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

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Trust, but verify.

RONALD REAGAN

7 Reconsideration of primary prospective analysis

As mentioned in the previous chapter, we discovered two contradictions between the outcomes of the primary analysis of the online prospective survey results and results produced by different sources (i.e., senior leaders, incident investigators, risk analysis experts and the Dutch Safety Board). The contradictions involve: a) interpretations of the contributions of Task-oriented leaders to the causes of major incidents (further referred to as Contradiction #1), and b) the views of different parties regarding the scores for the Recognition risk reduction phase (further referred to as Contradiction #2). Based on these discoveries, we decided to reconsider the analysis process for the online prospective survey. This reconsideration process is discussed in this chapter, and the subsequent Version III of the Safety Leadership Model is presented.

7.1 Reconsideration strategy

Comparing a certain outcome to a predetermined undisputed reference leads to a result which shows whether the outcome meets or does not meet that reference. The reference itself is believed to be true and reliable in this process, and therefore not subject to reconsideration. Argyris[1] coined this approach as 'single loop learning.'

In the event that the source of the reference might possibly be subject to change, the reference itself could be included as part of the equation, and its validity also be questioned as part of the process. Argyris called this approach 'double loop learning.' Figure 24 below shows this single/double-loop model.

1 Argyris (1977), pp. 115–125.

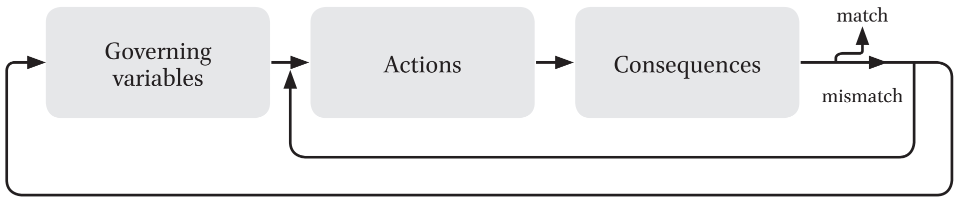

FIGURE 24 Single and double loop learning (Argyris)

Argyris explains this model using a comparison with room temperature control.[2] A room temperature (governing variable) is set according to the personal preference for room temperature of the people in the room. The adjustment of the thermostat (action) will instruct the heater to maintain the room at the preferred temperature (consequence). This represents a typical single loop process. When different people, who prefer a different room temperature, enter the room, the preference regarding the room temperature may change. If so, then this different preference (governing variable) is the motive for adjusting the thermostat setting (action), upon which the heater will change its behaviour, causing the temperature to change (consequence). This process, affected by changing the reference value, is a typical example of a double loop process.

With reference to measuring and monitoring against certain references, norms or standards, Baguley[3] explains double loop learning as follows:" … double loop learning takes place when a detection and correction process is applied to norms and standards. These norms and standards are subject to a process of measurement, monitoring, comparison and correction in order to establish if they are still relevant and appropriate. If they are not, they are changed ". We decided to refer to this single/double loop-concept as a methodological approach with which to reconsider the survey results. Our first reconsideration focuses on the validity of leadership orientations, because these were part of the survey references in the online prospective survey.

7.2 Task orientation-related contradiction

We developed a reference as part of this research: The Safety Leadership Model. The Safety Leadership node of this model contains three characteristics: the Safety Leadership orientations (Task, Relation and Self orientations). These Safety Leadership orientations represent certain combinations of indicators as included in the survey questionnaire. According to the model by Argyris (Figure 24), the Safety Leadership orientations serve as (part of) the Governing variables, conducting the survey represent the Actions, and the results of the survey are referred to as Consequences, which match or mismatch anticipated results.

2 Ibid., p. 116.
3 Baguley (1994), p. 18.

7.2.1 *Contradiction #1*

In this research we experienced a mismatch between the survey results, suggesting that a Task-oriented leader was a 'safe' leader, whereas the reflections on these results by senior leaders (ref. 6.7), as well as the views of the 18 professional incident investigators (ref. 10.1) suggested that Task-oriented leaders are the most instrumental in the causation of major incidents. This finding is an undesirable finding, and so we decided to investigate the origin of this contradiction.

The online prospective survey was conducted as a single loop process; the survey data generated by the respondents was analysed, using the Safety Leadership orientations as the undisputed reference (governing variables). To identify what went wrong, we referred to the theory by Argyris and decided to follow a double loop approach[4] by reconsidering the governing variables: the Safety Leadership orientations.

We decided to conduct two specific activities where the contradiction is concerned: a) the verification of the validity of the a-priori classification of the questionnaire indicators for Safety Leadership orientations, and b) the identification of the integrated dynamics of the Safety Leadership Model as a whole. Based on this decision we first verified the validity of the a-priori classification of the questionnaire indicators using two different types of factor analyses (EFA and CFA). After those analyses, we identified the integrated dynamics of Safety Leadership as a whole through Structural Equation Modelling. These activities are described in the following sections.

7.2.2 *Factor analyses*

The a-priori classification of the questionnaire indicators into the three Safety Leadership orientations (Task, Relation and Self) as used in this online prospective survey, was based on 21 indicators originating from leadership theory (ref. 4.2.3) and 13 indicators coined by the researcher referring to professional expertise in the field of risk management and safety. This survey questionnaire design was thus composed from different sources and its robustness and applicability were tested through a pilot survey among 88 professional experts. The reflections on the survey data by senior leaders in the surveyed organisations and the information obtained from risk analysis experts, however, meant that we thought a different classification of the questionnaire indicators into the three leadership orientations might be helpful. We therefore decided to seek proof of the a-priori classification of leadership indicators. We thus performed an exploratory factor analysis (EFA) and then (on a different sample) a confirmatory factor analysis (CFA).

4 Ibid., pp. 17–19.

7.2.2.1 Exploratory Factor Analysis (EFA)

Sample

The online prospective survey was conducted in two different phases. Once the pilot survey data had been analysed and (after implementation of some minor improvements) the robustness and applicability of the questionnaire was confirmed, we conducted an online prospective survey among another population of 3332 general employees (leaders and followers) working for the 33 organisations involved in this research. The original population surveyed comprised 4561 respondents. For data quality reasons, this was reduced by 1141 respondents (25.0%), leaving the data of 3420 (88 respondents in the pilot survey and a sample of 3332 respondents in the online prospective survey) to be taken into account. Section 6.2.3 shows how these respondents were selected.

The addition of the safety node to the Safety Leadership Model was one of the results of the analysis of the pilot survey. Safety statements were not included in the online prospective survey questionnaire from the initial survey phase. Due to this a-synchronicity, data about safety was not recorded by the initial group of 1326 respondents (39.8% of the total sample), to the survey questionnaire before the pilot survey was analysed. A total of 2006 respondents (60.2% of the total sample size of 3332) were presented with the improved survey questionnaire when the safety-related statements were included, so this group completed the entire questionnaire.

Analysis process (EFA)

The EFA was performed in order to classify the 34 leadership orientation indicators into consistent and discriminating factors. In order to minimise the risk of overfitting, the proposed EFA used a sample of 1326 (39.8% of the total sample size of 3332) respondents who had not been offered the safety statements. After the maximum number of identifiable dimensions was determined, the patterns of the loading factors for the EFA solution were examined. We checked the construct validity by applying a Cronbach's alpha evaluation to determine the internal consistency of the proposed factor structure of leadership orientations.

Classification of indicators

The EFA analysis demonstrated that 8 of the 34 leadership indicators did not meet the required statistical requirements. We found five indicators during the EFA procedure which were not compatible with their a-priori theoretical classification as suggested by the underpinning theory.[5] These indicators were removed from the analysis. We also found that three other indicators showed low loadings (< 0.25) or high cross-loadings, and therefore no classification for these indicators could be determined. Another item proved to be a dimension in itself as it did not load on any of the identified dimensions. These eight indicators were removed from the database, leaving 26 indicators to be classified into one of the leadership orientations.

5 Slocum and Hellriegel (2009), p. 368.

The EFA also included a classification of the leadership indicators into the suggested a-priori leadership typologies (*motivator, achiever*, *knowledge base*, *team player, stimulator, ruler* and *individualist*), as suggested in Section 5.1. The EFA revealed that the a-priori classification of some of the suggested typologies was insufficiently statistically supported by the survey data, and should therefore be revised. This revision encompassed quantitative (statistical), as well as qualitative (substantive meaning), characteristics of the different indicators, typologies and leadership orientations.

The leadership orientation Task was most affected in this optimisation process. The EFA analysis showed that the indicators which had been clustered to form this orientation actually represented *two* different constructs. Admittedly, both constructs relate to *achievers* (Task-oriented leaders), but the EFA analysis suggested that these leaders prefer using different leadership methods to achieve their goals, and are therefore considered to be differently oriented.

7.2.3 *Reconsideration of the leadership orientations*

We analysed the meaning of the survey indicators forming the two different Task-related orientations and we decided to split the Task leadership orientation into two distinctly different orientations. We found that one of the new orientations represents leaders who are characterised by achieving their objectives by acting decisively, behaving courageously and making intuitive decisions. In Atkinson's 'Theory of Motivational Determinants', the motivation of people to achieve certain goals is related to the risks they dare to take in order to succeed. Their behavioural motive is determined by their expectancy that their acts will lead to a particular consequence, and that these acts will be followed by a positive incentive. Atkinson claims that achievement motivation may lead to behaviour towards achieving the expected goal, but also to behaviour that aims to avoid failure (ref. 2.3.5.2). [6] In the following sections, the leadership type of leaders who demonstrate behaviours towards achieving an expected (economic) goal is called 'Production-oriented.'

The other (new) orientation represents leaders who typically demonstrate behaviours that aim to avoid failure. We called this leadership type 'Process-oriented.' These leaders are characterised by achieving their objectives by motivating their followers to intervene in safety risks, behave in a forgiving way, ensure that improvements are implemented and consider the safety of operations as top priority. Leaders who belong to a Production or a Process orientation are working to achieve production targets, but using different policies to succeed.

6 Atkinson (1957).

7.2.3.1 Production-oriented leaders

Leaders who behave Production-oriented are primarily focused on economic growth ("getting the job done, no matter what").[7] They show behaviours as *'power driven achievers'*, described by McClelland[8] as leaders, specialised in handling situations which call for something more than routine action, which implicitly involve taking risks of some kind (ref. 2.3.5.3) They operate with a focus on production targets and output: they are decisive and seem to be confident where, in reality, uncertainty is the case. This type of leader often has many years of operational experience, but (luckily) little personal experience with major incidents. These leaders lack sufficient risk awareness as well as the confirmation bias required to expect rare events, and they therefore underestimate the probability of such incidents; they honestly cannot imagine catastrophic scenarios happening under their leadership.[9] Leaders who lack the experience of critical failure are also overly optimistic about the effects of their decisions, as it is easy to imagine the successful completion of a project in the preparation phase, while the uncountable ways in which a project might fail are vague and elusive.[10] Steered by a lack of incident experience and ignorance, these optimists suffer from excessive confidence, due to which they behave decisively, courageously and take intuitive decisions.[11] According to Kahneman this optimistic bias is an important source of risky behaviour.[12] This behaviour, Kahneman's so-called 'System 1 behaviour', is typical of Production-oriented people.

7.2.3.2 Process-oriented leaders

Process-oriented leaders are also concerned with production objectives, but they demonstrate behaviours that are more contextually and socially motivated, as described by Winter[13] (ref. 2.3.5.4). These leaders take the possibility of surprises (e.g., the occurrence of safety incidents) seriously into account and consider uncertainty as an unmistakable element of their professional context. Process-oriented leaders believe in human potential (personal growth), always look for opportunities to do things more smartly, and motivate their followers to continually improve their performance.[14] Safety prevails; where safety risks are identified, time and effort are taken to reduce these to acceptable levels before operations are continued, and therefore they 'think twice' before taking a decision. Kahneman refers to this as 'System 2 behaviour.'[15] When Process-oriented leaders are faced

7 This description was given to this type of leaders by one of the incident investigators consulted in the retrospective review of incident analyses (ref. 9.1).

8 McClelland (1967).

9 Kahneman (2012), pp. 353–354.

10 Ibid., p. 347.

11 Ibid., pp. 343–356.

12 Ibid., p. 267.

13 Winter (1991).

14 Dweck (2012), pp. 125–127.

15 Kahneman (2012), pp. 259–269.

with a team member who has mistakenly interrupted the production process for safety reasons, they realise that people are fallible and they will forgive that team member their mistake.[16] In general, Process-oriented leaders endeavour to achieve their production targets in a more inclusive way, with equal focus on production and on the quality and safety-related aspects of the primary process. The behaviours of Process-oriented leaders show elements of multiple analogous leadership concepts, that is, High Reliable Organizing (HRO), psychological safety, a growth mindset and transformational leadership. We explain the relationship between these concepts and Process-oriented leadership.

We argue that when leaders exhibit behaviours matching the leadership concepts described above, they demonstrate that they possess the behavioural properties belonging to Process-oriented leaders. As our survey outcomes show, their focus and related behaviours will make a positive contribution to safety performance, and are the opposite of the focus and behaviours belonging to Production-oriented leaders.

7.2.3.3 Confirmatory Factor Analysis (CFA)

After the optimised taxonomy of leadership orientations proved internally consistent, we performed a CFA to verify the standardised loadings of the individual classified leadership indicators, as well as the mutual standardised loadings between the four leadership orientations as determined by the EFA. We used a different sample as the reference for this CFA analysis; the remaining 2006 (60.2% of the total sample size of 3332) respondents.

7.2.3.4 Internal consistency of leadership orientations

After completing the analyses as described above, we re-assessed the quality of the final taxonomy of leadership orientations by determining their respective construct validity (Cronbach's α). This assessment, using the test set (n=2006), revealed the following construct validity: Production (α=.76), Process (α=.79), Relation (α=.95) and Dominance (α=.82). These values indicate the good internal consistency of these four constructs.

7.2.4 *Explaining Contradiction #1* *The reflections by senior leaders*

The results of the online prospective survey suggested that a Task-oriented leader was a 'safe' leader, however, when senior leaders in the surveyed organisations reflected on the survey results, they characterised the 'ideal leader' by mentioning features such as personal involvement, mutual respect, empowerment and psychological safety (ref. 6.8). The definition of Task orientation proved ambiguous in our survey design: Task-oriented leaders are considered achievers who focus on achieving production targets, but the so-

16 Dweck (2012), p. 127.

cio-psychological factors mentioned by the senior leaders were also included as indicators for Task orientation. This seemed to cause confusing results.

Based on our experience with the reflections on the survey data by senior leaders, we considered challenging the survey reference used (the three leadership orientations, Task, relations- and Self-), because we believed that a different classification of the questionnaire indicators might be conceivable. This was confirmed by the EFA.

The EFA suggested that Task-oriented leadership actually encompasses two different orientations: a Process orientation and a Production orientation. We also discovered that the indicators that make up the Process orientation resemble the description of 'ideal leaders' as mentioned by the senior leaders during the survey reflection process. From that discovery, combined with the knowledge of the outcome of the EFA, we take it that the senior leaders actually consider Process-oriented leaders to be 'ideal leaders.'

The views of incident investigators

Another discrepancy was the mismatch between the survey results and the views of the 18 professional incident investigators (ref. 10.1), the latter suggesting that Task-oriented leaders were considered the most instrumental in the causation of major incidents. Once we had completed the EFA-analysis we re-consulted these incident investigators in order to discover what they consider a Task-oriented leader. We presented them with the seven questionnaire indicators representing Task orientation and asked them to mark the indicators they considered typical of Task-oriented leaders. The results of this consultation are shown in Table 11 below.

A task-oriented leader ...	**Responses**
... dares to take decisions based on his/her intuition	7
... has guts; does what he/she deems right, even when procedures prescribe otherwise	13
... dares to take decisions	15
... ensures that necessary improvements are made	**14**
... motivates employees to intervene themselves in case of safety risks	4
... says: "Safety first!"	5
... is forgiving when, out of caution, someone has unnecessarily disrupted production	3

TABLE 11 Leadership orientations consultation: results of incident investigators

The left side of the table shows the seven questionnaire indicators that, according to the questionnaire design, apply to Task-oriented leaders. The response column on the right shows the number of marks given by the incident investigators. The top three lines show the indicators of a Production orientation. The bottom four lines represent a Process orientation. The indicator printed in bold (... ensures that necessary improvements are made) has a factor load in common with both Process orientation (.35) and Production orientation (.31), so this Process orientation indicator might be called a 'shared' indicator.

We conclude from these responses that when the incident investigators suggested that Task-oriented leaders are considered most instrumental in the causation of major incidents (ref. 10.1), they referred to leaders who display a Production-oriented orientation.

7.2.5 *Conclusion on Contradiction #1*

The identified Task orientation-related mismatch involved the difference between the survey results (showing that Task-oriented leaders are 'safe' leaders) and a) the reflections on those results by senior leaders, and b) professional incident investigators (suggesting that Task-oriented leaders are considered most instrumental in the causation of major incidents).

The EFA and CFA analyses revealed that the 'Task orientation' construct actually encompasses two distinctly different constructs, a Process orientation (focusing on quality of the production process) and a Production orientation (focusing on quantity of production). This discovery resolved the identified contradiction.

7.3 Recognition-related contradiction

7.3.1 *Contradiction #2*

This mismatch concerns the difference in the outcomes of the statistical analyses of the survey results, showing that Recognition is perceived as the risk reduction phase generating the best or second-best scores. The professional incident investigators, however, argued the opposite; they suggested that the recognition of risks is considered the least controlled risk reduction phase (ref. 10.1). This argument is supported by the view of five consulted professional risk analysis experts (ref. 10.2), who suggested that lacking an understanding of safety risks, or ignoring them, often contributes seriously to the occurrence of major incidents. Moreover, the observations by investigators and risk analysis experts are supported by the view of the Dutch Safety Board (ref. 10.3), which noted a lack of recognition of risks as a contributing factor in the occurrence of major incidents in many of their investigation reports.

7.3.2 *Explaining Contradiction #2*

We noticed that the online prospective survey generated very high scores concerning the Recognition risk reduction phase. At the same time, we acquired very negative appraisals about Recognition from professional incident investigators, risk analysis experts and investigators of the Dutch Safety Board, who were all renowned experts in the field of risk management. Next, we show a selection of the acquired information.

Incident investigators

The 18 incident investigators were asked to analyse 19 major incidents, and they replied that, compared with the other four risk reduction phases, Recognition was the least controlled risk reduction phase (ref. 10.1). In a scoring system where the investigators could judge the contribution of a risk reduction phase on a scale from 0 (no contribution) to 5 (serious contribution), the investigators' judgements resulted in the following scores: Recognition 204, Ability 185, Motivation 156, Courage 151, Action 178.

Risk analysis experts

We individually interviewed five risk analysis experts, who possess substantial experience in the major hazard industry, and questioned them about risk awareness at the work floor level (ref. 10.2). One expert suggested that in general people in operations do know the safety risks, but also that there is a pattern of *normalisation of deviation*, meaning that certain deviations from safe practices have become the normal way of working; they know the risks, but they don't feel unsafe with them.

The other four experts explained that they consider that, for various reasons, operating staff have insufficient knowledge of risks. A lack of information communicated from risk analysis teams to operating staff seems an important reason. The answers to the question of whether supervisors are aware of safety risks are also cause for concern. Various reasons were mentioned, including lack of information, poor communication, and that risk analysis is considered 'owned' by technical departments. The experts were also worried about that operational leaders lacked knowledge about the major hazards.

Generally, the experts suggested that the identification and assessment of safety risks is a subjective and incomplete process, which does not produce a reliable representation of all potential safety risks. Moreover, organisations pretend that they have tackled all risks, but the interviewed experts wondered whether it was possible to identify and analyse all risks to begin with.[17] According to these experts, leaders live in an illusionary world, believing that their operations are safe.[18, 19]

Dutch Safety Board

We reviewed twelve investigation reports issued by the Dutch Safety Board (ref. 10.3). This stage of the research was introduced after we acquired the results from the incident investigators, who suggested that the insufficient Recognition of risks is in an important cause of major incidents. This suggestion was reason to investigate the role of recognition of safety risks in the causation of safety incidents in more depth. In our review of the incident reports from the Dutch Safety Board we focused on the role of risk awareness and risk assessment as contributors to these incidents.

We studied twelve investigation reports covering the tank storage, hospital, oil and

17 Pasman (2015), pp. 168–171.
18 Motet and Bieder (2017).
19 Beck (1986), p. 28–32.

gas industry, process industry, rail infrastructure and general infrastructure business sectors. We observed a high degree of Recognition-related conclusions. We note a selection here: "… one was not aware of the risks involved", "… the organisation was not able to use the knowledge of the safety risks involved", "… the company had no complete insight into its primary processes, installations and involved safety risks", "… as there was no effective hazard identification process, there was no complete picture of the major risks", "… risk identification of process safety risks was conducted in an insufficient way", "… risk identification of hazardous substances is insufficient and inadequate", "… in the HAZOP-study many risks of potential incidents have not been assessed…", "… none of the parties involved viewed this innovation as a particular risk for patients", "… nobody displayed awareness of the risks for patients due to this complex operation", "…insights into the interrelated risks were largely absent…", and "…risk assessments do not include the risk of trains colliding with heavy vehicles…".

Possible reasons for the mismatch in the recognition of risks

In this section we explain the Recognition-related mismatch wherein the above responses by risk management experts and professional incident investigators contradict the survey results concerning the Recognition risk reduction phase. In order to explain this contradiction, we refer to the underlying theory about the way people assess risk.

Slovic confirms the difference between the 'professional' approach to risk assessment by risk management experts versus an 'intuitive' approach by lay people. His research revealed that the experts, whom he refers to as 'technologically sophisticated analysts', employ risk assessment techniques to evaluate hazards, and that lay people rely on intuitive risk judgements. The expert seems to be the knowledgeable factor but that should be taken with a pinch of salt, because Slovic also argues that people in general suffer from similar biases resulting in the denial of uncertainties and misjudgement of risks (under- as well as overestimation) and that "… (perceived) characteristics such as familiarity, control, catastrophic potential, equity and level of knowledge also seem to influence the relationship between perceived risk, perceived benefit and risk acceptance."[20] These characteristics explain why the risk management experts and operational staff (often referred to as 'lay people'), who occupy different positions, have different kinds of experiences, play different roles in organisations and judge risks differently.

In an article entitled "Characteristics of Individual Risk Perception" Jungermann and Slovic suggest that controversies about risks are often caused by the question of which criteria are to be used and how these are to be weighed in a risk assessment process. These scholars argue that: "These questions cannot be solved scientifically, but only socially and politically."[21]

Some of the risk analysis experts suggested to us that people in operations are aware of the safety risks they run, but that due to a lack of serious incidents, there is a trend

20 Slovic (1987), pp. 282–285.
21 Jungermann and Slovic (1993), p. 100.

of *normalisation of deviation*, meaning that certain deviations from safe practices have become the normal way of working. We touch on non-compliance with safety directives here, which implies that people who are indeed aware of the actual safety risks, do not consider these risks threatening enough to comply. Our participants/risk analysis experts claimed that this observation is often made in relation to operational staff, and, because the behaviours of this group are so easy to observe and address, these people are often blamed for 'pulling the trigger' in safety incidents, and therefore considered responsible for the consequences.

Theorists tell us about a related, but very different trend: the ignorance of risks by leaders. In his review of the BP Texas City refinery disaster, Hopkins[22] argues:

> … managers knew that the longer they continued operating in a degraded state, the greater the tendency to "normalise" the situation, that is, to accept the greater level of risk as normal. The normalisation of risk has been a significant factor in many major accidents. For example, prior to the Challenger and Columbia space shuttle accidents, a certain level of equipment malfunction came to be accepted as normal because it had not in the past led to disaster. People became desensitised to the risks of operating in this way. Ultimately, these malfunctions proved fatal.

We recognise these phrases by Hopkins, because people who work in a specific physical and cultural working environment may easily be 'intoxicated' by the 'way we do things over here' (also explained as 'culture'), and, as a result, honestly do not realise the present risks, even if these are obvious to third party observers.

Perrow[23] refers to the safety risks that were ignored by NASA and finally resulted in the well-known shuttle disasters. He notes the "corrupted safety culture" and the "extraordinary display of power that overcame the engineers who opposed the launch", and he also refers to the normalisation of deviance as a serious risk potential leading to major incidents.

Another possible reason people become used to working under risky conditions is their dependence on the income; if they complain about safety risks, they run the risk of being dismissed. In such cases people undertake their own risk assessment and weigh the risk of getting hurt against the risk of becoming jobless. Hierarchical power is also a factor to take into account regarding whether people report safety risks. Perrow notes that power is a critical aspect of safety, when he suggests that people do not dare to refer to safety risks until they have, willingly or unwillingly, left the organisation, and in that respect, he states that "we miss a great deal when we substitute safety for power."[24]

Jungermann and Slovic explain that the concept of risk should considered many-layered, and that controversial and individual risk perception is a function of both the qual-

22 Hopkins (2008), p. 45.
23 Perrow (1999), p. 380.
24 Ibid., p. 380.

ities of our cognitive and motivational system, as well as of the conditions of our social, political and cultural environment.[25] Organisational socio-psychological norms may also affect the assessment of risks by employees; in “macho cultures” workers may receive psychological rewards for risk taking, when they honestly do not see the risk anymore.[26] We argue that risk acceptance is also strongly dependent on the specific business sector in which people work; for example flying helicopters scores highest on the ‘most dangerous activities list’ (even above motor cycle riding!) and, although oil companies proclaim ‘safety first’, workers on offshore platforms are frequent helicopter passengers in order to commute from their homes to their work places Medical doctors work many more hours than legally accepted in other business sectors, where fatigue is considered a safety risk. It is very easy to find many other examples. We therefore argue that economy and safety are out of balance in many sectors, and that this is not a case of not recognising the safety risks, but merely a case of personal preference.

Finally, we refer to the fact that recognising risk requires an understanding of the future; what is the most probable future outcome? Motet[27] argues that the main problem is that our knowledge of the future in principle is zero, and the concept of risk is considered a tool used by experts who claim to possess superior knowledge of future threats. This may also have affected the judgements made by incident investigators, risk analysis specialists and the Dutch Safety Board. It is appropriate here to recall the relatively low survey scores we received from support staff, the internal safety experts, who proved to have a more critical view than any of their colleagues in the survey.

Compared to internal experts, external experts have the advantage of their broad experience, which provides them with a much wider window through which they have seen many risky situations, not visible to internal people. External experts who have witnessed so many risky situations and personally seen the disastrous results of many uncontrolled safety risks, are inevitably subject to confirmation as well as hindsight bias, when asked to assess the recognition of safety risks. Actually, it would be curious if these external experts came to the same conclusions as internal respondents.

7.3.3 *Conclusion on Contradiction #2*

According to the above explanations, the origin of the mismatch may be considered a result of “unknown knowns”, which are explained by Aven as “… events not on the list of known events from the perspective of those who carried out a risk analysis (or another stakeholder), but known to others (unknown events to us, known by others).”[28] According to Kahneman, however, human optimistic bias is an important source of risky behaviour, and we tend to overestimate the benefits and underestimate the costs. We

25 Jungermann and Slovic (1993), p. 87.
26 Perrow (1999), p. 246.
27 Motet and Bieder (2017), p. 7.
28 Ibid., p. 28.

develop successful scenarios while not taking the potential errors and miscalculations into account.[29] This might be considered ignorance, but the frequent major incidents worldwide demonstrate that we are not good enough at recognising risks. In that respect we repeat the phrase by Slovic:[30]

> … danger is real, but risk is socially constructed. Risk assessment is inherently subjective and represents a blending of science and judgment with important psychological, social, cultural and political factors.

Probably even more importantly, Slovic stated: "Taking into account information that does not come to our mind, perhaps because we never knew it, is impossible."[31]

We argue that the arguments above have contributed, each in its own specific way and with a different grade of impact, to explaining the contradiction in judging the Recognition of risks as identified in this research. Both groups, the survey respondents as well as the experts, have contributed to this research a great deal through the unintended generation of this contradiction. We have learned through their contribution that general employees, who are considered very familiar with their primary processes, are optimistic (leaders even more than operational staff), probably overly optimistic, about the level of Recognition of safety risks in these primary processes, and three different kinds of renowned risk management experts have made opposing assessments of the very same reality, for which nobody will ever completely know all the risks. Nobody is able to calculate how many risks are still in the uncertain domain of the unknown. Thaleb has written: "We love known schedules and well organised knowledge, even so much so that we are blind to reality."[32] We conclude that solving the contradiction is not required, but being aware of the gap is considered a contribution to safety in itself.

7.4 Concluding taxonomy of classification of leadership indicators

As a result of reconsidering the leadership orientations (ref. 7.2.3), the leadership indicators were reclassified. The outcomes of the factor analyses (EFA and CFA) show that the total set of leadership indicators suggests the existence of four different leadership orientations, instead of the previous three orientations: Task, Relation and Self orientations. The Task-oriented indicators in particular have proven not to hold statistically as one single orientation, but instead, to belong to two different orientations. Taking into consideration the specific properties of the seven Task-related indicators concerned, we decided to label these two new orientations 'Production' and 'Process' (ref. 7.2.3). This results in a final taxonomy of 26 indicators clustered in four leadership orientations: Re-

29 Kahneman (2012), p. 267.
30 Slovic (2001), p. 23
31 Kahneman (2012), p. 277.
32 Taleb (2010), p. 148.

lation, Process, Production and Dominance. This is presented below in Figure 25.

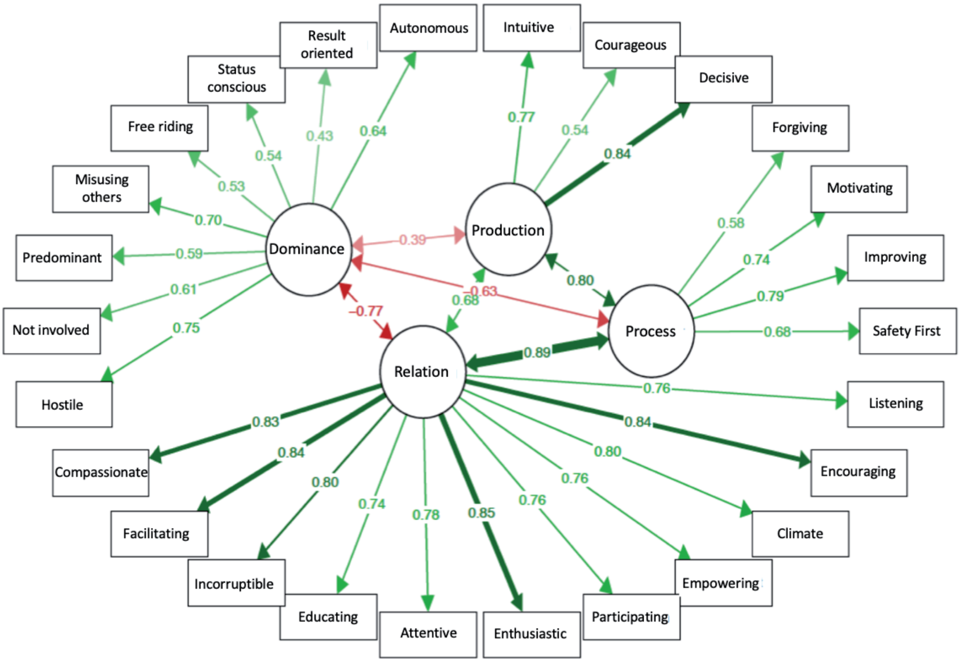

FIGURE 25 Leadership indicator taxonomy and factor loadings by leadership orientation

7.5 Safety Leadership Model Version III

The outcome of the exploratory and confirmatory factor analyses on the Safety Leadership node of the Safety Leadership Model recognised the redefinition of the leadership orientations and thus required upgrading the Safety Leadership Model Version II to Version III. This upgrade, as described in this chapter, encompassed the specification of Task orientation leadership by introducing two new leadership orientations, Production- and Process orientations. We also included the option of Safety Leadership having a direct effect on safety, not mediated by Risk Reduction Capacity. We added a new arrow between Safety Leadership and Safety. The final Version (III) of the Safety Leadership Model is presented below (Figure 26).

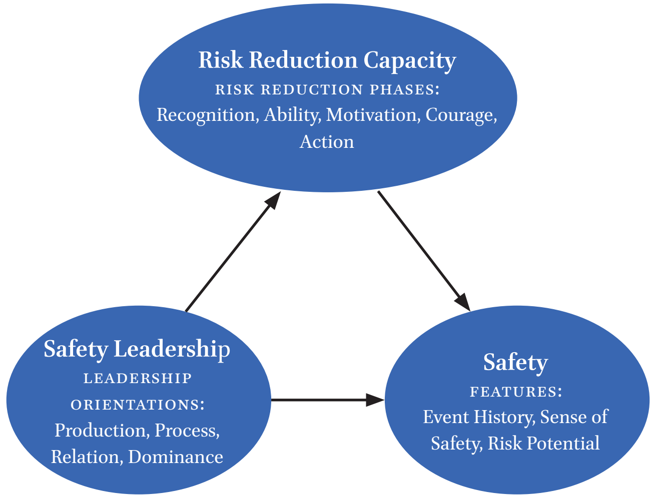

FIGURE 26 Safety Leadership Model Final Version III

7.6 Summary

After discovering two contradictions between the results of the online prospective survey and a) the interpretation of the contribution by Task-oriented leaders to the causation of major incidents, and b) the views about the contribution of the Recognition risk reduction phase to risk reduction in the previous chapter, we decided to reconsider the analysis process of the online prospective survey. We discussed this reconsideration process in this chapter.

First, we explained and applied the single/double loop model by Argyris. This model directed us to focus on a reconsideration of the survey questionnaire indicators referring to the Safety Leadership orientations. We decided to conduct an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA). Then we discovered from these analyses that the Task orientation construct was not an unambiguous concept. Actually, it encompasses two different constructs, each representing a different policy of leadership. This finding required a reclassification of the Task-oriented survey indicators. We thus solved this contradiction and modified the classification of the leadership orientations. This had important implications for the typologies. These implications are presented in Section 7.4, 'Concluding taxonomy of classification of leadership indicators'.

With respect to the leadership orientation Task, the term *Production* replaced the typology *achiever* and the term *motivator* was renamed as the now more applicable term *Process*. The suggested typology *knowledge base* was deleted, as the related group of indicators was not supported by the EFA analysis as a distinct construct. The suggested subdivision of the Relation orientation into the typologies *team player* and *stimulator* was not supported by the EFA analysis, so these typologies were combined into one orientation: Relation. The EFA showed a similar situation regarding the orientation Self: the suggested split into *ruler* and *individualist* was not statistically valid, so Self orientation survived as a single variable. In order to improve communication/understanding we translated the term Self orientation as Dominance orientation.

The above changes resulted in the following terminology: production-oriented leaders are primarily focused on meeting production targets; Process-oriented leaders are focused on the improvement of processes and have fundamental respect for the quality and safety-related aspects of the primary process; Relation-oriented leaders value interpersonal relationships and care for the social climate at the work place; and the Dominance-oriented leadership orientation encompasses self-centred, sometimes even narcissistic leaders, who are only interested in their personal priorities.

We also investigated another contradiction between the survey results as generated by general employees and the views of the consulted experts about the contribution the Recognition risk reduction phase makes to risk reduction. The different data proved to represent reality and is considered a logical effect of the different roles and perspectives of both groups (internal employees and external experts). We therefore concluded that the difference identified between the survey results and the views of the consulted experts has no effect on the content of this dissertation.

7.7 Conclusions

Due to the discovery of two contradictions between the survey data and otherwise acquired information we reconsidered the classification of the Safety Leadership orientations. We performed exploratory and confirmatory factor analyses. These analyses revealed that the Task leadership orientation actually encompasses two distinctly different orientations, called Process and Production. We thus recognised four instead of three leadership orientations: Relation, Process, Production and Dominance. This required an update of the taxonomy of leadership indicators, which led to a modification of the Safety Leadership Model into Version III. These changes solved Contradiction #1 concerning Task-oriented leaders.

Contradiction #2 between the survey data and information acquired otherwise was related to the Recognition risk reduction phase. Investigating that mismatch did not eliminate the contradiction, but its existence was satisfactorily explained as a result of the explainable different views held by internal operational employees and external risk management experts.

In the next chapter we will submit the results of the online prospective survey, using the Safety Leadership Model Version III as a reference. The mean scores of the survey data will be discussed. The causative relationships between the nodes of the Safety Leadership Model are determined using Structural Equation Modelling (SEM), which forms the basis for the answer to the principal research query: “Can leaders of organisations help to prevent safety incidents?”