.

Additionally, the middle managers' role in communicating strategies was emphasized in their findings. The middle managers were often responsible for the continuation of the flow of strategic information and also for ensuring the understanding of the strategy. In this process of communication, the informal communication between superiors and subordinates was considered more important than the formal communication of strategy.

They also noticed sufficient communication does not necessarily guarantee successful implementation. Interpretation, acceptance and adoption among implementers are crucial. A lack of understanding of strategy was one of the obstacles of strategy implementation observed in their study. Surprisingly, many organizational members typically recognized strategic issues as being important and also understood their content in generic terms. Yet, problems in understanding arose, when the strategic issues had to be applied in everyday decision making.

One of the most significant problems reported by the top and middle managers was conflicting activities and events that diverted attention from strategy implementation. Daily routines and the lack of time were mentioned as preventing the organizational members from thinking and acting strategically.

In their findings, they also emphasize two-way communication with all employees for improving strategy implementation. Because, understanding the strategy, requires the opportunity of querying, commenting, or questioning it. This can better

be achieved by continuous two-way communication with feedback and reacting to bottom-up messages. However, according to their data, the communication in organisations when implementing strategy is mostly linear and top-down.

Aaltonen & Ikävalko concluded: "For strategic change to happen, there must be defined what kind of change is desired. It should be clear whether the members of the organization are expected to simply follow a set of rules or think strategically in different situations. This should be comprehensibly communicated in the organization, so that each individual member of the organization will understand why she should act differently and what should be done differently."

Before any methodology or strategy can be used successfully, a certain amount of education will be necessary. Implementing TR³M requires a lot of understanding of the methodology by an appropriate number of stakeholders, including middle managers and employees. It therefore requires a substantial effort to cope with the findings mentioned above. New skills, new mental models and new attitudes will need to be developed during TR³M implementation, requiring two-way communication in the form of dialogue, as it will also include efforts to align individual perceptions with the organisational vision. In the next paragraphs a generic set of actions will indicate the minimum requirements for a successful TR³M implementation.

4.1. Personal development

Important aspects in implementing TR³M is developing leadership and systems thinking skills. For both aspects, the ability to develop dialogue competences are essential. Probably the most difficult one's are active listening and trying to let go of one's ego and mental models, to create an open mind attitude. Many different types of personal development education exist, and it would take this study too far to determine the best practice in this field. However, the design requires at least an introduction in systems thinking and some form of leadership and communication training, for instance an introduction to communication skills, such as an NLP[12] introduction course.

4.2. Alignment

When the required competences are available, the ideal next step is creating alignment within the organisation. TR³M requires the development of a razor-sharp shared vision, acknowledged by all relevant stakeholders. Surely, this is the ultimate

[12] Neuro-linguistic programming (NLP) is an approach to communication and personal development focusing on how individuals organize their thinking, feelings, and language. A growing number of academic articles highlight the application of NLP in organizational settings. (Kotera et al., 2019)

result and goal of a continuous and ongoing process, knowing that it will be very difficult, if at all possible, to fully reach this destination. Nevertheless, it is a crucial step in creating a supportive organisational culture. For a successful execution of this step, the ideas, knowledge and visions of individual stakeholders need to be captured and integrated in the overall and shared vision, for as far as possible. Hence, it is necessary to have two-way communication in the form of dialogue with relevant stakeholders. This dialogue must be organised and structured, ideally held in conditions far away from work, in order to avoid conflicting activities and events that divert attention from TR³M implementation. As such, it is most helpful to have this process managed by an external mediator who is not involved in the daily functioning of the organisation. As such, this person is a neutral factor to facilitate the expression of individual thoughts.

Depending on the size of the organisation, the process of alignment will involve a considerable effort, but it is an investment in the future which, when done correctly, will generate a multitude of benefits for the organisation and its stakeholders. When objectives and mental models are aligned, efforts will reinforce each other and create more value. Additionally, less conflicting objectives and fewer diverting mental models will reduce the amount of value lost.

4.3. Implementing ISO 31000

ISO 31000 is at the heart of the TR³M strategy and its importance for organisations is explained in sections 5 and 6 of Chapter 4. Consequently, the implementation of ISO 31000, throughout a team, department, organisation or even society, is paramount for a successful TR³M implementation and use. Because ISO 31000, with its principles, holds significant mental models that are important for a successful use of TR³M as a method and strategy. Furthermore, the ISO 31000 framework is a way to identify where to diffuse and use dialogue and apply the ISO 31000 process in the organisation. A correct use of the ISO 31000 process will also implement improvement, the way TR³M sees it via the KARAF model and process. A correct implementation of ISO 31000 will create more alignment and provides better decision making, increasing safety and performance over time.

4.4. Practical tools to be used with the design

In the book "Safety & Performance - Total Respect Management (TR³M) - A Novel Approach to Achieve Safety and Performance Proactively in Any Organisation", in which the design is presented, a few chapters have been dedicated at the end, to help implement the design successfully. For instance, a chapter is dedicated to essential leadership skills and practices to enable the use of the highest leverage points, which are "The power to transcend paradigms" and " Changing the mindset out of which systems emerge".

The design also proposes a framework in the form of a cube as a way to use the Swiss cheese metaphor and slice the cheese to find opportunities for improvement.

4.4.1. Essential leadership skills and practices

In order to implement TR³M, a number of essential leadership skills and practices are required to make it a success. The skills are important to simulate the level of dialogue in the organisation, which is a "conditio sine qua non" for building shared visions, missions and ambitions and fully use the TR³M methodology. Because these are crucial skills that will help show respect to people and really give the right amount of attention, building trust and confidence throughout the organisation. Using these skills and practices, over time, will help in being transparent and allows to spread correct information throughout the organisation, helping in decision making. Furthermore, using these skills and adopting these practices will bring the positive emotions that will facilitate change in the teams and departments of organisations.

In the book "Safety & Performance" (Book Chapter 9), each skill or practice is explained. Indicating what it is about, which ideas and concepts are foundational to that skill or practice and what the skill or practice can achieve and bring as benefits. It is not the purpose to duplicate this publication in this thesis. However, it is useful to have a view on the different skills and practices offered in the book. These practices and skills complement each other and, over time, should be part of the daily life of the organisation.

The 20 essential skills and practices presented in "Safety & Performance" are:

- Giving dedicated attention to the people you lead
- Showing vulnerability by expressing one's own feelings, admitting one's own mistakes and indicating one's own personal limitations and capacities
- Listening at different levels of attention
- Giving and receiving compliments and appreciations
- Giving and receiving feedback
- Discovering talents and learn how to use them
- Using and recognising body language
- Recognising and dealing with resistance
- Stimulating responsibility
- Making and respecting arrangements
- Handle diversity and create synergy
- Stimulate creativity
- Appreciative inquiry
- Providing for situations where it is possible to discuss problems
- Setting targets and achieve goals

- Setting priorities
- Putting forward and carrying out the organisation's vision, mission and ambition
- How to handle conflicts
- Working towards win-win situations
- Establishing a balance between control and trust.

4.4.2. The TR³M "Cube" and framework

Another practical tool presented in the book "Safety & Performance" is the TR³M Framework (Book Chapter 10). Total Respect Management is a systemic approach, which means that it is a methodology helping one to understand the whole and its parts and how these parts are connected and influence each other. In this view, the fundamental processes of leadership, management and excellence are linked and intertwined together. They all operate in sequence, as well as in parallel. Sometimes they operate together and on other occasions they function in solitude. Furthermore, they are also mixed with all other organisational processes. This mix of processes in daily actions makes it very difficult to distinguish which process need explicit attention at what moment. As a consequence, it is also hard to discern what is important at what time. Therefore, the TR³M framework wants to enable and to assist in the creation of a holistic vision on one's organisational processes.

Many, if not all, organisational processes are constantly influenced by the fundamental processes of TR³M, creating the results achieved over time. But there are also other fundamental organisational processes always present in organisations. Particularly, Total Respect Management has a dedicated attention for the way in which organisations go about with value. Especially the processes that are concerned with investing, increasing and distributing value matter for TR³M. How do organisations acquire value, how do they create / add value and finally, how and to what extent, do organisations allocate value to their stakeholders?

A seventh process the TR³M framework is concerned about is communication. In this framework, communication needs to be understood in its broadest sense, i.e., how people, processes or parts connect and exchange (share) information. The origin of the word communication comes from the Latin word 'communicatio' which comes from the verb 'communicare', meaning 'to share'.

The seven processes of Leadership, Management, Excellence, Value acquisition, Value creation, Value distribution and Communication, form a first cube, each side of the cube showing the steps of the corresponding processes. A second cube is dedicated to show various tools and memory aids that can be used to support the achievement of safety and performance proactively (Figure 10).

A more comprehensive explanation of the TR³M framework is not a part of this study but is to be found in the book "Safety & Performance Chapter 10.

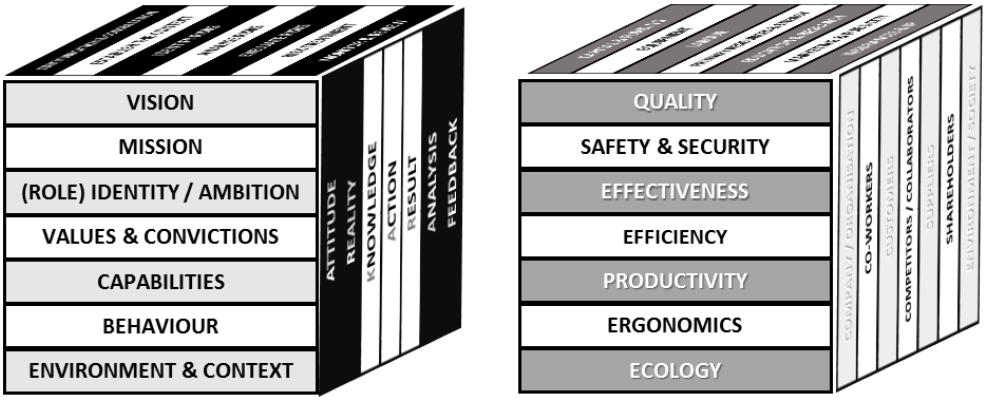

Figure 10 TR³M Cubes

5. Measuring the success of implementation and the effectiveness of the design

Implementing strategies is not an easy thing. However, with the right amount of preparation, using the appropriate methods and skills, success can be reached. However, new strategies are always a source of uncertainty, as it is not always obvious what will be the result of the change and what is to be attributed to other factors. Hence, it is important to measure safety and performance instantly and continuously when implementing the design to monitor its success. Because it is difficult to judge early on whether the implementation of the design and the corresponding change is successful. Since, the results of that change will only become clear after a while.

Therefore, an innovative way of measuring safety and performance instantly is presented in Chapter 6. It is an extra tool to be used when implementing the design.

6. Conclusion

In this chapter we investigated how organisations can implement pro-active safety management and improve their performance, even when operating in a volatile, uncertain, complex and ambiguous environment. We proposed and explained Total Respect Management as a design and described the fundamental ideas behind this idea, design, methodology, strategy, … and clarified how the design works. We explored the conditions needed to implement strategies and what is necessary to change. Hence, we made clear what is important for TR³M implementation and shortly presented some tools and practices that are helpful in this implementation process.

Unlike many other management systems, the TR³M methodology covers the aspects of leadership, management and continuous improvement in a holistic, systemic and integrated way, linking risk, safety and performance with the individual, organisational and societal objectives to pursue the organisational mission in a corporate socially responsible manner. Leadership determines and develops aligned objectives, management achieves and maintains these ambitions and continuous improvement enhances the purposes in order to pursue excellence, focused on seven characteristics that define excellence. Also, a specific view on risk, safety and performance allows the use of the ISO 31000 guidance to manage (individual) mental models, enhance alignment, structure dialogue and increase one's quality of perception to take better decisions. Although this can be considered the intended use of the standard, aside from taking better decisions in the organisation, this is rather an uncommon understanding and use of this standard in organisations today, where the focus often lies on assessment of risks and risk reporting, missing out on the huge potential this standard offers.

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Chapter 5[13]

"How can safety instantly and continuously be measured in a standardised way, independent of the type or size of the organisation?"

1. Introduction

Industrial safety performance has, for a long time, been the domain of health and safety specialists, measuring injury and absenteeism rates to discover patterns and trying to prevent accidents from happening. The drawback of this approach is that safety is reactive to accidents, mostly caused by operations. As a result, safety (performance) has become the reverse side of operations (performance) and is often seen as a hinderance in making the best possible profit for organisations. However, now already for a period of time, industries have become aware of the possible benefits of a more proactive approach towards safety. Therefore, increasingly more organisations are looking for more proactive methods in measuring and achieving safety performance. As a result, in recent years, important efforts have been undertaken to improve the understanding of safety culture and safety climate and how to measure these concepts in organisations, for instance in the process industry and chemical plants. Likewise, substantial efforts have been made to determine and develop a wide range of leading and lagging safety indicators that can reflect and predict safety performance. While developing leading indicators and making culture measurements are helpful, they both measure safety conditions indirectly. Because, an organisational culture or climate can be regarded as a specific indicator of a possible future performance, in the same way leading safety indicators aim to predict the future. Yet, little tools are currently available for the instant measuring of actual safety conditions and performance in organisations, providing information that allows for benchmarking between different sectors and industries. Nevertheless, when safety and its opposite "unsafety" are carefully defined, it becomes imaginable to develop tools that instantly measure the safety performances and actual safety situations in organisations so that they can be used for benchmarking regardless of sector or industry. In this chapter we will expound this way of thinking, based on an original paradigm about safety, unsafety and performance.

[13] This chapter has been published before as the conference paper "Measuring (un)safety. A broad understanding and definition of safety, allowing for instant measuring of unsafety." (Blokland & Reniers) in the AIDIC Journal "Chemical Engineering Transactions" Vol.75 2019.

2. A Challenge

One of the major challenges in safety science is to develop methodologies and systems that are able to proactively capture and recognise situations and patterns that have the potential to provoke severe accidents. This instead of being obliged to use reactive approaches, such as learning from accident investigations when disasters already occurred. In the past decades, different methods, resulting from different research traditions have been developed to tackle this issue. Four historical traditions of empirical and theoretical research in the pursuit of a better understanding of this challenge can as such be distinguished; safety management systems (SMS), safety culture (SC), high-reliability organisations (HRO) and accident models and investigation (AIM), each of them encompassing different purposes, covering a variety of scientific disciplines and investigating in a range of socio-technical domains, such as energy, transportation or process industry (Le Coze, 2013).

SMS is a concept which mainly is a result of empirical and conceptualised knowledge from industrial and consulting practices as well as guidance from control authorities, standards from international bodies or entities in specific industrial domains. Foremost, these practices and guidance are aimed at auditing and assessing safety in organisations. Safety culture, from a social engineering perspective, is concerned with designing and implementing safety programs in organisations. HRO is more descriptive in what safety in organisations requires in organisational design and structure, while AIM is geared towards investigating accidents (Le Coze, 2013).

As such, all of these traditions complement each other in their search of increasing safety performance in socio- technical systems. However, none of these traditions has led to a methodology or instrument that is capable of instantly measuring the results of any methodology in a way that it can equally be used for all approaches.

Performance and safety have always been issues in organisations, certainly in an industrial context. It is why the cost of accidents, and the danger they present to organisations, have already been recognised a long time ago. A pioneer in this field was Herbert W. Heinrich, well known for his theories regarding human error and safety, expressed in concepts such as the domino theory or his accident pyramid (sometimes also called Heinrich's safety triangle) (Heinrich, 1931, 1941). For many years these theories have dominated the realm of accident investigation and prevention, influencing a wide range of scholars in their search for safety indicators. Various authors have indicated that well into the 1990's, and even up till today, one particular indicator has been the key indicator in the process industry, the Lost Time Incident Frequency (LTIF), presenting the number of absences to work due to an accident per million hours worked (Swuste et al., 2016).

Safety performance indicators represent an important constituent of an SMS, involving the establishment, implementation and follow-up of corporate policies, acceptance criteria and goals related to safety. Safety indicators can be of a reactive (lagging indicators), or a proactive (leading indicators) nature and in developing safety performance indicators there will be a balance between concentrating on direct indicators with sufficient and meaningful data and focussing on indirect indicators with enough data providing early warnings, but with less direct safety relevance (Øien et al., 2011). To meet the need for quantification, dominant in industry, numbers of activities, incidents, interventions etc. are counted. However, problems with quantification, both for process as for management/organisation indicators, has been mentioned several times: they do not contain any information on quality. (Swuste et. al, 2016)

Following the 1986 Chernobyl disaster, the term "safety culture" started to be regularly used amongst a broad community of safety scientists. As a result, many contemporary organisations strive to understand and improve their safety culture in order to enhance their safety performance. A popular tool or approach to assess safety cultures is the use of maturity models. Maturity models involve defining maturity stages or levels which assess the completeness of the analysed objects, usually organisations or processes, via different sets of multi- dimensional criteria. However, the 'process' of using a maturity model seems to be more important than the actual 'outcome' (Filho & Waterson, 2018). A model that tries to capture safety cultures in a holistic way is "The Egg Aggregated Model of safety culture" (TEAM). It describes the complexity of a safety culture in three constituting and interacting domains: Technological – Organisational – Personal, where visible and invisible factors can be distinguished. But measuring a safety culture requires then capturing both visible as well as invisible aspects, for which interviews and questionnaires are required, needing collection, processing and interpretation of data to come to an indication of the level of safety in organisations (Vierendeels et. al, 2018). So, the actual approaches to discover and describe the level of safety in socio-technical systems all work indirectly. They either describe what has been in the past to predict the future or try to find parameters that are able to predict a future safety level.

3. Defining "safety" to discover "unsafety"

Many practitioners and scholars are searching for ways to predict and prevent accidents, approaching this problem from different angles. However, scarce literature can be found regarding the development of tools which instantly and continuously measure the actual safety conditions and performance in socio-technical systems that can be used for direct feedback to managers down to the operational level. Maybe because this can only be realised by changing the way on how organisations look at safety and performance. Actually, there's no commonly

agreed upon definition of "safety" nor of its opposite "unsafety". Today, safety is mostly defined by an absence of accidents, but how does one measure the absence of something? This lack of common ground also leads to different standards with which one tries to measure the safety conditions in organisations, without the possibility to benchmark and compare results between sectors and industries.

However, a standardised (commonly agreed upon) definition of risk exists. "Risk is the effect of uncertainty on objectives". Also, risk and safety are related. People want to avoid running risk in order not to lose what they want (and be safe), while they also take risks in order to achieve something and get or keep what they want (and be safe). In a sense, this is what Hollnagel describes being Safety I and Safety II (Hollnagel, 2014), where Safety II could be understood as being a focus on excellent performance when taking risk and where Safety I is the traditional view of safeguarding something from losses when running risks. The connection between risk and safety can therefore be seen as follows: risk is an uncertain effect on objectives, while the actual performance is the result of that uncertain effect. As such the actual performance is the result of Safety I + Safety II, indicating a level of safety (Blokland & Reniers, 2018).

Using the above stated connection between safety and risk, safety can be defined being "the condition/set of circumstances where the likelihood of negative effects on objectives is low". This perspective on safety explains the difficulty of measuring safety in a general and standardised way. To measure safety, it would be necessary to take into account all objectives that are or should be safeguarded or achieved and this at every moment in time. Furthermore, many "objectives" are not consciously monitored and often one is not aware of individual or other objectives, also being part of the objectives to be considered when trying to determine the (total) level of safety in the concerned socio-technical system. Nevertheless, it is much easier to measure unsafety instead. When everything goes right, most of the time, one is not aware of that fact, because this is a normal condition which the brain will dismiss. It is why measuring safety by leading indicators (SMS) or modelling safety cultures doesn't give a conclusive answer regarding the level of safety in organisations.

Yet, when things don't go as planned, intended or wanted, this will be noticed somehow. It is why safety is traditionally measured by calculating numbers of identified mishaps, measuring "unsafety" instead of safety.

In concert with the above definitions, unsafety could be defined as being "the condition/set of circumstances where the likelihood of negative effects on objectives is High" (Blokland & Reniers, 2017). In this way, it is possible to consider accidents and incidents as being "unsafety", which can also be defined as "negative effects on objectives" or shorter as "failed objectives". These definitions are the basis for developing a new approach in measuring safety in organisations, as explained

further in this paper.

4. Heinrich and Reason revisited

To a certain extent and in one form or another, Heinrich's theories are still considered valid and used today. Actually, you could consider Reason's Swiss cheese model (Reason, 1990) and all related models as an extension or a more comprehensive development of the domino theory, indicating that accidents happen due to a multitude of, most of the time human, factors that are influencing each other. As such, the holes in the slices of cheese in Reason's model/metaphor can be viewed being similar to the dominoes in Heinrich's model/metaphor. The strength of both models lies in their metaphors; they provide ways to understand the complex reality of accidents and loss and the presence and correlation of different categories of risk sources. However, the weakness of both models lies in the fact that they focus mainly on human behaviour and error and as a consequence, errors are categorised and given specific significance. Although it helps to have a limited number of categories and a specific significance, it sometimes leads people to dismiss the basic knowledge both models provide. Besides human error, other factors which are not represented in these models also play a role in organisational safety and performance. This makes these models incomplete from the start when only these specific categories are considered, certainly when maintaining a very strict interpretation on their significance.

A more holistic way to look at the Swiss cheese metaphor is to consider that the presence of cheese can be understood as everything that goes well. It relates to the objectives that have been achieved and which are safeguarded. Hence, the cheese stands for the objectives of sub-systems for which the value is present and can be considered being the result of Safety-II. The cheese therefore represents the achieved and safeguarded objectives and the related created value. On the other hand, the holes in the cheese are the sub-systems for which objectives are not achieved or not safe-guarded and for which the value has been lost or has become out of reach. It represents the unsafety which Safety-I traditionally aims to prevent or tries to compensate for by putting barriers in place. These are the objectives that have failed. As such, these are the different reasons (negative risk sources) which contribute to things going drastically wrong when they become connected. Thus, the holes in the cheese and their barriers represent Safety-I thinking.

5. A systems perspective

Leveson says that 'Safety' is an emergent property of systems, not a component property (Leveson, 2011). It means 'Safety' is something that needs to be pursued, achieved and safeguarded by the system, repeatedly over and over again as a never-ending story. Of course, a component can also be considered as a system on its own,

but every system is also made up of sub-components which also have other and more specific (sub)objectives that need to be safe, different from the objectives of the overarching system, of which the safety has to be achieved and maintained as well. Systems are always part of larger systems and will always consist of subsystems and each of them has its specific objective(s) (purposes) and each of them is subjected to a set of risk sources that can affect those more specific objectives. Failure of objectives of sub-systems can therefore lead to failure of the objectives of the overarching system and ultimately the whole socio-technical system, causing disaster.

Today's socio-technical systems are ever more complex. Complex and chaotic contexts are unordered—there is no immediately apparent relationship between cause and effect, and the way forward is determined based on emerging patterns. Furthermore, a complex system has the following characteristics:

- It involves large numbers of interacting elements.
- The interactions are nonlinear, and minor changes can produce disproportionately major consequences.
- The system is dynamic, the whole is greater than the sum of its parts, and solutions can't be imposed; rather, they arise from the circumstances. This is frequently referred to as emergence.
- The system has a history, and the past is integrated with the present; the elements evolve with one another and with the environment; and evolution is irreversible.
- Though a complex system may, in retrospect, appear to be ordered and predictable, hindsight does not lead to foresight because the external conditions and systems constantly change.
- Unlike in ordered systems (where the system constrains the agents), or chaotic systems (where there are no constraints), in a complex system the agents and the system constrain one another, especially over time. This means that we cannot forecast or predict what will happen. (Snowden & Boone, 2007)

There are cause and effect relationships between the agents in complex systems, but both the number of agents and the number of relationships defy categorization or analytic techniques. Therefore, emergent patterns can be perceived but not predicted (Kurtz & Snowden, 2003). It is why even leading indicators or safety maturity levels will not predict disaster and although the measuring systems of SMS and safety maturity model results can provide interesting and very valid indications of the level of safety in organisations, only an instant notification and aggregation of as much as possible of failed objectives (holes in the cheese) of systems and their sub-systems of socio-technical system, can give a true indication of the level of safety in socio-technical systems. When the number and the importance of failed objectives of systems and their sub-systems is high, then the safety level is low. But when the

number of failed objectives is low, the level of safety is high. This is what Heinrich already noticed when studying accidents in the early decades of the twentieth century. It is also the consequence of the Swiss cheese metaphor. Less and smaller holes in the cheese make it less likely to have a severe accident, as the possibilities for the holes to connect are reduced.

Measuring unsafety to quantify a safety level

A precise measuring of the number of failed objectives (holes) and their level of importance (size of the holes) is, according to this systemic perspective, a direct way to measure the level of unsafety in any organisation or socio-technical system. The biggest challenge is to capture as much as possible of these failed objectives, regardless of the type of objective. These objectives can be technical, organisational or individual, and of relevant stakeholders, including failing technological devices. When this measuring can be instant and direct, an instant indication of a safety level can be obtained, independent from the size, industry or sector of the concerned organisation. However, to make this work, objectives need to be clustered in categories that are equal to any organisation and that provide meaningful information. Also, levels of impact of failed objectives need to be determined in a way that they have the same value for any type of organisation. This would allow for direct benchmarking and comparison between organisations irrespective of their size, sector or industry. Surely, organising such a measurement would be a real challenge, but this becomes possible when all significant stakeholders are willing to instantly report any noticed occurrence of a failed objective and its impact, regardless of the kind of objectives involved. Ideally this situation results from a supporting organisational (no blame) culture, allowing to also report individual failed objectives without attributing consequences to such reporting.

6. Logical levels as impact categories

Another challenge for such a measuring/reporting system, would be to assign commonly accepted categories and levels of importance of objectives to facilitate reporting of failed objectives. The obvious metrics to be used to represent the level of impact of the lost value would be an indication in terms of money and/or time. However, this would not have the same meaning or weight to each organisation or socio-technical system. For small organisations a certain amount of money and time can be much more significant than the same amount for a larger organisation. So, it is also necessary to provide a hierarchy of value that is equal to any organisation.

One of the possible hierarchies that can be used to provide a quick judgement of the level of importance of a failed objective is the concept of the logical levels, attributed to Dilts and Bateson. Dilts (1996) defined the logical levels as leadership skills in applying the concept of Bateson (1972) who recognized “natural hierarchies of

classification" in processes of learning, change, and communication. Dilts (1990) called logical levels "…an internal hierarchy in which each level is progressively more psychologically encompassing and impactful.'' (Janschitz & Zimmermann, 2010). It means that an impact at a higher "logical level" will be perceived as being more important. The scientific problem with the originally proposed logical levels, is the fact that the upper levels, as defined by Dilts, are considered to be "spiritual". But it is less an objection when "spiritual" is replaced by "inspirational". The inspiration of socio-technical systems lies in their purpose, the vision, mission and ambition that will determine the objectives that matter and how they can be valued. In their article "Organizational change: A critical challenge for team effectiveness", Goodman and Loh (2011) describe the logical levels related to change. It provides a good basis to see how the impact of a failed objective increases in importance when this concerns higher logical levels. The logical levels, in increasing level of importance, can be described as follows:

- Environment: is the lowest logical level and refers to what is outside the system: the place and time (where and when) the system pursues its objectives.
- Behaviour: refers to specific actions: what each system does. This will be the outward display of having successfully applied the key expected behaviours for achieving or safeguarding a particular objective.
- Capabilities: are also referred to as 'competencies'. these are the skills, qualities and strategies, which characterise the system. They are how actions of the system are executed. They will often need to be defined, taught and practised in order to support the achievement and safeguarding of objectives.
- Values and Beliefs (rules): 'Values' are what an individual or team/system holds to be important, so they act as the drivers for what the system does. 'Beliefs' are what an individual or team holds to be true, and so influences what the system does and how it acts.
- Identity is how a system sees itself, it consists of the core beliefs and values that define it, and which provide a sense of 'what the system' is'.
- Purpose: 'Purpose' refers to the larger system of which the system is part. It connects to a wider purpose – 'for whom?' or 'what else?'

Using Dilts' model of logical levels to distinguish different levels of importance in failed objectives therefore provides a powerful tool to determine and assess the impact of a failed objective on a socio-technical system.

7. Impact levels

Objectives can be individual, team related, at an organisational or even societal level. Another way to express the level of unsafety is therefore to indicate the

corresponding level of the system that is impacted by a failed objective. This can be seen as a hierarchy of systems, ranging from an individual, a team, to an organisation, or even society as a whole. The larger the system impacted, the more significant the level of unsafety. Again, these levels can be used for expressing a level of unsafety that is not industry, size or sector specific.

8. Discussion

Measuring unsafety can be achieved by capturing and aggregating failed objectives. However, just capturing numbers of occurrences will not provide a correct basis for comparing and benchmarking between organisations of different size, sector or industry. To determine the level of safety of a system that can be compared to another system, irrespective of size, sector or industry, an indication in time and money is not sufficient. Though, this can be solved by creating a multidimensional model that allows to aggregate results in a way that is equal to all sorts of socio-technical systems. A first step is to distinguish the kind of objective that failed and to categorize them in groups of similar purpose (for instance: financial, technical, operational, reputational, physical, …). Furthermore, failed objectives can be scaled in size by categorizing them according to the logical levels and the levels of impact, as discussed earlier. Additionally, the impact can be further refined by setting universal categories of time and money to value the loss occurred by the failing objective. For instance, time lost can be expressed in minutes, hours, days, weeks, months or even years and money can be expressed in <10, $<10^2$, $<10^3$, $<10^4$, etc… of a currency, as such using levels that are the same worldwide.

Measuring can be done by reporting anything that is not giving (full) satisfaction or of anything that doesn't function as expected or doesn't reach the intended goal, which has an impact on one or more objectives, linked to the different categories expressed earlier. These reports can then be aggregated per category as indicated earlier. This is not an easy thing to achieve, but ways can be found to build a workable solution that allows for such a multi-dimensional, instant measuring system.

9. Practical issues and challenges

Still, such a measuring system needs to be easy and acceptable to the involved stakeholders. The proposed "pro-active unsafety measuring system" aims to accommodate for these prerequisites. Ease of use can be obtained by using such an application on smartphone, tablet or computer, categorising the objectives involved into categories that reflect the kind of loss incurred (loss categories) and categorising

the negative effects by the range of logical levels impacted (impact category), the kind of system that is impacted (impact level) and its size expressed in clear numbers of money and/or time (severity level). This creates a multidimensional model describes and reports any set of negative effects on objectives and "near misses" (losses), ranging from the smallest time loss to the biggest catastrophe, in only a few seconds.

Acceptability needs to come from how collected data is represented, how managers use obtained information and how the information is presented and fed back to the concerned stakeholders. Ideally, the data is fed into a dashboard that instantly translates the data into a safety situation of the entire organisation and its components.

10. Conclusions

For decades, scholars have been looking at ways to capture the level of safety in organisations, creating complicated measuring systems, capturing a multitude of parameters that have been determined by analysing organisations and their mishaps. But until now, no system is capable of exactly and continuously indicating a quantified level of safety of an organisation.

Starting with a clear definition of safety and unsafety and a clear notion of what unsafety represents in socio- technical systems, combined with the use of a multicriteria model, using specific loss and impact categories combined with impact and severity levels, it would be possible to create an aggregated model that can provide a clear and instant indication of levels of unsafety in organisations, indifferent from size, sector or industry.

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PART 2

REFLECTIONS

&

CONCLUSIONS

1. Reflections

1.1. Build-up of a design that proactively achieves, maintains and improves safety and performance

In Part 1, Chapter 1, a semantic and ontological foundation regarding the concepts risk, safety and performance has been forwarded to provide a coherent set of mental models regarding these constructs that form the bedrock for a design that proactively aims to achieve, maintain and improve safety and performance in organisations. A crucial part of this paradigm that underpins the design, exists in the fact that risk is to be seen as a neutral idea, where the qualification of being positive or negative will be determined by the most likely effect of a risk source on an objective of concern. When a risk source is considered most likely to have a positive impact on an objective, the associated risk can then be regarded as positive, while a likely negative impact on an objective is to be thought of as being negative risk. This is extremely important, because both the positive and the negative impacts on objectives need to be managed simultaneously in order to increase safety and performance proactively. Another consequence of this paradigm is the understanding that risk, safety and performance, when considered from an objectives-based viewpoint, in essence are the same, and that only a time perspective for an actual situation separates these concepts. Furthermore, this perception regarding risk entails that different risks exist for individuals or organisations that have different objectives and that they can be in conflict when they ore not aligned. Yet, today, there are still many scientists and professionals that consider risk and safety being antonyms, only considering the negative side of risk, with a focus on uncertainties instead of objectives. As such, they are ignoring the possibilities that looking at the positive side of risk, and a focus on goals, offers in being proactive towards intentions, also when these objectives are conflicting. Therefore, they are also discounting the associated benefits of such viewpoint for safety and performance. But new mental models are high leverage points, and, as Meadows indicated, they meet a lot of resistance, also in the scientific world.

The effect and importance of mental models on safety and performance have been explored in Part 1, Chapter 2. In this chapter, additionally the benefits of adopting a systems thinking approach have been studied. Essential for the design and how to understand it, is the (innovative) mental model on how to look at safety in organisations from an objectives viewpoint, as presented in Chapter 1, in combination with the Swiss Cheese metaphor, where "cheese" represents achieved and safeguarded objectives and the "holes in the cheese" represent unachieved and

failed objectives. The essential part of this mental model is the attention given (respect) to the smallest "holes" in the "cheese", as rapid change and dynamics can have these "little" shortcomings appear as being important causes for major accidents or, likewise, they can become the drivers of future success when correctly managed. Altogether, this way of looking at reality forms a broad and encompassing perspective on safety and performance in organisations. In this chapter it is also made clear how individual mental models can significantly impact safety and performance in organisations and therefore need to be managed carefully, also at an individual level.

A logical next step in developing the design is answering the question on how to manage mental models in organisations, also at an individual level, which is the subject of Chapter 3 in Part 1. Changing mental models and organisational/team learning is achieved by combining a systems thinking approach and integrated thinking. The innovation in this chapter is to be found in the combination of the understanding how these two complementary ways of looking at reality provide the handles to become more proactive in managing risk, safety and performance. Individual perceptions that come about (ladder of inference) need an appropriate leadership perspective (Cynefin & Logical Levels) and alignment of individual and organisational objectives, taking into account societal objectives, in order to generate a strong and appropriate organisational culture. Furthermore, all of these concepts are brought together in a specific use of the knowledge contained in the ISO 31000 standard. Adapting leadership and thinking styles in relationship to one's quality of perception (domains of the Cynefin framework) is how one can improve safety and performance in organisations when combined with the ISO 31000 principles, framework and process, to adapt and improve the mental models that govern the decisions taken throughout an organisation.

Chapter 4 puts the guiding ideas of the different chapters of Part 1 together into the Total Respect Management design. This chapter also explains how the processes of "Leadership" (respecting people), "Management" (respecting profit) and "Continuous Improvement" (respecting the planet) form the pillars on which the TR^{3}M design rests. These three processes, in a way, also respond to the questions "why" things need to be done (leadership), "what" needs to be done (management) and "how" things need to be done (continuous improvement) to achieve the organisational purpose and its subsequent objectives. A special focus towards excellence is made clear in the specific characteristics that correspond with the results, such as tasks, processes, products or services of the organisation, which can

or need to be improved.

An important aspect of the design is the cooperation and engagement of all relevant stakeholders in the overall improvement effort. A systemic and integrated methodology will work best when all concerned are involved and participate in the attempt to reach excellence. Chapter 5 offers a way how appropriate stakeholders can contribute by sharing their experiences and emotions of events that happened. Sharing the bad and good experiences in the structured way of an instant safety measurement system, aligned with the semantic and ontological foundation provided in Chapter 1 and following the guidance forwarded in Chapter 5, can serve as a direct input to improvement actions of the leadership and management of the organisation, given that the measuring system and the feedback it provides can also be used as a communication tool to discover and tackle issues that otherwise remain unnoticed. Unnoticed concerns or unexpected successes can influence safety and performance drastically when solutions can be found to these hidden latent failures or unknown success modes. Because, when adequately managed, the system will provide the data (numbers and parameters) and information needed, allowing to improve the quality of perception on hidden issues throughout the organisation, permitting the start of a dialogue regarding the issues of importance in a structured way, when aiming to improve situations, solve problems, or pursue new opportunities.

1.2. The use of leverage points by the design

By design, TR³M acts on all of the leverage points proposed by Meadows, as mentioned in the introduction part. Foremost, adopting a systems thinking mindset should allow people to become aware of the value of different perceptions and offer the ability to become capable in changing one's existing beliefs and adopt new mental models. Furthermore, the TR³M design offers a whole range of coherent paradigms that allow to build a learning organisational system, improving the mental models present in the organisation and therefore generating safety and performance automatically. TR³M also has appropriate and dedicated attention for objectives and the goals of the various systems that make out the organisation. The above qualities additionally create the power to add, evolve, change or even self-organise the organisations systemic structures when required. Moreover, continuous improvement allows to change the rules of the system when needed. So does it for the information flows, as "communication and consultation" is a crucial aspect of ISO 31000, and an essential part in the functioning of the leadership process. Integrated and systems thinking also provide attention for the dynamics to

be found in the organisational systems, looking for the enhancement of the various feedback loops that exist, as well as the other elements of the systems, such as delays, stocks and flows or buffers. Finally, the measuring system, proposed in Chapter 5, allows to get constants, parameters and numbers of items in a very detailed and standardised way, allowing to react much quicker and even anticipate to positive and negative events alike. As such, TR³M is able to act on all of the leverage points proposed by Meadows.

1.3. Towards an empirical application of the design

A first, very preliminary attempt was made to implement Total Respect Management in an operational environment, as a design, and test it by measuring daily results. As sponsors of this research project, the Dutch gas distribution companies were very much willing to support a first empirical application. During the entire period of this study, the belief in the design was present. Also, the ideas on which the design was based were recognized. As part of the informative briefings held at the sponsoring organisations, the design was welcomed with enthusiasm and people felt that it could help them in achieving safety and performance proactively. Yet, at the end this plan could not be realized for various reasons.

For the distribution companies, this research project came at the wrong time. This was the general impression shared by all interviewed managers. They are operating in a period of constant and significant change that goes along with different kinds of initiatives. This provides for a high workload and a lack of room in their resources (people and time) to accommodate yet another new initiative. There was also a concern that this new initiative could be conflicting with ongoing programs, or the fact that some teams would be trained and others not, leading to inequality between people, something that could possibly cause grief.

Although the managers didn't support a test of the design at this moment, they didn't express doubts or major concerns regarding the design itself. On the contrary, after reiteration of the main ideas and concepts and how these could practically work, they saw similarities with the ongoing projects and actually believed the design could work as a methodology to proactively achieve safety and performance in organisations. Another remark noticed, was the fact that only very late in the project people were informed of the subject and extend of the study, making it very difficult to support the research as initially intended. To implement such a project, at least one year of lead time would be required.

Another brief test of the design was conducted in the academic environment of the

researcher at two involved research groups at the faculty of Technology, Policy, and Management at TUDelft. An embryonic version of a measuring system was developed, based on the principles forwarded in Chapter 5. We were interested to see if this new way of looking at safety, the use of the logical levels of awareness as a yardstick, and instant reporting could work. This initial test only assessed the principles of recording safety and unsafety with a web-based tool, without having the use of a permanent dashboard and without any immediate action on the reporting by the leadership and management of those sections. This in spite of the fact that it is to be considered that a permanent dashboard and immediate action, in our experience, are absolutely necessary for any successful use of an instant measuring system when reporting and monitoring the safety situation in organisations. As such, the test is performed without much actual use of the data received, as this would require a larger investment in the actual tool and the active cooperation of the leadership and management of the research groups to act and respond promptly on the data received. The only objective of the test was to validate the usability of a comprehensive but simple test system, specifically developed for this research, coherent with the papers mentioned above.

The basic test tool used was an online open survey, where employees could log in anonymously, accessible via a dedicated link to the survey. As such, the reporting could be done from any device with an internet access. Initially, only reporting for Safety I was considered, but advancing insight made that soon the application provided dedicated links for each of the possibilities of Safety I and Safety II reporting, in complete alignment with how safety and performance are regarded in this study.

Research Group1

Both tests were conducted at a voluntary basis. At Research Group 1, a maximum number of people were briefed on the purpose of the test and the use of the system. However, with a few exceptions, the tenured staff was not able to contribute to the test. It meant that only PhD students participated and mainly because they were strongly suggested to do so. For the test, this posed a problem. Because PhD students are less involved with the objectives of the organisation or the department/section they belong to. Their goals are very individual and do not necessarily align with the goals of the section, the department or the faculty. Hence, the reporting did not reveal or indicate a safety situation within the organisation, other than the very obvious hazards and the safety of individual goals. Furthermore, it soon became clear that the needed trust and involvement to report seemed lacking, as only reports

were received that were very similar to the examples given during the briefing. Therefore, the test was soon terminated as no meaningful substantial information could be gathered.

The only feedback taken from this test was the fact that the reporting system could work as a tool for immediate reporting, as the use of the different categories was appropriate, and no difficulties were noted regarded the comprehensiveness of the proposed parameters. Any occurrence could be reported using the proposed classifications and also no problems were noted for the use of the logical levels as a yardstick to indicate the importance of the impacted objectives. Furthermore, according to the tool's statistics, the average reporting time was less than 2 minutes to file a full report. This confirmed the finding that using the tool wasn't perceived as a burden on the participant's time expenditure.

Research Group 2

As a result of this first test, a second attempt was conducted at Research Group 2. This time, the group consisted of a small number of participants that all volunteered to take part in this second test. The experience of the first test was helpful in setting up this second try-out of the system, in the way that it provided for a better context, with a variety of staff members and students that participated. Furthermore, a periodical feedback moment was planned to gather and offer feedback on the use of the system and its results. In that regard, it was interesting to notice that spikes of increased reporting occurred, each time following the moments where the results of a past period were presented to the group, confirming the need for active and immediate involvement of leadership and management when reporting happens. These spikes didn't occur in the first test, as no feedback was provided to the participants at that time. This finding supports the idea that feedback on what has been reported is essential in using a voluntary reporting system. Additionally, the preliminary findings of the first test regarding the useability of the reporting tool were confirmed.

1.4. Tailoring the design

Although Total Respect Management conceptualizes the method, strategy, and philosophy upon which this study is based, it still needs to be further developed and tailored into a customised set of actions to be implemented in any organisation. The crucial aspect of the design is the ability of changing individual mental models in organisations to create a corporate culture of excellence. This is not an obvious task, nor easily achieved, as it will require a specific effort of, amongst others, human

interaction in the form of dialogue. The above description of the first attempts to bring this approach into practices are illustrative in this respect. Selecting and/or developing dialogue tools that are aligned with TR³M is therefore an important aspect to consider in developing the design. Although the elements of TR³M contain several mental models essential to its application, it could be necessary to reflect on and study additional mental models (supporting or hindering the implementation and use of the design) and determine which mental models need to become part of the organisational culture and also which one's should be eliminated or altered to prevent problems in the execution of the project.

Also, the design itself (processes & procedures) needs to be tailored to the organisation willing to cooperate in this study before it is implemented. Hence, the investment in time and effort to reach a full implementation are substantial.

The effort and resources needed to tailor and implement the design is most certainly one of the reasons why an operational test wasn't thought possible. Furthermore, such implementation impacts at the core of a system and its paradigms. Therefore, without sufficient means and an appropriate explanation and preparation, implementation of the design might encounter opposition and fail.

However, as in any systemic approach, the investment precedes the results and there's no such thing as a free lunch. As a consequence of how the design works, it needs the full cooperation, support and belief of the top. Leadership will need to picture and show this new reality to the people and intervene at all places to leverage the system. Nevertheless, all leverage points are covered by the design and when leadership and management prepare an implementation well, with full support of the top and used in alignment with a corporate purpose, a TR³M implementation is bound to be successful, sooner or later leading to an improved safety and performance at all levels and in all aspects of the organisation.

2. Conclusions

2.1. SRQ 1: *"How to understand and conceptualize the notions of risk, safety, security, and performance?"*

In this chapter, we presented the controversial opinions on the concepts of risk, safety, and security, and expounded on how the awareness, meaning and understanding regarding these concepts vary and changed in the past decades. Accordingly, an ontological and semantic foundation for safety and security science was proposed, based on the ISO 31000 definition of risk, providing a coherent point of view on these topics. This foundation is to be used in a general and universal way, providing a common understanding of these very important concepts. Furthermore, the proposed ontology provides a basis on which the Total Respect Management design stands and also on how safety can be measured in an innovative way.

2.2. SRQ 2: *"What is the significance of mental models for upholding safety in organisations?"*

In our ever more complex and connected world, the safety of systems depends on the interactions and performance of the much smaller sub-systems. Hence, a proactive way to reach safety and performance of systems, therefore, is to focus on the performance of the sub-systems at ever deeper levels of detail within the concerned system. Ultimately, from a systemic perspective, the safety and performance in teams, departments, organisations or even society as a whole, depend on the mental models that govern the system, or in our case, the organisation and its relevant stakeholders.

2.3. SRQ3: *"How to change mental models in organisations to proactively improve safety and performance?"*

Goals (objectives) and how to approach them, are the crucial mental models in organisations that govern the organisation as a system. Determining, developing and communicating objectives are crucial leadership responsibilities. These leverage points need to work in concert, and this is the role of leadership. Hence, the importance of alignment. Looking at different systemic models led to the proposition of a "Dynamic Cultural Alignment model" (Flywheel of Alignment) and a "Dynamic Organisational Alignment model", both based on the "logical levels of awareness" with which an organisation can align its members with the goals that coincide with the vision, mission and ambition of the organisation. Alignment will also occur with its corresponding strategy. Furthermore, ISO 31000, as a part of the TR^{3}M design, can be used as a practical organisational alignment tool to achieve safety and performance in organisations proactively. Because, following the guidance in this standard allows to organise and structure dialogue in organisations

to create, change and disseminate the needed mental models (objectives, values, criteria), that generate and allow for a dedicated focus on what matters for the organisation. ISO 31000 also respects and includes the human and cultural factors (the role of leadership) and discovers how the sub-systems interact and create value or produce unwanted events that can be avoided (the role of risk management). As such, ultimately, it is possible to simultaneously consider risk, safety (and security) and performance of even the smallest sub-systems and aim to reduce the number of failed objectives by continuous improvement. This will be achieved by focusing on, and giving attention to, even the smallest details, creating and maintaining safety in a sustainable way (the role of excellence).

Consequently, Total Respect Management, as a design, is a methodology, a strategy, a practice, … based on a specific perspective on risk, safety and performance. It focusses on leadership by respecting people to create alignment. Alignment provides for clear objectives for which the effects of uncertainty on those objectives need to be managed. Subsequently, TR³M also focusses on risk management according to ISO 31000 to respect the profitability of the organisation by creating and protecting value. Finally, this methodology also focusses on a continuous improvement of a dedicated set of characteristics of processes, procedures, products and services, resulting in more safety and better results, including "to do more with less", in order to respect the planet.

2.4. SRQ4: *"How to implement pro-active safety management and improve the performance of organizations of any size or sector, operating in a volatile, uncertain, complex and ambiguous environment?"*

Unfortunately, no implementation of the TR³M design could be achieved. TR³M is a holistic and systemic approach. It will likely not work as well as anticipated whenever parts of the design are not fully implemented. It involves new paradigms, a lot of change and needs education of those who are going to use the design. A comprehensive program has been proposed to candidate organisations. But the effort needed to implement the design seemed to drastic, where mostly the effort in time of concerned personnel appeared to be problematic. As such, no final conclusions could be drawn regarding this question.

However, studying this question from a theoretical viewpoint, implementing the design and its practices should accommodate for most of the pitfalls encountered in strategy changes. When executed in the right order, i.e., increasing leadership skills, then implementing ISO 31000 and finally focus on continuous improvement, the accompanying mental models will generate the systems needed to reach success. As indicated earlier, this will require a substantial effort, there's no way around it. But when properly done, the benefits will make up for those efforts, as investments

always precede the profits. The more one puts in, the more will be received afterwards.

2.5. *SRQ5: How to measure safety and performance in dynamic sociotechnical systems in a comprehensive and standardised way?*

The theoretical approach, forwarded in Part 1 Chapter 5, based on the ontological and semantic foundation expounded in Part 1 Chapter 1, starts with a clear definition of safety and unsafety and a clear notion of what unsafety represents in socio- technical systems. This foundation is combined with the use of a multicriteria model, using specific loss and impact categories combined with impact and severity levels.

A model, using 8 "loss categories" and 8 "impact categories" combined with 7 "impact levels" related to the logical levels and 7 "severity levels" expressed in time and/or 8 "severity levels" expressed financially, has been tested with two research groups at TUDelft. The methodology itself seems to be comprehensive and sufficiently universal to achieve its aim. However, more robust testing will be required to draw definitive scientific conclusions. But, in such case, it is crucial to have the involvement of the top and a functioning feedback system that presents the gathered information in such a structured and generalised way that it allows leadership and management to act on the data received. As in any voluntary reporting system when trying to capture sensitive information, anonymity and protection of the data is also paramount to build trust.

3. **How can organisations proactively generate and improve safety and performance in volatile, uncertain, complex and ambiguous situations, taking into account sustainability, human factors and mental models?**

In order to change an organisation and how people behave, mental models present in the organisation need to change, as these mental models, whether collective or individual, will determine the system and its outcomes. A possible approach to change mental models in organisations, in such a way they will generate systems that engender safety and performance proactively, is the full implementation of Total Respect Management.

TR³M changes mental models through developed leadership and alignment. It further changes mental models through extensive use of risk management according to ISO 31000 to enhance one's quality of perception. Finally, mental models are further shaped by the dedicated attention for continuous improvement.

The three complementary ways of changing and influencing mental models, will eventually generate the systems that provide for safety and excellent performance in a sustainable way. First preliminary steps towards empirical implementation are made, as reported earlier. As already indicated above, an important aspect of the design and its methodology is a new, innovative and more encompassing way on how to look at risk, safety and performance. Another part is the assumption that mental models are at the origin of the results obtained by organisations, whether these results are intended and good or unintended and bad. Together, these attributes form a new way on how to look at, and deal with, safety and performance in organisations, offering a more proactive approach to deal with the challenges regarding safety and performance organisations face in a VUCA world. This new way is assumed to work by accessing important leverage points through increasing alignment of goals (objectives) and increasing the quality of perception in organisations (improving mental models), which in turn should lead to better decisions and consequently the proactive achievement of more safety and better results.

Following this new paradigm, Total Respect Management has been presented as a design that answers the search for a more proactive approach towards safety and performance. As a consequence of the proposed foundation also a new innovative (un)safety measuring system has been suggested as a by-product of this research. When properly developed, it should be able to be used as a dialogue and alignment tool when embedded in the Total Risk Management methodology.

Most important is that Total Respect Management, as a design, aims at the highest possible leverage points, the way they are proposed by Meadows. TR³M aims at leadership skills and practices that incite an improved level of dialogue in

organisations, combined with educating managers regarding systems thinking. This offers the possibility of using the highest leverage point imaginable. When these qualities are present in the management of an organisation, and when these abilities are used, they will create the capability to transcend paradigms. Furthermore, through the application of ISO 31000 to its fullest potential, when communication and consultation is structured in an approved approach to communication and when held in the form of a dialogue, it will enhance the quality of perception. It will allow an organisation to communicate deliberately and align around the corporate goals, ranging from strategic goals down to the day-to-day tasks. Using the techniques and tools offered in the book "Safety & Performance", this dialogue can be structured throughout the organisation and used as an alignment tool to develop a common understanding of corporate goals and to create and strengthen the mindset that has to support these objectives. The use of the ISO 31000 framework allows the organisation to be very clear about risk ownership, the authority, responsibilities, accountabilities and the rules of the system. Also, with the ISO 31000 process, it adds a way to react to change on a daily basis, aligned with the corporate purpose in a structured way. The ISO 31000 process also enables an organisation to improve anything that needs improvement or change anything that needs to be changed proactively when risks are identified in due time.

Combining systems thinking with the use of the ISO 31000 process also allows to be proactive about the gain of positive feedback loops and the timely discovering and use of the presence and strengths of negative feedback loops. It can also be used to react appropriately when delays in the system occur or when buffers and stabilising stocks need to be installed or improved, making best use of parameters such as risk, safety or performance indicators.

Furthermore, the TR³M design offers a dedicated focus on excellence, increasing the sustainability of the organisation and its products and services by controlling and improving on the levels of excellence (effectiveness, productivity, efficiency, ergonomics, ecology, safety and quality) of products and services.

4. Future research

While the theoretical foundations of the design and the basic set-up of an instant measuring system have been explored and determined, an actual implementation of TR³M could still be the subject of a scientific study where it should be the purpose to fully implement the design and its measuring instrument to assess and evaluate their effectiveness.

However, crucial for the success of a TR³M implementation is the belief and support of top leadership and management, providing adequate resources in time, people and money, in order to train managers and decision makers in their leadership skills, ISO 31000 knowledge and understanding and the implementation and use of a comprehensive (un)safety measuring system to create an organisational information feedback loop where managers and leaders can act upon. This is not an easy task, but an effort needed to become excellent in a sustainable way. When top leadership and management don't embrace the mental models on which the design is based, it will be impossible to make it work.

Other possible studies can be carried out regarding the presence of hindering or supporting mental models in organisations. And additional studies can be imagined, specifically regarding the mental models concerning risk, safety and performance in organisations and society. For instance, the role of mental models in society for example in energy transitions, transportation or climate change, can provide insight how to deal with perceptions on a societal level. This information can then also be used inside organisations in changing and improving mental models.

Furthermore, research can also be conducted concerning dialogue and its effect on safety and performance in organisations. Also, the various dialogue tools that are in use in organisations and how they are structured and used can be studied, in order to determine their specific effects on safety and performance. For example, how do organisations perform compared to the level of dialogue present in those organisations and how sustainable are the results these organisations achieve.

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6. Publications

Type of article	Title	Authors	Publication
Foundation for safety & security science			
Conference paper	An ontological and semantic foundation for safety science.	Blokland & Reniers 2018	Safety and reliability: safe societies in a changing world: proceedings of ESREL 2018, June 17-21, 2018, Trondheim, Norway/Haugen, Stein [edit.] (pp. 3157-3164). https://doi.org/10.1201/9781351174664
Concept paper	An Ontological and Semantic Foundation for Safety and Security Science	Blokland & Reniers 2019	Sustainability 2019, 11, 6024 https://doi.org/10.3390/su11216024 Published: 30 October 2019
Book Chapter	The Concepts of Risk, Safety, and Security: A Fundamental Exploration and Understanding of Similarities and Differences	Blokland & Reniers 2020	SpringerBriefs in Applied Sciences and Technology FONCSI https://doi.org/10.1007/978-3-030-47229-0 http://www.springer.com/series/15119
Mental Models			
Concept paper	Safety Science, a Systems Thinking Perspective: From Events to Mental Models and Sustainable Safety	Blokland & Reniers 2020	Sustainability 2020, 12, 5164; https://doi.org/10.3390/su12125164 Published: 24 June 2020
Concept paper	Achieving Organisational Alignment, Safety and Sustainable Performance in Organisations	Blokland & Reniers 2021	Sustainability 2021, 13(18), 10400; https://doi.org/10.3390/su131810400 Published: 17 September 2021
Measuring Safety			
Literature review	Process safety indicators, a review of literature	Swuste, Theunissen, Schmitz, Reniers & Blokland 2016	Journal of Loss Prevention in the Process Industries 40 (2016) 162e173 http://dx.doi.org/10.1016/j.jlp.2015.12.020
Concept paper	Measuring (un)safety. A broad understanding and definition of safety, allowing for instant measuring of unsafety.	Blokland & Reniers 2019	Chemical Engineering Transactions, 77, 253-258. https://doi.org/10.3303/CET1977043
Total Respect Management			
Book	Safety and Performance Total Respect Management (TR^3M): A Novel Approach to Achieve Safety and Performance Proactively in Any Organisation.	Blokland & Reniers 2017	Nova Science Publishers, Inc. 415 Oser Avenue, Suite N Hauppauge, NY, 11788 USA ISBN: 978-1-63485-845-8

7. Curriculum Vitae Peter Johan Blokland

Peter Blokland, born the 8th of August 1957 in Antwerp, Belgium, studied mathematics and sciences at the Royal Athenaeum Mortsel (1977). He obtained his master diploma at the Royal Military Academy in Brussels in Military and Aeronautical sciences (1983), to become a fighter pilot, flying the F-16 at Kleine Brogel airbase in 1985.

In 1988 he was appointed flight instructor continuing his career educating student pilots.

In 1991, he continued studies at the Royal Higher Institute for Defense (KHID) to become a superior officer.

As a superior officer, he occupied duties as a staff officer, commanding officer and aircraft accident investigator, following various courses regarding aviation safety, human factors and aircraft accident investigation. He also served at the NATO, SHAPE, NucOps, dealing with nuclear surety and command an control.

At the age limit, he retired from military service in 2007 to start a second career as a business coach, trainer and consultant, specialised in ISO 31000, Systems Thinking and Organisational Alignment.

In 2013, together with Prof.dr.ir. Genserik Reniers, het wrote the book "Total Respect Management", bringing together his experience as a pilot, staff officer, commanding officer and consultant.

As a consequence, in 2014, he started a PhD project at TUDelft, sponsored by Netbeheer Nederland, that lasted till 2018. The purpose of this project was to implement and study a design to proactively achieve safety and performance in one of the member organisations of Netbeheer Nederland. Unfortunately, this could not be accomplished. Therefore, a new approach was followed between 2018 and 2022 to produce this thesis on a theoretical basis.

8. List of Figures

Introduction

No figures

Part 1

Chapter 1

Chapter 2

Chapter 3

Chapter 4

Chapter 5

No figures

Part 2

No figures

9. List of tables

Introduction

No tables

Part 1

Chapter 1

Chapter 2

No tables

Chapter 3

Chapter 4

No tables

Chapter 5

No tables

Part 2

No tables

10. References

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