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

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What has happened, we take seriously, what could have happened, we ignore.

NICOLAS TALEB

6 Extended prospective research

Using the pilot survey described in the previous chapter, we investigated the relationship between the characteristics of Safety Leadership and Risk Reduction Capacity as perceived by a group of safety experts. We evaluated the draft questionnaire according to the findings of this pilot survey, and developed an improved version. In order to verify the representativity of the data provided in the pilot survey we extended our research by conducting an online prospective survey among a wider group of respondents: 4561 general employees working in 33 different organisations, operating in six different specific business sectors. After the survey data had been collected and analysed, interviews were held with CEOs, operational managers and safety managers, to collect their thoughts on the data.

This chapter contains information about the online prospective survey, as well as about the reflection process. In the following sections we discuss the design, organisation, conduct and results of the online prospective survey.

6.1 Survey design

General

In addition to some demographic questions, the survey questionnaire contained statements in order to identify the relationship between the three core constructs of the Safety Leadership Model Version II (Safety Leadership, Risk Reduction Capacity and Safety) used to find an answer to the principal research query: 'Can leaders of organisations help to prevent safety incidents?'

We used the survey questionnaire version including the improvements described in Section 5.4.

The questionnaire invited the respondents to score their (dis-)agreement with 42 statements; 34 statements relating to Safety Leadership, five statements relating to Risk Reduction Capacity and three statements relating to safety. Next, we explain the structure of these statements:

Statements related to Safety Leadership

The target population was invited to indicate their personal perceptions of the way their direct leaders behave. In order to receive a structured picture of these perceptions, the population was presented with a set of 34 indicators regarding individual behavioural orientations. These statements relate to specific Task-, Relation- and Self-oriented behaviours, which are considered indicative of the construct, referred to as the leaders' behavioural orientations (ref. 2.3.6).

The 34 statements (see Appendix 15.5) were thus categorised into the following labels:

- 13 statements indicative of Task-oriented behaviours;
- 13 statements indicative of Relation-oriented behaviours;
- 8 statements indicative of Self-oriented behaviours.

Statements related to Risk Reduction Capacity

- In the workplace, people are aware of the local safety risks;
- In the workplace, people are able to solve those safety risks;
- In the workplace, people are motivated to solve safety risks;
- On the work floor, people dare to intervene themselves to solve safety risks;
- Known safety risks are resolved in a timely manner.

Statements related to Safety

Safety was measured by collecting the respondents' individual (dis-)agreement regarding statements concerning three indicators representing their views on historical (events history), present (Sense of Safety) and future safety-related (Risk Potential) conditions.

The following statements are included in the questionnaire:

- Event History: 'A great deal has gone wrong in the field of safety within my organisation in the past year';
- Sense of Safety: 'I feel safe in my organisation';
- Risk Potential: 'There is a real risk of accidents in my organisation'.

Moderator variables

The design of the survey questionnaire allowed the mean scores to be analysed, distinguished by the following moderator variables: general, business sectors, gender of supervisors, hierarchical positions, age, vocational experience, accident-related history.

A copy of the survey questionnaire is presented as Appendix 15.5.

6.2 Survey Organisation

6.2.1 *Survey reference*

Safety Leadership Model Version II (ref. Figure 23) served as a reference in this online prospective survey.

6.2.2 *Selection criteria*

Selection criteria for participating business sectors

The six business sectors were selected on the basis of:

- The diversity of their primary processes;
- The vulnerability of these processes to major incidents (fatality, permanent disability, major economic effect, major environmental effect).

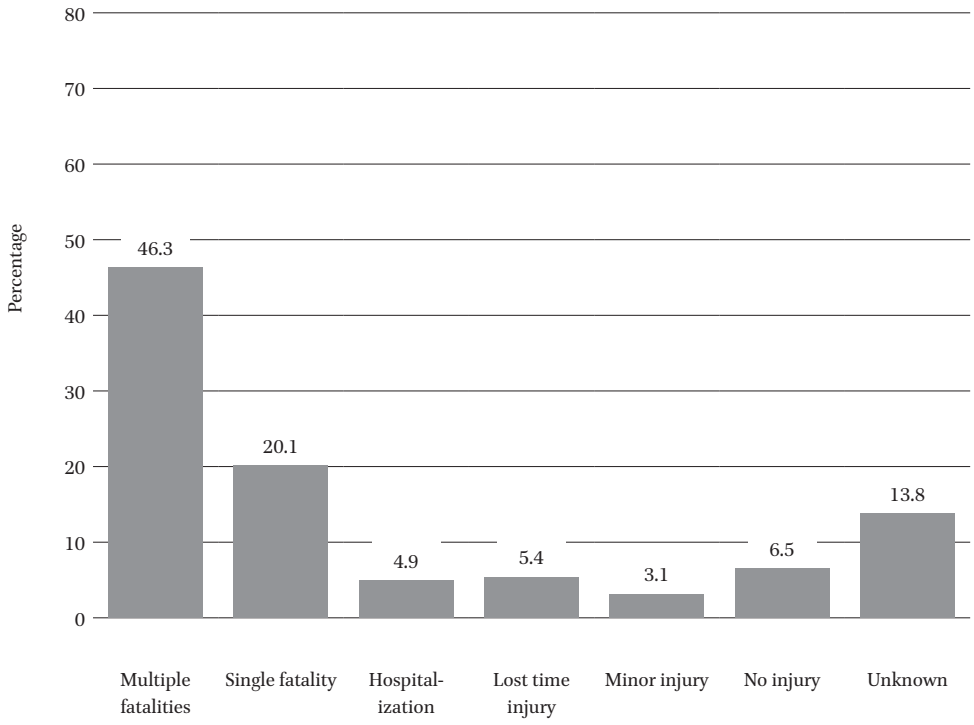
Selection criteria for participating organisations

This research includes the tank storage, hospital, process industry, oil and gas exploration and production, general infrastructure, rail infrastructure and other industries as business sectors. These business sectors are considered 'high-risk' in the context of safety incidents. All participating organisations are based in the Netherlands.

Organisations in each of the six business sectors were asked to participate in this study. They were selected if:

- The organisation operates in one of the selected business sectors;
- Management supported participation in this study;
- The researcher had access to key people; and
- Their primary processes had a high potential for safety incidents for example fatalities, permanent disability, major economic effect, or major environmental effect.

The participating organisations were selected based on the presumption that they were vulnerable to safety incidents because they execute primary processes where high safety risks are present. We asked all respondents to indicate the type of safety incidents (in terms of severity) they considered possible in their organisations. Bar Chart 5 below shows the percentages of respondents, and their responses regarding the potential of possible safety incidents.



BAR CHART 5 Potential severity of incidents

The presumption that these organisations are vulnerable for safety incidents was confirmed as 66.4% of the respondents replied that an operational disturbance in their organisations could result in a (multiple) fatal incident or (major) damage to assets, pollution of the environment, or damage to the organisations' reputation. Also, 4.9% of the respondents indicated that their organisations run the risk of incidents requiring the hospitalisation of victims. This question was answered by 75.8% of the valid survey population.

These percentages confirmed the relevance of conducting this research in the selected business sectors.

6.2.3 *Demography*

Respondents

The participants of this online prospective survey totalled 4561 respondents, labelled 'general employees' and working in six different specific business sectors.

For the purpose of analysis, the original data collected was exported using the online data collection tool Qualtrix XP to SPSS (v. 25), and then sanitised as described below.

Of these 4561 people, 141 respondents did not give consent to use their responses for scientific research. Another 344 respondents did not complete the questions related to

risk reduction. After these 485 respondents were removed from the database (Sanitation 1) 4076 valid respondents were left. Of this group, 508 people completed less than 70% of the Safety Leadership related questions.[1] These respondents were removed from the database (Sanitation 2). The data base still comprised 3568 respondents. Of this subtotal, 61 respondents answered three or more of five questions related to risk reduction with 'Don't know.' After this (Sanitation 3) process, 3506 valid respondents populated the data file.

The scores of 29 respondents showed no spread (SD 0). These respondents were eliminated and another 58 respondents were taken out as the spread of their data exceeded the limit of two standard deviations (Sanitation 4). After eliminating these 87 respondents from the database, a complement of 3420 valid respondents were left included in the analysis of this prospective survey. After these sanitation operations, the database was split into two separate data files: one for data obtained from safety experts (88 valid respondents), and one for data obtained from general employees (3332 valid respondents).

Direct supervisors of respondents

The valid respondents in this research also reported the hierarchical position of their respective direct supervisors. Out of a total population of 3332, 3326 respondents answered this questionnaire question. This investigation found that 12% of the general employees were directly supervised by directors or board members, 25% by managers and 29% supervisors, and 34% were supervised by senior staff (the latter category refers to hospital employees only). The details of this investigation are given in Table 4 below.

	Frequency	%
Director/Board	401	12.0
Manager	818	24.5
Supervisor	973	29.2
Senior staff	1134	34.0
Subtotal	3326	99.8
Missing	6	0.2
Total	3332	100.0

TABLE 4 Hierarchical positions of respondents' direct supervisors

1 A 70% response was considered the cut-off point for a representative response rate.

6.3 Survey conduct

We used personal communication (email and telephone) to ask the management of the participating organisations to encourage their employees to participate in this survey. The general employees/potential respondents were asked to participate in this survey by their individual leaders.

The survey questionnaire could be accessed via an internet link and included an option to answer the survey questions using a smart phone. We had no access to the identity of the respondents.

Most of the data was collected using the Qualtrix XM online survey tool under licence of Leiden University.[2] The respondents scored each statement in the questionnaire on a seven-point Likert scale from strongly disagree, to disagree, somewhat disagree, neither agree nor disagree, somewhat agree, agree and strongly agree. These terms corresponded in the Qualtrix data collecting programme with a numerical scale ranging from -3 to +3. A 'don't know' option was included. We decided to use wording (from strongly disagree to strongly agree) instead of the numerical scale for optimal understanding.

The average response time for this survey was expected to be around 15 minutes (as indicated by the Qualtrix data collection software).

The data acquisition period was from March 2016 until October 2019.

6.4 Survey results (primary analysis)

In order to determine the answer to our principal research query, 'can the leaders of organisations help to prevent safety incidents?' we analysed the data acquired through the online prospective survey. We analysed the mean scores for each node on the Safety Leadership Model. This analysis focused on general results according to all respondents, and also the results distinguished per business sector.

We performed two different types of statistical analysis on the acquired data related to the three nodes of the Safety Leadership Model: a) a Spearman's Rank correlation analysis, and b) a linear regression analysis. These analyses were performed on data generated by 3332 respondents.

Finally, in order to obtain an impression of the representativity of the survey results, we asked a selection of senior leaders in the surveyed organisations to reflect on the survey results as applicable to their organisations. We present the results of these primary analyses below.[3]

2 Most of the survey questionnaires were distributed using an online data collection tool (Qualtrix). According to the request of one participating organisation, the questionnaires were distributed to the respondents as paper copies ('hard copies').

3 Out of respect for individual anonymity, data recognisably generated by groups that consisted of fewer than four people is not presented.

6.4.1 *Mean scores*

We analysed the acquired survey data for the constructs of Safety Leadership Orientations, Risk Reduction Capacity and Safety in order to establish the different mean scores of the nodes on the Safety Leadership Model.[4]

The employees of 33 organisations operating in six different specific business sectors responded to the online prospective survey questionnaire. Due to the differences in staffing between the participating organisations, the distribution of the respondents is not identical over the business sectors. The contributions of general employees from the rail infrastructure sector (n=1010) and the hospital sector (n=767) are relatively large, but fewer employees from the process industry (n=128) and the tank storage sector (n=185) participated. The number of responses from the oil and gas industry (n=414) and the general infrastructure sector (n=454) were in between the other categories. The category 'other' represents respondents who participated as attendees of symposia, courses and workshops, and whose business sectors are not known. An overview of the distribution of respondents is presented in Table 5 below.

	Frequency	%
Tank Storage	185	5.6
Hospitals	767	23.0
Process Industry	128	3.8
Oil & Gas	414	12.4
Infra General	454	13.6
Rail Infra	1010	30.3
Other	374	11.2
Total	3332	100.0

TABLE 5 Distribution of respondents over business sectors

We next present the results of the analysis of the mean scores for the Safety Leadership Model nodes in general and per business sector.

6.4.1.1 Safety Leadership orientations

The Safety Leadership related behavioural orientations of leaders were established by collecting the respondents' individual judgements on three statements concerning the (Task, Relation and Self-) behavioural orientations of their direct supervisor. They are represented in the general mean scores for the 34 Safety Leadership-related indicators as included in the survey questionnaire.

4 The underpinning statistical data is presented in Appendix 15.6.

6.4.1.1.1 *General mean scores for Safety Leadership orientations*

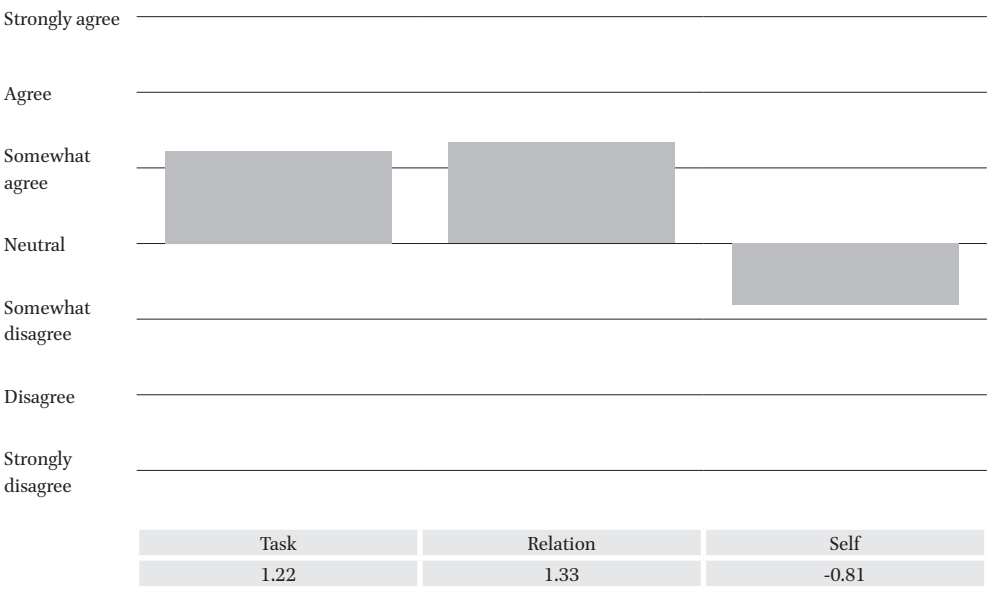
This section presents the leadership orientations of the respondents' direct supervisors in all organisations in general, as well as the mean scores per business sector.

Safety Leadership	Task	Relation	Self
Valid	3332	3332	3332
Missing	0	0	0
Mean	1.2223	1.3279	-0.8121
Std. deviation	1.00683	1.20012	1.13131

TABLE 6 Safety Leadership orientations by all general employees (N=3332)

The scores in the above Table 6 represent the perceptions of the population of general employees, and mean that these respondents, on average, *somewhat agree* that their direct supervisors show Task- and Relation-oriented behaviours, where a Relation orientation slightly prevails over a Task orientation (respectively *M*=1,22, *SD*=1,00 and *M*=1,33, *SD*=1,20). These respondents, on average, *somewhat disagree* that their direct supervisors show Self-oriented behaviours (*M*=-0,81 *SD*=1,13).

Bar Chart 6 below shows a graphical presentation of these scores.



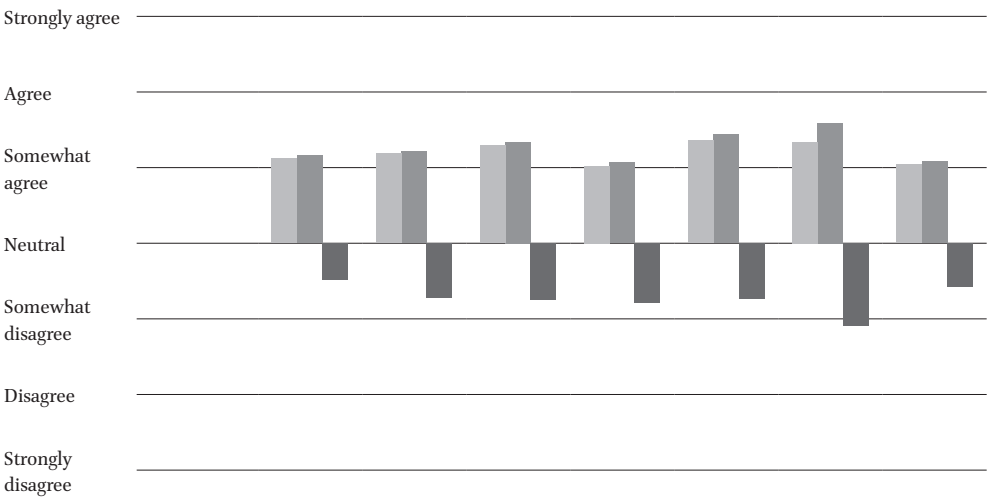
BAR CHART 6 General Safety Leadership profile by all general employees

Observations and interpretation of scores

These scores suggest that most of the respondents' direct supervisors show Relation-oriented behaviours, somewhat fewer leaders show Task-oriented behaviours and many fewer leaders show Self-oriented behaviours. However, the score for the latter category shows that there are respondents being supervised by Self-oriented leaders, otherwise this score would have been 'strongly disagree' (-3).

6.4.1.1.2 *Safety Leadership orientations per business sector*

The general data above presents the mean scores of non-sector specific data, which shows a picture of 'the respondents' world', which cannot be related to any specific source. We have also analysed the general means of the nodes of the Safety Leadership Model according to the different business sectors. The scores for Safety Leadership per business sector are shown in Bar Chart 7 below.



	Tank storage (n=185)	Hospitals (n=767)	Process industry (n=128)	Oil & gas (n=414)	Infra general (n=454)	Rail infra (n=1010)	Other (n=374)
Task	1.12	1.19	1.29	1.02	1.36	1.34	1.04
Relation	1.16	1.21	1.34	1.07	1.44	1.59	1.08
Self	-0.48	-0.72	-0.75	-0.79	-0.73	-1.09	-0.58

BAR CHART 7 Safety Leadership per business sector

Observations and interpretation of scores

Some remarkable scores were found in these data. The respondents in the tank storage sector showed the highest, *close to neutral* score for Self-oriented leadership behaviour (*M*=-0.48, *SD*=1.36). Leaders are more Relation-oriented than Task-oriented In all sec-

tors. The general infrastructure participants stand out for their relatively high scores for Task-oriented leadership behaviour (*M*=1.36, *SD*=0.89). The rail infrastructure sector stands out regarding Relation-oriented behaviour (*M*=1.59, *SD*=1.06). This sector also has the lowest scores for Self-oriented leadership behaviour (*M*=-1.09, *SD*=1.02).

6.4.1.2 Risk Reduction Capacity

The general mean scores for Risk Reduction Capacity were established by collecting the respondents' individual judgements on the five phases of the Risk Reduction Cycle (Recognition, Ability, Motivation, Courage and Action). We present these mean scores for Risk Reduction Capacity in general, as well as the mean scores for each business sector.

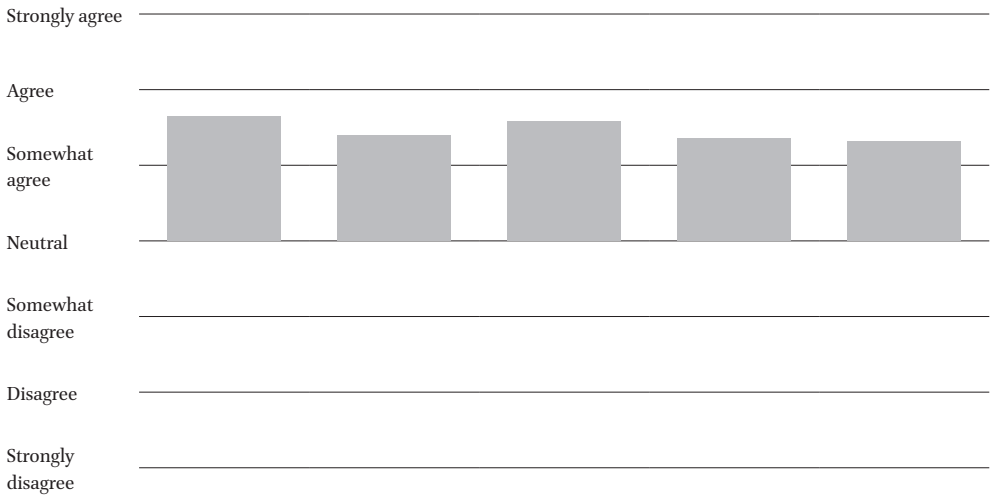
6.4.1.2.1 *General mean scores for Risk Reduction Capacity*

Risk Reduction Capacity	Recognition	Ability	Motivation	Courage	Action
Valid	3322	3320	3310	3297	3291
Missing	10	12	22	35	41
Mean	1.6508	1.4000	1.5782	1.3588	1.3102
St. deviation	1.28842	1.27988	1.31422	1.41341	1.45053

TABLE 7 Risk Reduction Capacity of all general employees

The scores in Table 7 above show how the general employees on average perceived the different levels of the five risk reduction phases. These scores mean that these respondents, on average, chose to *agree* that people at the work floor level recognise the safety risks in their working environment (*M*=1.65 *SD*=1.29). The respondents perceived that people at the work floor level had the ability to intervene when risks were recognised to a lesser extent (*M*=1.40 *SD*=1.28). In between the scores for these two risk reduction phases was people's Motivation to intervene (*M*=1.58 *SD*=1.31). The Courage to intervene scored somewhat less than Motivation (*M*=1.36, *SD*=1.41). Timely Action to solve safety risks scored lowest, but the respondents still scored slightly over *somewhat agree* concerning this risk reduction phase (*M*=1.31, *SD*=1.45).

A graphical presentation of these general scores is shown in Bar Chart 8 below.



Recognition	Ability	Motivation	Courage	Action
1.65	1.4	1.58	1.36	1.31

BAR CHART 8 Risk Reduction Capacity of all general employees

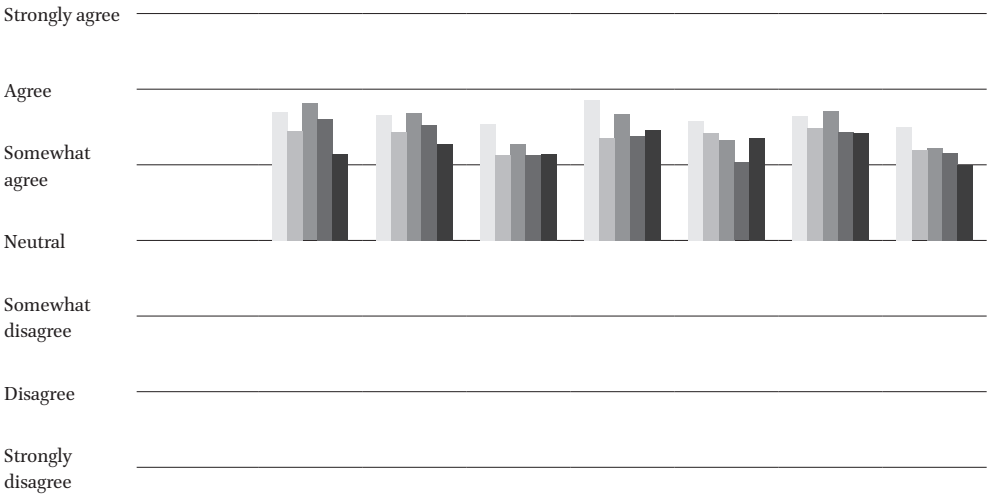
Observations and interpretation of scores

These scores show that the Recognition and Motivation risk reduction phases score relatively highly, and Action scores relatively low, which suggests that the respondents are convinced that they recognise risks relatively well, that they are motivated to intervene when risks are recognised, but that remedial Actions leave something to be desired. This coincides with the findings of Drupsteen,[5] whose case studies confirmed that the implementation of lessons learned from incident investigations was seldom performed systematically due to bottlenecks in implementing and communicating the Actions.

6.4.1.2.2 *Risk Reduction Capacity per business sector*

The different natures of the primary processes in the business sectors surveyed in this research mean that the risk reduction profiles of these sectors also show differences in the mean scores for their respective risk reduction phases. As we can see in Bar Chart 9, however, there are similarities too.

5 Drupsteen, Groeneweg and Zwetsloot (2013), p. 73.



	Tank storage (n=185)	Hospitals (n=766)	Process industry (n=127)	Oil & gas (n=414)	Infra general (n=453)	Rail infra (n=1005)	Other (n=373)
Recognition	1.70	1.66	1.54	1.86	1.58	1.65	1.50
Ability	1.45	1.43	1.13	1.36	1.42	1.49	1.19
Motivation	1.81	1.68	1.27	1.67	1.33	1.71	1.22
Courage	1.61	1.53	1.13	1.38	1.03	1.43	1.16
Action	1.14	1.28	1.14	1.46	1.36	1.42	1.00

BAR CHART 9 Risk Reduction Capacity per business sector

Observations and interpretation of scores

Our first observation is that the respondents in all sectors, except general infrastructure, report the Recognition and Motivation risk reduction phases as the highest scoring risk reduction phases in their respective sectors. The respondents working in the sector general infrastructure report the risk reduction phase Recognition as ranking first and Ability as ranking second. The respondents working in the process industry, oil and gas and general infrastructure sectors all perceive the risk reduction phase Action as ranking third. The other sectors, tank storage, hospitals, rail infrastructure and other, rank Action lowest of all risk reduction phases. In the tank storage sector respondents judge Courage (M=1.61 SD=1.43) relatively highly, and the general infrastructure sector scores lowest (M=1.03 SD=1.49).

The relatively overall high scores from the respondents in the oil and gas industry are of special interest, with Recognition (M=1.86, SD=1.21) as the highest scoring risk reduction phase of all sectors. The respondents working in the oil and gas industry also report a relatively high score for Action (M=1.46, SD=1.35). The oil and gas sector thus shows that risks are recognised *and* remedied more effectively than in other sectors. This might be explained by the fact that most of the respondents in that sector work *and* live 24 hours

per day on isolated offshore platforms, surrounded by open sea, where the risk of a safety incident is the main safety threat, and the workers themselves are the potential victims of these safety incidents if risks are not recognised and remain unremedied.

6.4.2 *Safety*

The respondents were asked to respond to statements indicating their perceptions about their organisations' recent Event History (questionnaire statement used: "In the area of safety, a great deal went wrong within my organisations in the past year."), their present Sense of Safety (questionnaire statement used: "I feel safe in my organisation."), and their views on the future Risk Potential (statement: "The risk of an accident is real within my organisations.").

NOTE: The safety of organisations was not investigated during the early phase of this online prospective survey, because adding the 'safety' node to the Safety Leadership Model arose as a result of analysing the pilot survey. Due to this development, only 2006 respondents were offered the improved questionnaire which included the statements about 'safety.'

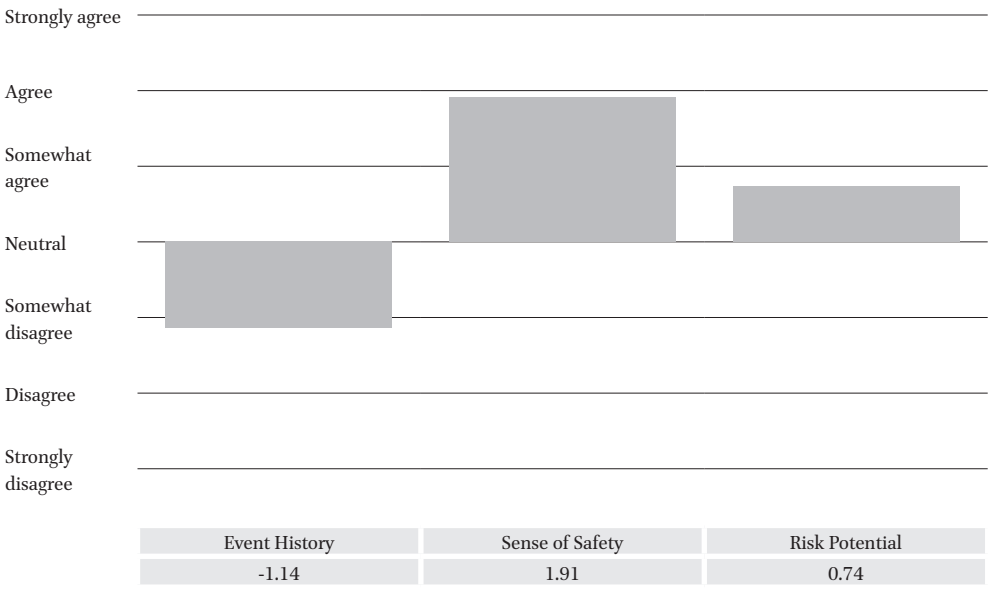
6.4.2.1 General mean scores for safety

Table 8 below shows the results of this part of the analysis of mean scores.

Result	Event History	Sense of Safety	Risk Potential
Valid	1906	2005	1991
Missing	1426	1327	1341
Mean	-1.1443	1.9102	0.7373
Std. deviation	1.50995	1.24732	1.75591

TABLE 8 Safety as reported by general employees

A graphical presentation of these scores is shown in Bar Chart 10 below.



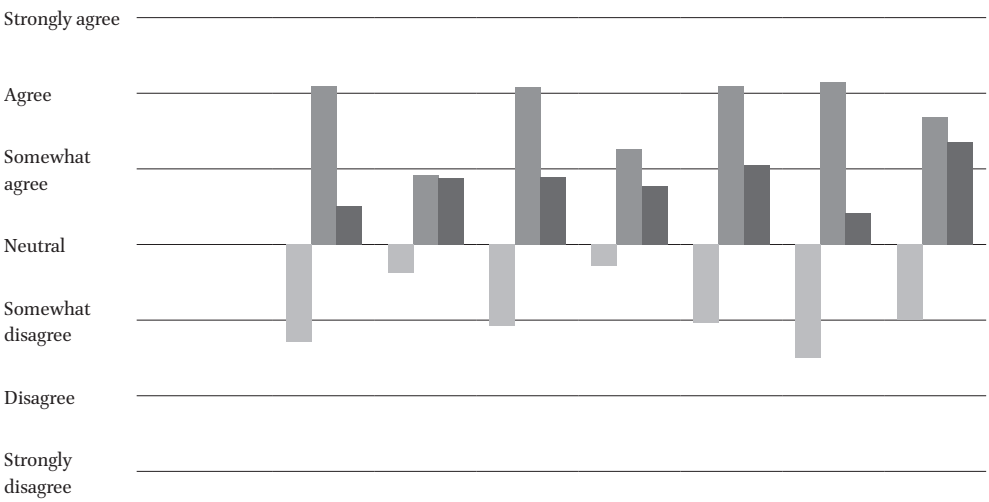
Event History	Sense of Safety	Risk Potential
-1.14	1.91	0.74

BAR CHART 10 Safety of all general employees

Observations and interpretation of scores

The scores in Table 8 and Bar Chart 10 represent the responses to the three statements above, and show that with respect to Event History the respondents, on average, *somewhat disagree* with the statement that 'a great deal went wrong in the area of safety' (*M*=-1.14 *SD*=1.51). The respondents indicate regarding their individual present Sense of Safety, that on average they feel safe (*M*=1.91, *SD*=1.25). The respondents, on average scoring between *neutral* and *somewhat agree* (*M*=0.74 *SD*=1.76), do not perceive potential safety risks as a real threat.

6.4.2.2 Safety per business sector



	Tank storage (n=98)	Hospitals (n=211)	Process industry (n=48)	Oil & gas (n=96)	Infra general (n=436)	Rail infra (n=901)	Other (n=215)
Event History	-1.29	-0.38	-1.08	-0.29	-1.04	-1.50	-1.00
Sense of Safety	2.10	0.92	2.08	1.26	2.09	2.15	1.68
Risk Potential	0.51	0.88	0.89	0.78	1.06	0.42	1.35

BAR CHART 11 Safety per business sector

Observations and interpretation of scores

As we can see in Bar Chart 11 the outcome data for safety shows some interesting scores. At first the hospital sector and oil and gas sector showed relatively high scores, close to *neutral,* for the 'Event History' variable (respectively *M*=-0.38, *SD*=1.57 and *M*=-0.29, *SD*=1.58), indicating that the respondents in these sectors consider that, safety-wise, a great deal went wrong in their organisation in the past year. These sectors score well above the mean score for this variable (*M*=-1.14, corresponding with: *somewhat disagree*). Remarkably the tank storage and rail infrastructure sectors reflect the opposite belief; both sectors score lower than *somewhat disagree* (respectively *M*=-1.29, *SD*=1.51 and *M*=-1.50, *SD*=1.31).

How the respondents experience their present individual Sense of Safety is closely connected to their scores for Event History; in sectors in which less went wrong last year (i.e., tank storage, process industry and general as well as rail infrastructure), the respondents score their Sense of Safety relatively highly; above *agree*. In the sectors with relatively high scores for Event History (i.e., hospitals and oil and gas), the respondents indicated feeling less safe; around *somewhat agree* (respectively *M*=0.92, *SD*=1.52 and *M*=1.26, *SD*=1.35). With respect to perceptions of the potential risk of accidents, all sectors

except the 'other' group (*M*=1.35, *SD*=1.50) indicated lower scores than *somewhat agree* (*M*=1.00), resulting in a mean score of 0.74 (*SD*=1.76). The rail infrastructure sector estimate is exceptionally low, at close to *neutral* (*M*=0.42, *SD*=1.89).

6.4.3 *Correlation and regression analysis*

We analysed the correlations and regressions as applicable to the acquired survey data with respect to the three Safety Leadership orientations (Task, Relation and Self-) in relation to the data regarding the five risk reduction phases (Recognition, Ability, Motivation, Courage and Action). We also analysed the survey data acquired for the five risk reduction phases (Recognition, Ability, Motivation, Courage and Action) in relation to the data for safety characteristics (Event History, Sense of Safety and Risk Potential). Finally, we analysed the data concerning the three Safety Leadership orientations (Task, Relation and Self-) in relation to the data regarding the safety characteristics (Event History, Sense of Safety and Risk Potential).

A Spearman's Rank correlation analysis and a linear regression analysis were performed. These analyses were undertaken using SPSS Version 25.

6.4.3.1 Classification of identified values

The Safety Leadership correlation matrix presents the mutual correlations between Safety Leadership and Risk Reduction Capacity.

In order to evaluate the statistical power of the identified correlation levels, we refer to a hierarchical taxonomy of variables to produce empirical effect size benchmarks, as developed by Bosco et al.[6] Their Correlational Effect Size Benchmarks table (Appendix 15.4) refers to statistical power criteria as published by Cohen[7] in terms of uncorrected effect size (|r|). The criteria as published by Bosco et al. conclude that |r| values between .24 and .50 are classified as a 'medium' or 'moderate' effect size. We used this effect size classification as guidance during the interpretation of the correlations as described below.

The results of these analyses are presented in the following sections.

6.4.3.2 Correlation analysis

A Spearman Rank bivariate correlation analysis of the acquired survey data generated by 3332 respondents revealed the mutual relationship between aspects of the three different nodes of the Safety Leadership Model Version II (ref. Figure 23).

6 Bosco, Aguinis, Singh, Field and Pierce (2015), p. 433.

7 Cohen (2013)

6.4.3.2.1 *Interpretation of correlation analysis*

The outcomes of the correlation analysis suggest that Task-oriented leaders, and Relation-oriented leaders both relate in a significant and positive way to all phases of the Risk Reduction Cycle, whereas Self-oriented leaders had a significantly negative relationship with these phases.

We also observed that Task- and Relation-oriented leaders relate significantly and positively to the respondents' 'Sense of Safety'; whereas Self-oriented leaders relate in a negative way to this safety aspect. The reverse is true with respect to 'Event History'. The correlations between 'Risk Potential' and leadership orientations, as well as with safety, are negligible.

These observations are presented in Table 9 below.[8]

6.4.3.2.2 *Table of correlation coefficients*

	Recognition	Ability	Motivation	Courage	Action	Event History	Sense of Safety	Risk Potential
Task	.214**	.247**	.250**	.234**	.302**	-.293**	.463**	.025
Relation	.175**	.211**	.232**	.199**	.257**	-.275**	.444**	.026
Self	-.081**	-.093**	-.127**	-.099**	-.142**	.274**	-.311**	.044*
Event History	-.255**	-.257**	-.215**	-.245**	-.297**			
Sense of Safety	.250**	.251**	.221**	.199**	.283**			
Risk Potential	-.016	-.020	-.026	-.030	-.049*			

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

TABLE 9 Safety Leadership correlation matrix (N=3332)

The following is a detailed explanation of the above observations.

6.4.3.2.3 *Correlation between Safety Leadership and Risk Reduction Capacity*

Where the relationships between Safety Leadership and Risk Reduction Capacity are concerned, the following applies:

Task-oriented leaders may moderately positively influence the levels of every risk reduction phase (Recognition (r=.214, ρ=.000), Ability (r=.247, ρ=.000), Motivation (r=.250, ρ=.000), Courage (r=.234, ρ=.000) and Action (r=.302, ρ=.000)).

Relation-oriented leaders may be also moderately influencing the levels of the risk re-

8 Applied SPSS v.25 analysis: Bivariate correlation (Spearman Rank).

duction in the Motivation and Action phases (respectively r=.232, ρ=.000) and r=.257, ρ=.000). The have slightly less influence on the other risk reduction phases (Recognition (r=.175, ρ=.000), Ability (r=.211, ρ=.000) and Courage (r=.199, ρ=.000).

Self-oriented leaders only have a negative influence on Risk Reduction Capacity; all risk reduction phases correlate weakly negatively with this behavioural orientation (between r=-.081 and r=-.142, all orientations ρ=.000).

6.4.3.2.4 *Correlation between Risk Reduction Capacity and Safety*

As far as the relationships between Risk Reduction Capacity and Safety are concerned, we found the following correlations:

All risk reduction phases (Recognition, Ability, Courage, Motivation and Action) correlate moderately negatively with the *'Event History'* safety characteristic (between r=-.215 and r=-.297, all risk reduction phases ρ=.000). Low scores for risk reduction phases thus correlate with high numbers of actual incidents and vice versa.

Conversely, all risk reduction phases correlate moderately positively with the safety characteristic *'Sense of Safety'* (between r=.199 and r=.283, all risk reduction phases ρ=.000). So: high scores for risk reduction phases correlate with a high Sense of Safety.

None of the risk reduction phases showed a significant correlation with the *'Risk Potential'* safety characteristic.

6.4.3.2.5 *Correlation between Safety Leadership and Safety*

We found the following direct correlations between Safety Leadership and Safety:

Task-oriented leaders have a moderately negative relationship with the *'Event History'* safety characteristic (r=-.293, ρ=.000). So: leaders scoring highly for Task orientation are related to low incident numbers. Task-oriented leaders also have a strongly positive relationship with the respondents' *'Sense of Safety'* (r=.463, ρ=.000). *Task orientation* shows a very weak and non-significant correlation with the *'Risk Potential'* safety characteristic (r=.025, ρ=.259).

Relation-oriented leaders show similar correlations as their Task-oriented colleagues: leaders scoring highly for Relation orientation have low scores for 'Event History' (r=-.275, ρ=.000), and Relation-oriented leaders show a strong positive relationship with the *'Sense of Safety'* (r=.444, ρ=.000). Relation orientation shows a very weak and insignificant correlation with the *'Risk Potential'* safety characteristic (r=.0.026, ρ=.251).

Self-oriented leaders show a positive relationship with *'Event History'* (r=.274, ρ=.000). Leaders scoring highly for Self orientation are related to high incident numbers. The opposite applies to the relationship between Self-oriented leaders and *'Sense of Safety'*

(r=-.311, ρ=.000); leaders scoring high on Self orientation, score low for *'Sense of Safety.'* Self-oriented leaders are very weakly correlated with the *'Risk Potential'* safety characteristic (r=-.044, ρ=.049).

6.4.3.3 Regression analyses

After establishing the correlations between Safety Leadership, Risk Reduction Capacity and Safety, we applied linear regression analyses to: 1) leadership behavioural orientations versus the risk reduction phases, 2) risk reduction phases versus the safety aspect, and 3) leadership behavioural orientations versus the safety aspects.

6.4.3.3.1 *Interpretation of regression analysis*

The associations identified between the different nodes of the Safety Leadership Model suggest that Task-oriented leaders are significantly and positively associated with all phases of the Risk Reduction Cycle. Relation- and Self-oriented leaders are considered to have negligible associations with these risk reduction phases.

We also observed that Task-oriented leaders are significantly and positively associated with the 'Sense of Safety'; whereas the association between Relation-oriented leaders and 'Sense of Safety' is negligible, and the association between Self-oriented leaders and 'Sense of Safety' is significantly negative. Task-oriented leaders seem significantly negatively associated with 'Event History', whereas the association between Relation-oriented leaders and 'Event History' is negligible, and the association between Self-oriented leaders and 'Event History' is significantly positive. Task- and Relation-oriented leaders are negligibly associated with 'Risk Potential', while Self-oriented leaders seem to be significantly positively associated with this aspect of safety.

The findings of this regression analysis suggest that a) Task-oriented leaders are positively associated with risk reduction and with the respondents' Sense of Safety, b) Self-oriented leaders have the opposite effect, and c) Relation-oriented leaders do not show any significant association with any of the risk reduction phases or safety aspects.

The observations described above are presented in the table below.[9]

9 Applied SPSS v.25 analysis: linear regression.

6.4.3.3.2 *Table of regression coefficients*

	Recog-nition	Ability	Motivation	Courage	Action	Event History	Sense of Safety	Risk Potential
Task	.356**	.349**	.279**	.346**	.510**	-.393**	.455**	.029
Relation	-.056	.003	.062	.006	-.028	.086	.089	.042
Self	.026	.054*	.019	.028	.005	.233**	-.072**	.138**
Event History	-.120**	-.102**	.011	-.048	-.202**			
Sense of Safety	.103**	.126**	.000	-.041	.207**			
Risk Potential	-.017	.007	-.001	-.024	-.072*			

** Regression is significant at the 0.01 level (2-tailed).
* Regression is significant at the 0.05 level (2-tailed).

TABLE 10 Safety Leadership regression matrix (N=3322)

A detailed explanation of the above observations is given below.

6.4.3.3.3 *Influence of Safety Leadership on Risk Reduction Capacity*

A regression analysis was performed to determine how the three leadership orientations (Task, Relation and Self-) influence the five risk reduction phases (Recognition, Ability, Motivation, Courage and Action). In this section we present the results of this analysis.

There was a significant association with a moderate effect size between the predictor variable Task-oriented leadership and the dependent variable Recognition risk reduction phase (b=.356; ρ=.000). The associations between the dependent Recognition variable and the predictor variables Relation-oriented leadership (b=-.056; ρ=.204) and the Self-oriented leadership (b=-.026; ρ=.301) proved to be non-significant.

Another regression analysis was performed to determine how leadership orientations influence the dependent variable risk reduction phase Ability. A significant association with a moderate effect size was found between the predictor Task-oriented leadership and Ability (b=.349; ρ=.000). The association between the predictor Self-oriented leadership and Ability is significant, but shows a weak effect size (b=.054; ρ=.028). The association between the predictor Relation-oriented leadership and Ability proved very weak and non-significant (b=.003; ρ=.950).

We performed a regression analysis to determine how the leadership orientations affect the Motivation risk reduction phase as the dependent variable. A significant association with a moderate effect size was found between the predictor Task-oriented leadership and Motivation (b=.279; ρ=.000). The associations between predictor Relation-oriented leadership and the dependent variable Motivation (b=.062; ρ=.163), and between the predictor Self-oriented leadership and Motivation proved both very weak and non-significant (b=.019; ρ=.450).

Finally, a regression analysis was performed to determine how the leadership orientations affect the Courage risk reduction phase as a dependent variable. A significant association with a moderate effect size was found between predictor Task-oriented leadership and the dependent variable Courage (b=.346; ρ=.000). The associations between predictor Relation-oriented leadership and the dependent variable Courage (b=.006; ρ=.904), and between the predictor Self-oriented leadership and Courage proved to be very weak and non-significant (b=.028; ρ=.311).

After conducting this correlation analysis, a regression analysis was performed to determine how the predicting leadership orientations affect the Action risk reduction phase as a dependent variable. A significant association with a moderate effect was found between the predicting Task-oriented behaviours and Action (b=.510; ρ=.000). The associations between the predictor Relation-oriented leadership and the dependent variable Action (b=-.028; ρ=.562), and between the predictor Self-oriented leadership and Action (b=.005; ρ=.855) proved to be very weak and non-significant.

6.4.3.3.4 *Influence of Risk Reduction Capacity on Safety*

A regression analysis was performed to determine how the five risk reduction phases (Recognition, Ability, Motivation, Courage and Action) affect the three safety characteristics (Event History, Sense of Safety and Risk Potential). We present the results of this analysis below.

First a regression analysis was performed to determine how the predicting risk reduction phases affect the dependent variable safety characteristic Event History. Significant, but weak negative associations were found between the predictor Recognition and the dependent variable Event History (b=-.120; ρ=.000), between the predictor Ability and Event History (b=-.102; ρ=.003) and between the predictor Action and Event History (b=-.202; ρ=.000). The associations between the predictor Motivation and the dependent variable Event History (b=.011; ρ=.742) and the predictor Courage and Event History (b=-.048; ρ=.133), proved to be non-significant.

Another regression analysis was performed to determine how the predicting risk reduction phases affect the dependent safety characteristic Sense of Safety. Significant, but weakly positive associations were found between the predictor Recognition and the dependent variable Sense of Safety (b=.103; ρ=.000), between the predictor Ability and Sense of Safety (b=.126; ρ=.003) and between the predictor Action and Sense of Safety (b=.201; ρ=.000). The associations between Motivation and Sense of Safety (b=.000; ρ=.991) and Courage and Sense of Safety (b=-.041; ρ=.115), proved very weak and non-significant.

A regression analysis was also performed to determine how the predicting risk reduction phases affect the dependent safety characteristic Risk Potential. A significant, but weakly positive association was found between Action and the Risk Potential (b=-.072; ρ=.036). All of the associations between the other four predicting risk reduction phases Recognition, Ability, Motivation and Courage showed very weak and insignificant associ-

ations with the dependent variable Risk Potential: Recognition (b=-.017; ρ=.676), Ability (b=.007; ρ=.863), Motivation (b=-.001; ρ=.988) and Courage (b=-.024; ρ=.546).

6.4.3.3.5 *Influence of Safety Leadership on Safety*

A regression analysis was performed to determine how the three Safety Leadership orientations (Task-, Relation- and Self-) affect the three Safety characteristics (Event History, Sense of Safety and Risk Potential). We present the results of this analysis below.

Initially a regression analysis was performed to determine how the Safety Leadership orientations affect the dependent safety characteristic Event History. A significant negative association with a moderate effect size was found between the predicting variable Task-oriented leadership and dependent variable Event History

(b=-.393; ρ=.000). A significant positive association was found between the predictor Self-oriented leadership and Event History (b=.233; ρ=.000). The association between the predictor Relation-oriented leadership and the dependent Event History (b=.086; ρ=.193), proved weak and non-significant.

A regression analysis was performed to determine how the Safety Leadership orientations affect the dependent safety characteristic Sense of Safety. A significant positive association with a moderate effect size was found between the predicting Task-oriented leadership and the dependent Sense of Safety (b=.455; ρ=.000). A significantly negative but weak association was found between Self-oriented leadership and the Sense of Safety (b=-.072; ρ=.010). The association between Relation-oriented leadership and the Sense of Safety proved to be weak and non-significant (b=-.089; ρ=.070).

Finally, a regression analysis was performed to determine how the Safety Leadership orientations affect the dependent safety characteristic Risk Potential. A significantly positive, but weak association was found between predicting Self-oriented leadership and the dependent variable Risk Potential (b=.138; ρ=.002). The associations between the predictor Task-oriented leadership and the Risk Potential (b=.029; ρ=.742), as well as between the predictor Relation-oriented leadership and the dependent variable Risk Potential (b=.042; ρ=.598) proved to be very weak and non-significant.

6.4.3.4 Evaluation of correlation and regression analyses

Conducting this correlation and regression analyses on the survey data generated by 3332 respondents meant that we gained clear insights into the relationships as well as the associations between the different components of the Safety Leadership Model.

The outcomes of the correlation analysis suggest that Task- and Relation-oriented leaders are positively related to risk reduction and the respondents' Sense of Safety and that the behaviours of Self-oriented leaders have the opposite effect.

The outcomes of the regression analysis suggest that Task-oriented leaders are positively associated with risk reduction and with the respondents' Sense of Safety, that Self-oriented leaders have the opposite effect and that Relation-oriented leaders do not

show any significant association with any of the risk reduction phases or safety aspects.

These outcomes suggest that Task-oriented leaders have the potential to prevent the development of safety incidents, that the contribution of Relation-oriented leaders to this prevention process is not significant, and that Self-oriented leaders are considered to have a negative effect on operational safety.

6.5 Summary

In the next sections we present the preparation, process and results of an online prospective survey among 3332 general employees, working in 33 organisations, operating in six different specific business sectors. The theoretical framework, embedded in Version II of the Safety Leadership Model, served as an analysis reference. We analysed the mean scores of the Safety Leadership Model nodes in general, as well as per business sector. We performed correlation and regression analyses to identify the relationships and associations between the different nodes of the Safety Leadership Model. Below is a summary of the subjects discussed in this chapter.

6.5.1 *Mean scores*

Leaders in all sectors are mainly Relation-oriented, closely followed by leaders showing Task-oriented behaviours. Self-oriented leaders are a minority in all sectors, although this is a is relatively large minority in the tank storage sector and is relatively small in the rail infrastructure sector this minority. The rail infrastructure sector is found to be very people-oriented, with the highest score of all sectors for Relation-oriented leaders.

We see that there are two risk reduction phases that stand out in opposite ways: Recognition and Action. The respondents told us that safety risks are quite well recognised, but that remedial Action is often not implemented (or not in a timely way). If we look more closely, however, there is a distinction between hierarchical levels. In general, senior levels have a more optimistic view of risk reduction than operational staff. This applies specifically to Recognition and Action. Senior levels are very positive where these risk reduction phases are concerned, and respondents working in more operational areas are relatively positive about the recognition of risks, but often (very) pessimistic about whether remedial Actions are actually implemented. With respect to the other three risk reduction phases, Ability, Motivation and Courage, we found that in many sectors Motivation scores relatively highly (ranking second behind Recognition). Depending on the specific sector, Ability and Courage are either the third or fourth rank. Another distinction is the overall level of scores by support staff. This response group comprises mainly quality and HSE (safety) advisors. They prove to have a more critical view of the Risk Reduction Capacity of their organisations than their operations-affiliated colleagues.

We observed clear differences in mean scores concerning safety (Event History, Sense of Safety, Risk Potential). Two sectors, hospitals and oil and gas, reported relatively high scores for Event History compared with the other sectors. In contrast, the respondents in

the rail infrastructure sector show the lowest Event History scores of all sectors.

The scores for actual Sense of Safety match the previous scores for Event History; the respondents working in hospitals and in the oil and gas industry report a much lower Sense of Safety than their colleagues in other sectors. The highest score of all sectors is shown in the rail infrastructure sector, but the respondents in the tank storage, process industry and general infrastructure also report feeling safe by giving high scores for Sense of Safety.

Respondents working in the rail infrastructure and tank storage sectors foresee the fewest problems regarding Risk Potential, but Risk Potential is not considered a reason for fear in any of the other sectors.

6.5.2 *Correlation analysis*

Correlation analysis identified significant relationships between the characteristics of the three nodes of the Safety Leadership Model. Task-oriented leaders were positively related to all phases of the Risk Reduction Cycle. Albeit to a lesser extent, this also applies to Relation-oriented leaders. We found that Self-oriented leaders were negatively related to all phases of the Risk Reduction Cycle.

Task-oriented leaders are negatively related to the safety characteristic Event History. To a lesser extent this also applies to Relation-oriented leaders. In contrast we found that Self-oriented leaders relate in a positive way to Event History. Task- and Relation-oriented leaders are both positively related to the safety characteristic Sense of Safety. Self-oriented leaders are negatively related to Sense of Safety.

Findings concerning the relationships between Task- and Relation-oriented leaders and the safety characteristic Risk Potential were not considered, as these did not meet the minimum requirements with respect to significance. Self-oriented leaders were weakly positively related to Risk Potential.

The regression analysis determined the associations between the characteristics of the three nodes, and dependent and predicting variables were determined. In this regression analysis design, safety characteristics are considered to depend on leadership orientations, acting in a predicting role, either in a direct hierarchical relation, or in a relation mediated by the phases of Risk Reduction Cycle. An analysis of the predicting leadership orientations and the dependent safety characteristics revealed certain significant associations. Task-oriented leaders are negatively associated with the dependent variable Event History, meaning that they are considered to *prevent* incidents. These leaders are also positively associated with the dependent variable Sense of Safety, which means that Task-oriented leaders are considered to have a positive effect on the state of safety. No significant effect was observed concerning the influence of Task-oriented leaders on the dependent variable Risk Potential, so people working for Task-oriented leaders do not see a significant association between their leaders and future safety risks. Self-oriented leaders are positively associated with Event History and Risk Potential, meaning that these leaders enable safety incidents and their followers expect a relatively high level of

future safety risks. As an understandable coexisting effect, Self-oriented leaders have a negative influence on their workers' Sense of Safety.

Relation-oriented leaders are not significantly associated with any of the safety variables (Event History, Sense of Safety and Risk Potential).

6.5.3 *Regression analysis*

We observed the following with respect to the associations between leadership orientations and the risk reduction phases as dependent variables:

Task-oriented leaders are strongly positively associated with all phases of the Risk Reduction Cycle, meaning that these leaders have a positive effect on safety due to their positive effect on Risk Reduction Capacity. Self-oriented leaders are positively, but weakly, associated with Ability, meaning that these leaders have limited influence over the competences of their followers. Self-oriented leaders were not seen to have any significant influence over the other risk reduction phases. Associations between Relation-oriented leaders and any phase of the Risk Reduction Cycle were insignificant.

We discovered the following effects with respect to the associations between predicting risk reduction phases and dependent safety characteristics. Event History is negatively affected by the Recognition, Ability and Action risk reduction phases. This implies that these three risk reduction phases can be considered to have a preventive effect where safety incidents are concerned. Associations between the Motivation and Courage phases and Event History were insignificant. Sense of Safety is positively influenced by the Recognition, Ability and Action risk reduction phases. There were also no significant associations between the predicting risk reduction phases Motivation and Courage and Sense of Safety.

The dependent variable Risk Potential is weakly and negatively affected by the Action risk reduction phase. None of the other risk reduction phases had significant influence.

6.6 Conclusions of extended prospective research

The previous sections described the full process of an online prospective survey among a population of 3332 respondents, from the design of the survey questionnaire to a primary analysis of the survey results.

We present the conclusions of this preliminary analysis below.

Conclusions concerning the mean scores

Compared with the other three risk reduction phases, Recognition and Motivation scored relatively high. Two risk reduction phases stand out in opposite ways: Recognition and Action. The senior levels returned higher scores for Recognition and Action than operational staff. Operational staff had a positive view where the recognition of risks is concerned, but were (very) sceptical about the timely implementation of remedial Actions. Support staff (e.g., HSE) returned clearly lower scores than any other discipline.

Leaders in general were found to be mainly Relation-oriented, closely followed by leaders showing Task-oriented behaviours. Self-oriented leaders were a minority in all sectors.

We observed clear differences in mean scores concerning safety (Event History, Sense of Safety, Risk Potential). Event History scores were high in hospitals and the oil and gas sector, and lowest in the rail infrastructure sector. The scores for Sense of Safety were generally good, however the hospital sector and the oil and gas industry returned much lower scores than their colleagues in other sectors. Risk Potential did not result in interesting scores.

Conclusions concerning the correlation and regression analyses

The outcomes of the correlation analysis suggest that Task-oriented leaders and Relation-oriented leaders relate in a significant and positive way to all phases of the Risk Reduction Cycle; whereas Self-oriented leaders had a significantly negative relationship with these phases. Task- and Relation-oriented leaders relate significantly and positively to the respondents' Sense of Safety; whereas Self-oriented leaders relate in a negative way to this safety aspect. The reverse is true with respect to Event History. The correlations between Risk Potential and leadership orientations, as well as with safety, were negligible.

The findings generated by the regression analysis suggest that: a) Task-oriented leaders are positively associated with risk reduction and with the respondents' Sense of Safety, b) Self-oriented leaders have the opposite effect, and c) Relation-oriented leaders do not show any significant association with any of the risk reduction phases or safety aspects. The correlation analysis thus suggests that Task- and Relation-oriented leaders are 'safe' leaders and Self-oriented leaders should be considered a 'dangerous' group. The regression analysis also suggests that Task-oriented leaders are the 'safe' leaders, that Relation-oriented leaders have no significant effect on safety, and that Self-oriented leaders should considered a 'dangerous' group indeed.

6.7 Reflections by senior leaders

We considered it necessary to have the survey results appraised by the people this research is about. We thus approached senior leaders in organisations in the tank storage, hospital, oil and gas and rail infrastructure business sectors on an individual basis in order to obtain their thoughts on these survey results. If the organisations agreed, and depending on the logistical possibilities, we interviewed the CEO/managing director/board member or the most senior manager of the organisational unit considered, an operational/line manager of the unit and the safety manager/head of safety assigned to this unit. In total 38 leaders (9 CEOs, 8 board members, 9 senior managers and 12 safety managers). We shared our findings with these interviewees and asked them to tell us what these findings mean to them with respect to their individual views on safety leadership in their own organisations.

6.7.1 *Design of the reflection process*

All interviewees were informed about the survey results for their organisations well before the interviews took place. The interviews were conducted in a semi-structured way, guided by a pre-developed conversation guide. The primary objective of these interviews was to obtain the interviewee's specific feedback on the survey results generated by respondents working in the organisational unit for which they were responsible. A conversation guide, including the Risk Reduction Cycle, leadership in general and the informer's personal safety-related (incident) history, was used to structure the conversation. The duration of the conversations was between 60 and 90 minutes. Where this was considered of added value to the research, we allowed some room to include additional subjects introduced by the interviewees.

The interviews were conducted by the researcher. In all interviews the researcher was seconded by an independent experienced safety expert, acquainted with the design of this research and informed about the design and context of the interviews. This third person controlled the flow of the interviews, filled gaps where required, took notes and recorded the key items brought forward. All interviews took place at the premises of the interviewees. The conversation guide is presented in Appendix 15.8.

Various organisations asked the researcher to present their organisation-specific survey results at management meetings or safety-related sessions with staff members in different hierarchical positions (from CEOs to operational staff). All presentations took place at the organisation premises or at events organised by these organisations. After every presentation session we asked senior leaders to reflect on the survey results and to give us their opinion regarding the applicability of this survey method in an operational environment. The feedback received during these conversations has been amalgamated with the overview of people's reflections below.[10]

6.7.2 *Acquired reflections*

Although the reflections differed in each organisation, and often also depending on the hierarchical position within these organisations, all interlocutors told us that they understand the logic of the Risk Reduction Cycle and consider the resulting profiles clear and informative.

The survey respondents in most sectors perceived the Recognition and (secondary) Motivation risk reduction phases as relatively well implemented in their organisation and Action as the weakest phase. We asked the leaders to reflect on this. The generally high scores given by management (e.g., for Action) were considered curious, and sometimes debated by subaltern leaders ("we wonder whether management really knows what is

10 Each of the opinions was obtained shortly after the survey data for the particular organisation had been analysed. This implies that the conversations with senior leaders were conducted *before* we discovered the contradictions described in Section 6.8 and the consequential need to modify the leadership orientation Task to Production/Process. Reference is therefore still made to Task orientation in these reflections.

happening on the work floor"). The relatively low scores for Action by operational staff were generally recognised. The variation in scores for Courage at different organisational levels was clarified as due to the different roles of people operating on these levels. Some relatively low scores in specific departments could be explained by particular temporary situations, for example by issues with specific staff members, unrest due to reorganisation, and so on. In general, the participants showed broad agreement regarding the risk reduction profiles related to their organisations.

With respect to the effectiveness of safety leadership, all our interlocutors noted that personal involvement, mutual respect, clear responsibilities and related authority, empowerment and psychological safety were salient ingredients with which to improve the safety of risky operations. Nevertheless, we discovered from these conversations that not all organisations comply with the ideal leadership profile, and that different organisations in a single business sector demonstrate differences where leadership orientations are concerned. External influences seem to be crucial in the choice of a leader's behaviours.

These conversations produced a wealth of valuable data in terms of relatively common, but interesting views, about which risk reduction phases are strongly or weakly managed in the different business sectors, and which leadership orientations are applied by the leaders in the different organisations in these sectors. A summary of these reflections by the tank storage, hospital, oil and gas and railway infrastructure sectors is given below.

Tank storage

Due to some major safety issues, which have aroused increased interest from governmental inspectorates and the public press and media, the tank storage sector is closely supervised by the inspectorates. As a result of this reputational damage, organisations now understand that auditable risk management activities are important, not least in order to keep their licence to operate. There seems a relationship between the emphasis on operational risk reduction and experienced safety issues, and the consequential involvement of officials. This officials involvement is often heard as an argument used for paying increased attention to safety aspects.

All conversation partners in this sector told us that they consider a risk reduction profile to be a clear communication tool.

The risk reduction profile of the tank sector included high scores for the Recognition, Motivation and Courage risk reduction phases, and low scores for Action. Most leaders in this sector are Relation-oriented, closely followed by Task-oriented leaders. As in all sectors, Self-oriented leaders are the least common group, however, there were more Self-oriented leaders in the tank sector compared with all the other sectors in this research.

The tank sector scores second of all sectors for Sense of Safety, second lowest for Event History and second lowest for Risk Potential. These scores show that the respondents working in the tank storage sector feel safe, report few accidents and believe that the

potential risk level is low. This picture is probably the result of the intense external pressure and consequential risk management activities initiated by the leaders in this sector.

Next, we refer to some organisation-specific reflections by senior leaders.

The leadership profile of Tank Storage Company A can be summarised as: Task orientation slightly higher than Relation orientation, and Self orientation relatively high compared with other organisations in this survey. Reorganisation in this company means that there are leaders assigned on a temporary basis. Their views on risk reduction were mixed, but certainly not positive. The most common opinion was that authoritative leadership is how the company is trying to recover from a difficult safety and commercial position.

Tank Storage Company B can be summarised as an organisation where the majority of leaders are Task- and Relation-oriented; there are some Self-oriented leaders present, but they are a small minority. All conversation partners consider the tank storage business as very Task-oriented; the 'satisfaction of clients' is paramount for management. Some conversation partners were surprised by the positive view held by management on the Recognition risk reduction phase, as in their view this risk reduction phase is 'somewhat poor' in the real world.

Relation-oriented leaders stand out in the leadership profile of Tank Storage Company C, there are less Task-oriented leaders and Self-oriented leaders are a small minority. The site director with whom we held a conversation, explained that he leads his people on the basis of trust, but at the same time requires his team 'to deliver.' The workers at an operational level experience this requirement as pressure, and they do not agree with the declaration of trust. In some departments the company suffers from serious dysfunction. This can be seen in the department-specific survey results.

The HSE director of this company was concerned about the low level of competence among operational staff. In the risk reduction profile this concern is clearly reflected in the low scores for the Ability risk reduction phase. In the HSE Director's opinion, not all team members are sufficiently competent, which is considered a handicap for the management policy of striving to empowerment. As an example of one serious danger, we were informed about the complacency of experienced staff with long track records, who ignore safety risks. It is suggested that this behaviour originates in the fact that incidents occur seldomly, and luck has been on their side for years. It is considered a serious risk that junior employees mistakenly consider these seniors 'professionals' and therefore adopt bad habits and unsafe methods, often for their own comfort or to increase production, in order to obtain individual compliments or bonuses.

The CEO told us that he recognises and understands the low score for the Action risk reduction phase; he sees his workers as fire-fighters, who are not focused on preventive actions, which are often planned by other departments and are put in process only after things have gone wrong. Although safety professionals are generally considered a very critical group, the CEO is surprised about the low-risk reduction profile scores by the support staff (mainly HSE officers). He is probably not aware, or ignores, the concerns regarding safety. The survey results for this company also clearly address the classical

competition between the maintenance department and the production teams; maintenance does not trust operations, and vice-versa. An intervention by the site director quoted, operating on the basis of trust, seems useful here. The CEO would like to see his leaders as strongly empowered, but there is still considerable reluctance (fear?) among operational leaders; they told us that a mistake is easily made in this highly technical environment in which many manual operations are required, and 'losing face' is a serious reason to be careful rather than empowered. The CEO and the HSE director told us that they will consider adding the Risk Reduction Cycle to the safety toolbox of the company.

Hospitals

Since Hippocrates, health care workers have considered patient safety an important part of their daily work. These people are dedicated to their mission: 'Do no harm.' The type of work, high work load, psychological stress and complex processes in this sector, however, mean that workers are faced with many incompatible goals. Most patient safety depends on the individual risk awareness and safety motivation of doctors and nurses. In this complex environment with many uncertainties about the conditions of patients and the treatments required, slips, lapses and mistakes are easily made, and even small errors may result in major harm to patients. The representatives we met are aware of this, and are convinced of the importance of risk reduction. They believed the risk reduction profile was a clear communication tool.

Risk reduction profiles in the hospital sector reflect high scores for the Recognition, Motivation and Courage risk reduction phases, and lower scores for Action but the scores generated by different hospitals differ. The scores for Task- and Relation-oriented leaders were identical this sector, and relatively low for Self-oriented leaders. This sector shows a worried population as regards safety: the lowest score was for Sense of Safety, there was a medium score for Risk Potential and it had the second highest score for Event History (only the oil and gas industry had a higher incident record).[11]

Next, we refer to some organisation-specific reflections by senior leaders in this sector.

The leaders at Hospital D can be summarised as: Relation-oriented, with Task orientation second, and a small minority of Self-orientated leaders.

The leader-doctor we talked with believes that the hospital's risk reduction profile is realistic. He indicated that, as far as he was concerned, Recognition is the primary risk reduction phase, followed by Ability and Motivation. Courage is not worth talking about; you simply do what is necessary. Older generation doctors are important where safety is concerned; they do not always comply with new rules, such as the prohibition on wearing watches or closing their white coats; the younger doctors are more compliant. The younger doctors show less arrogant behaviour and are thus important in creating a safety

11 Due to the phrasing of the particular questionnaire statements, respondents working in hospitals probably related 'Event History' to safety incidents involving patients, and related 'Sense of Safety' to their own feeling about the safety in their hospitals.

culture. The leader-doctor considered 'Relation' the most important leadership orientation (which is confirmed for this hospital by the survey data).

Another conversation partner, a senior supervisor, agreed with the Risk Reduction Cycle; he considers the identification of serious risks and their immediate elimination as very important. He explained that Motivation depends on the particular individual. Courage is sometimes a difficult topic in this hospital. Some leaders behave in a Task-/Self-oriented way, but there is development to increasingly Relation-oriented leadership. The patient safety manager noted that there is insufficient compliance with the Action risk reduction phase (this is in alignment with the risk reduction profile produced by the survey data). Leaders suggest that they are supporting safety well, but the supporting advisors are of a different opinion. Budgets for safety improvements, promised by the board, do not always materialise, which hampers the solution of safety issues. According to this interlocutor, the Recognition of risks is a weak phase, and sometimes leaders do not want to acknowledge the existence of safety risks. External pressure from inspectorates or accrediting bodies has positive effects on the hospital sector. Accreditation is becoming compulsory in more and more workplaces and is considered very important. Many safety-related activities must be undertaken in order to obtain a Joined Commission International (JCI) certificate. The primary motivation to obtain such certificate is to ensure the continuation of business and retain a licence to operate. The CEO agreed with the Risk Reduction Cycle and said that it fit the hospital sector perfectly. He considered motivation the key bottleneck; in his view doctors are not interested in safety management systems and are relatively stubborn regarding compliance. Doctors believe in the quality of their own way of working. External pressure is effective to reduce resistance, but the hospital sector lags behind major hazard industrial sectors. Patients and governmental inspectorates play an important role in the improvement process. As a result of the accreditation process there is growing risk awareness. The CEO leads 'at a distance.' His style is a mix of Task and Relation orientations, because he is not an expert in a medical discipline. He believes that in order for the hospital to operate as he wants it to operate, it is important to show people the direction in which he wants them to move.

The leadership profile of Hospital E can be summarised as a mix of Task- and Relation-oriented. Self-oriented leaders are a minority. The doctor we met agreed with the risk reduction profile, especially where Recognition (high) and Action (low) are concerned. Action is often difficult to pursue due to incompatible operational goals. Time pressure is a major problem, which is only solved if more financial resources are allocated to reduce time- and work-pressure. External pressure is also an important lever with which to reduce safety risks in this hospital. Patient safety is in a relatively early stage of development; some structures (committees/tools) were recently put in place, and the decision to achieve JCI[12] certification has been recently taken. This is considered a positive development. The insurer has a positive effect on patient safety in this hospital. The CEO recognises the risk reduction profile; it was no surprise to him. He also specifically

12 Joint Commission International, an international certification institute in the health care sector.

recognised the low scores for the Action risk reduction phase. Regarding department specific scores, he believed he was able to trace the leadership orientation profiles back to individuals. These profiles perfectly match the people working in these departments.

The leadership profile of Hospital F can be summarised as Task-oriented, closely followed by a Relation orientation. Self-oriented leaders are a minority. The doctor charged with patient safety recognised (and understood why) the difference in risk reduction scores between managerial and operational staff. Action was the lowest scoring risk reduction phase on almost all levels. Management and senior staff set their own priorities, so improvements are only implemented when the individual concerned takes it as their personal and urgent chore. This is why the Action score is lowest. When external parties (the inspectorate and the press were mentioned) show interest in certain, especially safety-related, topics the sense of urgency is increased. The safety department returned relatively low scores for Risk Reduction Capacity, and the surgery department had a remarkably high score for Courage (!). The differences in scoring patterns are understood: the critical safety people on the one hand, the courageous surgeons on the other. An interesting observation is that the people in higher positions are perceived as less Self-oriented. The chairperson-doctor of the medical staff observed relatively high scores by management, which she considers nice, because this is interpreted as trust but Courage and Action score lowest (there was no further comment by this participant). The fact that the safety department returned relatively low scores is considered a logical consequence of the critical orientation of safety people. The high scores for Courage by surgeons are also well understood. The low score for Action does not surprise this chairperson-doctor; "We live here by the issues of the day. Everyone is busy and when there is no sense of urgency, action is lacking." The fact that senior staff scored Courage and Action relatively highly shows how mentally distant they are from the reality of the operational workers. Management trusts the information communicated by senior staff, but have no clue about what is going on at operational level. This doctor has not specifically reflected on the scores of leadership orientations. A senior staff member agrees with the risk reduction profile and thinks that the high score for Courage by surgeons is logical. He is not surprised about the relatively high scores for Action by department heads; they are the people responsible for action being taken. The low scores for Action by operational staff may be caused by a lack of feedback after actions are taken. The long timespan between identification of risks and completion of actions, may also be a reason that operational staff do not realise actions have been taken. According to this senior staff member, doctors choose 'quick-fixes', but these often do not lead to structural solutions. Many problems re-occur, because there is no long-term vision. The surgeons scored relatively highly for Self orientation, which this conversation partner understands very well but a similar score from the 'observing' disciplines is not understood. The hospital is considered a classic example of a hierarchical organisation. People with courage, an individual opinion and who are walking their own path, however, get everything done as they want it; to this senior leader these behaviours support the relative high Task-oriented scores. This applies only to the doctors, as the CEO is considered a more Relation-oriented person, who

has to negotiate with many different disciplines in order to get support for his views. The hospital's CEO agrees with the Risk Reduction Cycle and understands the high Courage scores for the surgeons. He is not surprised about the low scores from his subordinates where Self-oriented leadership is concerned. The high scores for Self orientation by the surgeons are understood. He noted that more pronounced scores (high as well as low) given by higher hierarchical positions. In general, this participant recognised the scores that stand out, and states that he can relate these to certain individuals. He is surprised about the low perceptions of himself as regards 'stimulating innovation.' In his own perception he supports innovation, but apparently his subordinates perceive this differently.

Oil and gas industry

In the oil and gas industry also the risk reduction phase most positively scored is Recognition, followed by Motivation and Action. In this sector Recognition as well as Action are even scoring highest of all sectors. This indicates a relatively risk-aware population, which may be explained by the fact that the population in this sector, often working on isolated offshore sites or platforms, are the primary potential victims of safety incidents. In case safety risks are not identified or identified risks are not timely controlled by remedial Actions, vast amounts of energy may escape uncontrolled and situations may worsen too quickly to escape. This may explain the relatively safe behaviour of the respondents in this sector.

The leadership profile of Oil Company G shows an equal Task- and Relation-oriented leadership where a minority of Self-oriented leaders are present.

The respondents in this sector presented a relatively low Sense of Safety, a relatively high score for Event History and an average judgement where potential risks are concerned. This safety profile indicates a business sector where people are aware that incidents happen, and (for that reason?) do not feel they are in a safe situation. This profile most resembles the safety profile of hospitals, where safety is considered to be in an early development phase.

We had conversations with an ex-CEO, the operations manager, an area manager and the HSE manager. There was broad agreement among them about the importance of professional skills, knowledge and the competence of operational staff in safely operating primary processes. This was often mentioned in the context of a 'lack of risk awareness.' An example of operational risk was described as insufficiently trained staff being required to work in risky processes without being informed about the risks to which they are exposed. The operations manager stated that current incidents are much less serious than those 10 years ago. This positive development backfires, however, by reducing alertness regarding the occurrence of major incidents. The company therefore tries to increase risk awareness with the assistance of third-party experts; 'uncertainty' is one of the topics thoroughly discussed in this process. The operations manager specifically described positive experiences with the 'management of change' in the way that female leaders had tackled resistance. Mutual trust and empowerment are important aspects of leadership. This manager communicates to his subordinates that making mistakes is

allowed, as long as people learn from these mistakes. Communication about safety risks is considered important; it is the first agenda item in the daily pre-work meeting, and this operations manager always attends this meeting. He felt that his presence leads to mutual respect and team spirit. The HSE manager explained that many people do not dare to speak up (Courage), and lack the required knowledge of safety risks (Recognition), as well as having insufficient knowledge to intervene (Ability). There is a general feeling that the opportunity for safety risks to become major incidents is underestimated. Time-pressure due to commercial targets is considered a disastrous factor. It leads to intuitive decisions by leaders, who, when in doubt, should take the time (and have the courage) to consult other resources. The safety manager claimed that his organisation works to create a culture in which mutual respect, and listening as well as talking (uneasy feelings), are key values: but he felt that the company wasn't there yet. The area manager also worried about small events with negligible consequences, which he saw as a sign that risk awareness is weakening. He considered Courage an important risk reduction phase; "Dare to speak up and dare to correct people showing risky behaviours!" In his opinion, mutual trust and personal relationships are also important aspects of leadership supporting risk reduction; he always tries to 'click' with operational staff on site. He hopes that if they are in doubt, they will call to ask his advice. He also noted that making mistakes is allowed, as long as all relevant colleagues in the organisation learn from it. He was brought up in a military family, and described himself as dual oriented: Relation-oriented during standard operational situations and Task-oriented for crisis-situations. This manager takes it that leaders must have integrity and be authentic, and not behave as if they are acting in a role-play.

All the participants from this company stated that a major incident acts as a wake-up call and serves as a trigger for a paradigm shift in safety policies. They indicated that there were too many minor incidents with the potential to become major incidents in their organisation. They all felt uncomfortable with this situation, and sought ways to improve it before major incidents arose.

The leadership profile of Oil Company H can be summarised as predominantly Relation-oriented, followed by Task-oriented and low Self-oriented leadership. This company was the first organisation in which we held our feedback conversations.

We communicated with three functionaries in a plenary meeting in this company. Our communication was mainly about the format for reporting the survey data, but some interesting feedback was received about the content of the reporting. The technical manager interpreted the scores for risk reduction as indicative of there being 'room for improvement', and he focused on the empty spaces above the bars in the bar charts. He thus judged high scoring respondents as being satisfied, and therefore without any urge to improve. He clearly recognised the profile of his managing director from the reported scores for specific leadership behaviours. The managing director also recognised himself in the profiles. With respect to the leadership behavioural scores, he suggested that the managers were very Action focused, which leads to lack of discipline concerning compliance with procedures. This is clearly shown by the leadership profiles as delivered

and discussed. The HSE manager announced that the board of the company had decided to design a follow-up programme in which the survey results will serve as a 'basis for change.'

Rail infrastructure

Motivation scored highest in the rail infrastructure sector, closely followed by Recognition and Ability. Regarding Ability this sector shows the highest score of all sectors. Courage and Action scored almost identically and the lowest of all risk reduction phases.

The leadership profile of Company J is strongly Relation-oriented (the highest score in all sectors), followed by a Task orientation, with the smallest minority of Self-oriented leaders among all sectors.

The safety manager noted that people in operations indeed recognise safety risks quite well. Safety is part of the product of this sector. People are reluctant to take up tasks which they are not confident about, and tend to make decisions only when they feel supported by their supervisor. The high score for Motivation is confirmed by this participant. The safety manager was not surprised that the leadership profiles show mainly Relation-oriented people. This is explained as because it is considered important to be friendly among colleagues in this organisation, but this cultural aspect does not help to discriminate between competent and incompetent people, and therefore the CEO has expressed a wish to change this culture in order to empower employees to become stronger partners, especially to third parties. The management was afraid to be out of control after a major incident for which this organisation was responsible. The board thus increased their emphasis on supervision and 'track and trace' the progress of safety related plans and activities. The CEO is pushing employees to show more courage and take more autonomous positions.

A regional Manager Operations and Maintenance had entered the organisation recently and had not participated in the survey, but nevertheless accepted our invitation for a conversation. His statements are based on his experience during this short period of employment. This participant recognised the high scores for Relation- and the low scores for Self-oriented leadership. He questioned whether third party suppliers will agree with this, as the behaviour of respondents when among colleagues is different than when with third parties. The high score for Courage regarding respondents working in the department responsible for the trains being on time is not a surprise, as the people working in this department can (and should) make their decisions in a very autonomous way, so courage is virtually a requirement. That Courage is also scoring high in the finance department, is a surprise to this manager. The Chief Operations Officer (COO) of this organisation was not surprised about the high scores for Motivation, as he considered his employees very motivated, and having a positive orientation. The Action risk reduction phase was indeed considered a point of concern; many plans are agreed, but too often they are not followed-up. According to this manager, Action is the risk reduction phase 'where processes freeze.' He recognises that the traffic control department has better scores than any other department. He attributes this to the necessary job discipline for

this type of work. He also recognises that the survey results show that people are predominantly Relation-oriented; good mutual relations are considered as important here. Where there is an emphasis on relations, however, the Action aspect is undermined; there is no culture of consequences, and people who do not comply with agreements are rarely criticised. This participant observed that the leadership orientation consists of indicators, which, from the point of view of a COO, could also be interpreted as Task-oriented; for example, impatience and courage could very well help to speed up projects. Nevertheless, these indicators had low scores, so this interpretation did not change the general view of the leadership orientation of this organisation. This COO supports the fact that his organisation shows up as mainly Relation-oriented.

A summary of the above reflections is given below.

6.7.3 *Summary of reflections*

It goes without saying that, the leaders of high-risk organisations understand and feel their responsibility where the prevention of major incidents is concerned. We assume that the medical mission "Do no harm" is unwittingly adopted by all leaders in all business sectors covered by this research, however, when push comes to shove, the fear of reputational damage and losing the license to operate plays an important role. The senior leaders who kindly accepted our invitation to reflect on the survey results were very open, honest and clear to us about their dilemmas; everyone proclaims 'Safety first', but sometimes the real world is a difficult place.

Major incidents, widely covered by the media and the consequent increased external pressure from inspectorates, were referred to as effective motivators for improving risk management activities. Obligatory certification/accreditation by independent certifying bodies (often imposed by governmental inspectorates) also plays a motivating role.

The tank storage sector made considerable progress in risk management after the sector faced unanticipated strong interventions by safety and environmental authorities, resulting in the compulsory shutdown of a whole tank farm. The hospital sector was shaken awake by publications about the number of patients who died after medical error, and now hospitals are working hard to develop better systems to prevent harm to patients. The oil and gas sector and their high level of safety are traditionally mentioned in the same breath, but for this industry the Piper Alpha disaster was needed as a tipping point, after which safety cases and safety management systems became compulsory and the industry's focus changed from being on human error by operators to a system approach which emphasised the role of management in major incidents.

The rail infrastructure sector proved to be something of the odd one out. Major incidents (e.g., train collisions) rarely happen and when they do, the focus of incident investigators is on train drivers (e.g., having passed red signals) or on the human error of railway workers. Investigators do not (yet) focus on the contribution of the leaders of rail infrastructure companies; maybe this explains why the survey results show the highest level of Relation-oriented leadership and the lowest level of Event History of all sectors.

In general, all participants considered the Risk Reduction Cycle an effective means of risk communication, and most also agreed with the risk reduction profile as applied to the organisations they work for. Nevertheless, various interviewees stated that some of the high scores by managerial respondents, especially for Recognition and Action, did not represent reality at the operational level. The low scores, mainly by operations-related respondents, for the Action risk reduction phase are well understood by senior leaders and the requirement to increase attention to remedial Action is confirmed by all participants.

6.8 Contradictions emerged

By comparing the data as acquired by the online prospective survey and the reflections as obtained from the senior leaders, we discovered two contradictions. The first relates to the analysis of the survey output data, which suggests that the Task-oriented leader should be considered a 'safe' leader. During their reflections, many of the senior leaders characterised the 'ideal leader' as a leader who demonstrates characteristics such as personal involvement, mutual respect, and empowerment and who ensures psychological safety. In our survey design, however, these terms do not match 'Task orientation': Task-oriented leaders are seen as achievers who focus on achieving production targets. It is also of interest to refer to the views of the 18 professional incident investigators (ref. 10.1), who argued that Task-oriented leaders are not considered a safe type of leader; the investigators even mentioned them as most instrumental in the causation of major incidents.

The second contradiction relates to the survey output data for the Recognition risk reduction phase, where we found a similar situation. The outcomes of the statistical analyses of the survey results show that Recognition is perceived as the risk reduction phase scoring highest or second highest, but various senior leaders stated that some of the high survey scores for Recognition, especially from managerial respondents, do not represent the reality at operational level. This statement was confirmed by the views of the consulted experts. The incident investigators suggested that the recognition of risks is considered the least controlled risk reduction phase (ref. 10.1). This view is supported by the five professional risk analysis experts (ref. 10.2), who suggested that a lack of understanding of safety risks, or ignoring them, often contributes seriously to the occurrence of major incidents. Moreover, the views of the incident investigators and risk analysis experts are supported by the view of the Dutch Safety Board (ref. 10.3), which mentioned a lack of recognition of risks as a contributing factor in the occurrence of major incidents in many of their investigation reports.

The above observations imply that some of the outcomes of the primary analysis of the online prospective survey results, as presented in this chapter, seem mismatched with the reflective opinions of the interviewed senior leaders, the retrospective views of professional incident investigators, the views of professional risk analysis experts and the conclusions as presented in investigation reports by the Dutch Safety Board.