Universiteit
Leiden
The Netherlands

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

Roggeveen, V.

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The essence of leadership is to get others to do something because they think you want it done and because they know it is worth while doing.

DWIGHT EISENHOWER

5 Prospective study (pilot survey)

Prior to conducting an online prospective survey among all anticipated business sectors, we decided to test the robustness of the Safety Leadership Model and verify the validity and reliability of the designed survey questionnaire by conducting a pilot survey. We also used this pilot to obtain an indication of its relevance and practical applicability for the target population. We distributed the final draft of the questionnaire among a group of experts in the field of operational safety. Reviewing the survey responses as generated by the pilot population enabled us to review the appropriateness of the questionnaire questions and to analyse the reliability and validity of the questionnaire. These responses showed some promising results concerning the relationship between safety leadership and risk reduction. The following sections describe the design, conduct and results of this pilot survey.

5.1 Pilot survey (design)

We included five statements in the questionnaire relating to the five phases of Risk Reduction Capacity (Recognition, Ability, Motivation, Courage and Action). We developed a set of 35 indicators to represent the particular leaders' behaviours in relation to the three leadership orientations (Task, Relation and Self) as described in Section 2.3.6 'Profiling leaders'.

We also took the opportunity during the design of this questionnaire to include seven *leadership typologies*, which we considered sub-categories of the three leadership orientations, and to describe more specifically the meaning of leadership orientations. These leadership typologies are described as follows. Vis-à-vis their followers, Task-oriented leaders typically behave as *motivators, achievers*, or as a *knowledge base*. Relation-oriented leaders are typically *team players,* or *stimulators*, and Self-oriented leaders exhibit behaviours which are typical of *rulers* or *individualists*. During the design process of the draft survey questionnaire, we assigned all leadership indicators included in the questionnaire to one of these leadership typologies. Compared with the relatively conceptually-phrased behavioural orientations (Task, Relation and Self), we expected these more specific leadership typologies to better communicate the meaning of specific behaviour-

al orientations. To prevent the respondents being influenced/biased, these relationships (questions/behavioural orientations/leadership typologies) were not visible on the questionnaires distributed to the respondents. The layout of the pilot survey questionnaire is shown in Appendix 15.3: Questionnaire Used in Pilot Survey.

The draft questionnaire underwent various iterations during the design phase, mainly as a result of feedback from the different safety experts and scientific researchers consulted, who kindly shared their views and experiences with us. In order to improve the representativeness and validity of the survey's indicators, these 'first level testers' also advised us about how to improve the different draft versions of the questionnaire. After this first level test, the final draft of the questionnaire was considered ready for use, and the online pilot survey was initiated.

5.2 Pilot survey (conduct)

The online pilot survey was conducted among safety experts who work in the Dutch business sectors relevant to this research. We approached 150 safety professionals for the pilot survey, mainly members of the Dutch Society of Safety Practitioners (NVVK). The respondents are all recognised as experts in the field of risk management and safety. We asked these people to complete the questions on our final draft online survey questionnaire and provide us with feedback about their experience of the activity.

The survey questionnaire invited the respondents to report their individual perceptions regarding the behaviours of their direct leaders. The respondents were also asked to describe their perceptions of Risk Reduction Capacity as applicable to their own working environment. The responses to the pilot survey confirmed that our draft questionnaire indeed produced reliable and useful data regarding the relationship between Safety Leadership orientations (Task, Relation and Self) and Risk Reduction Capacity (Recognition, Ability, Motivation, Courage and Action). We also received positive feedback about the applicability and relevance of the design of the online questionnaire.

We next present the demography of the response group, and describe the way the data acquisition for the online pilot survey.

5.2.1 *Demography*

We asked 150 professionals to participate in an online pilot survey. A total of 99 questionnaires were returned, of which 88 responses were sufficiently completed and thus usable for analysis. All participating professionals were employed by organisations operating in one of the business sectors relevant to this research. The valid participating respondents held five different hierarchical position levels: directors/board members, managers, supervisors, support staff and operational employees. Within this group of safety experts 55% of the respondents indicated belonging to the support staff category and 36% indicated belonging to the manager category. These positions are considered representative of professional safety advisors in the target business sectors. The remaining 9% of the

respondents reported belonging to the director, supervisor, or operational employee categories.

The responses as returned by this group revealed that 82% of their direct supervisors were men and 18% women.

5.2.2 *Data acquisition*

The data was collected using the Qualtrix XM online survey tool under licence of Leiden University. The respondents scored each statement in the questionnaire on a 7-point Likert scale from strongly disagree, to disagree, somewhat disagree, neither agree nor disagree, somewhat agree, agree and strongly agree. In the Qualtrix data collecting programme these terms corresponded with a numerical scale ranging from -3 to +3. A 'don't know'-option was also included. For optimal understanding we decided to use wording instead of a numerical scale.

5.3 Pilot survey (results)

Among other, mainly demographic, information, this pilot survey revealed data related to Safety Leadership and to Risk Reduction Capacity. The acquired data served as an essential information source to assess the quality of the draft survey questionnaire in terms of its validity, reliability, relevance and practical applicability to test the Safety Leadership Model, and thus to reliably answer the principal research query: "Can leaders of organisations help to prevent safety incidents?" We therefore analysed the survey data generated by safety experts regarding: a) mean scores of Safety Leadership orientations, b) mean scores of Risk Reduction Capacity, c) the correlation between the three Safety Leadership orientations and the five phases or the Risk Reduction Cycle, and d) the construct validity of the survey questionnaire.

In the following sections we present the outcome of these testing phases.[1]

We first present the mean scores as acquired by this survey from the general employees.

5.3.1 *Mean scores in pilot survey*

We analysed the acquired survey data in order to establish the different mean scores for Safety Leadership orientations in general and for each business sector. We then present the results of that analysis.

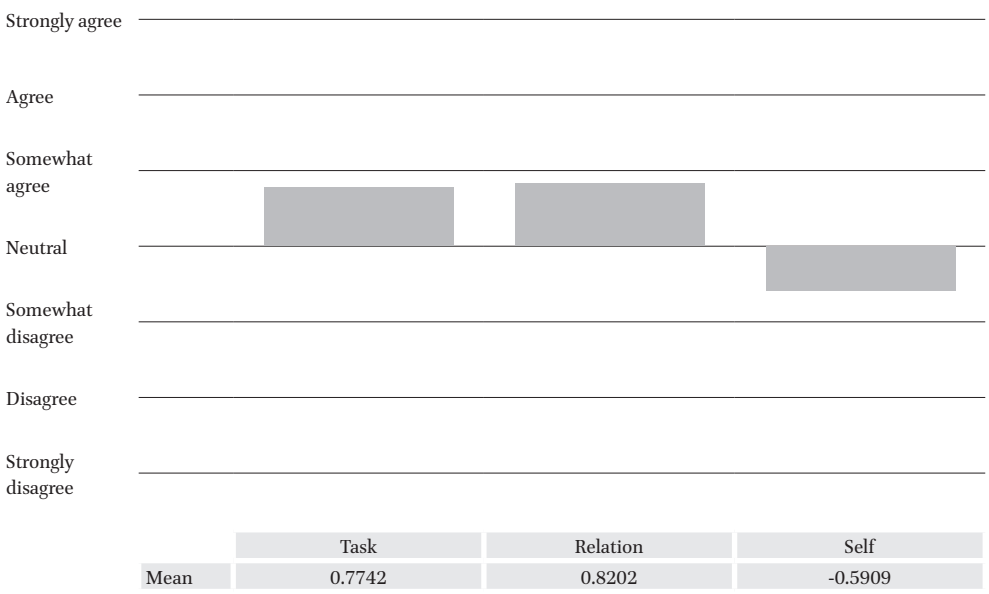
1 Out of respect for individual anonymity, data recognisably generated by groups consisting of fewer than four people is not included.

5.3.1.1 Safety Leadership in pilot survey

The Safety Leadership-related behavioural orientations of leaders were established by collecting the respondents' individual judgements on three statements concerning the behavioural orientations (Task, Relation and Self-) of their direct supervisor. The leadership orientations (Task, Relation and Self-) are represented by the mean scores for the 35 Safety Leadership-related indicators as included in the survey questionnaire. We then present these general mean scores, as well as the mean scores for each business sector.

General Safety Leadership orientations

This section presents the leadership orientations of the respondents' direct supervisors in all organisations.



	Task	Relation	Self
Mean	0.7742	0.8202	-0.5909

BAR CHART 1 General Safety Leadership Profile (pilot survey)

The mean scores as generated by the respondents, shown in Bar Chart 1 above, represent the perceptions that safety experts have regarding the preferred leadership orientations (Safety Leadership) of their direct supervisors. The scores show that, on average, they *somewhat agree* that their direct supervisors show Task- and Relation-oriented behaviours, where Relation orientation (M=0.82, SD=0.99), slightly prevails over Task orientation (M=0.77, SD=0.71). The respondents also report that, on average, they *close to somewhat disagree* that their direct supervisors show Self-oriented behaviours (M=-0.59, SD=1.10).

Safety Leadership orientations per business sector

This section explains the leadership orientations of all respondents' direct supervisors, distinguished per business sector are explained.

		Tank storage (n=14)	Hospitals (n=18)	Process industry (n=11)	Oil & gas (n=10)	Rail infra n=10)	Other (n=23)
	Task	0.8000	0.8370	0.4788	0.8667	1.1333	0.6348
	Relation	0.8961	0.8788	0.6860	0.7091	1.2182	0.6443
	Self	-0.7857	-0.5278	-0.3182	-0.2750	-1.2750	-0.5217

BAR CHART 2 Safety Leadership per business sector (pilot survey)

Bar Chart 2 presents the mean scores for each business sector. Here we see some interesting differences between six business sectors. At first the safety experts in the tank storage sector show a relatively low, *close to somewhat disagree* score for Self-oriented leadership behaviour (*M*=-0.79, *SD*=1.00). In the process industry leaders are more Relation-oriented than Task-oriented, and in the oil and gas sector the reverse is the case. The oil and gas sector reports a relatively high score for Self-oriented leadership behaviour (*M*=-0.28, *SD*=1.2). The rail infrastructure population stand outs by having relatively high scores for Task-oriented (*M*=1.33, *SD*=0.59) and Relation-oriented (*M*=1.21, *SD*=1.08) leadership behaviours, and it has a relatively low score for Self-oriented leadership behaviour (*M*=-1.28, *SD*=1.11).[2]

Apart from the above respondents' individual judgements about the statements concerning the behavioural orientations (Task, Relation and Self-) of their direct supervisors, we collected their statements regarding capacities for risk reduction in their organisations. The next section shows the data collected in this part of the pilot survey.

2 The scores from the sector General Infrastructure are not shown due to lack of respondents (n=2)

5.3.1.2 Risk Reduction Capacity in pilot survey

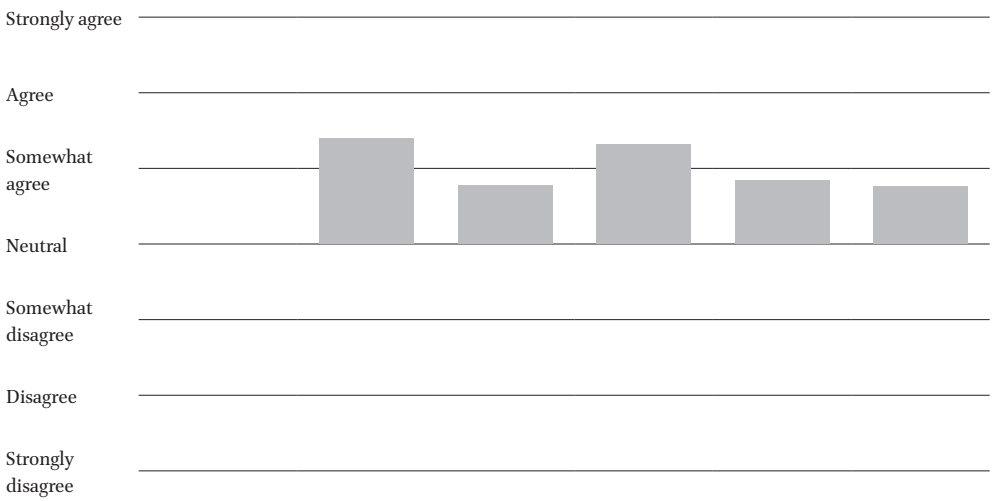
The Risk Reduction Capacity of an organisation is represented by the mean scores for the five risk reduction phases (Recognition, Ability, Motivation, Courage and Action).

The Risk Reduction Capacities as perceived by the safety experts were established by collecting the respondents' individual (dis-)agreement concerning the effectiveness of the five individual phases of the Risk Reduction Cycle.[3]

We resent the results of that analysis via the different mean scores for Risk Reduction Capacity in general, for each business sector and according to the gender of the supervisors.

General Risk Reduction Capacity

In this section the overall Risk Reduction Capacity of all organisations is presented.



	Recognition	Ability	Motivation	Courage	Action
Total pilot group	1.4	0.77	1.32	0.84	0.76

BAR CHART 3 General Risk Reduction Capacity (pilot survey)

The perceptions of the safety experts, as graphically presented in Bar Chart 3 above, show that people at the work floor level recognise the safety risks in their working environment, to an average degree, scoring between the levels *somewhat agree* and *agree* (M=1.44, SD=1.12). To a lesser extent, the respondents *somewhat agreed* that people at work floor level had the ability to intervene when risks are recognised (M=0.77, SD=1.2). Motivation had similar scores to recognition, between *somewhat agree* and *agree* (M=1.32, SD=1.21).

3 Since the safety experts, members of the safety experts are divided over different organisations, it is to be understood that the scores generated by the safety experts are for the purpose of testing the quality of the questionnaire only and do not reflect the real situation in a particular organisation.

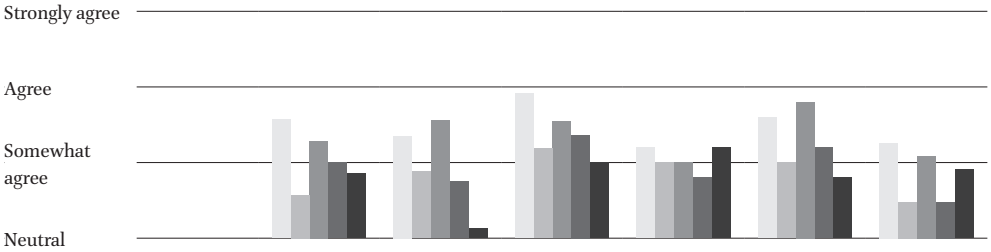
Courage scored a little lower than *somewhat agree* (*M*=0.83, *SD*=1.34). Timely Action to solve safety risks scored lowest, between *somewhat agree* and *neutral* (*M*=0.76, *SD*=1.46). The statistical results of this investigation are presented in Table 2 below.

	Recognition	Ability	Motivation	Courage	Action
Valid	87	86	88	86	85
Missing	1	2	0	2	3
Mean	1.4368	0.7674	1.3182	0.8372	0.7647
Std. deviation	1.11753	1.20464	1.20864	1.34480	1.46098

TABLE 2 Risk Reduction Capacity (pilot survey)

Risk Reduction Capacity per business sector

This section presents the risk reduction capacities of all organisations, distinguished per business sector.



	Tank storage (n=14)	Hospitals (n=18)	Process industry (n=11)	Oil & gas (n=10)	Rail infra (n=10)	Other (n=23)
Recognition	1.5714	1.3529	1.9091	1.2000	1.6000	1.2609
Ability	0.5714	0.8824	1.1818	1.0000	1.0000	0.4783
Motivation	1.2857	1.5556	1.5455	1.0000	1.8000	1.0870
Courage	1.0000	0.7500	1.3636	0.8000	1.2000	0.4783
Action	0.8571	0.1250	1.0000	1.2000	0.8000	0.9091

BAR CHART 4 Risk Reduction Capacity per business sector (pilot survey)

Due to the different nature of the various business sectors in this research, the mean scores for the respective risk reduction phases are also different for these sectors, however, as can be seen in Bar Chart 4 above, there are also similarities.[4]

We first note that the respondents in the tank storage, hospital, process industry, and rail infrastructure sectors, as well as the respondents working in non-specified sectors (combined in the 'other' group), consider Recognition and Motivation as the two highest scoring risk reduction phases in their respective sectors.

The respondents working in the hospital, process industry, and rail infrastructure sectors, and the 'other' group, consider Action as the lowest scoring risk reduction phase. The relatively high scores overall from the respondents in the process industry are of interest, with Recognition (M=1.91, SD=1.38) the highest scoring risk reduction phase in all sectors. The relatively low score for Ability in the tank storage sector (M=0.57, SD=1.4) shows that the respondents perceive that workers have limited opportunity, knowledge and skills to intervene when risks are recognised. The response for the Action risk reduction phase in the hospitals sector is worrying (M=0.13, SD=1.26), which scores lowest of all risk reduction phases in all sectors. The relatively high score for Action (M=1.2, SD=1.48) in the oil and gas sector shows that recognised risks are remedied more effectively than in other sectors. The fact that the respondents/employees are employed in remote locations with limited options to escape, and are thus potentially vulnerable victims, may play a role.

We next present the correlation analysis of the survey data acquired in this pilot survey.

5.3.2 *Correlating Safety Leadership and Risk Reduction Capacity in pilot survey*

We correlated the mean scores of the three leaders' behavioural orientations (Task, Relation and Self-) with the mean scores of the five risk reduction phases (Recognition, Ability, Motivation, Courage and Action) as obtained in a pilot survey among a group of 88 safety experts.[5]

The results of this analysis are provided in Table 3 below.

4 The scores from the General Infrastructure sector are not shown due to the lack of respondents (n=2).

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

Safety Leadership correlation matrix
(Safety experts N=88)

	Recognition	Ability	Motivation	Courage	Action
Task	.248*	.317**	0.202	.351**	0.169
Relation	.270*	.250*	.363**	.354**	0.155
Self	-0.171	-0.121	-.363**	-0.191	-0.126

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

TABLE 3 Safety Leadership correlation matrix safety experts

5.3.2.1 Classification of identified values

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.

5.3.2.2 Observations and interpretation of identified correlations

When evaluating the identified correlations, we applied the effect size criteria as described in the previous paragraph. This evaluation led to the following results:

Task-oriented leadership behaviours correlate significantly, and with moderate effect size, with the risk reduction phases Recognition (ρ=.248**), Ability (ρ=.317**) and Courage (ρ=.351**). Task-oriented leadership behaviours do not correlate meaningfully with the risk reduction phases Motivation and Action. Relation-oriented leadership behaviours correlate significantly, and with moderate effect size, with the risk reduction phases Recognition (ρ=.270*), Ability (ρ=.250*), Motivation (ρ=.363**) and Courage (ρ=.354**). Relation-oriented leadership behaviours do not correlate meaningfully with the Action risk reduction phase.

Self-oriented leadership behaviours correlate significantly *negatively*, and with moderate effect size, with the Motivation risk reduction phase (ρ=-.363**). Self-oriented leadership behaviours do not correlate meaningfully with the risk reduction phases Recognition, Ability, Courage and Action.

6 Bosco, Aguinis, Singh, Field and Pierce (2015), p. 433.
7 Cohen (2013).

Based on the above observations, there is support for the assumption that different types of leader behaviours engage different aspects of Risk Reduction Capacity. More specifically: Task- and Relation-oriented leaders appear to relate to the Risk Reduction Capacity of organisations in a positive way. Conversely, Self-oriented leaders seem to relate to Risk Reduction Capacity in a negative way.

5.3.3 *Construct validity of draft survey questionnaire*

After analysing the data generated by this pilot survey, the construct validity of the draft online survey questionnaire design was assessed by determining the construct validity (Cronbach's α) for the three constructs that comprise the variable *Safety Leadership orientations* (Task, Relation and Self-). The responses returned in this pilot survey demonstrated the following construct validities for the survey questionnaire: Task (α=.848), Relation (α=.921) and self (α=.862).

Based on the values reported by this pilot survey, we hold that the construct validity of the survey questionnaire suggests sufficient robustness for its use obtaining valid data regarding the different Safety Leadership orientations.

5.4 Improving survey questionnaire design

In addition to acquiring survey data, the pilot survey described in the previous sections also served to test the robustness and representativity of the Safety Leadership Model and the applicability of the draft survey questionnaire. The experiences gained by evaluating the pilot survey showed some room for improvement with respect to the questionnaire design. These improvements involved the removal of one superfluous Safety Leadership indicator statement, and the inclusion of three safety indicators. The design improvements are explained below.

Removal of superfluous leadership indicator

The draft survey questionnaire consisted of 35 statements related to Safety Leadership orientation; all of which had been categorised into three Safety Leadership orientations. We noticed from the data in this pilot survey, however, that one statement did not fit any of the Safety Leadership orientation constructs. This was: 'My supervisor sometimes deliberately turns a blind eye and is flexible where compliance with rules and procedures is concerned.' We therefore removed that particular statement from the questionnaire, which resulted in a total of 34 statements related to Safety Leadership orientations.

Inclusion of safety indicators

The safety of the organisation was not investigated via the pilot survey for safety-experts, because the need to add safety (the third node of the Safety Leadership Model Version II, (ref. Figure 23) to the survey questionnaire had not been identified before the evaluation of the pilot survey. 'Safety' was thus added *after* the pilot survey had been conducted. We

solved this by updating the design of the questionnaire by adding three indicators related to safety, in order to elicit the respondents' views about safety in their organisations from historical, present and future perspectives. We added three statements addressing: a) safety incidents experienced, b) their present level of confidence in the safety of their organisations, and c) their perceptions of the potential risk level of their organisations.

5.5 Pilot survey conclusions

We conducted a pilot survey in which 88 safety experts were recognised as valid respondents to establish the quality of the draft survey questionnaire.

Based on the results of this pilot survey, we argue that there is support for the assumption that different types of leader behaviours engage different aspects of Risk Reduction Capacity. More specifically: Task- and Relation-oriented leaders appear to relate to the Risk Reduction Capacity of organisations in a positive way. Conversely, Self-oriented leaders seem to relate to Risk Reduction Capacity in a negative way.

An analysis of the data from this pilot survey shows that the construct validity of this questionnaire is sufficient to produce reliable data concerning the Task, Relation and Self-Safety Leadership orientations.

Based on the above analysis of survey data collected via the draft survey questionnaire, we argue that applying a questionnaire via an online survey is an appropriate means with which to solve the principal research query. We did identify some room for improvement in the design of this particular questionnaire during evaluation of this pilot survey exercise. After implementing the above improvements, we declared the survey questionnaire final, and 'fit for purpose' in extended research in which an online prospective survey among a wider population was foreseen.

This extended prospective research will be explained further in the next chapter.