

Evaluating the Success of Safety Culture Interventions

Andrew Hale^{a*1}, Frank Guldenmund^a, Joy Oh^b, Patrick van Loenhout^b, Peter Booster^c,
Maryke Oor^d

^a Safety Science Group, Delft University of Technology, Delft, Netherlands

^b Ministry of Social Affairs and Employment, The Hague, Netherlands

^c Corus, IJmuiden, Netherlands

^d MCFE, Almere, Netherlands

Abstract: The Dutch Ministry of Social Affairs and Employment has been running a program to improve the safety performance of companies and reduce the accident rate in the country significantly. One aspect of this program was to provide a 50% subsidy to a selected number of companies to help them finance interventions to improve safety performance. The chosen interventions concentrated particularly on changes to the safety culture of the company, but also contained elements of safety management and workplace or process improvements. 23 projects were subsidized and have been implemented, starting in late 2004. The Ministry has funded a scientific evaluation of the projects in order to extract lessons over what does and does not produce significant improvements in safety performance. This paper reports the preliminary results of a selection of these projects covering 15 companies and two industry associations. The paper presents a summary of the types of interventions implemented and their targets and an analysis of the available measures of safety performance and changes occurring in them between the period before the interventions and after these were introduced. Data have currently been analyzed for the period up to the end of 2006. Analysis of 2007 is currently being conducted. The paper also indicates the difficulties of conducting such evaluations due to problems of availability, sensitivity and quality of data, the difficulty of defining intermediate measures between the intervention and the ultimate accident rates and the length of time over which the performance indicators need to be followed to offer the chance for significant changes to take place. The interventions in the two most successful companies are discussed briefly.

Keywords: Safety culture, safety management, evaluation of interventions.

1. INTRODUCTION AND DESIGN OF THE STUDY: the complexities of evaluation

In 2003 the Dutch Ministry of Social Affairs and Employment announced a program of support for interventions in companies designed to improve occupational safety by concentrating particularly on changes to the safety culture. The Ministry offered a 50% contribution to companies, who were asked to come forward with their own proposals and plans, which had to have a minimum aim of reducing their accidents by 10%. The companies were required in exchange to conduct a before, during and after study of their safety climate to assess changes in it and to provide access to their sites and records for assessing the effect of the interventions. The objective was that these companies would become examples of good practice to others, who could profit by the lessons learned. The questionnaire surveys of the safety climate were conducted by RIGO [1].

23 projects were eventually financed, some covering individual companies, others industry branches or industrial areas. Because of delays in companies coming forward with proposals, a number of projects did not start until 2005, or even early 2006. The Ministry subsequently commissioned from researchers at the Delft University of Technology a further evaluation of the interventions, which was aimed to be as scientifically rigorous as was possible, given the constraints of the companies taking part, and the fact that the evaluation was agreed upon only after the start of the interventions in most of the companies. This meant it was too late to conduct additional data collection before the projects started, and 'before' measures were therefore collected largely retrospectively. It was decided to concentrate on evaluating 13 of the projects, covering 17 intervention projects: two industry branches

¹ A.r.hale@tudelft.nl

(agriculture with over 100,000 enterprises, and corrugated cardboard manufacture with 14), five companies from the branch covering subsidized work for physically and psychologically handicapped, and 10 individual companies. See table 1 for details of the sites. The projects were chosen to represent the range of interventions planned and to cover those projects starting early in the program, and ones where it was felt that sufficient data for an evaluation study would potentially be collectable. The research was conducted in two periods, one in 2006-7 collecting data about the starting situation in the companies, the introduction of the interventions and the first year's results, and one in 2007-8 to assess the results at the official close of the program at the end of December 2007.

Table 1: Companies studied

Company activity	Nos. of inter-vention	Persons covered by the intervention	Start date*	Date initial qu'aire	Target reduction ²
1. Reinforced concrete element manufacture	20	± 700 at 3 sites	02.04*	05.05	10-15%
2. Corrugated cardboard	22	± 2350 in 12-14 companies	06.04*	02.05	25%
3. Distribution/ warehousing	18	± 1600 at 25 sites ³	06.04*	01.06	10-15%
4. Meat processing	20	± 750 on 3 sites	09.04*	01.05	20%
5. Rubbish collect/treatment	15	± 2400 in 7 regions	09.04*	09.05	10-15%
6. Maintenance: steelworks	29	± 1100 on 1 site	01.05*	12.05	100%
7. Social work provision 1	16	± 890 on 1 site	02.05*	09.06	10-25%
8. Air cargo handling	20	± 1200 on 1 site	04.05	09.05	60-75%
9. Fork-lift truck manufacture	28	± 700 on 1 site	06.05	10.05	50%
10. Agricultural sector	3	± 230,000 ⁴	07.05	N/A	10-15%
11. Brewery	24	± 450 in 2 depts.	09.05*	01.06	50%
12. Social work provision 2	7	± 1220 on 18 sites	01.06*	09.06	10-25%
13. Social work provision 3	11	± 400 on 1 site	02.06	09.06	10-25%
14. Social work provision 4	15	± 1300 on 1 site	06.06	09.06	10-25%
15. Construction	20	± 900 contractors across many sites	08.06*	08.06	20%
16. Academic hospital	10	795 on 15 wards	01.07	11.06	25% needle prick accidents
17. Social work provision 5	3	±700 on 1 site	N/A ⁵	09.06	10-25%

* See text for an explanation

The study was designed as a before and after study of the accident rates. The aim was to compare the trend of accidents in the three years before the intervention started, with the trend in the years after the intervention to see if there was a significant change associated with the intervention period. In addition data was collected about any other activities or changes which might be associated with the intervention. These ranged from 'input' measures such as training or workshops conducted, toolbox meetings held, workplace layout and equipment changes, through intermediate output measures such as wearing rates of personal protective equipment (PPE), counts of violations of procedures, the safety climate measures from the RIGO questionnaires, numbers of reported dangerous situations or near accidents, to the output measures of safety performance, such as total and lost-time accident numbers and frequency rates (either per thousand employees or per million hours worked, whichever was available), absence days per accident, damage numbers and costs. The data available depended strongly on the company and its stage of development in monitoring its own safety effort and performance. One major concern in using accident numbers and rates was that a number of the interventions had as explicit or implied objectives to encourage reporting and investigation of minor

² Official target compared to a designated reference year before the intervention. Target was all accidents with absence unless otherwise stated

³ 2 large warehouse complexes and 23 small distribution depots

⁴ Intervention aimed at safety of children on family farms. Figure is for the workforce in the whole industry

⁵ After initial agreement this company () withdrew from the project before starting the intervention

injuries in order to learn from them. It was obvious in these cases that these companies could show increased reported accident rates masking an underlying improvement in safety. Attempts were made, where possible, to compare trends in minor accidents (first aid treatments) with those in lost-time accidents to detect eventual rises in the former coupled with falls in the latter, which could be interpreted as showing such a pattern of improved reporting, coupled with improved underlying safety.

Data were collected on all changes going on in the companies in the years leading up to the interventions subsidized by the Ministry, during the period of those interventions and after them. These data were divided between direct safety-related interventions and other changes such as replacements of senior managers, company reorganizations, expansions or lay-offs, which could have an indirect effect on safety outputs or the reporting of them. This data collection process showed that many of the companies under study were in a state of continuous change, and that the interventions being subsidized were very often part of a much longer process of safety improvement attempts. This meant that the dates originally taken as the start of the intervention had to be modified, in discussion with the companies concerned, to choose a point in time before which there was relatively little change, or only change of another type. Table 1 indicates these agreed start dates, which are in a number of cases (indicated by the asterisk) somewhat arbitrary. This also explains why the date of the initial safety climate measurement, taken around the date of the official start of the assessed intervention, is quite often after the subsequently agreed start date shown in the table.

The collection of data about the interventions also showed that, contrary to the expectations in the original research planning, they were not limited to one or two well-defined changes, but usually consisted of a whole range of related changes with different targets: **work process change** (e.g. modified hardware and PPE, changed working methods), **organizational change** (e.g. new or updated safety, reporting or emergency procedures, systematization of the safety management system [SMS]) and **safety culture interventions aimed at the workforce and/or management as a group or set of individuals** (e.g. training, changing risk perception, openness to discussion of safety problems and learning, use of key performance indicators [KPIs] & other techniques for motivation, etc).

Across the 17 intervention projects studied there were on average more than 16 different changes made per project over the two to three years that I monitored the companies. The interventions were aimed at many different targets (directors & senior managers, line management, workforce, new, temporary or contractor staff, safety staff). Table 2 summarizes the changes made over all projects together and gives an indication of the most popular targets. As might be expected from the overall program objectives, interventions aimed at individuals and groups were the most common. However, there were still a large number (14%) aimed at improving the structure, staffing and processes of the SMS, and the organization of the process of safety improvement. Even the primary risk-producing processes (work methods, layout and equipment) still accounted for 10% of the interventions, many of these arising out of the improvement in risk assessment, incident and accident investigation, or observation and discussion of behaviour. The choice of intervention was generally based on a review of the current status of the SMS, and was therefore linked to its maturity, filling gaps in it. It is clear from table 2 that the number of interventions under many of the headings exceeds the number of companies taking part, particularly those aimed at individuals and groups. This is because, interventions such as training were aimed separately at different groups, such as the senior management, line and staff, and covered different topics in separate programs.

This plethora of changes means that the analysis of safety performance in the study could not be expected to pinpoint clear cause and effect relationships with well-defined separate interventions. The researchers were faced with a complex and interacting set of changes and had to reason backwards, trying to work out what are the combinations of interventions, or ways in which they are implemented which distinguish companies showing clear improvements in safety performance from those not (yet) showing such changes. The next section gives details, up to the end of the second year of the project, of these changes in safety performance. The final section of the paper considers two apparently successful companies and tries to answer this question. A fuller discussion of the research and the findings is to be found in [2] in Dutch.

Table 2: Intervention types and targets

Intervention types	How often used
Design or purchasing criteria for machines, PPE	14
Modification of workplaces, work methods + good housekeeping campaigns	9
Changes to walking/vehicle routes around site or controlled site access	5
Systematization of the SMS and improved access to SMS information by handbooks (5), intranet (6), checklists (2), CD/DVD (3) or by updating procedures (6)	22
Certification of SMS or at least implementation of the ISO/OHSAS standard approach	9
Improved procedures for incident/accident/dangerous situation reporting, analysis & follow up.	13
Improved design and use of risk inventory and evaluations	10
Improved methods of assessing and choosing contractors	2
Appointment of extra safety staff, mentors, coaches	3
Dedicated project/sounding board/brainstorm groups to steer the interventions	11
Use of a thematic approach to the intervention project	7
Provision of cost information on accidents for managers	1
Use of formal questionnaires to assess & feed back attitudes & beliefs	5
Safety-related KPIs defined and managers assessed on them	10
Training, workshops, presentations for different groups (directors 6, line managers 30, workforce (29), temporary staff & contractors 4, planners 3, safety staff 3, family 1) to improve knowledge and or motivation ⁶	76
Walk-around inspections and audits (8) and behaviour observation tours (15), usually (10) including feedback & discussion of behaviour, sometimes with the use of cameras (3) to record & illustrate dangerous behaviour/situations	23
Incorporation of safety in toolbox meetings	16
Dynamic risk assessment just before starting a piece of work	5
Incentives/encouragement to report incidents & dangerous situations	8
Publicity material (posters, flyers, brochures, company newsletters, information boards, intranet, e-mails, board with accident-free days, competitions & prizes)	31
Audiometric testing & feedback	1
Total intervention types	281

2. ANALYSIS & RESULTS

As can be seen from table 1, the last 6 intervention projects only started in 2006 or even 2007, and so had not even a full year of figures to be analyzed by the end of that year. No further comment is made on these projects in this paper. Current analyses, being carried out with data up to the end of 2007, will provide the opportunity to see how successful these are. The remaining 11 projects provided data on accidents which could be analyzed to look for trends. Where possible data were collected on accident frequency, either per 1000 people employed, or per million man-hours worked, whichever metric was used by the company, rather than just on absolute numbers, in order to control for any large changes in numbers at risk. Where possible data were collected both on accidents with absence (numbers of accidents and total days absence) and accidents requiring only first aid treatment with return to work on the day of the accident, so as to compare the trends in both. If there was a trend upwards in first aid treatment accidents, but downwards in accidents with absence, this could be interpreted as showing an increase in reporting accompanied by an increase in safety. To support this further, data were collected where possible on the number of dangerous situations or incidents not involving injury which were reported in the company's reporting system. The expectation was that a clear rise in these numbers

⁶ 58 separate training activities fall under this heading, 36 aimed more at knowledge, skills and fitness, and 22 more at motivation of those concerned. Most were a mixture of both and many for more than one target group.

would indicate an improved reporting in relation to safety. This rise was therefore taken as an indicator of improving safety management, not of deteriorating safety.

Table 3. Safety performance trends for 11 companies

Company	Metric	-3	-2	-1	0	+1	+2	Trend all years	Trend before ⁷
1. Concrete element	Freq. absence acc./10 ⁶ manhour	16	47	44	48	35	48	n.s	n.s
	Absence days/absence acc.			14.5	14.6	12.9	9.9	<0.10	Not testable
2. Corrugated cardboard	Freq. absence acc./1000 man	31.3	31.5	23.6	23.5	19.5	10.4	<0.01	n.s
3. Distribution	Total acc.		93	81	91	82	99	n.s	n.s
	Absence acc.		24	40	42	40	38	n.s	n.s
4. Meat processing	Total acc.		15	28	52	37	38	n.s	n.s
5. Rubbish collection & treatment	Freq. total acc./10 ⁶ manhour		24.2	16.9	13.3	18.4	17.8	n.s	n.s
	Absence days/total acc.		25.3	16.6	15.7	10.7	10.7	<0.05	n.s
6. Steel Maintenance	Freq. total acc./1000 man	79	68	56	29	6		<0.01	<0.05
	Reported dangerous sit.	186	237	324	506	1243		<0.05	n.s
7. Social Work Provision 1	Freq. total acc./1000 man	24	17	12	25	10		n.s	n.s
8. Air cargo	Freq. total acc./1000 man	104	72	53	66	51		<0.10	<0.10
	Freq. absence acc./1000 man	34	32	22	27	36		n.s	n.s
	Absence days/absence acc.	31.7	33.0	37.1	39.8	16.4		n.s	n.s
9. Fork-lift truck manufacture	Freq. total acc./10⁶ manhour	109	100	79	84	80		<0.10	n.s
	Freq. absence acc./10⁶ manhour⁸	84	67	41	37	29		<0.05	<0.05
		80	63	47	37	37		<0.05	<0.05
	Absence days/absence acc.	8.91	7.69	22.3	9.68	7.33		n.s	n.s
	Reported dangerous sit.	0	21	18	63	107		<0.05	n.s
10. Agriculture ⁹	Hospital treatments	3300	2800	2800	3400	3400		n.s	n.s
11. Brewery	Freq. total acc./1000 man	104	80	95	86	80		n.s	n.s
	Freq. absence acc./1000 man	61	38	52	30	39		n.s	n.s
	Absence days/absence acc.	10.9	7.8	12.7	4.35	6.4		n.s	n.s

Year 0 is the year in which the intervention is deemed to have started. The years either side -3 to +3 give the figures which were available for these years. Gaps are either because the company had not kept (reliable) figures before a certain date, or the intervention had not yet run more than a year after the start year. Significant trends are highlighted in bold.

⁷ Over 3 years before the intervention where data were available. Where only two years were available, the year of the intervention itself was included to make 3 years.

n.s = no significant trend. Otherwise the level of significance is given.

⁸ Top figure is excluding contractors & other temporary staff, the bottom figure including these groups

⁹ Estimates [3] based on outpatient & inpatient records from a representative sample of Dutch hospitals.

Regression analysis was used to calculate the trends in the data. The ideal situation would be to have three years both before and after the start of the intervention (leaving out the year of the intervention itself, as a transition year), so as to compare the two trends. This was not possible with the present data, but will be for some companies with the data currently being analyzed. As an interim measure the trend was calculated over all years available, from before the intervention until the end of 2006, and this was compared to the trend before the intervention. Table 3 sets out the data available on the accident rates, or absolute numbers where rates were not available, for the 11 companies.

Two companies in particular stand out in this table, the steel company maintenance department and the fork-lift truck manufacturer. Both have more than one indicator showing a positive trend (less accidents or more reported dangerous situations) over the whole period, and at least one indicator showing that this trend was significant over the whole period, but not (yet) before the intervention. Four more companies show some indicators of improvement, again with more significance in the trend over the whole period than in the pre-intervention years, although two of these show only a trend at the 10% level of significance. It should be remembered in interpreting the trend over all years vs. that before the intervention, that a trend over three years must be more marked than one over five years in order to be statistically significant, as can be seen by examining the actual figures in the table. Interpreted conservatively, therefore, it would appear that the positive trends were in most cases already under way before the interventions studied here were introduced. This strengthens the observation made in the previous section that the interventions being studied are just one part of a continuing process. It is disappointing for the program that only just over half of the companies show significant improvement of any sort as yet.

Very rich data on the interventions themselves was collected via the interviews and analysis of documentation and the input and process indicators mentioned in section 1. These are reported elsewhere [2] and will be the subject of future papers. Two aspects are relevant to this paper. In discussion with the informants at the companies (usually the safety, working conditions or quality staff) the support from the relevant general managers or divisional directors was assessed as either enthusiastic (+), passive/supportive (0) or largely absent (-). It was also noted where there had been a new director in that position. In 11 of the 17 projects this had been the case, resulting, in the opinion of the informant, in 6 cases in a clear improvement in the support, in 4 cases in a decline (one of which led to stopping the project) and in one case to no difference. The scores on this factor at the start and end of the assessed period were as follows:

	-	0	+
Start	2	10	4
End	4	5	7

Based on the interviews and discussions and the documentation, the researcher made a subjective assessment of the enthusiasm and creativity of the project coordinator, usually the safety professional or working conditions coordinator, sometimes coupled with a quality role. Characteristics such as the charisma, creativity in developing new interventions and selling them within the company, doggedness in follow-up and challenging of poor uptake of the intervention were taken into account. In all but two of the project this was clearly present (+), in four it was marked (++), whilst in three more it was present to a very high degree (+++).

3. SUCCESSFUL COMBINATIONS OF INTERVENTIONS

The main interventions and the way they were managed in the case of the two companies with the most significant improvement in the safety performance indicators are shown in table 4. The number of different interventions – 29 and 28 respectively – were the highest of all 17 projects (table 1), demonstrating the dynamic in the projects and the way it was sustained with new ideas. Both companies had a very enthusiastic, creative and persistent safety professional (+++) as coordinator, matched only in one other project. One had an enthusiastic director from the beginning of the project, the other a more passively supportive one, replaced late in the project by a more enthusiastic one. Both had clear plans, divided into themes with project groups working on them, but this was shared by

several other less successful projects. The two sets of interventions look very similar in their mix of actions.

Table 4: Interventions in most successful companies

6. Steel maintenance	10. Fork-lift truck manufacture
<p>Key performance indicators (KPIs) for managers with yearly targets on 7 topics (reporting & resolution of dangerous situations, observation & communication rounds, accidents, risk inventory & plan of action, toolbox meetings with safety, housekeeping) reported in a safety ‘dashboard’ every 6 weeks for discussion with boss</p> <p>6-weekly communication cascade, supported by material from the safety department, conducted in toolboxes, with two way communication to resolve any issues brought up from the shopfloor</p> <p>8 programmes on changing safety themes, particularly involving contractors, with before and after assessment of attitudes & beliefs, presentation material, etc.</p> <p>STOP-GO-cards to empower workforce to stop work if risk controls not in place.</p>	<p>Active steering group defining themes and assigning them for action to 5 workgroups to develop detailed plans covering new procedures, behaviour monitoring, information & training, publicity & poster campaigns & the STOP-GO cards</p> <p>5-weekly communication cycle about safety issues, incidents and dangerous situations in toolboxes to spread information from above and resolve problems from below</p> <p>5 themes chosen within first two years, with others to follow based on risk analysis and incidents.</p> <p>STOP-GO-cards to empower workforce to stop work if risk controls not in place.</p> <p>Training of managers and workforce on use and interaction skills</p>
<p>Observation rounds of behaviour with discussion with employees. Line trained in that skill</p>	<p>Observation rounds of behaviour – just record but not discuss with employee</p>
<p>Continuous publicity via different media, posters, information sheets, flyers, etc.</p> <p>Time-out for safety workshops with use of emotional film & personal commitment to change behaviour</p>	<p>Publicity in company newssheet, information sheets, photos, checklists, competitions</p> <p>Systematic process for deciding on and issuing PPE + monitoring behaviour of wearing, discussion in toolbox meetings & warning letters to non-users</p>
<p>Encouraging reporting of dangerous situations to line management for action</p>	<p>Encouraging reporting of dangerous situations to line management for action and reporting</p>
<p>Expansion of staff of Quality, Working Conditions & Environment Dept to 8.</p> <p>Safety passport scheme indicating safety competences of contractors etc.</p>	<p>General manager conducts monthly meeting on safety with all line managers</p> <p>Reorganize internal transport logistics & routing</p> <p>Good housekeeping campaign</p> <p>Coaching training for line and ergonomics coordinators</p> <p>Board at entrance with accident free days</p>

Both used the STOP-GO card system, a set of simple rules (5 or 6 in number) printed on a card to keep in the pocket and be used as check, before starting on any task, as to whether the risk control measures were all in place. Three other projects used last minute risk assessments, but not formalized with such a card. Both used behavioural observation audits, but only the steelworks coupled this with a

discussion with the employees based on that; but almost all other projects used these audits as well. Both placed a strong emphasis on two-way communication in toolbox meetings to inform the workforce and to identify and resolve problems, but so did almost all other projects. Both supported all their actions with publicity, but that was a common feature of all of the projects. For both projects reporting and dealing with dangerous situations was a central theme and the figures in table 3 show that they both succeeded over the whole period in greatly increasing the number of situations reported and dealt with. The major difference between the two was the very great emphasis on key performance indicators to inform and motivate managers in the steelworks, an approach not nearly so developed in detail anywhere else. Looking at the relative improvements of the two companies, it is clear that the improvement in the steelworks exceeds that in the fork-lift truck manufacturer, which may have much to do with this last aspect.

4. CONCLUSION

What is striking about these two sets of interventions, but is also true to a lesser extent of other projects, is the concentration on motivation and involvement, so that a dialogue was created between the workforce and the management and staff to identify and resolve dangerous situations. This creates a motor, which keeps safety as an active concern and objective for all concerned. This dialogue was fed by training in the skills of coaching and interaction, since these do not always come naturally to first line supervisors. The whole was energized by a highly active coordinator and by management pressure to perform against targets. All of these elements could be found individually, or in partial combinations in other less successful projects. It may be that these two companies have found a better combination of all of these elements than the projects currently showing less success. Further analysis of the data from 2007, which will allow the success of more of the 17 projects to be assessed on more adequate data, will look to see if such combinations of factors can be found.

The paper also demonstrates how difficult evaluation research is, given the extensive nature of the changes usually made, the paucity and questionable reliability of accident and incident data and the timescale over which they are introduced.

Acknowledgements

The research for this paper was funded by the Dutch Ministry of Social Affairs and Employment as part of its program "Improvement of Occupational Safety". Their support is gratefully acknowledged.

References

- [1] RIGO. 2007. Monitoring versterking arbeidsveiligheid: overallrapportage veiligheidsscan 1 & 2 (Monitoring improvement in work safety: overall report of safety scans 1 and 2). Rigo Research & Advies BV, Amsterdam.
- [2] A.R. Hale. 2007. Evaluatie van bedrijfsinterventies (Evaluation of company interventions). Report to the Dutch Ministry of Social Affairs & Employment by HASTAM Ltd, Maldon, Essex, UK.
- [3] K. Oldenziel. 2007. Ongevallen in de land- en tuinbouw en visserij (Accidents in agriculture, horticulture and fisheries). Stichting Consument en Veiligheid, Amsterdam