Scand J Work Environ Health 2009;35(6):403-413
https://doi.org/10.5271/sjweh.1355
Published online: 01 Oct 2009, Issue date: 00 Dec 2009

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Refers to the following texts of the Journal: 2007;33(2):122-130 2007;33(2):81-83 2007;33(3):161-164

The following articles refer to this text: 2009;35(6):401-402; 2009;35(6):413-420; 2010;36(4):313-318; 2010;36(4):289-298; 2010;36(4):269-271; 2010;36(4):305-312; 2010;36(6):515-516; 2018;44(5):458-474; 2021;47(4):318-327

Key terms: business case; cost–benefit analysis; economics; occupational safety and health; occupational safety and health business case; productivity; review

This article in PubMed: www.ncbi.nlm.nih.gov/pubmed/19806275

Print ISSN: 0355-3140 Electronic ISSN: 1795-990X

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A systematic review of occupational safety and health business cases

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Verbeek J, Pulliainen M, Kankaanpää E. A systematic review of occupational safety and health business cases. *Scand J Work Environ Health.* 2009;35(6):403–412.

Objective Business cases are commonly developed as means to rationalize investment. We systematically reviewed 26 reported cases on occupational safety and health (OSH) interventions to assess if health and productivity arguments make a good business case.

Methods To be included in the review, studies had to analyze the costs and benefits, including productivity, of an OSH intervention at the enterprise level. We searched Medline and Embase for studies and used Google search in addition. Two reviewers independently selected studies and extracted data. The intervention profitability was calculated in euros (€ in 2008) as the first year's benefits minus the total intervention costs per worker. The payback period was calculated as the intervention costs divided by the first year's benefits.

Results We found three ex-ante and 23 ex-post cases. In 20 cases, the study design was a before–after comparison without a control group. Generally a 100% reduction of injuries or sickness absence was assumed. In two cases, productivity and quality increases were very large. The main benefit was avoided sick leave. Depreciation or discounting was applied only in a minority of cases. The intervention profitability was negative in seven studies, up to €500 per employee in 12 studies and more than €500 per employee in seven studies. The payback period was less than half a year for 19 studies. Only a few studies included sensitivity analyses.

Conclusions Few ex-ante business cases for management decisions on OSH are reported. Guidelines for reporting and evaluation are needed. Business cases need more sound assumptions on the effectiveness of interventions and should incorporate greater uncertainty into their design. Ex-post evaluation should be based preferably on study designs that control for trends at a time different from that of the intervention.

Key terms cost–benefit analysis; economics; occupational safety and health; productivity.

It is often argued that a business case is necessary to increase the uptake of occupational safety and health (OSH) interventions (1, 2). The objective of a business case is to obtain management commitment and approval for investment in business change by providing a rational for the investment (3). Thus, a business case should provide argumentation to convince management to increase the use of OSH interventions at the corporate level (4, 5).

Studies show that legal, financial, and moral reasons (in that order) are the key drivers for businesses to engage in OSH (6). Employers perceive regulations as a real risk and are mindful of reputational damage. In addition, employers support the use of a business case as it shows the benefit to the company of complying with OSH interventions (7, 8). Therefore, a business case should contain at least legal, financial, and moral justification for taking action.

The financial aspects of a business case concerning an occupational health project in a firm are usually covered by a cost–benefit analysis (9). Cost–benefit analyses have historically been used to estimate all the costs and benefits of a proposed project in monetary values, which are then combined into a summary measure such as the net present value (NPV) or cost–benefit ratio. Frequently used in business to compare different interventions and corporate investments, the NPV is calculated by adding all the benefits and subtracting all the costs – with discounting applied as appropriate – to give the current value of future net cash flows (10). The cost–benefit ratio is simply the total benefits divided by the total costs. If the NPV is >0 or the benefit–cost ratio

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is >1, a project would be financially beneficial and the decision-maker may consider it desirable to initiate the proposed project (10). The cost–benefit analysis can, thus, provide an estimation of the financial aspects of a project before it has been carried out. However, a major concerns about cost–benefit analyses is that the estimations can be too optimistic.

Confusingly, the term "business case" also applies to case descriptions from real firms that are widely used in business schools as a learning material for students; they are, by definition, ex-post descriptions. Both in sociology and medicine, case descriptions are also used as a scientific method of gathering study material usually to generate hypotheses for further study. It is obvious that ex-ante estimation involves different information and yields different knowledge than an ex-post description. It is, however, often argued that ex-post descriptions of the costs and benefits of OSH interventions can also motivate employers to take up preventive measures (11).

In healthcare, economic evaluation is used to support decision-makers in finding the most cost-effective interventions (12). For OSH interventions, it is important to measure the costs that are important for employers because these will influence their decision-making more than the total societal costs (13). Accounting in firms does not easily provide an overview of the cost of occupational diseases and injuries (14). Ex-post case descriptions can enhance an employer's understanding of how costly these can be for the firm (11).

Traditionally, OSH regulations and occupational health services are used to maintain and improve employee health. The assumption underlying regulations protecting worker health is that the market would not provide such protection, at the socially optimal level, if left unregulated (15). More recently, workplace health promotion has been introduced as an addition to the traditional approach, focusing more on general health factors through workplace promotion of a healthy lifestyle (4). A further extension of the approach is known as "health and productivity management", which is based on the idea that health and productivity improvements for companies are intertwined (16, 17). Recent business case descriptions have focused on the argument that OSH interventions also increase productivity (18). Ergonomic interventions, as a specific OSH intervention, are intended to improve both productivity and employee health (19, 20). Many ergonomic interventions, therefore, also include an evaluation of productivity (21).

We have argued that a systematic review would help to assess whether health and productivity arguments make a good business case for OSH (22). We, therefore, gathered all business case studies focused on OSH interventions and analyzed the assumptions underlying each case and the components taken into account.

Methods

Studies were included if they described a case study in a company where economic arguments were used to enhance the implementation of an OSH intervention. Cases had to fulfill the following criteria: (i) involve an OSH intervention that aimed to improve or maintain worker health, safety, and wellbeing in the setting of the workplace or occupational health services (we deliberately excluded interventions that were performed in the context of general healthcare in which productivity was measured as part of the evaluation of the healthcare treatment); and (ii) contain any measurement of (a) productivity, (b) health or injury, and (c) the costs and benefits in monetary terms.

We conducted a search in Medline through PubMed and Embase in October 2008. In Medline, we searched with economics [subject heading], (occupation* *or* worker*) and ("case study" *or* business*). We also searched the references of included articles. In Embase, we searched with "business case" as text word or the keyword "cost–benefit analysis" combined with the keywords "occupation" or "occupational health" or "work", with a limitation to Embase-only records. Since we anticipated that many reports would be published in the "grey" literature, we also searched the internet using Google search with the key terms "business case" combined with "occupational" *or* "safety" *without* "patient".

We analyzed and reported the business cases according to the following features: (i) whether performed ex-ante or ex-post, (ii) the objectives of the case study, (iii) the study design, (iii) the assumptions about the effectiveness of the intervention, (iv) if the costs of the interventions included labor and equipment costs, (v) if the consequences of the intervention included avoided (a) sickness absence/injury costs, (b) productivity losses, or (c) other costs such as training new workers, productivity increases, or quality improvement. Ex-ante was defined as a business case in which data were gathered *before* the actual intervention was carried out, which reflects most a practical business case. Ex-post was defined as the evaluation of an intervention *after* it has been carried out.

The recommended metric to present the output of cost–benefit analyses was the NPV or cost–benefit ratio (10). In order to calculate the NPV, information is needed on the depreciation of the investments and the time horizon of the consequences to enable discounting. To make cases comparable, we wanted to calculate a NPV per worker for every case. However, hardly any cases provided sufficient details of the time horizon of the consequences which made discounting impossible. Information on the depreciation of the investments was also missing in most cases. Therefore, in order to

compare the information in the cases with a common metric, we used the total costs of the intervention and the first year's benefits. Assuming that the first year's benefits would continue at the same level over time, we calculated the time needed to pay back the investments as the "pay-back period". In addition, we calculated the "intervention profitability per worker per year" using the following calculation: (benefits in the first year) - (total costs) / number of workers involved in the case.

We converted all monetary values to the 2008 value by using the consumer price index and then converted to euros if needed.

Results

Included studies

The search yielded 427 references in Medline and 796 in Embase. In Google, the first 100 links were explored. A selection of the references resulted in 108 full text papers and three reports. After applying the inclusion criteria to these papers, we retained 21 articles and one report. Six articles reported on three studies twice so we included each study only once which left us with 18 articles (23–28). In one article, four cases were reported, in another three cases, and in one report, three cases were reported, resulting in 26 cases for use in the review (9, 11, 24, 26, 28–42)

We excluded cases that: (i) did not concern occupational health but general health interventions such as case studies of influenza vaccination (43–47); (ii) did not include costs and benefits in monetary terms (48); (iii) did not include productivity measures (49); (iv) did not include the costs of the intervention (50); (v) were economic models only (51); or (vi) had calculated costs and benefits relative only to production (52).

Description of included cases

The description of the cases is given in table 1. Three cases were ex-ante studies and business cases, in which an estimate was made of the future impact of an

Table 1. Characteristics of business cases of occupational health interventions (N=26).

Study	Country	Industry	Intervention	Study Design	Reporting of Effects
Ex-post studies					
Alamgir, 2008 (29)	Canada	Healthcare	Installation of overhead lifts for reducing the risk of musculoskeletal injury in health care workers.	Interrupted time-series analysis	All decrease in injuries and associated costs due to the intervention. Indirect costs assumed to be equal to direct costs
Bergström, 2005 (30)	Finland	Metal	Participatory ergonomics to find good solutions for ergonomic changes in layout and work rotation; included purchase of lifting devices	Before–after comparison without a control group	Reduction in sick leaves from 14–26 days/year, 3% productivity increase, 30 hours less worker overtime
Brophy, 2001 (31)	United States	Healthcare	Purchase of lifting devices and ergonomic training for nursing home workers	Before–after comparison without a control group	Reduction of low-back injuries and associated costs fully ascribed to intervention
Chhokar, 2005 (26)	Canada	Healthcare	Purchasing of ceiling lifts and ergonomics training in extended care facility to prevent back injuries	Before–after comparison without a control group	The three-year pre-intervention trend was supposed to continue post-intervention. The difference was ascribed to the intervention.
Engst, 2005 (32)	Canada	Healthcare	Installation of ceiling lifts and education of patient handling education in an extended care unit to prevent back injuries	Controlled before–after comparison	Cost–benefit analysis only for intervention group. Benefit recalculated as the avoided claim costs in the intervention minus the control group. Indirect costs assumed to be equal to direct claim costs
Hlobil, 2007 (33)	Nether-lands	Aviation	Graded activity intervention for workers sick-listed because of low-back pain compared to care as usual	Randomized controlled trial	Avoided sick leave (control-intervention) minus the additional costs of intervention (control-intervention)
Kemmlert, 1996 (34)					
case 1	Sweden	Metal	Automation of extremely heavy physical work to prevent back pain	Before–after comparison without a control group	All changes were attributed to the automation or based on estimations by the personnel manager
case 2	Sweden	Public admin	Purchase of new chairs and manuscript supporters to prevent musculoskeletal problems	Before–after comparison without a control group	All changes were attributed to the automation or based on estimations by the personnel manager
case 3	Sweden	Metal	Provision of a hoist and adjustment of working height to prevent back pain and musculoskeletal injuries	Before–after comparison without a control group	All changes were attributed to the automation or based on estimations by the personnel manager
case 4	Sweden	Healthcare	Reduction of patients, purchase of hoist and improvement of existing hoist, and ergonomic training	Before–after comparison without a control group	All changes were attributed to the automation or based on estimations by the personnel manager

(continued)

Table 1. Continued.

Study	Country	Industry	Intervention	Study Design	Reporting of Effects
Lahiri, 2005 (9)					
case 1	United States	Wood processing	New adjustable equipment and exercises instruction by physiotherapist for prevention of back pain	Before–after comparison without a control group	Reduction of low-back pain from 5/100 person years to 0 cases. Estimation of 10% productivity increase by company official
case 2	United States	Automotive	Program to reduce back discomfort by providing pads and backrests and back schools.	Before–after comparison without a control group	Reduction of low-back pain of 41/637 before to 12/637 after the intervention. Productivity increase of 5% assumed.
case 3	United States	Automotive	Ergonomic intervention in various assembly lines workers in automobile plant to prevent back pain	Before–after comparison without a control group	Reduction of low-back pain of 11.3 cases per year before to 3.3 after the intervention. Productivity increase of 40% assumed.
Lanoie, 1997 (35)	Canada	Distribution center	Purchase of ergonomic equipment and participatory ergonomics program	Before–after comparison without a control group	Estimation of injury decrease with Poisson regression analysis adjusting for age, overtime, strike, job dissatisfaction, department
Melhorn, 1999 (36)	United States	Metal	Post-hire, pre-placement assessment to prevent musculoskeletal disorders	Before–after comparison without a control group	The decrease in the compensation costs after the intervention was fully ascribed to the intervention
Miller, 2007 (37)	United States	Transportation	Peer-care-based workplace substance abuse program to prevent injuries in a transportation company	Interrupted time-series analysis	Monthly injuries modeled with a Poisson regression analysis over a 16-year period of time. Reduction of 30% in injuries ascribed to the intervention
Shearn, 2003 (11)					
case 1	United Kingdom	Pet food production	Change traditional footwear into slip-resistant footwear to prevent slip-related injuries	Before–after comparison without a control group	Reduction in sick leave ascribed to the intervention
case 2	United Kingdom	Newspaper	Improvement of office equipment to reduce upper limb disorders	Before–after comparison without a control group	Benefits ascribed to an estimation of increased productivity and reduction of injury-related costs
case 3	United States	Meat production	New work routines and improvement of fleshing machine to prevent cumulative trauma disorders	Before–after comparison without a control group	All changes in time lost, medical costs, compensations costs and productivity from before the intervention to after were ascribed to the intervention.
Tompa, 2009 (38)	Canada	Automotive	Participatory ergonomics program implemented 10 ergonomics change projects to prevent injuries and workers' compensation claims	Before–after comparison without a control group	Changes in injury incidence and related claims and costs calculated using regression analysis adjusting for production hours, demand, line speed, labor relations, new hires, turnover
Yassi, 1995 (39)	Canada	Healthcare	Early comprehensive rehabilitation for back injured nurses at a Canadian tertiary care hospital to decrease back injuries, time lost and related costs	Controlled before–after comparison	Avoided compensation costs (control-intervention) minus the additional costs of intervention (control-intervention)
Yassi, 1995 (39)	Canada	Healthcare	A needleless intravenous access system to prevent needle stick injuries in hospital workers	Before–after comparison without a control group	All changes in needle stick injuries before and after the introduction of the system were ascribed to the intervention of the new system with a range of uncertainty
Yeow, 2003 (28)	Malaysia	Electronics	Ergonomic intervention such as better arm support and training for an electronic factory's workers	Before–after comparison without a control group	A 41% change in muscle fatigue was measured in the intervention group during follow-up. All productivity increase and quality improvement was ascribed to the intervention
Ex-ante studies					
Estill, 2002 (41)	United States	Household appliance assembly	Purchasing mechanical equipment for production workers to prevent future musculoskeletal injuries	Ex-ante cost–benefit analysis with post-intervention evaluation	Risk of tendinitis and carpal tunnel syndrome reported in the literature with associated costs. Unanticipated increase in production.
Seeley, 2003 (24)	United States	Electrical	Converting a manually-operated press and cutter for line workers into battery-operated tools to avoid musculoskeletal complaints	Ex-ante cost–benefit analysis	50% reduction in severe musculoskeletal injuries and lost working days and a reduction of medical costs for two cases based on ergonomists assessment
Zwerling, 1992 (42)	United States	Postal Service	Pre-employment drug screening intervention for employees of the postal service	Ex-ante cost–benefit analysis	The difference in absence, injuries, and turnover between the drug-negative and drug-positive group could be completely avoided by not hiring drug positive workers. Sensitivity to different levels of positive tests analyzed

investment decision. The remaining 23 cases were actual ex-post case descriptions.

Ten cases were carried out in the United States, seven in Canada, four in Sweden, two in the United Kingdom and one each in the Netherlands, Malaysia, and Finland.

Seven cases were carried out in the healthcare sector mainly by the same research group in Canada. Three cases were carried out in the automobile industry, four in the metal industry, four in the transport sector, seven in other industries, and one in public administration.

Most cases (N=19) dealt with an ergonomic intervention to prevent musculoskeletal disorders/pain or to automate heavy physical work. Of these, seven dealt with various topics while five cases focussed on the installation of ceiling lifts in healthcare institutions to prevent lifting and the resulting musculoskeletal disorders. Two cases evaluated the costs and benefits of rehabilitation of workers with musculoskeletal injuries while two others concerned pre-employment screening. In the three remaining cases, the interventions concerned peer support to prevent injuries from alcohol abuse, the use of safety footwear to prevent slips, and the introduction of new equipment to prevent needle stick injuries.

In 18 cases, the design was a before–after comparison without a control group. In two studies, a controlled before–after study design was used, one used a randomized controlled trial design and two an interrupted time-series design. The three ex-ante studies used various data sources as forecast input.

Assumptions on effectiveness and benefits

In 15 of the 18 studies that used a before–after comparison design, all changes that occurred between the two measurements were ascribed to the intervention. For example, if there were cases of back pain prior to the intervention and no cases at the moment of measurement after the intervention, then it was assumed that the intervention was 100% effective. In two of the before–after comparison studies, the authors adjusted for confounders using regression analysis (35, 38). In one case, the pre-intervention trend was assumed to continue after the intervention and the difference between the extrapolated pre-intervention trend and the measured value was taken as the benefit of the intervention (26). In two other studies, an additional assumption was made that the avoided indirect costs, such as avoided turnover and training of new personnel, would be equal to the avoided direct costs from workers' compensation claims (29, 32).

In the controlled studies, the effect, costs, and benefits of the intervention were measured as those in the intervention group minus those in the control group (32, 33, 39). However, in one study, we had to recalculate the outcomes because the authors used a before–after comparison in the intervention group only (32). In the interrupted time-series analysis, the intervention effectiveness was measured as the difference between the beginning and the end of the time-series.

Personnel managers assessed productivity increases in four cases; these varied from 5–40% (9, 30). In one case, there were objective measurements of productivity (28) and in another the lack of quality defects – compared to those that had occurred in the previous year – was taken as the quality improvement (11).

In the ex-ante studies, the assumptions were based on an ergonomist assessment of a 50% reduction in injuries in one study (24), a 100% reduction of the risk reported in the literature in another study (41), and a 100% reduction of the risk found in an earlier cohort study (42).

Costs of the intervention

The costs and consequences of the interventions are given in table 2. The costs of the intervention were split into different costs, such as labor and equipment costs, only occasionally. The intervention costs ranged from €607 to as high as €1.4 million (real 2008 value) in total. Per worker the costs varied from €1 to €11 655.

Intervention consequences

In most cases, the avoided "time loss due to sick leave" was calculated as a benefit but in some it was included in the total avoided costs and could not be presented separately. In the North American context, the employer bears a substantial part of the medical costs which resulted usually in additional avoided medical costs for those cases. The other avoided costs usually comprised those relating to personnel turnover which can be considerable according to these case studies. In one ex-ante case, the authors stated that they had overestimated the benefits of avoided sick leave, but luckily they had grossly underestimated the avoided costs of training new workers (24).

Intervention profitability

The intervention profitability was positive in 19 cases meaning that the intervention was paid back by the resulting benefits within one year. The median value was €214 per worker in the first year. In only a few cases, the intervention profitability reached extreme outcomes of more than €10 000 due to big improvements in productivity resulting from alterations in machinery. In most cases, the intervention profitability ranged between €5–500 per worker in the first year. The median was €214. Interventions that consisted of installing ceiling lifts in healthcare facilities were negative, meaning that the investment was not returned in the first year (figure 1).

Table 2. The intervention costs, consequences, and benefit in 2008 euros, and pay-back period of business cases reported in literature that included both health and productivity measurements (N=26). All intervention costs included but only benefits for the first year post-intervention or the yearly average over the follow-up period.

Study	Workers (N)	Intervention costs (€)			Intervention consequences per year/first year (€)					Intervention profitability	
		Labor	Equipment	Total	Avoided sick leave	Avoided medical cost	Other avoided cost	Productivity increase	Quality increase	Per worker first year (€)	Pay-back period (years)
Ex-post studies											
Alamgir, 2008 (29) [a]	910			789 812	263 271					-579	3.0
Bergström, 2005 (30)	60			6029	32 489		2787	27 911		476	0.1
Brophy, 2001 (31)	193			133 871	89 269					-231	1.5
Chhokar, 2005 (26)	127		234 904	234 904	68 651					-1309	3.4
Engst, 2005 (32)	34			207 637	12 692					-5734	16.4
Hlobil, 2007 (33)	67			6810	81 962					1122	0.1
Kemmlert, 1996 (34)											
case 1	4	1076	2767	3843	541		9878			1644	0.4
case 2	60	1353	2121	3474	7302		6534			173	0.3
case 2	4	369	538	907	909		2725			682	0.2
case 4	20	160	738	898	9305		1343			488	0.1
Lahiri, 2005 (9)											
case 1	**123**	**362**	**3499**	**3861**	**1562**	**730**		**57 164**		**452**	**0.1**
case 2	**637**	**362**	**245**	**607**	**3471**	**69**		**45 129**		**75**	**0.0**
case 2	**1500**	**361 614**	**9154**	**370 768**	**88 083**	**11 774**		**1 959 221**		**1126**	**0.2**
Lanoie, 1997 (35)	86			157 114	26 472	23 067				-1245	3.2
Melhorn, 1999 (36)	3152			130 075	803 147					214	0.2
Miller, 2007 (37)	26 000	712 786	712 786	1 425 572	38 094 474					1410	0.0
Shearn, 2003 (11)											
case 1	**191**			**4170**			**14 122**			**52**	**0.3**
case 2	**170**			**62 726**			**28 417**			**-202**	**2.2**
case 3	**8**			**93 244**	**25 054**	**9723**	**16 091**	**76 741**	**108 891**	**17 907**	**0.4**
Tompa, 2009 (38)	175			18 529	97 460		950			228	0.2
Yassi, 1995 (39)	131			6323	14 674					64	0.4
Yassi, 1995 (40)	6000		40 609	40 609			69 259			5	1.6
Yeow, 2003 (28)	31		849	849				553 538	443 572	32 137	0.0
Ex-ante studies											
Estill, 2002 (41)	18		29 178	29 178	21 884	38 315				1723	0.5
Seeley, 2003 (24)	370		216 969	216 969	18 330	82 022	32 907			-5	0.3
Zwerling, 1992 (42)	2353			530 157	1 326 347					314	0.4

[a] Assumed that staff : bed ratio would be 2.

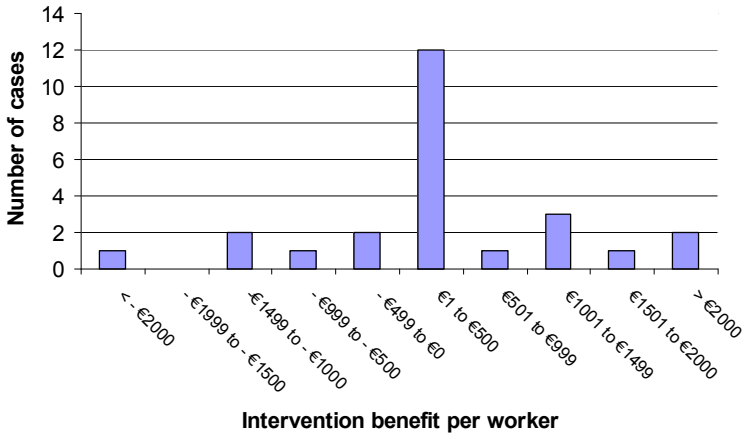

Figure 1. Intervention profitability per worker, per year in case studies of occupational safety and health interventions (N=26).

The payback period reflected the same as the intervention profitability, with a payback period of less than one year in 19 of the 26 cases.

The intervention profitability and payback periods did not appear to be impacted by the size of the firm (ie, there were no differences in the findings for small or large firms).

Of the ex-ante studies, in one case, the benefit was considerable making a positive argument for investment. In another case, there was a small negative intervention profitability but, due to depreciation of the investment, the benefit was much bigger in reality. Management accepted this case (23). In the third case, while the investment was shown to be profitable, there was no information on its presentation to management.

Other intangible benefits

None of the cases mentioned intangible benefits such as improved reputation or increased worker satisfaction.

Discussion

We found three ex-ante business case descriptions that showed that OSH investments would be profitable. The other ex-post cases showed a median profitability of €214 per worker and a pay-back period of less than a year. Benefits from productivity increases were very large in two cases. In ten cases, the authors adjusted for the influence of factors other than the intervention. Many cases provided incomplete estimates of the costs and benefits. Intangible benefits were not assessed in any of the cases.

Strengths

The strength of our study is that we systematically searched for business cases in the scientific and grey literature. We used a systematic approach to analyze cases based on those aspects that are important for a cost–benefit analysis and convincing for decision-makers. An important aspect of our analysis was the breakdown of the cases into the various costs and benefits included and the underlying assumptions thereof. In addition, we recalculated the figures given by authors to improve comparability.

Limitations

Even though our intention was to calculate the NPV for all cases, this was not possible due to a lack of precision in measurement of the economic outcomes. For example, most cases lacked depreciation and a time horizon. The lack of a depreciation period was especially disturbing as all investments are supposed to be paid back in the first year; this can easily make a factor difference of 5–10. Seeley depreciated the new equipment but for reasons of comparability we did not use these data (24). This made the case look less profitable than it was in reality. The lack of a longer time horizon and discounting distorts the benefits less since most firms would like to see a fast real return on investment. In many studies, it was assumed that the benefits would continue at the same level as during the first year which is a questionable assumption. In most studies, productivity losses were only measured as sickness absence. However, production loss extends usually beyond absence and is also reflected in lower productivity just before and after sick leave (ie, presenteeism) (53).

It might be that we missed case studies that are reported in the grey literature in spite of our Google search as an internet search is much less controllable than a search in medical databases. However, given the number of cases we found, it is not very probable that this would have altered the picture.

It is clear that unfavorable business cases would not be published since the whole idea of a business case is that it provides a rationale for investment. Therefore, it is not possible to generalize the results of these cases to the profitability of OSH interventions. Nevertheless, much can be learned from presenting cases for management decisions.

Meaning of the findings and comparison with other studies

Not surprisingly, we found only three ex-ante business cases in the scientific and grey literature. The cases are meant for decision-making and not as a scientific evaluation. However, those cases that we found provide valuable information on how the costs and consequences were estimated. Seeley describes how the costs of avoided sick leave and injuries were grossly overestimated, but luckily the avoided costs of training new workers were underestimated which made the case still profitable (24).

The general assumption that productivity increases form a large part of the intervention consequences is not confirmed by the cases in this review. Only two cases reported large productivity increases but they were exceptional. In addition, the other cases that reported productivity increases were based on rather loose estimates by personnel managers.

The median of €214 as the intervention profitability per worker per year is difficult to interpret. In one ex-ante case, the authors state that the firm wanted a pay-back period of 2–3 years (41). However, even with a payback period of more than five years, authors

call their results supportive of the intervention (29). Nevertheless, this would mean that the majority of the reported cases would be acceptable to management. Another comparison is that the intervention profitability amounts to about 0.5% of the costs of a gross (monthly) wage of an average worker, which would probably be a convincing figure for management. More research is needed to show how and when management decisions can be best influenced.

A disturbing finding was that hardly any of the cases incorporated uncertainty in their calculations. Especially in ex-ante cases, there will always be uncertainty because of the lack of information about future events. However, with sufficient training, experts can estimate a 90% confidence interval that includes the uncertainty about their results. This, in turn, can easily be incorporated in the calculations (54). Another option is to conduct more traditional sensitivity analyses to see if changes in the assumptions also lead to changes in the conclusions.

In none of the cases, intangible benefits – such as the avoidance of damaged corporate reputation – were reported even though these are important drivers of business decisions (6, 55).

Other authors have looked at case studies and found a different numbers of cases. Shearn found 15 cases of which three fulfilled our inclusion criteria (11). He concluded that the cases were of low methodological quality and it was unclear in how far business cases really support decision-making in firms. Goggins et al (21) reported on 250 cost–benefit analyses gathered by the Washington State Department of Labor and Industries to estimate the benefits of ergonomic interventions. However, they reported especially on effectiveness which in our view is not warranted based on case studies alone. Compared to these other studies, our search had a favorable outcome.

Implications for practice

Business cases provide valuable clues to the costs and benefits of OSH interventions. Areas for improvement include: (i) a better underpinning of assumptions, (ii) inclusion of depreciation of investments and time horizons, (iii) incorporation of uncertainty, and (iv) assessment of intangible benefits such as reputation damage and risk of breaching the law.

Implications for research

Guidelines for the reporting of business cases are needed. The value of the cases could be improved by reporting both the ex-ante assumptions and calculations, and providing an ex-post evaluation. Research is needed to find out if well-designed business cases really improve the uptake of OSH measures and which elements of the business case matter the most.

Acknowledgements

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement number 200549 EcOSH.

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Received for publication: 17 July 2009