Strategic Accident Reduction in an Energy Company and Its Resulting Financial Benefits

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This study provides a case example of an energy company that prioritised occupational safety and health and accident reduction as long-term, strategic development targets. Furthermore, this study describes the monetary benefits of this strategic decision. Company-specific accident indicators and monetary costs and benefits are evaluated. During the observation period (2010–2016), strategic investments in occupational safety and health cost the company EUR 0.8 million. However, EUR 1.8 million were saved in the same period, resulting in a 2.20 cost-benefit ratio. The trend in cost savings is strongly positive. Annual accident costs were EUR 0.4 million lower in 2016 compared to costs in 2010. This study demonstrates that long-term, strategic commitment to occupational safety and health provides monetary value.

Keywords: Economic benefits; Lost time accident; Non-work accident; Occupational accident; Occupational safety and health

1. Introduction

Modern employers acknowledge occupational safety and health (OSH) as a strategic investment affecting their overall economic success [1–5]. OSH (and employee well-being in general) has a positive effect on company performance [6]. Improper OSH practices and processes may lead to negative outcomes due to e.g., accidents. In addition to human suffering, the financial cost of an accident can be substantial,

affecting the employee, the employer, and society at large [7,8]. Studies have shown that the economic costs of work-related illnesses and injuries are equivalent to anywhere between 1.8% and 6% of global gross domestic product [9].

To contribute to strategic decision-making, OSH professionals must be able to provide top management with calculations and estimations that demonstrate the effectiveness of their work [7]. However, the literature on the topic lacks studies and descriptions in which OSH development actions are monetarily evaluated [10,11]. This case study introduces an example of how OSH and accident reduction were prioritised as a strategic development target by an energy company. Furthermore, this study describes the costs of accidents and the monetary benefits gained by the company through this strategic decision. Specifically, this study aims to determine (a) the measurable results realised through OSH indicators during the observation period and (b) the financial benefits of this accident reduction process.

1.1. OSH performance evaluation

Different indicators are used to monitor OSH levels [12]. For example, after-the-loss measurements, such as lost working days, the number of accidents and fatalities, and accident and incident frequencies, are often used to measure the OSH performance. However, these failure-focused reactive indicators do not provide enough information to avoid future accidents and must be complemented with leading indicators that recognise the early signs of potential failure [13]. Among other processes, these potential failures may be effectively identified through safety observations and the collection of near-miss data [13-15]. For example, Häkkinen [16] links major increases to the number of safety observations with decreased accident and injury rates, noting that the active reporting of safety observations and near-misses indicates a good safety culture.

Employers often find that OSH development involves a trade-off between its

costs and expected benefits [17]. Cost-benefit analyses require an understanding of sociotechnical entities and complex calculations [18,19]. The total cost of accidents is often used as an outcome measure [4]. However, determining this figure requires complex calculations that account for both direct (i.e., visible to the company and traceable to a cost object) and indirect (i.e., hidden) costs [8]. Terms such as insured and uninsured costs, ledger and non-ledger costs, tangible and intangible costs, or visible and invisible costs are sometimes used as well [20,21].

Costs incurred by employers in the event of an accident may include sick payments, damaged equipment, increased insurance premiums, administrative and legal fees, production losses and disturbances, expenses related to the reintegration and re-education of disabled employees, and losses resulting from damage to company reputation [22,23]. Further indirect costs, such as reduced employee morale, may also result [24]. Lebeau and Duguay [20] emphasise that there is no formal consensus regarding the division of different cost components between direct and indirect cost categories and argue that this hinders company-level comparisons. Contextual and country-specific factors, such as accident insurance programmes and the coverage they provide, also complicate comparisons [11]. As to be expected, employers are not the only stakeholders involved in covering these costs: Firm owners, investors, insurance providers, the public sector, and employees and their families are also affected [22].

2. Methods and material

This ex post facto case study focuses on the actions taken by the case company to improve OSH and analyses the results of these initiatives. Company-specific OSH and economic figures from 2010–2016 are analysed in this quantitative study. All authors participated in the study's design and data analysis. Data collection from the company's databases was performed by the authors representing the case company (TR

and TA).

2.1. Context

With annual revenues consistently in excess of EUR 250 million, the case company is the leading energy company in northern Finland. Over the study period (2010–2016), revenue grew steadily, and the number of employees remained relatively stable (in 2010, the company had 350 employees, of whom 78% were male and 22% were female, with a mean age of 46.0 years; in 2016, it had 370 employees, of whom 74% were male and 26% female, with a mean age of 42.9 years). The company operates in a variety of fields in the energy industry value chain, including the production of raw materials, the sale and distribution of electricity and heat, and maintenance services. The company operates in a geographically large area covering the whole of northern Finland.

The variety of tasks performed by the company and its large operating area both pose significant challenges to OSH management. In 2010, loss-time accident frequency (LTA1; occupational accidents resulting in one day or more of missed work per million working hours) among the company's personnel was 53.0, resulting in a total 225 working days lost due to absence from work. In addition, 41 non-work accidents (during free time) occurred in 2010, leading to 606 working days lost. Thus, in total, 831 working days were lost due to accidents that year.

The company's accident rate in 2010 (and in the preceding years) was noticeably higher than the national average for the energy industry, and it was therefore identified as a target for strategic development by top management and the board of directors. Accordingly, several strategic decisions were made. Firstly, safety was recognised as one of the key values guiding the company's strategy. Secondly, the company addressed the need to strengthen its OSH team by creating a full-time OSH

104 position for a manager that would report directly to top management. Thirdly, a safety
105 vision of zero accidents was defined and measurable objectives were established.
106 Subsequently, the company implemented several OSH development actions (Table 1).
107 **TABLE 1 HERE**

108 ***2.2. Accident statistics data***

109 Annual OSH data (2010–2016) were collected from company records and
110 databases. The data, expressed in absolute numbers, included: (a) all reported accidents
111 and LTA1s, including all occupational, non-work, and commuting accidents; (b) the
112 number of working days lost; and (c) the number of safety observations made by the
113 personnel, which not only contained reported near-misses but also identified good
114 practices and other workplace deficiencies.

115 ***2.3. Economic analysis***

116 The direct cost of reported occupational accidents (including commuting
117 accidents) was calculated by summing (a) the mean costs of a lost working days, (b)
118 annual accident premiums, and (c) administrative in-house costs resulting from accident
119 inspections. Based on the company's payroll calculations for the observation period, the
120 direct costs of a lost working day (including wages paid and possible costs related to
121 compensatory work and temporary work arrangements) averaged EUR 360. To
122 calculate the costs related to insurance premiums for single accidents, annual accident
123 insurance premiums were divided by the number of occupational accidents (including
124 accidents that did not cause an absence from work) reported in the corresponding year.
125 According to the company's bookkeeping and estimations, inspections following an
126 accident required a mean of approximately 100 h of extra work, the value of which was
127 estimated to be EUR 3,000 based on payroll calculations. Accident insurance does not

cover non-work accidents and no accident investigation is made to non-work accidents. Thus, only their wage-related direct costs (average EUR 360/day; including wages paid during the sick leave and possible costs related to compensatory work and temporary work arrangements) were included.

On the basis of the financial parameters outlined above, an average occupational accident was calculated to incur EUR 7,700 in extra costs to the company. Indirect costs, including lost productivity, damages to property and the environment, and impaired quality of life, were not included in these calculations.

The cost of the company's OSH development process was calculated as the sum of all expenses identified as resulting from the strategy, namely costs that were deemed to be in addition to those spent on OSH in 2010 and in earlier years (extra costs; Table 2). Costs related to legal duties (such as OSH inspections and audits), first aid training, occupational safety card training, and workplace surveys conducted by their occupational health providers were considered basic OSH costs and therefore excluded.

TABLE 2 HERE

Total annual cost was calculated as the sum of the total accident cost and all costs related to the company's strategic OSH development process in the corresponding year. Annual savings were considered the benefit of the OSH development process, i.e. computational number of prevented accidents for that year. Annual savings were calculated by comparing the annual accident cost level to the cost level in 2010. A cost-benefit ratio [26] was calculated by dividing the total annual benefit by the total annual cost. A cost-benefit ratio >1 was taken to indicate financial benefit.

As Verbeek et al. [26] demonstrated in their review of the economics of OSH business cases, several variables are usually involved in calculating OSH costs and benefits. In this study, the main cost variables related to OSH training hours and

153 management. As different units in the company might have included OSH issues in
154 their annual personnel training prior to the introduction of the OSH development
155 strategy, identifying the extra costs related to training hours was a challenge. Therefore,
156 only safety meetings were considered extra costs related to training in this study's
157 calculations. In 2011, a full-time OSH manager was hired. Prior to this, OSH
158 management duties were integrated with human resource management duties and
159 performed on a part-time basis. Therefore, this study's calculations were based on an
160 assumption that half of the OSH manager's annual wage costs constituted extra costs.
161 The sensitivity of the calculations was tested at different levels for OSH trainings (one
162 and two annual training days considered as extra costs, including safety meetings) and
163 wages (25% and 75% of the annual salaries of the OSH manager).

164 **3. Results**

165 ***3.1. OSH performance 2010–2016***

166 Figure 1 shows a clear positive trend for absolute accident figures in both
167 occupational accidents and non-work accidents over the six-year study period.
168 Altogether, 163 reported occupational accidents (including commuting accidents)
169 occurred in 2010–2016. Annually, employees were involved in a mean 4.4 accidents
170 (min = 3, max = 7) during the commute to or from work. Over the course of the study
171 period, the annual number of all reported occupational accidents decreased from 44 in
172 2010 to 20 in 2016. Additionally, the annual number of reported non-work accidents
173 decreased from 41 to 4, and the annual number of LTA1s decreased from 28 to 2. The
174 computational accident frequency for LTA1s experienced a decline from 53 in 2010 to
175 2.9 in 2016. Meanwhile, the number of OSH observations increased from 256 annual
176 observations in 2011 to 1,333 observations in 2016.

FIGURE 1 HERE

Note: LTA1 = occupational accidents leading to 1 day or more of absence from work; OSH = occupational safety and health

Figure 1. Annual safety observations and reported accidents (including commuting accidents), LTA1s, and non-work accidents.

During 2010, 831 working days were lost due to accidents. Conversely, only 109 working days were lost in 2016 (two days due to an occupational accident and 107 days due to non-work accidents; Table 3).

TABLE 3 HERE

3.2. Costs

During the observation period (2010–2016), the cumulative direct cost of occupational and non-work accidents was EUR 2.13 million, of which EUR 1.26 million (163 accidents × EUR 7,700) was the direct cost of all occupational accidents (including commuting accidents). Simultaneously, the cumulative cost of non-work accidents, which only included the direct cost of lost working days, totalled EUR 0.87 million (2,415 days × EUR 360). The weakest full year was 2010, during which EUR 0.56 million was lost due to accidents. The best full year was 2016, in which only EUR 0.155 million was lost.

3.3. Savings

If the annual cost of accidents had remained stable at EUR 0.56 million (i.e. in 2010 cost level) for the duration of the study period, the cumulative cost would have totalled EUR 3.90 million. However in reality, as shown above, the cumulative accidents costs for the observation period totalled only EUR 2.13 million. Therefore, the computational cumulative savings for 2011–2016 was EUR 1.77 million due to this

strategic OSH development process.

The extra costs for the OSH development process were EUR 134,000 annually (Table 2), totalling EUR 804,000 for 2011–2016. At a cost of EUR 804,000 and a benefit of EUR 1.77 million, the OSH development process had a cost-benefit ratio of 2.20. This clearly demonstrates that the strategy was economically beneficial through the observation period. To account for the range of possible variables contributing to the extra costs, sensitivity analyses were performed, according to which the cost-benefit ratio is mostly dependent on costs related to OSH training (Table 4).

TABLE 4 HERE

4. Discussion

In 2010, our case company's OSH indicators determined that its performance was well below the Finnish national mean for the energy industry. A strategy was therefore devised to reduce accidents and promote safe working conditions. Subsequently, the company implemented strategic actions that improved its OSH performance, thereby propelling it to the forefront of the industry. By 2016, the company's LTA1 accident frequency had dropped well below the Finnish energy industry's mean of 11.5 to 2.9 [27].

Due to data restrictions, this study discusses the cost of accidents from the employer's perspective; costs and savings as experienced by employees and society at large are not included. In spite of this restriction, our calculations show that accidents cumulatively cost the company over EUR 2.13 million during the period 2010–2016. The amount of EUR 2.13 million should be considered an extra cost lowering the company's financial performance. Hypothetically speaking, the company would have to sell electricity and heat to 2,600 new customers for six years to cover this cost (based on the company's 2016 electricity price).

Our calculations found that each missed working day resulted in a mean loss of EUR 360 and that each occupational accident caused a mean loss of EUR 7,700. As the case company operates in the costly energy industry, these calculated figures are comparable to national values. For example, Seppänen [28] calculated that lost working days constitute 5% of employees' total wages and salaries in Finland and cost companies a mean of about EUR 300 per working day (2009 values). Additionally, Rissanen and Kaseva [29] estimated the national costs of occupational accidents in a non-refereed study. According to their calculations, the direct costs of occupational accidents in Finland totalled EUR 487 million in 2012. The indirect costs were estimated to vary between EUR 1.5 billion and EUR 2 billion. In 2012, a total 128,264 compensated occupational accidents occurred in Finland [30], meaning that the mean direct cost of each occupational accident was approximately EUR 3,800. Similarly, the mean indirect costs varied between EUR 11,700 and EUR 15,600.

A majority of the working days lost at the case company resulted from non-work accidents (i.e., those occurring during employees' free time). This is in line with earlier studies on the subject e.g., by Verrier et al. [31] and Yrjämä-Huikuri and Väyrynen [32]. However, only about one-third of the total accident costs resulted from non-work accidents. This difference is due to the insurance system, in which the company insures personnel only for working hours.

A topical question is, whether employers have the willingness and capabilities to contribute to safety and accident prevention outside working hours. Smith et al. [33] found work and non-work injuries to share similar characteristics and concluded that the lack of comparable data prevents a more precise discussion. This is often the same when evaluating the complex effects of different OSH development actions. Based on this study, it could be argued, that by having a strategic approach to improve employees'

OSH skills and knowledge, it would also have an influence on behaviour outside the working hours. Our results clearly indicate that safety performance improved in both work and non-work environments, which suggests that employees' overall awareness of safety had advanced.

An organisation might get more precise data on the risks related to non-work activities by providing employees with group accident insurance for non-work hours. Indeed, a large Finnish employer belonging to an international steel company has a long tradition of providing this type of insurance, which allows it to collect precise data on employee's non-work accidents. This data, in turn, enables the employer to engage its employees in more focused prevention strategies [32].

4.1. Sensitivity of the calculations

Although we did not include them in our calculations, property damage and environmental hazard costs are often closely related occupational accidents. For example, occupational accidents may result in pollution, production losses, quality errors, mechanical breakdowns, chemical leakages, and health hazards affecting local communities. Furthermore, accidents can influence a company's public image and affect the productivity, satisfaction, and suffering of the individuals involved. Each of these variables is highly complex, and the costs involved are difficult to estimate. An often quoted (although debated [34]) study by Bird and Loftus [35] has shown that approximately 20 incidents occur for every accident involving human injury. The case company considers incidents like these to be near misses, but it does not record them as such. Instead, safety observations are recorded. These observations contain not only incidents, but also observations on good practices and other workplace deficiencies. Therefore, the data we examined did not provide a means to estimate the total costs resulting from these events.

Concerning our cost-benefit calculations, certain debatable assumptions were made. As the sensitivity analysis shows, costs related to OSH training hours were the major variable affecting extra costs. An assumption was made that all training-hour costs (excluding safety meetings) could be allocated to normal OSH routines and thus excluded from the calculations. This assumption was based on (a) a Finnish labour market agreement that guarantees employees three days of paid training each year and (b) the fact that some OSH-related training (such as completion of the Finnish occupational safety card) had occurred in some of the units. However, the costs related to training hours might have been higher in our calculations, especially if all personnel received the training. If each employee were to receive 1.5 days of OSH training (including monthly safety meetings) annually, the resulting extra costs would total EUR 270,000 annually and EUR 1.62 million cumulatively. In this case, the cost-benefit ratio would be 1.1. Although this is only slightly above the critical limit of 1.0, it should be acknowledged that non-quantified benefits or other externalities could positively affect the overall estimation of an intervention (even in cases where the ratio is lower than 1.0) [7].

We considered other cost variables to be minor. For example, annual costs related to the technical development measures for OSH development were estimated to total EUR 30,000 based on a three-year cost surveillance of the energy production unit. We believe that this estimated value is close to the actual company level costs because the energy production unit was clearly the largest unit, where most of the technical improvements are made.

A number of activities were not conducted in every year of the observation period. For example, a protocol for safety meetings was introduced in 2012, which established quarterly meetings. Later in 2013, the company moved to a monthly format.

However, the cumulative extra cost of the safety meetings was calculated assuming that a mean 300-participant meeting occurred once a month for the duration of the study period. Based on these assumptions, it can be argued that the annual extra cost level provided in Table 2 should be close to the actual extra costs.

4.2. Future challenges

This study supports Loepke et al. [36], who found that aligning OSH more closely to strategic management resulted in significant economic and social benefits. Moreover, this study parallels Zink and Fischer [37], who argued that an OSH development process requires a long-term orientation. Following six years of strategic OSH development, our case company made significant strides towards achieving its strategic target of safety in the workplace and improved employee well-being. In doing so, they were able to lower the rate of health-related absence from 5.5% of total working hours in 2010 (which is near the national mean for industrial workplaces [38]) to 3.0% in 2016. Similarly, the rate of absence resulting from occupational accidents declined from 1.0% of total working hours in 2010 to 0.1% in 2016. Thus it can be argued that our findings are in line with Kaplan and Norton [39], who stated that the benefits of a cultural change affecting regulatory and social processes (including OSH) are typically realised within 24–48 months.

Following their achievements in OSH performance, our case company now faces new challenges as it attempts to maintain current level while improving towards a stable zero accident target. For example, it must develop effective means to reduce the number of accidents that occur during employees' commutes and free time. During recent years, the most severe commuting accidents involved cycling, while injuries resulting from sports and physical exercise dominated leisure-related accidents. This might require trade-offs. Although cycling and exercise should be encouraged to

support healthy living, the company must accept they cannot manage all accident risks faced by their employees. Thus, a balance is needed in safety prevention measures and targets.

Furthermore, matters affecting OSH and environmental sustainability are often closely related. For example, environmental hazards often include a threat to employee and community health [40,41]. The company's zero accident target might therefore benefit if considered in the context of a broader zero vision [2] that includes also other objectives related to accidents; such as zero quality losses, zero emissions, and zero waste.

5. Conclusions

Investing in OSH can positively affect a company's economic performance. However, a successful OSH development process requires time and monetary investment. This study shows that the case company was able to save nearly EUR 1.8 million by reducing accidents. Both occupational and non-work accidents were included in these calculations. The extra costs of the OSH development process were calculated to total around EUR 0.8 million, resulting in a cost-benefit ratio of 2.20.

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TABLES

Table 1. OSH actions implemented by the case company by year of introduction.

Year	Action
2010	• Shared OSH performance status with employees • Developed a new protocol for manual safety observation reporting
2011	• Hired a full-time OSH manager • Defined and issued strategic OSH development targets and objectives • Shared the new OSH strategy with employees • Developed a new protocol for quarterly safety meetings • Developed a new protocol for safety thinking sessions
2012–2013	• Extended safety meetings to a monthly format with changing themes • Deployed a new electronic safety observation program • Instituted new root cause analysis procedure for accident inspections • Introduced new personal risk assessment tool • Selected proactive OSH indicators • Developed new models for OSH communication practices
2014–2015	• Developed a new protocol for safety walk practices • Conducted personnel trainings at Safety Training Parks [25]
2016	• Developed a new protocol for in-house OSH audits • Developed a risk assessment protocol for contract work • Selected OSH committees for all operating sectors in the company • Launched a safety promotion campaign • Issued new OSH development targets for 2016–2020

462 Table 2. Cost objectives for the extra costs of the strategic OSH development process.

Variable	Cost objective	Annual cost (EUR)	Calculation principle
OSH management	OSH management actions and top management OSH activities (OSH walks)	51,000	Payroll calculations for the appropriate personnel groups in top management
Technical improvements	Technical development actions	30,000	Based on three years of cost surveillance* at the energy production unit
	New electrical OSH management systems	10,000	Procurement and annual license costs
	OSH action processing in OSH management systems	4,000	850 actions annually with an estimated processing time of 10 min/action based on mean wage costs
OSH trainings	Safety meetings	27,000	15 min/meeting monthly for 300 participants based on mean wage costs
OSH processes	Committees and development groups	6,000	Calendar bookings and participant lists with mean wage costs for the different personnel groups involved
	Analyses	3,500	22 OSH analyses calculated with mean wage costs for the different personnel groups involved
	Observation entries and processing	2,500	1,000 entries annually with an estimated processing time of 10 min/entry and based on payroll
	Total	134,000	

463 *based on an estimation following the company records that cover the costs from the
464 energy production unit for 2012–2104.

Table 3. Working days lost annually.

Year	Number of days lost (occupational accidents)	Number of days lost (non-work accidents)
2010	225	606
2011	192	583
2012	52	424
2013	85	273
2014	0	245
2015	19	177
2016	2	107

467 Table 4. Variables and sensitivity analyses of the cost-benefit ratio calculations for
468 2011–2016.

Variable	Cost objective	Annual total cost (EUR)	Benefit-cost ratio
Wages	25% of the annual wages	114,000	2.59
	75% of the annual wages	154,000	1.92
Training	1 full working day included in extra costs annually	215,000	1.37
	2 full working days included in extra costs annually	323,000	0.91
Combinations	25% of the wages and 1 full day included in extra costs	195,000	1.51
	25% of the wages and 2 full days included in extra costs	303,000	0.97
	75% of the wages and 1 full day included in extra costs	235,000	1.26
	75% of the wages and 2 full days included in extra costs	343,000	0.86

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