



Delft University of Technology

Fading of Safety Awareness Influence of Ethical Fading in (Petro)Chemical Industry

Ziskoven, Benjamin Elias; de Bree, Martin; Reniers, G.L.L.M.E.; van Nunen, K.L.L.

DOI

[10.3390/su172310463](https://doi.org/10.3390/su172310463)

Publication date

2025

Document Version

Final published version

Published in

Sustainability

Citation (APA)

Ziskoven, B. E., de Bree, M., Reniers, G. L. L. M. E., & van Nunen, K. L. L. (2025). Fading of Safety Awareness: Influence of Ethical Fading in (Petro)Chemical Industry. *Sustainability*, 17(23), 1-21. Article 10463. <https://doi.org/10.3390/su172310463>

Important note

To cite this publication, please use the final published version (if applicable). Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

Takedown policy

Please contact us and provide details if you believe this document breaches copyrights. We will remove access to the work immediately and investigate your claim.

Article

Fading of Safety Awareness: Influence of Ethical Fading in (Petro)Chemical Industry

Benjamin Elias Ziskoven ¹, Martin de Bree ^{1,*}, Genserik Reniers ² and Karolien van Nunen ²¹ Rotterdam School of Management, Erasmus University, 3062 PA Rotterdam, The Netherlands² Safety and Security Science Section, Faculty of Technology, Policy and Management, Delft University of Technology, 2628 BX Delft, The Netherlands

* Correspondence: mbree@rsm.nl; Tel.: +31-6-5161-2866

Abstract

A lack of safety awareness in industrial companies can cause substantial harm to people and the environment. This study explores how fading of safety awareness influences safety-related decisions in (petro)chemical companies. Drawing on ethical fading theory, the research aims to better understand the mechanism that causes safety to decline and to identify ways to prevent this process and reduce safety incidents. Semi-structured interviews were conducted within the (petro)chemical industry to explore this phenomenon. The findings suggest that self-interest plays a more significant role in safety incidents than previously assumed and manifests in multiple forms that contribute to the fading of safety awareness. Moreover, self-interest was seldom identified as a formal root cause of incidents, likely because the fading process occurs largely at a subconscious level, as described in ethical fading theory. Finally, the study found that neutralization techniques were frequently used to justify unsafe behavior, both ex ante and ex post. These insights extend existing theory by linking ethical fading to safety management and highlight the need for interventions that address subconscious drivers of unsafe decision-making.

Keywords: safety awareness; ethical fading; industry; safety management; neutralization; sustainability



Academic Editor: Lucian-Ionel Cioca

Received: 29 August 2025

Revised: 14 November 2025

Accepted: 14 November 2025

Published: 21 November 2025

Citation: Ziskoven, B.E.; de Bree, M.; Reniers, G.; van Nunen, K. Fading of Safety Awareness: Influence of Ethical Fading in (Petro)Chemical Industry. *Sustainability* **2025**, *17*, 10463.

<https://doi.org/10.3390/su172310463>

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Safety is essential for the (petro)chemical industry. Incorrect handling of hazardous substances, industrial processes, or installations can cause substantial harm to people and the environment, with lasting effects on sustainability [1,2]. Although safety in the (petro)chemical sector is relatively high compared to other industries [3,4], the ambition remains to improve further.

Past research mainly explains environmental disasters such as Deepwater Horizon through technical failures or unsafe choices by morally disengaged people that were consciously motivated by financial motives [5,6]. This study, however, builds on ethical fading theory, to examine another mechanism that may lead to unsafe decisions and ultimately, environmental disasters.

It is known from research that employees sometimes take shortcuts that can cause unsafe situations [7–9]. Some shortcuts may be related to mechanisms referred to as ethical fading. Although research has been conducted on the ethical fading mechanism [10,11], the specific threat that this mechanism may pose to safety awareness in industry remains

understudied. This threat is problematic as the fading of safety awareness may impact the safety of people and the environment [12].

Safety awareness refers to an individual's own awareness of safety issues [12]. Wang et al. (pp. 2–3) emphasize that safety awareness works on a cognitive and behavioral level: "Cognitively, safety awareness means being mentally aware of safety in one's work and recognizing what behaviours foster operational safety. Behaviourally, safety awareness encourages the behaviour that fosters operational safety. Therefore, safety behaviour is the employee's immediate emotional response to awareness." [13]. Safety awareness involves recognizing and comprehending potential dangers, adopting a proactive mindset to prevent accidents or incidents, and being knowledgeable about safety protocols and procedures.

Safety awareness, just like environmental and quality awareness, relates to the awareness of a value, safety. As safety can be perceived as an ethical value, safety awareness can be considered to be a part of ethical awareness. Hence, safety awareness fading can be seen as a part of ethical fading. Knowledge needs to be developed about the phenomenon of ethical fading or fading of safety awareness in order to understand whether this problem is substantial, and if so, how possible causes can be overcome, what role fading of safety awareness plays in, and how the unwanted or negative consequences of fading of safety awareness can be limited. The aim of this research is, therefore, to find out what role the fading of safety awareness plays in safety-related decisions in (petro)chemical companies.

Ethical Fading Theory

Business ethics research has shown that decision frames may be modified under the influence of self-interest [10]. Building on Becker, we define self-interest as the pursuit of one's own goals, welfare, or advantage [14]. This process, referred to as ethical fading, leads to the removal of ethical considerations in decision-making. The theory of ethical fading can be helpful in explaining why unethical decisions are made, such as decisions relevant to safety. An obvious risk when making decisions is that practical considerations that are important for safety can fade under the influence of various forms of self-interest, such as financial gain, or other practical considerations, such as fulfilling a task faster. Tenbrunsel and Messick define ethical fading as the "process by which the moral colors of an ethical decision fade to bleached hues that are void of moral implications" (p. 224). Decision frames can change so that, for instance, economic considerations become dominant [15]. Tenbrunsel and Messick posit that ethical fading is usually triggered by self-interest, leading to self-deceit [10]. This self-deceit then leads to a change in decision frame and possibly to unethical decisions. Examples of incidents in the (petro)chemical industry in which ethical fading may have played a significant role include the fire at Chemiepack Moerdijk in 2011 [16], the explosion at the Texas City Oil Refinery in 2005 [17], and the Deepwater Horizon disaster in 2010 [18,19]. In all these incidents, forms of self-interest were somehow on the agenda of the operators and managers involved. In this article, it is explored whether this ethical fading mechanism may be a cause for decisions leading to unsafe situations.

Related theoretical concepts such as bounded ethicality [20,21] and normalization of deviance [22,23] may be mentioned for those readers interested in the topic to be explored. Bounded ethicality refers to the psychological and organizational factors that constrain individuals' ability to act ethically, even when they want to do so. Normalization of deviance refers to the process by which a group or organization gradually comes to accept unsafe, unethical, or otherwise deviant behavior as normal, due to its repeated occurrence without immediate negative consequences.

Ethical fading causes decisions not to be made in the interest of the organization but in the self-interest of the individual [10]. Furthermore, these authors argue that ethical fading in part takes place at an unconscious level and is, therefore, difficult to identify and

influence. In line with this notion, Moore and Loewenstein argue that in many instances, ethical and professional responsibilities operate via controlled processes, whereas self-interest tends to operate via automated processes [11]. The latter is, therefore, naturally advantaged over ethical and professional responsibilities. Moore and Loewenstein (p. 189) put it this way: “The automatic nature of self-interest gives it a primal power to influence judgment and make it difficult for people to understand its influence on their judgment, let alone eradicate its influence.” [11]. This notion also clarifies why codes of ethics and training are not sufficient because they do not address the fact that ethical considerations compete with frames that are based on self-interest. The latter can be strong due to their automatic nature.

Identifying this ethical fading mechanism is problematized by the notion that this mechanism triggered by self-interest takes place at the unconscious level of the person involved [24]. The person in question is convinced that they are doing the right thing while nevertheless making a decision that may lead to unsafe situations and incidents.

Conditions that enable ethical fading—so-called enablers—include the use of euphemisms, such as justifying safety risks, by using terms, such as “it has to remain workable”, expressions of complacency, such as “this has been going well for 30 years”, and a slippery slope of gradually sliding towards more convenience or laziness with regard to safety aspects [24].

The mechanism described by ethical fading theory mainly concerns what precedes a decision leading to an unsafe situation. It is also interesting to explore what happens after such a decision has been made, and, in particular, when a (near) incident occurs as a result. When the decision is analysed in retrospect, there is a tendency to neutralize the behaviour in order to maintain the belief that the action was safe despite the actual events. Neutralizations are justifications for deviant behaviour [25]. During neutralization, the cause is placed as far away from the person as possible using the following order: questioning the facts, questioning the norm, identifying circumstances as the cause, and pointing to one’s own inability as the cause. Remarkably, people mostly disapprove of neutralizations, while, in practice, the majority uses them [26]. Neutralizations in which aspects other than safety, such as financial aspects, are first considered and often lead to a process of sliding to a level where safety has been rationalized away.

2. Method

2.1. Research Design

The study adopts an exploratory and qualitative approach by means of semi-structured interviews (see Appendix A). Qualitative research allows for the interpretation, description, and explanation of perspectives, behaviours, and experiences of participants [27], highlighting details that might otherwise remain unnoticed. This provides flexibility to view issues from various perspectives, which is essential for exploratory research to facilitate the sharing of experiences and insights into the role of ethical fading in safety and factors influencing ethical fading. Consequently, this approach can provide insights into the extent to which ethical fading plays a role in individual and organizational safety decisions in (petro)chemical companies in the Netherlands.

The research approach we have chosen is abductive. It makes use of explanatory considerations in order to assess the value of research hypotheses and theories [28]. The notion that the ethical fading mechanism may play a role was deduced from existing literature. Next, we searched for likely explanations of this fading mechanism derived from interview data seeking patterns and themes that might both supplement existing theories, and demonstrate how this applies to safety. Unlike focusing on norms and obligations (normative ethics), this study endeavours to understand behaviour from reality

(behavioural ethics), as recommended by Gino & Bazerman [24], to augment existing ethical fading literature.

Semi-structured interviews were chosen for their capacity to enable thorough data analysis, deep research, observation of non-verbal signals, rich information, and nuanced understanding [29]. They provide both structure and flexibility, fostering personal contact, trust-building, and discussion of sensitive topics [27].

2.2. Data Collection

With the financial and operational support of Safety Delta Nederland (SDN), five (petro)chemical companies located in the Netherlands participated in this research. Prior to the interviews, the 21 respondents of participating companies were briefed that the interviews would be recorded and transcribed and that the transcripts would be anonymised. The interviews were conducted in the Dutch language by one of the authors. In two companies and for practical reasons of scheduling the meetings, participants were interviewed together. Interviewees, their positions, and interview dates are given in Appendix A. During the interviews, relevant parts of the safety management systems were presented, explained and made available for reading. When noticing that interviewees found it hard to reflect on their own mistakes, we invited them to also reflect on the mistakes of others. This avoids bias and prevents interviews from giving socially desired answers during the interviews.

2.3. Sampling

The interviewees were selected from the (petro)chemical companies that had agreed to participate in the project. A purposeful sampling method was employed, targeting a specific research population based on the problem statement, following criteria for selecting respondents who could provide the most relevant and in-depth insights into the research theme, as suggested by Mortelmans [30]. This method ensured the representativeness of the respondents. A combination of criterion and dimension sampling was used to guarantee diversity and depth in the collected data. Adhering to fixed selection criteria ensured a realistic and rigorous sampling strategy, confirmed by Suri [31]. The sample included employees that make decisions related to safety on a daily basis from each of the five participating (petro)chemical companies, comprising safety experts, operators, supervisors, and managers, totalling 21 interviews across five companies, conducted between 6 January and 27 February 2023.

2.4. Data Analysis

All interview recordings were transcribed verbatim, anonymized, and imported into Atlas.ti 22.0.6 for systematic analysis. A thematic analysis was conducted following the six-phase framework of Braun and Clarke [32], which is widely applied for its flexibility in identifying, analyzing, and reporting patterns within qualitative data.

The analysis began with familiarization through repeated reading of transcripts, followed by the creation of first-order codes to label meaningful statements and observations related to safety awareness, decision-making, and contextual influences. These codes were then refined and grouped into second-order categories to capture broader conceptual relationships across participants.

Building on these categories, themes were developed to represent recurrent mechanisms and patterns within the data. Throughout this process, themes were continuously reviewed, merged, or removed as analytical insight deepened. Thematic definitions and supporting quotations were consolidated in overview tables.

To ensure analytic rigour, two researchers coded a subset of transcripts independently to assess coding consistency; discrepancies were discussed until consensus was reached.

This iterative discussion strengthened interpretive reliability and contributed to theoretical saturation. Finally, all interpretations were revisited in light of theoretical concepts such as ethical fading, self-interest, and neutralization to maintain conceptual alignment between empirical data and the model presented in Section 3.

3. Results

3.1. Topics

In this section, we reflect on the findings that emerged from the interviews. Quotations are translated from Dutch by the authors. We have structured the findings along the following topics:

- Intentions to work safely
- Behaviour as a factor in safety
- Occurrence of fading mechanism
- Causes of fading mechanism
- Incident investigation and the role of ethical fading
- Suggestions for improvement

We use the term ‘fading’ to refer to the fading of safety awareness, following the mechanism described in the ethical fading theory section.

3.1.1. Intentions to Work Safely

The interviewees display a strong intention to work safely within the companies. Nevertheless, things often go wrong while carrying out work. Interviewees have a strong intention in advance to work according to the safety instructions. For example, after an incident, it is said:

“The overwhelming response was a bit rude, ‘you don’t do that’, ‘we don’t do that’.” (R2)

“I asked point blank, and none of his other colleagues said he could have made that mistake too; they all said no, ‘it won’t happen to me’ and I think that mistake is one we can all make. Thinking that won’t happen to me.” (R3)

However, sometimes working safely is under pressure due to practical and business-related factors. Making time to pay attention to safety is not always easy when agendas are full.

“And I have to be honest, I went through the permit this morning with two people who also showed me everything, that does take, yes, the time factor, it already takes you 45 min before you have done that one permit, actually does not fit in the agenda, but everything should be put aside.” (R15)

Financial resources for safety are sometimes a topic of discussion. According to a ShiftLeader Production EHSS Expert, safety is always a priority, but there is discussion about the costs involved:

“But we always agree that safety is number one, and this is also reflected in the capital investments. Yes, what do we do? We receive 70 million annually; yes, of course we as a plant believe that we still receive too little. But hey, that’s always a discussion.” (R11)

3.1.2. Behavior as a Factor in Safety

Most interviewees endorse the major influence of behaviour on safety.

“If you look at all the incidents that happen here in Europe. I think 80% depends on behaviour.” (R5)

“The starting point is that 80% of incidents are human behaviour.” (R10)

But some respondents are less clear about the role of behaviour in incidents and safety and indicate that it can be difficult to determine the actual cause. This operator says:

“I think this percentage is perhaps around 15–20%. Human factors within our factories and ultimately this may increase due to other root causes. . . // I don’t know if that is real . . . there is a balance of course. Look, if those guys aren’t really sure, then someone has to go outside and check whether the valve is actually open and then you can put an ignore on it and then put it in SAP (enterprise resource planning software system) for repair, that is also a report.” (R14)

3.1.3. Occurrence of Fading Mechanism

The interviewees provided several examples in which fading is likely to have played a role in decisions leading to unsafe situations. One example of circumstances that can lead to the fading of safety awareness is given by this supervisor:

“Tomorrow I have an incident analysis, which concerns a membrane that was exchanged last week, so one was broken. The technical service was given the assignment to replace it on Friday afternoon. But yes, Friday afternoon, Carnival weekend, so the one who had to do it, quickly put that thing down. On Sunday, our team will use that pump for the first time with a very poisonous substance. Apparently, that pump is leaking. That pump was never properly tightened; they had eight bolts just loose. // With this knowledge I am curious what he will say tomorrow. Because look, he may not realize that we are handling very toxic things with that pump that weekend. // I think at that moment he is thinking about celebrating Carnival. So hurry, hurry, hurry.” (R19)

There are indications of self-deception that can lead to fading. An example is given by an HSEQ manager who is breaking the rules by carrying two coffees and not holding the railing:

“This morning I had to climb the stairs. And my colleague asked, can you bring me a cup of coffee? Sorry, but the rule is that you hold the handrail. Then I stand at the front of those stairs. I think how am I going to do that, huh? Then I’m faced with two things, and then I think for a certain moment, hey, I’m already honest, I didn’t hold the railing, I just walked upstairs. // I stood still, and I thought, shit, when I go on a winter sports holiday, I walk around in those clogs of shoes with two skis in one hand. How come I can hold on to the handrail, because I can go up those stairs with the whole crowd, right? How do you hold the handrail there? // And I do realize that I am aware that I can fall now, and I am aware that I cannot adhere to the rules now.” (R5)

In this example, the ski holiday was used to justify a violation of a safety instruction. The standard is also being questioned with the argument that the person in question has now become more aware of the risk.

A superintendent gives an example of an incident where three violations of safety rules occurred. The colleague in question continued to work at height in the installation after discovering that his protective mask was not working (violation 1). The man had also entered the installation alone, while the instructions stated that people should go in pairs (violation 2).

“He climbs up there with his stuff, with his tools, and with his breathing apparatus that you put on your back, and a mask that you put on, and he comes behind with all the stuff he has dragged up there. This part is outlined in red, indicating

that the hose connecting the mask is missing. That it was not included with the set that he had received. So you can't use that set. And then a decision has to be made. And you click it together like that, and it's not there. At that moment, he has the option to stop my work, go downstairs, and get a new set. Or I pick up the radio and ask someone else to bring it. While we had plenty of time at that point. Two weeks to do that. Yes, but he felt so much the owner of this problem. // Potentially this could have been fatal." (R1)

His colleague adds:

"It was one o'clock in the morning, his last watch shift. He wanted to do this job. Because it was his shift that discovered the leak before he went down, and he also doesn't want to be confronted with the fact that it didn't happen when the unit is up again. // Whatever was going on with him, I thought, is just a lot of positive, wrong positive motivation to do it." (R2)

After the person in question becomes unwell due to an apparent escape of gas, his colleague rushes to his aid, while the procedure stipulates not to do that (violation 3).

Another variant of overriding safety measures is declaring instructions. This can be tempting when one wants to continue working and avoid the time required to apply the instructions.

"What you saw there is that we occasionally used the 'not applicable' design on the work instructions, not applicable, and I noticed that myself. I also accepted that a few times." (R15)

It is interesting that there is often doubt as to whether the stated cause for unsafe behaviour or not applying the instructions was the actual cause. This operations manager explains:

"There is no workload, because that thing doesn't have to be there for another year. If you get into a situation where you think, hey, the housekeeping is not good or whatever, stop work and clean up. // Effective yes, but for yourself, you see three examples where you wonder, is that workload experienced, or is this an argument to justify my unsafe behaviour?" (R2)

3.1.4. Causes of Fading Mechanism

The interviewees reflected on several different possible causes for fading. One suggested cause is experienced pressure. This HSE supervisor states:

"If there is a reason, it is often haste, a rush, haste and absent-mindedness. And routine." (R10)

Wanting to work quickly seems to be a common circumstance that may lead to (near) incidents. The HSE supervisor continues:

"I'm going to skip those steps because then I can go faster, and in fact, we often see incidents happen because people want to do something quickly to go faster, with the best intentions. // What those people see as an advantage is because they otherwise think that if things don't go fast enough, there will be delays, or, for example, they think that their boss will blame them for not getting something done." (R10)

This ShiftLeader-Production-EHSS-Expert notes that the pressure is not always explicitly imposed by the environment but can be self-imposed pressure.

"But you also regularly hear that in incident investigations and we then try to ask further questions. And that is often self-imposed pressure." (R11)

A potential cause of this self-imposed pressure could be cultural, i.e., in the nature of the Dutch.

“Yes, the Dutch are really driven to get things done. But the question is, up to what limit?” (R15)

Perhaps the underlying realization that it is ultimately about the financial results, as suggested by this supervisor, may form a cause for fading.

“We are very performance-oriented, we are of course a commercial company, we want to make profits, we want to grow.” (R19)

Another possible cause for the fading of safety awareness, according to a ShiftLeader-Production-EHSS-Expert, lies in the motivation to get the job done by oneself and reluctance to ask for help.

“But ultimately it is intrinsic motivation and that is that people think about wanting to do well and not wanting to ask for help and that ultimately it can go completely wrong.” (R11)

Certain moments seem to be vulnerable to fading. The change of a shift comes up several times. Things are not always transferred properly, and there seems to be a certain haste to stop work on time. This phenomenon is mentioned several times by the interviewees, as this HSE specialist explains.

“I feel like it’s a bit, in the end, more than prestige. Everyone wants to hand over the factory to the next shift in a good way. Hey, you don’t want to saddle someone else with your mess. // That people then want to do things quickly or at least want to take care of them.” (R13)

This supervisor puts it this way:

“For example, a change of shift, that is quite dangerous here, that is a graveyard moment, yes, people there try to get everything ready as quickly as possible to leave. Or just do something before the next team arrives, it doesn’t matter what your intention is. That’s a moment where things happen faster than they should.” (R19)

An operator explains it as follows:

“Then nine times out of ten, you have an operator who actually wanted to leave here. I don’t really want to be here: this is not the right time, I want to go home, I want to go to my wife, I want to go to my children.” (R21)

Finishing a job seems to be a strong motivation. Conversely, not completing a job feels like defeat. This superintendent says:

“Yes, we actually reward ourselves by completing work, right? It just gives you a good feeling when you finish work and that you have some time left at the end of the day to do something else.” (R1)

Sometimes safety awareness is compromised by social pressure when people do not want to be seen as a complainer. This operations manager explains it as follows:

“But he doesn’t talk to him about it. Because he says yes, but if I keep doing that, I will be perceived as a whiner and difficult. That’s what he tells me at some point, right? Then people no longer want to work with me, and here you wonder, is it correct or is this his own argument to justify that he should actually have followed those same rules.” (R2)

If monitoring and supervising correct and safe behaviour is not given continuous attention, organizations may end up on a slippery slope regarding compliance with safety instructions. This top manager explains:

“But at some point, people stop doing important things. Because they think it is not necessary, because that has always gone well.” (R12)

Other factors that may play a role in the fading of safety awareness, according to the interviewees, are shame, overconfidence, fear of delivering bad news, and convenience. A clear improvement in the OSHA incident rate (OIR) was noted at one company during the COVID-19 period likely related to a general shift in safety risk perception:

“But they had a huge awareness about everything and yes, I think that has led to fewer accidents in the industry, I think. But the fact that after Covid we have had a real uptick in the number of cases, really very impressive is not the right word, but really very significant. Both in the Netherlands and across the board in America. // That number was enormous, increased from 0.3 to 0.9 at one point, so it really tripled.” (R10)

3.1.5. Incident Investigation and the Role of Ethical Fading

There is considerable doubt as to whether the actual causes of accidents can be determined through current forms of incident investigation. Interviewees expressed uncertainty about whether the full and honest account is always disclosed and indicated that information may sometimes be withheld out of fear of reprimand.

“There is also the complication, which I have gradually come to realize by investigating incidents. That the moment someone does something, and that is indeed a normal action, then apparently, your brain does not remember exactly what you have done. Because yes, you are not that aware.” (R3)

In the earlier explained incident just before the Carnival weekend the operator indicates not to have much confidence that the person in the incident would admit that he did the job too hastily. However, the operator is convinced that haste must have played a role.

“No one is going to say that. I’m curious, I’m really curious what that man is going to say.” (R21)

In incident investigations, work pressure is often referred to as a cause of unsafe working. An example is when it turned out that a contractor worked without the required signed work permit, while he should have known that a permit was required because this was discussed in introductory training and safety tool meetings. An operations manager doubted whether the cause of the violation given by the individual was accurate:

“Then you get to a point where you wonder, ‘Is he experiencing the time pressure, or is he using this as an argument?’” (R2)

Sometimes there are serious doubts as to whether the real cause of incidents comes to light. For example, this HSEQ manager points out that the facts regarding what happened are not so easy to determine.

“Then that person has difficulty ... and we have experienced that with someone with a fairly high level in the hierarchy, but also someone at the level of an operator, I now have such an example in mind. And in both cases or in mind and in both cases, the person could not explain afterwards why he had taken that shortcut.” (R3)

“The question then is whether the reporting is always honest. I do not know.” (R15)

Sometimes memory is not as reliable as we would like. It is noted here that different persons who witnessed an incident remember the facts differently.

“And we have also noticed during interviews with people that two colleagues completely contradicted each other.” (R3)

And so this HSEQ manager concludes:

“If we depend on what information someone provides during an interview for fact-finding, then you also have to bear in mind that what the person honestly thinks he remembers, how it went, is not always the case.” (R3)

Self-reflection does not come naturally to everyone.

“Some people have that self-reflection, and others don’t.” (R21)

“It is safer to direct it to someone else.” (R8)

Despite the awareness that behaviour plays such a major role in safety decisions, the solution is often sought in adjustments to technical facilities, systems or the general organization of the functionalities involved.

“Well, I think so, but so far we haven’t done a lot of research into that here in this company. Looking at the statistics I hear, I would expect it. But the tendency is often that we try to solve things technically or organizationally.” (R13)

3.1.6. Suggestions for Improvement

One way to positively influence employee behaviour is through a culture program. One of the companies involved in using a culture program recognizes that people’s state of mind plays a role in their alertness to safety. The company has implemented a multi-year culture program to promote safe behaviour. A 40% reduction in incidents is claimed, which revolves around four aspects:

“It’s about four things. Hurry, frustration, fatigue, overconfidence. If you recognize those states of mind in yourself, yes: in almost all incidents, 90%, one of these things plays a role.” (R13)

Another company has set up a training course to make employees aware of irrational behaviour:

“Not long ago we had also introduced a concept with training with everyone in which we make people aware that behaviour is sometimes inexplicably irrational.” (R3)

Recognizing that safe working at the location and at the time of action must be emphasized to maintain safety awareness on a desired level, one of the participating companies introduced a targeted initiative to prevent objects from being dropped from height within the installation. The initiative, called ‘Stop the drop’ and consists of hanging banners at heights in the installation where the risk of falling equipment is substantial. The initiative includes a demonstration dropping a bolt onto a watermelon to show the devastating effect of falling objects.

There are also initiatives to improve the reporting of unsafe situations. This HSE specialist says:

“Once a month we choose the best reporter, well, best report, yes, the best for safety awareness, which could be that you saw something, yes, something and immediately took action.” (R13)

Good exemplary behaviour from management is also recognized as an important factor in maintaining a sufficient level of safety awareness:

“Well, I think what I rightly think is very important is that we as leaders or management really continue to set a good example and also continue to realize that an unsafe situation is always lurking.” (R13)

4. Discussion

4.1. Ethical Fading as a Mechanism

The main contribution is that ethical fading as a mechanism can play a significant role in the erosion of safety awareness. This has several implications for both theory and practice.

According to theory, decisions and behaviour may be influenced by the process of ethical fading [10]. However, this fading mechanism could have implications for safety, and, as far as we know, was not previously the subject of academic research. During the process of ethical fading, safety awareness gradually decreases, and behaviour becomes less safe, which increases the risk of incidents and accidents [33]. The process of ethical fading is characterized by a trigger, usually self-interest, but it can also be driven by economic or commercial motivations, which distort the decision frame, justifying one’s own behaviour by unconscious self-deception and neutralization [2,10,11,20].

This research also has substantial implications for practice. The process of ethical fading takes place mainly unconsciously [2,10,11,20,24,34,35], and it is, therefore, difficult to uncover by means of interviews. However, there are clear indications that ethical fading as a mechanism plays a role in a substantial number of incidents, such as the case in which a pump was incorrectly attached just before the Carnival weekend. In this case, it is likely that the self-interest of being able to go home on time has played a role in decision-making. Another example is the case in which the person in question was at work just before the end of a shift without a required properly functioning protection mask. In this case, two forms of self-interest may have played a role, namely the desire to leave on time and the desire not to leave colleagues with an unfinished job.

Several interviewees expressed the conjecture that self-interest regularly plays a role in safety-related decisions. In several examples, there seems to be a combination of interests at play, such as ease and getting home on time, but also social interests, such as appreciation from colleagues or managers. For example, the haste in which jobs were carried out at the end of a shift, in which case the self-interest of limiting working time and the social interest of colleagues or managers to finish the job seems to have a significant impact on the decision-making process. In both motivations, self-interest is a component, namely the feeling of reward that comes with completing the task, and the advantage of being able to go home on time. Various personal aspects may play a role here, such as the satisfaction one feels when completing a task, shame about not completing a task, burdening colleagues with the problem of an unfinished task, as well as the prestige and competitiveness of wanting to be the best at the job in combination with overestimation. These aspects that carry components of self-interest were suggested as factors by interviewees. Although it is not possible to determine the exact effect of these factors based on this exploratory study, we found that the period at the end of a shift or working time is very vulnerable to fading because time pressure arises, potentially leading to fading of safety awareness.

Interestingly, we have found strong indications that neutralization techniques are not only used after the incident, but also during the decision-making process along the fading mechanism. In the example of the interviewee who was carrying two coffee cups, the interviewee applied a neutralization technique during the activity to downplay the significance of the safety instruction to hold the railing. This use of a neutralization technique could imply that neutralization techniques are an enabler positively moderating the fading process, which is—to our knowledge—not yet identified by existing literature.

4.2. Several Forms of Self-Interest

The interviews of our research, however, show that different forms of self-interest may play a role in the decision-making process [36–38]. Forms of self-interest that were discussed in the interviews include a wide variety of forms, as presented in Table 1.

Table 1. Several forms of self-interest.

Potentially Positive	Potentially Negative
Personal wish to stay safe Appreciation from management for complying with safety procedures	Ease/Convenience Limiting time or overall working time Shame to show ignorance Reluctance to show vulnerability Social pressure Temptation to complete a job in a rush Meeting targets other than safety Prestige and reputation Overconfidence Fear of delivering bad news Reluctance to burden colleagues with unfinished work
Pressure to comply with the rules * Competitiveness *	

* These factors can either positively or negatively influence the fading of safety awareness depending on the circumstances.

The current research suggests that all kinds of self-interests may interact and lead to distortion of the decision frame, which can lead to fading of safety awareness. We argue that the concept of self-interest as a purely financial motivation described in the literature of ethical fading clearly is too much of a monolithic approach [10]. We suggest that future research may focus on how different categories of self-interest correspond to different unsafe behaviours.

There are indications from the interviews that neutralizations may take place before the unsafe situation occurs. This ex-ante neutralization has not been recognized by earlier studies, as far as we are aware. Figure 1 shows the fading mechanism. Self-interest may lead to the fading of safety awareness. This process is moderated by ex-ante neutralization. The fading of safety awareness may lead to an unsafe decision leading to either an incident or a near miss. Obviously, the decision affected by the fading mechanism is not the only factor determining whether or not a safety incident will occur. Examples of other factors may include specific circumstances like technical safety precautions, last-minute interventions of colleagues, and chance.

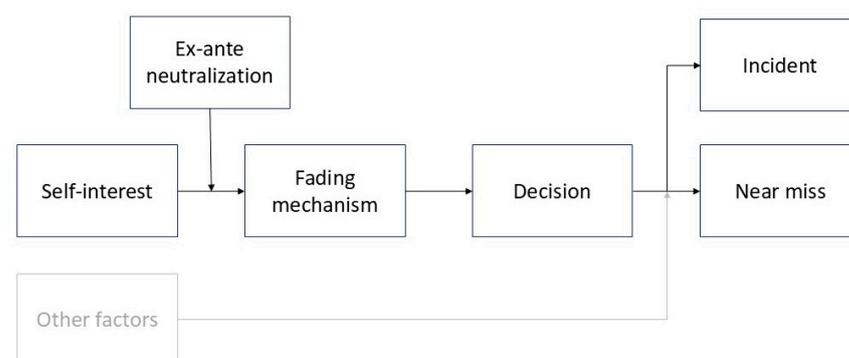


Figure 1. Self-interest leading to an incident or near miss. Light colors are outside the scope of the study.

In this article, we focus on self-interest in its different forms. A very interesting area of future research we perceive is the context in which these various distinct forms of self-interest play a role. For example, the company culture will most likely have an influence on the degree to which several forms of self-interest, such as ease and shame to show ignorance, may reach a level to fade safety awareness.

Also, another area for future research, which is outside the scope of this article, is the question of specific improvement measures to be developed that may be effective in countering the mechanism of fading.

4.3. Self-Reflection and Ex-Post Neutralization

Several interviewees observed that not everyone engages easily in self-reflection. Although respondents have mostly worked in (petro)chemical plants for many years, they provide few examples of their own mistakes. Moreover, two out of the three examples that were recorded took place in office situations. Two examples were at a distance from the installations where most safety risks arise. This could indicate that interviewees find it difficult to show their own vulnerabilities even in the relatively safe conditions of the interview, which was known to be anonymous.

The interviews show that several of the found causes of safety incidents fit within the neutralization techniques of Kaptein & Van Helvoort [26]. In particular, circumstances beyond the employee's control, such as workload and production importance, are often mentioned as explanations for unsafe actions. These explanations can be seen by the notion in theory that the fading mechanism takes place in the unconsciousness of the person in question. The self-deception theory described by Tenbrunsel and Messick [10] causes the person to believe that he or she has acted correctly. Before or after the unsafe situation, the wrongness of the decision may be neutralized using the techniques described by Kaptein and van Helvoort [26]. These two forms we call ex-ante and ex-post neutralization respectively.

It has been suggested that there is a taboo on neutralizations. Existing research supports that reflection on one's own behaviour can be unconsciously avoided when this behaviour does not meet ethical standards and, therefore, goes against the social wish to be seen as ethical [20]. On the one hand, neutralization techniques are widely used, and on the other hand, it is very difficult to recognize that people are using them [26]. That it is difficult to recognize is, in itself, not surprising. After all, if the cause of an incident lies with the person and he or she uses a neutralization technique, then there is essentially a double failure, which includes acting unsafely and concealing the real cause. Such outcomes indicate that neutralization constitutes a significant obstacle to learning and improvement.

4.4. Incident Enquiries

It is difficult to identify fading and the use of neutralization techniques. Some of the most commonly used incident investigation methods are root cause analysis, the "5 why" method, Tripod Beta and Bowtie [39]. A root cause analysis is drawing of a diagram in which the relationships between the causes of an event are displayed, based on gathering data, investigating to generate evidence, to interviewing witnesses, analyzing evidence, preparing recommendations and actions, and reporting. The 5 Why method is a way of asking questions in order to understand the cause-consequence relationships that underlie a certain problem. The core of a Tripod Beta analysis is a diagram representing the incident mechanism which describes the events and their relationships. The Bowtie diagram contains a lot of information about the ways incidents can happen and how to prevent them.

The circumstances make interviewees presume that fading has often been a relevant factor of influence on safety-related decisions and incidents. However, because of the difficulty of identifying fading, the formal cause, as identified during incident investigations, is almost never found to be in self-interest. In incident enquiries, interviews are the most common form of data collection, and, as we know, ethical fading is a process taking place unconsciously. Therefore, the fading mechanism does not come to light as a formal cause by interviewing the person involved and relying on his or her statement.

In line with the fact that ethical fading stays hidden, interviewees indicate that the improvement measures that follow after an incident investigation are usually not focused on behaviour, but mainly on areas where the formal cause is presumed, namely technical facilities, systems, and organizations. The discrepancy between fading as a presumed root cause and the incapability of investigation routines to identify it as such raises the question of whether current methods of incident investigation are suitable for identifying causes in the sphere of behaviour. People find it difficult to properly understand the role of behaviour. Personal aspects of the mood and state of mind of people that can be an important cause of fading are sometimes recognized and intuitively interpreted, but not or hardly identified as a formal cause. At most, the person investigating the accident may sense from the circumstances that the fading mechanism may have played a role. However, a structural and reliable analysis is lacking in current incident investigation routines to uncover the fading of safety awareness hidden by neutralization. Figure 2 shows the full process of fading up to and including the identification of the formal root cause by investigation of incidents or near-incidents. Figure 2 shows the process already explained in Figure 1, expanded to the investigation following an incident or a near miss. The investigation leads to a root cause that may be obscured by ex-post neutralization in the sense that the found root cause, which is a form of self-interest if the ethical fading mechanism applies, is false.

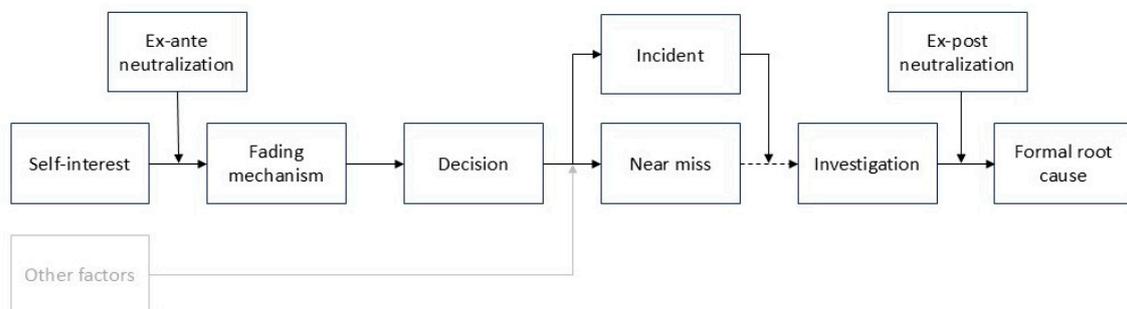


Figure 2. Fading process and identification of the formal root cause of incidents and near misses. Light color object are outside the scope of the study. The dotted line means that not all cases of near misses are followed by an investigation. This depends on the potential consequences of a near miss.

A suggestion for future research is to identify ways to uncover the fading mechanism in incident enquiries that take into account the fact that people are able to articulate this as a cause. As self-interest stays hidden as a possible incident cause because the fading process takes place unconsciously, and people involved tend to neutralize the true cause, other ways should be explored to detect forms of self-interest in incident investigations. A suggestion for future research is, therefore, to explore methods to uncover forms of self-interest in incident investigations. In addition, future research may be aimed at identifying neutralization techniques applied by interviewees as an indication that self-interest may play a role.

4.5. Narrowing Down the Safety Concept

This research shows an inconsistency in the broad explanation of the concept of safety on the one hand, and the specific examples given on the other hand. According to the interviewees, both occupational safety and safety for the living environment are part of the concept of safety. When asking for examples of incidents in the interviews, it is remarkable that interviewees mostly mentioned incidents that are limited to occupational safety implementation, and incidents that were mostly committed by others. Interviewees did not bring up examples of safety in relation to endangering the environment.

Due to the narrowing down of the safety concept, other forms of self-interest may not have been addressed by the management of a (petro)chemical plant. Consider, for example, a culture in which other interests prevail, a remuneration structure that may or may not be based too heavily on financial results, which may cause reluctance to address dangers for the external environment. Another example may be the fear of negative publicity due to incidents, and possible harmful consequences for one's career if incidents endangering the environment are uncovered.

4.6. General Attention for Safety Due to COVID-19

It is interesting that, during the COVID-19 period, the safety performance of at least one company included in this research was significantly better. This phenomenon has previously been researched by Denning [40] and would not only be caused by lower production activity in the companies and the associated lower occupancy rate. It could indicate that the explicit attention to safety in society as a whole, as a result of the COVID-19 measures, could have had a significant influence on the dominance of safety in the decision frame of employees in the (petro)chemical industry. This finding resonates with Tenbrunsel and Messick's [10] proposition that the more frequently situations are assessed from an ethical frame, the more people will act in line with their ethical values. It is beyond the scope of this exploratory study to make statements about the likelihood of this relationship, but it seems plausible to argue that when safety receives more attention in society at large, safety may get more weight in the decision-making frame within companies. This phenomenon may offer new options to improve safety and deserves further research regarding how this improvement may be materialized.

4.7. Euphemistic Language

According to the literature, euphemistic language, such as downplaying risks, is an important enabler for the fading of safety awareness. Although this is hardly discussed in the interviews, using euphemistic language may offer opportunities for identifying the lapse in safety awareness in a timely manner. After all, downplaying is essentially an abstraction of risks. For example, talking about 'getting the job done', 'collateral damage', or 'risks of the trade' could (1) indicate that safety risks are too easily taken and could (2) be a precursor to unsafe behaviour. We suggest that future research may look into the possibility of using euphemistic language as an identification tool for the fading of safety awareness.

4.8. Limitations and Strengths of This Study

Research quality depends on credibility, transferability, reliability, and confirmability [41,42]. Credibility was enhanced by conducting the interviews in participants' native language and sharing interview questions beforehand for better understanding [43]. Detailed descriptions of interviewees' roles within their organizations and examples of ethical fading from literature in both (petro)chemical and other sectors supported the transferability of findings across sectors [44]. Reliability was fostered through a clear research process,

including the fact that a clear research question logically followed from the theoretical background for consistency [43]. To augment confirmability, detailed information and diverse perspectives and examples were provided [42]. Data collection and analysis processes were described to support confirmability, and similar roles were interviewed across multiple companies for data validation [43].

In spite of these measures, this study encountered several limitations that impacted the quality of the results and conclusions. A primary limitation was restricted access to documents and systems due to the companies' need for approvals, aiming to avoid negative publicity or legal repercussions. A confidentiality agreement allowed for the presentation of safety management systems during company visits and the reading of documents on risk management and methodologies. However, access to these systems was limited to the duration of the visits. Prolonged access could have enhanced internal validity and potentially would have yielded deeper insights.

Another limitation pertains to social desirability bias, the tendency to present oneself as ethical and socially acceptable. To mitigate this limitation, kick-off sessions were held before interviews, explaining that transcripts would be anonymized and recordings deleted after transcription. Despite these measures, socially desirable responses could not be entirely avoided. Observations during interviews indicated that most participants avoided providing personal examples of ethical fading, either remaining silent, claiming ignorance, or deflecting the question. Consequently, the results might be skewed as participants mainly discussed ethical fading and self-interest in others, with limited self-reflection. This limited expression of self-reflection suggests that the prevalence of ethical fading might be greater than this study indicates.

The transferability of results in case studies can be challenging due to organizational differences [45]. Despite these differences, valid findings applicable to industries and sectors where EHSS (Environment, Health, Safety, and Sustainability) plays a prominent role, such as businesses with safety risks outlined in legislation, can be obtained [1,2,46]. Comparing cases through semi-structured interviews enables verification of interview data, testing of replication logic, and in-depth exploration of studied phenomena and theories [47]. Transferability was ensured by interviewing only roles relevant to the research question and conducting interviews until data saturation was achieved, with all participants (safety experts, operators, supervisors, and managers) involved in safety decisions.

In addition, all samples in the study are sourced from the Netherlands, and cultural contexts may have an impact on the results. Future research should address this difference by taking into account cultural differences.

Finally, biases that are inherently related to qualitative research based on interviews can influence both the researcher and participants, complicating the adequate understanding, interpretation, and presentation of actual events in safety incidents. In two companies, participants were interviewed together, possibly leading to conformist answers influenced by groupthink and self-censorship. To counteract this possibility of groupthink and self-censorship, one-on-one interviews were conducted in other companies. The researcher aimed for neutrality in the interviews by maintaining an open stance, focusing on participants' viewpoints, and avoiding personal biases.

4.9. Contribution to Sustainability

The contribution regarding sustainability lies in showing that environmental disasters are not only technical failures but also ethical failures. Preventing oil spills, explosions, and toxic leaks requires addressing how self-interest interacts with organizational culture, incentive structures, and leadership signals [48,49]. By identifying fading moments—such as shift changes, production peaks, or prestige-driven shortcuts—companies can design coun-

termeasures: culture programs, awareness training, reporting incentives, and leadership practices that keep safety salient [48–50]. Thus, researching ethical fading contributes to sustainability by making the human side of risk visible, enabling interventions that prevent both occupational harm and large-scale environmental disasters. It shifts sustainability research from a narrow technical frame to an integrated socio-technical approach where human behavior, ethical awareness, and safety culture are treated as core components of sustainable operations [50,51].

5. Conclusions

A lack of safety awareness in industrial companies may lead to substantial harm. The fading of safety awareness is likely to occur in situations where self-interest is strong. Self-interest may change the decision frame following the ethical fading mechanism, in such a way that safety no longer has the weight it should have for safe operations. This process mainly occurs at an unconscious level, so that the people involved are not aware that they are acting unsafely. Consequently, self-interest is rarely uncovered as the main root cause in incident investigations. People affected by this fading process tend to apply neutralization techniques *ex ante* and *ex post* to justify their conduct.

Author Contributions: Conceptualization, B.E.Z. and K.v.N.; Methodology, B.E.Z. and M.d.B.; Formal analysis, B.E.Z., M.d.B. and G.R.; Investigation, M.d.B.; Writing—original draft, B.E.Z. and M.d.B.; Writing—review & editing, G.R. and K.v.N.; Visualization, B.E.Z., M.d.B. and G.R.; Project administration, M.d.B.; Funding acquisition, M.d.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Stichting Nederland Onderneemt Maatschappelijk. Stichting Nederland Onderneemt Maatschappelijk is a partnership between the Dutch (petro)chemical industry, scientific institutions, and the government, with the ambition to make the Dutch (petro)chemical industry the safest in the world by 2030.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Erasmus Research Institute of Management Ethics Review Committee of Erasmus University Rotterdam (reference ETH2425-0590, approved on 4 April 2025).

Informed Consent Statement: Verbal informed consent was obtained from the participants after participants reviewed the written informed consent statement.

Data Availability Statement: The datasets presented in this article are not readily available because of privacy, legal and ethical reasons. The companies that have participated in this research are strictly confidential.

Acknowledgments: The authors express their sincere gratitude to the participating employees for their openness and engagement, and to Stichting Nederland Onderneemt Maatschappelijk for their collaboration and financial support. This study would not have been possible without their valuable contribution.

Conflicts of Interest: Author Martin de Bree declares that he has received funding from Stichting Nederland Onderneemt Maatschappelijk for this study. The funder had the following involvement with the study: Not other than funding. The other authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

BRZO	Besluit Risico Zware Ongevallen *
EHS	Environment, Health and Safety
EHSS	Environment, Health, Safety and Security
HSE	Health, Security and Environment

HSEQ Health, Security, Environment and Quality

SDN Safety Delta Nederland

* Major Accident Risk Regulation: A Dutch Act based on European regulation to control risk of severe incidents with hazardous substances.

Appendix A. Interview Overview

Appendix A.1. Interviewees

Table A1. Interviewees.

Interview #	Respondent	Company	Position	Date
1	R1		Superintendent	
1	R2	A	Operations production manager	6 January 2023
1	R3		HSEQ manager	
1	R4		Supervisor EHS manager	
2	R5		Supervisor EHS manager/ specialist fire brigade	13 January 2023
2	R6	B	EHS manager permits	
2	R7		EHS program manager	
3	R8		HSE manager	
4	R9		HSE specialist	
5	R10		HSE supervisor	
6	R11	C	Shift leader EHSS expert	20 January 2023
7	R12		Top manager	
8	R13		HSE specialist	
9	R14		Operator	
10	R15		Production leader	
11	R16	D	EHSS program manager	30 January 2023
12	R17		EHSS supervisor	
13	R18		Site director	
14	R19		Supervisor	
15	R20	E	EHSS manager	27 February 2023
16	R21		Operator	

By # is meant the number of the interview.

Appendix A.2. Interview Questions (Translated from Dutch into English)

Table A2. Interview questions.

1	Ethical Fading and Safety Awareness
a	Ethical fading or the erosion of safety awareness occurs when safety concerns are overshadowed by other priorities (e.g., avoiding delays or additional costs), and individuals rationalize that this is justified. What are common examples of declining safety awareness that you can think of in the chemical industry?
b	Have you or your colleagues ever faced a dilemma where safety conflicted with other priorities?
c	What examples of declining safety awareness do you recognize in practice? What behaviors are associated with this?
d	How do people with a strong sense of safety behave?
2	Causes and Conditions Related to Safety Awareness Decline
e	In your opinion, what was the cause of past unfortunate incidents in the chemical industry/factories?
f	What circumstances in daily operations might contribute to the decline of safety awareness?
g	Do you have examples of safety incidents or near-misses where it was difficult to implement effective preventive measures?

Table A2. Cont.

3	Safety Measures and Prevention Strategies
h	What measures do you currently take to prevent the decline of safety awareness? How is your safety management system (SMS) designed to address this issue?
i	Are there any documents we can review regarding safety systems, policies, and incidents to examine how ethical fading is addressed or might play a role?
j	Can you share your thoughts on a major incident in this industry and your opinion on how such events can be prevented?
k	Does your company provide training to employees in this area (to reinforce safe behavior) to prevent safety awareness from fading?
l	Many research studies suggest that an operator cannot be solely responsible for a safety incident, as there are multiple direct and indirect contributing factors influencing poor judgment. What is your perspective on this?
m	How can companies build a better system to prevent safety incidents?
4	Company Efforts and the Positive Impact of Preventing Ethical Fading
n	What does your company do to prevent or reduce the fading of safety awareness?
o	What positive impacts do you see when ethical fading is prevented in safety-related work (or even beyond)?
p	What additional measures, not yet implemented, could contribute to further improvements?
q	Are current risk assessment methods sufficient? If not, how could they be improved?
5	Regulations, Compliance, and Inspections
r	What are your suggestions for how companies can establish better safety regulations?
s	Do you believe companies comply with all applicable safety regulations?
t	What positive impact do you see when companies adhere to these regulations? For example, what is your estimate of how many accidents or fatalities could be prevented, in the Netherlands or worldwide?
u	How can good internal communication help improve safety awareness?
v	How do you experience inspections under the Major Accident Risk Regulation (BRZO)? Do they help you reduce unsafe situations?
w	Do you think the regulations set by governing bodies are actually implemented at the operational level?

Note: Questions were translated from Dutch by the authors.

References

- van Leeuwen, L.C.; Beetstra, R.; de Boer, L.M. Een Veilige Leef-én Werkomgeving: Samenwerking Tussen Uitvoeringsorganisaties Versterken. Available online: <https://www.rivm.nl/publicaties/veilige-leef-en-werkomgeving-samenwerking-tussen-uitvoeringsorganisaties-versterken> (accessed on 18 October 2025).
- Butler, B.; Bodnar, C.; Cooper, M.; Burkey, D.; Anastasio, D. Towards Understanding the Moral Reasoning Process of Senior Chemical Engineering Students in Process Safety Contexts. *Educ. Chem. Eng.* **2019**, *28*, 1–12. [CrossRef]
- Hansler, R.; Pompe, L. Toekomstverkenning Veiligheid Chemiesector: Inventarisatie van Ontwikkelingen Tussen Nu En 2050 Die van Invloed Zijn Op de (Arbeids)veiligheid. Available online: <https://www.rivm.nl/bibliotheek/rapporten/2019-0196.pdf> (accessed on 18 October 2025).
- Van Nunen, K.; Reniers, G.; Swuste, P. *Verkennde Studie Naar (Petro)Chemische Clusters en Veiligheid: Veiligheidsparameters Binnen (Petro)Chemische Clusters En Losstaande (petro)Chemische Bedrijven*; Delft University of Technology: Delft, The Netherlands, 2019.
- Cao, S.; Zhang, H.; Chen, Q. Leader Fault Tolerance and Employees' Green Silent Behavior: The Mediating Role of Psychological Ownership and Moral Disengagement. *Sustainability* **2024**, *16*, 6431. [CrossRef]
- Delikhoon, M.; Zarei, E.; Banda, O.V.; Faridan, M.; Habibi, E. Systems Thinking Accident Analysis Models: A Systematic Review for Sustainable Safety Management. *Sustainability* **2022**, *14*, 5869. [CrossRef]
- Hayes, J. Investigating Accidents: The Case for Disaster Case Studies in Safety Science. In *Safety Science Research*; CRC Press: Boca Raton, FL, USA, 2019; pp. 187–202. ISBN 9781351190237.
- Folkard, S.; Tucker, P. Shift Work, Safety and Productivity. *Occup. Med.* **2003**, *53*, 95–101. [CrossRef]
- Kern, M.C.; Chugh, D. Bounded Ethicality: The Perils of Loss Framing: The Perils of Loss Framing. *Psychol. Sci.* **2009**, *20*, 378–384. [CrossRef] [PubMed]
- Tenbrunsel, A.E.; Messick, D.M. Ethical Fading: The Role of Self-Deception in Unethical Behavior. *Soc. Justice Res.* **2004**, *17*, 223–236. [CrossRef]
- Moore, D.A.; Loewenstein, G. Self-Interest, Automaticity, and the Psychology of Conflict of Interest. *Soc. Justice Res.* **2004**, *17*, 189–202. [CrossRef]
- Kiani, F.; Khodabakhsh, M.R. Promoting Individual Learning for Trainees with Perceived High Helplessness: Experiences of a Safety Training Program. *Iran. J. Psychiatry Behav. Sci.* **2014**, *8*, 19–28.
- Wang, M.; Sun, J.; Du, H.; Wang, C. Relations between Safety Climate, Awareness, and Behavior in the Chinese Construction Industry: A Hierarchical Linear Investigation. *Adv. Civ. Eng.* **2018**, *2018*, 6580375. [CrossRef]

14. Baumol, W.J.; Becker, G.S. The Economic Approach to Human Behavior. *Economica* **1978**, *45*, 313. [CrossRef]
15. Gneezy, U.; Rustichini, A. A Fine Is a Price. *J. Legal Stud.* **2000**, *29*, 1–17. [CrossRef]
16. Brand bij Chemie-Pack te Moerdijk, 5 Januari. 2011. Available online: <https://onderzoeksraad.nl/onderzoek/brand-bij-chemie-pack-te-moerdijk-5-januari-2011/> (accessed on 18 October 2025).
17. Failure to Learn: The BP Texas City Refinery Disaster. Wolters Kluwer Australia. Available online: <https://shop.wolterskluwer.com.au/items/10076285-0001S> (accessed on 18 October 2025).
18. Disastrous Decisions: The Human and Organisational Causes of the Gulf of Mexico Blowout. Wolters Kluwer Australia. Available online: <https://shop.wolterskluwer.com.au/items/10076375-0001S> (accessed on 18 October 2025).
19. Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling: Report to the President. 2011. Available online: <https://www.govinfo.gov/app/details/GPO-OILCOMMISSION> (accessed on 18 October 2025).
20. Rees, M.R.; Tenbrunsel, A.E.; Bazerman, M.H. Bounded Ethicality and Ethical Fading in Negotiations: Understanding Unintended Unethical Behavior. *Acad. Manag. Perspect.* **2019**, *33*, 26–42. [CrossRef]
21. Chugh, D.; Kern, M.C. A Dynamic and Cyclical Model of Bounded Ethicality. *Res. Organ. Behav.* **2016**, *36*, 85–100. [CrossRef]
22. Price, M.R.; Williams, T.C. When Doing Wrong Feels so Right: Normalization of Deviance. *J. Patient Saf.* **2018**, *14*, 1–2. [CrossRef]
23. Pinto, J.K. Project Management, Governance, and the Normalization of Deviance. *Int. J. Project Manag.* **2014**, *32*, 376–387. [CrossRef]
24. Gino, F.; Bazerman, M.H. When Misconduct Goes Unnoticed: The Acceptability of Gradual Erosion in Others' Unethical Behavior. *J. Exp. Soc. Psychol.* **2009**, *45*, 708–719. [CrossRef]
25. Maruna, S.; Copes, H. What Have We Learned from Five Decades of Neutralization Research? *Crime Justice* **2005**, *32*, 221–320. [CrossRef]
26. Kaptein, M.; van Helvoort, M. A Model of Neutralization Techniques. *Deviant Behav.* **2019**, *40*, 1260–1285. [CrossRef]
27. Blumberg, B.; Cooper, D.; Schindler, P. *EBOOK: Business Research Methods*; McGraw Hill: Columbus, OH, USA, 2014; ISBN 9780077157494.
28. Haig, B.D. Abductive Research Methods in Psychological Science. In *Handbook of Abductive Cognition*; Springer International Publishing: Cham, Germany, 2023; pp. 1681–1708, ISBN 9783031101342.
29. Langley, A. Strategies for Theorizing from Process Data. *Acad. Manag. Rev.* **1999**, *24*, 691–710. [CrossRef]
30. Mortelmans, D. *Handboek Kwalitatieve Onderzoeksmethoden*; Acco: Kings Park, Australia, 2013; ISBN 9789033493607.
31. Suri, H. Purposeful Sampling in Qualitative Research Synthesis. *Qual. Res. J.* **2011**, *11*, 63–75. [CrossRef]
32. Braun, V.; Clarke, V. Using Thematic Analysis in Psychology. *Qual. Res. Psychol.* **2006**, *3*, 77–101. [CrossRef]
33. Reason, J. Human Error: Models and Management. *West. J. Med.* **2000**, *172*, 393–396. [CrossRef]
34. Beasley, B.B. Keep Ethics from “Fading” When You Face a Tough Decision. Available online: <https://ethicalleadership.nd.edu/thought-leadership/ethical-fading-dont-let-ethics-fade-from-view> (accessed on 18 October 2025).
35. Greene, J.D.; Nystrom, L.E.; Engell, A.D.; Darley, J.M.; Cohen, J.D. The Neural Bases of Cognitive Conflict and Control in Moral Judgment. *Neuron* **2004**, *44*, 389–400. [CrossRef]
36. Amernic, J.; Craig, R. CEO Speeches and Safety Culture: British Petroleum before the Deepwater Horizon Disaster. *Crit. Perspect. Account.* **2017**, *47*, 61–80. [CrossRef]
37. Cremer, D.; Vandekerckhove, W. Managing Unethical Behaviour in Organisations: The Need for a Behavioural Business Ethics Approach. *J. Manag. Organ.* **2017**, *23*, 437–455. [CrossRef]
38. Maclean, T.; Litzky, B.E.; Holderness, D.K. When Organisations Don't Walk Their Talk: A Cross-Level Examination of How Decoupling Formal Ethics Programs Affects Organisational Members. *J. Bus. Ethics* **2015**, *128*, 351–368. [CrossRef]
39. Available online: <https://www.wolterskluwer.com/en/solutions/enablon/bowtie/expert-insights/barrier-based-risk-management-knowledge-base/incident-analysis-methods> (accessed on 8 November 2025).
40. Denning, M.; Goh, E.T.; Scott, A.; Martin, G.; Markar, S.; Flott, K.; Mason, S.; Przybylowicz, J.; Almonte, M.; Clarke, J.; et al. What Has Been the Impact of COVID-19 on Safety Culture? A Case Study from a Large Metropolitan Healthcare Trust. *Int. J. Environ. Res. Public Health* **2020**, *17*, 7034. [CrossRef] [PubMed]
41. Creswell, J.W.; Miller, D.L. Determining Validity in Qualitative Inquiry. *Theory Pract.* **2000**, *39*, 124–130. [CrossRef]
42. Tracy, S.J. Qualitative Quality: Eight “Big-Tent” Criteria for Excellent Qualitative Research. *Qual. Inq.* **2010**, *16*, 837–851. [CrossRef]
43. Cassell, C.; Symon, G. *Essential Guide to Qualitative Methods in Organizational Research*; Cassell, C., Symon, G., Eds.; SAGE Publications: Thousand Oaks, CA, USA, 2004; ISBN 9780761948889.
44. Silverman, D. *Interpreting Qualitative Data: Methods for Analyzing Talk, Text, and Interaction*; SAGE: London, UK, 2006.
45. Yin, R.K. Case Study Research and Applications. Available online: <https://us.sagepub.com/en-us/nam/case-study-research-and-applications/book250150> (accessed on 18 October 2025).
46. Nwankwo, C.D.; Arewa, A.O.; Theophilus, S.C.; Esenowo, V.N. Analysis of Accidents Caused by Human Factors in the Oil and Gas Industry Using the HFACS-OGI Framework. *Int. J. Occup. Saf. Ergon.* **2022**, *28*, 1642–1654. [CrossRef] [PubMed]

47. Pickard, A.J. *Research Methods in Information*, 2nd ed.; Facet Publishing: London, UK, 2019; ISBN 9781783303205.
48. Draghici, A.; Dursun, S.; Başol, O.; Boatca, M.E.; Gaureanu, A. The Mediating Role of Safety Climate in the Relationship between Transformational Safety Leadership and Safe Behavior—The Case of Two Companies in Turkey and Romania. *Sustainability* **2022**, *14*, 8464. [[CrossRef](#)]
49. Won, S.; Choi, J.; Kim, K. Development of Sustainable Industrial Safety and Health Policy for Electronic Industry in Korea: A Study on the Relationship between Safety Leadership of Managers, Safety Climate, and Safety Behavior. *Sustainability* **2024**, *16*, 10308. [[CrossRef](#)]
50. Blokland, P.; Reniers, G. Safety Science, a Systems Thinking Perspective: From Events to Mental Models and Sustainable Safety. *Sustainability* **2020**, *12*, 5164. [[CrossRef](#)]
51. Zhang, J.; Chen, X.; Sun, Q. A Safety Performance Assessment Framework for the Petroleum Industry’s Sustainable Development Based on FAHP-FCE and Human Factors. *Sustainability* **2019**, *11*, 3564. [[CrossRef](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.