European Agency for Safety and Health at Work

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The business case for safety and health at work: Cost-benefit analyses of interventions in small and medium-sized enterprises

European Agency for Safety and Health at Work

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Authors:

Dr. Antonis Targoutzidis, Dr. Theoni Koukoulaki - ELINYAE, Greece

Dr. Ellen Schmitz-Felten, Klaus Kuhl - Kooperationsstelle Hamburg

Karen M. Oude Hengel, Evelien Rijken - TNO, the Netherlands

Prevent: Karla Van den Broek - Prevent, Belgium

Dr. Ruth Klüser - IFA DGUV - Germany

Project management:

Dietmar Elsler, Xabier Irastorza, European Agency for Safety and Health at Work (EU-OSHA)

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Executive summary

Small and medium-sized enterprises (SMEs), often referred to as the backbone of the European economy as they account for 67 % of employment. However, at the same time they also account for 82 % of occupational injuries. It is widely recognised that occupational safety and health (OSH) in SMEs involves a number of particular challenges:

- SMEs are subject to greater risks, as shown by the relevant statistics.
- Many OSH improvements are low-cost solutions, but sometimes SMEs have problems financing an OSH policy, owing to limitations on their access to capital and do not benefit from the effects of economies of scale.
- SMEs have problems implementing an OSH policy, owing to a variety of organisational features.
- Governments face difficulties in fostering effective OSH management in SMEs, mainly because there are so many SMEs and these businesses have limited resources.

Research has shown that once SMEs understand the relationship between OSH and productivity, they are then able to see the link between OSH and economic performance. The European Agency for Safety and Health at Work (EU-OSHA) has identified the need for further research and case studies on the business case for good OSH management, particularly with a focus on SMEs.

The aim of this report is to provide clear case studies that can act as ‘eye-openers’ for SMEs, raising awareness of the benefits of OSH at enterprise level and addressing the need to change the perception of OSH, so that it is viewed not as a cost factor but as a beneficial investment. The SME case studies can be found in Appendix II of this report and will be presented to enterprises and intermediary organisations at suitable events. This report is accompanied by an executive summary and a PowerPoint presentation in order to facilitate its dissemination by stakeholder organisations to their target groups. Furthermore, policy-makers should understand that costs at enterprise level are often shifted to the societal level, and that this is a strong argument for promoting OSH in SMEs through public programmes.

The economic aspect of OSH is usually examined at two levels: the macro level, which includes legislation and central incentives having the state as the key player, and the micro level, which focuses on individual enterprises. Although the role of the state is generally accepted as necessary to regulate working conditions, the economic benefits of good OSH could, at least to some extent, motivate OSH interventions initiated by enterprises. Furthermore, external economic incentives for enterprises to improve OSH can help to achieve a better use of central resources by allowing them to be focused on those aspects of OSH where prevention is not economically beneficial at enterprise level alone.

The business case was examined in order to better serve these aims. In the case of each intervention studied, all the costs and benefits were examined, regardless of whether they were purely OSH-related or not, as in a business case such investments need to be assessed as a whole, from the enterprise’s point of view. This approach is the most appropriate for examining decisions that are taken at enterprise level, as the decision to initiate an intervention is taken on the basis of its overall impact on the enterprise, rather than on the basis of the improvement in OSH alone.

This study had two main strands: identifying case studies of OSH interventions in the existing literature and developing new case studies on OSH initiatives in European SMEs. Seven institutes from various European countries were involved.

91 existing case studies were identified, 19 of them from Europe. Their distribution by sector, type of OSH intervention and country is presented in Tables 1, 2 and 3.

Table 1: Existing case studies by sector

Sector	Existing case studies
Healthcare	30
Manufacturing and warehousing	24
Administration	9
Transport	7
Public administration	5
Mining	3
Accommodation and food	2
Construction	1
Other and multiple	10
Total	91

Table 2: Existing case studies by type of OSH intervention

Factor	Existing case studies
Ergonomics	53
Prevention	10
Rehabilitation	19
Other and multiple	9
Total	91

Table 3: Existing case studies by country or region

Country or region	Existing case studies
United States	50
Canada	14
North America	1
Australia	6
Malaysia	1
Sweden	11
Norway	1

Country or region	Existing case studies
Finland	2
UK	2
Netherlands	3
Total for Europe	19
Grand total	91

In addition, 56 cases of ex ante estimations of the costs and benefits of particular OSH interventions (all in European countries) were identified from the benOSH project1.

Moreover, 13 new case studies of OSH-related interventions in European SMEs were developed in the course of this study. These interventions were described using a common template and were assessed using a common accounting model. Eleven of these interventions were found to provide a positive return on investement in the five-year period examined. Short descriptions of these case studies are presented in Table 4.

[1] http://ec.europa.eu/social/BlobServlet?docId=7416&langId=en

Table 4: Case studies developed in this study

Case number	Sector	Short description of the intervention	Results	Payback period (years)
Case 1	Manufacturing (metal)	Purchase of individual air cleaning and supply systems, in collaboration with workers	Improved productivity due to enhanced protection and ergonomics of new personal protective equipment (PPE)	1.00
Case 2	Manufacturing (bakery)	Implementation of equipment to reduce concentration of flour particles in the air	Elimination of baker's asthma cases	3.40
Case 3	Waste management	Training and improved PPE to reduce slip and trip accidents	Reduction in accidents (20 %)	1.30
Case 4	Construction (floor coverings)	Training in correct lifting, exercises (taught by a gymnast), lifting equipment, reminders about safe lifting, incentives (from health insurance)	Reduction in back pain and sick leave due to back pain.	2.16
Case 5	Manufacturing (bakery)	Training and issuing of instructions	Reduction in delivery accidents (67 %)	<1.00
Case 6	Construction (houses)	Individual visits from a physiotherapist, a rest break tool, training (in empowerment)	Reduction in musculoskeletal disorders and related absenteeism	<1.00
Case 7	Construction (window panes)	Renting equipment for handling window panes during deliveries (charged to customers)	Elimination of absenteeism due to occupational accidents and ill health, improved productivity.	2.62
Case 8	Construction (agriculture)	Implementation of equipment to reduce physical strain in load handling	Reduction of related incidents, improvement in quality of work	<1.00
Case 9	Agriculture (cucumbers)	Implementation of equipment to reduce physical strain in load handling	Improvement in job tenure, improvement in productivity	>4.00

Case number	Sector	Short description of the intervention	Results	Payback period (years)
Case 10	Agriculture/construction	Implementation of equipment to reduce accident risks and physical strain	Reduction in accident risks and physical strain, improvement in productivity	>4.00
Case 11	Construction	Automatisation through provision of equipment	Reduction in accident risks and physical strain, improvement in productivity	3.20
Case 12	Manufacturing (food)	Use of lifting equipment and a film-stretching machine in the packaging sector.	Reduction in back pain, improvement in productivity and reliability.	2.00
Case 13	Construction (pipes, houses)	Use of a material lift, continuous training, OSH awareness raising initiatives.	Productivity raised by up to 30 %, improvement in quality of work and working conditions (noise, dust), reduction in sick leave	1.31

Some of the most important questions identified and discussed in this study were:

Are investments in OSH interventions driven by financial factors within SMEs? Economic implications are expected to affect OSH interventions like any other type of investment. However, the extent to which this factor defines whether or not the intervention will be undertaken is not clear, as enterprises mainly refer to commitment to OSH as the dominant factor.

How should an OSH intervention be economically evaluated? Proper measurement is a critical factor for the economic assessment of an OSH intervention, as many factors are difficult to measure. Looking at the business case for an intervention is proposed here as a sound approach.

When should such an evaluation be performed? Any intervention needs to be assessed *ex ante*; however, an *ex post* assessment as a follow-up is useful to take into account any unforeseen factors. A five-year period of examination was used, although many OSH effects (especially those related to health) may take many years to show.

Does prevention pay? Leaving aside some oversimplified statements by non-experts, investment in OSH is not always financially beneficial. Like any other type of investment, it might be economically profitable or not, depending on some key factors, as well as on how the financial effects of the intervention are measured.

When is an OSH intervention profitable? The key factors identified in the literature are existing OSH practice, type of intervention (for example, organisational, technical), kind of OSH factor targeted (for example musculoskeletal disorders, accidents, skin disorders), size of investment (capital employed) and method of measurement and assessment.

Some key factors identified for the accurate evaluation of the economic impact of an OSH intervention are:

- Benefits and costs related to OSH must be identified, attributed and quantified properly.
- Inflation and reference period must be taken into account.
- Outcomes may occur over a long period after the intervention, which makes the length of the examination period very important.
- Mistaken assumptions can have a serious impact on the evaluation.

These serious difficulties underline the need for a common cost model to obtain comparable and essentially reliable evaluations. Therefore, a common cost model (with common assumptions and accounting principles) was used in analysing the new case studies carried out for this report. As well as improving the comparability of results, this was helpful for enterprises, which had remarkable success in identifying and estimating economic costs and benefits related either to absenteeism or to improved productivity, which were the two main cost categories (although they did not manage to quantify all the relevant costs and benefits).

Some qualitative results from the present study (the new case studies) indicate that:

- Wide-ranging interventions appear to be more profitable than interventions targeting a particular issue related to the sector of the enterprise.
- Interventions that mainly concern training and organisational change appear to be more profitable than interventions based on technical changes (such as introducing new equipment).
- Interventions that include direct worker (participatory) involvement appear to be more profitable, regardless of whether or not increased productivity benefits are taken into account in the economic evaluation.
- In most cases, the enterprises managed to estimate benefits related to increased productivity. It should be emphasised that increased productivity does not always come as a result of improved safety and health, but it is taken into account in the context of a business case.

An obvious conclusion of this report is that further research is required on the business case for OSH in SMEs. With respect to a qualitative finding of this research (that general-scope interventions suitable for many types of enterprises appear to be more profitable), properly designed research into widely applicable OSH interventions (for example automatic palletising and use of common load-handling equipment) that will allow generalised conclusions is proposed to examine and present certain beneficial interventions that are widely applicable.

1 Introduction

The economic aspect is important in research and policy for occupational safety and health (OSH). Since work is an economic activity, issues related to OSH cannot be efficiently dealt with unless their economic dimensions are systematically examined (ROWER (Repository of Occupational Well-being Economics Research), 2010).

In the literature, OSH economics are split into two main branches:

- The macro level, including policies, legislation, social security and centrally planned incentives.
- The micro level, which focuses on individual enterprises. The latter has gained more attention in recent literature.

Accordingly, there are different perspectives depending on the party (society, enterprise, the worker) that bears the costs. These costs can be shifted from one party to another (externalisation) regardless of which party enjoys the benefits of safety and health at work.

There is consensus in the literature that market mechanisms do not suffice to ensure optimal OSH for workers and thus a central policy for improvement of OSH is necessary to provide motives for investment in it (OECD (Organisation for Economic Co-operation and Development), 1989). However, this also has disadvantages, such as high administrative costs (Bailey et al.), 1995), a negative impact on competitiveness (Dorman, 2000) and requiring commitment of available resources.

External economic incentives for enterprises to improve OSH can help to achieve a better use of society resources by allowing them to be focused mostly on those aspects of OSH where prevention is not economically beneficial at enterprise level alone. A beneficial investment is one whose returns exceed the secure returns (such as bank interest) that the sum of its costs would produce. Therefore, proper assessment of an investment requires full knowledge of all costs and benefits (a business case). Some costs and benefits (for example fines, compensations, insurance premiums) are externally imposed to create economic incentives, whereas others (such as productivity, improved public image, decreased absenteeism) are a direct (internal) result for enterprises. Any deficit in knowledge of the costs and benefits can can distort the assessment of the investment.

The aim of this report is to support small and medium-sized enterprises (SMEs) in setting up OSH interventions based on a strong business case. A business case takes into account all aspects of the enterprise that are affected by the intervention (whether translated into monetary values or not) to provide support for an investment decision. It requires an appraisal of the proposed intervention based on, among other things, a sound economic evaluation (see Appendix IV) and taking into account the characteristics and the perspective of the company. SMEs have specific characteristics (see section 1.2) that make it difficult for them to develop and set up tailor-made business cases. The cases that are developed and/or presented in this report can serve as good practices and be taken up by SMEs and adapted to their needs.

This report presents existing case studies from the literature along with some new case studies that were developed in the context of this study. This presentation aims to offer these cases as ad hoc examples that can be replicated by an enterprise (in the same form or properly adapted).

After this introduction the recent research on the business case of OSH will be discussed. The next chapter describes the methodology followed in the two aspects of the research carried out for this study: (a) research into literature on (reviews of) case studies of OSH-related interventions in SMEs and (b) an in-depth analysis of 13 case studies that had not yet been published in the scientific literature in this form.

1.1 Small and medium-sized enterprises in the European economy

According to the new European Union definition of SMEs, enterprises with no more than 25 % of their capital or voting rights held by other (large) enterprises are categorised as medium-sized, small and micro in accordance with the criteria shown in Table 5.

Table 5: New definition of SMEs

Category	Personnel	Sales (€)	Assets (€)
Medium-sized	51–250	≤50,000,000	≤43,000,000
Small	11–50	≤10,000,000	≤10,000,000
Micro	1–10	≤2,000,000	≤2,000,000

An enterprise that exceeds the limits of a category in any one criterion is ranked in the next category.

SMEs are of special interest in the European economy. According to the European Commission's annual report on SMEs (Ecorys, 2012), they have retained their position as the backbone of the European economy, accounting for more than 99.8 % of all enterprises (micro enterprises are 92.2 % of all enterprises). The report estimated that SMEs accounted for 67 % of total employment and 58 % of gross value added (GVA) (see Table 6).

Table 6: Proportion of total enterprises and employees by size of workplace in the EU in 2012

Proportion	Micro	Small	Medium	Large
Proportion of enterprises	92.2 %	6.5 %	1.1 %	0.2 %
Proportion of employment	29.6 %	20.6 %	17.2 %	32.6 %

Source: Ecorys, 2012

On average, SMEs across the EU employed 4.22 people in 2012, down slightly from 4.23 in 2011 and continuing a steady decline from 4.34 in 2005. This small decrease reflects the fact that the average growth of SMEs was lower than the average growth in SME employment (Ecorys, 2012).

Although SMEs are usually mentioned together, there is are important differences (between micro, small and medium enterprises, between different sectors, between 'start-ups' and traditional family businesses, and so on), and this diversity means that more sophisticated study and conclusions are required (Griffin, Hall and Watson, 2004).

1.2 Small and medium-sized enterprises and occupational safety and health

OSH in SMEs involves a number of particular challenges.

SMEs are subject to greater risks

A number of papers (see Sorensen, Hasle and Bach, 2007) have identified increased risks at work for SMEs, either in terms of accident risks or incidence rates (EU-OSHA (the European Agency for Safety and Health at Work), 2001; Clifton, 2005), especially when it comes to serious injuries, although accident underreporting is higher in SMEs. The European Commission (2004) estimated that 82 % of occupational injuries and 90 % of fatal accidents happen in SMEs although less than 70 % of the workforce is employed in them.

SMEs are more vulnerable than large business to the consequences of poor OSH management. For example, small enterprises are more exposed to lost revenues, as fewer employees are there to take up the slack when an employee is absent because of sickness or injury (Rikhardsson and Impgaard,

2004). Moreover, research (Health and Safety Executive, 2005) has shown that 60 % of SMEs with a disruption of business of more than 9 days go out of business.

SMEs have problems financing an OSH policy

SMEs face particular difficulties in accessing financing (Dorman, 2000). This limited access to capital inevitably restricts SMEs' investments to only those essential for survival, meaning that long-term investments are a low priority, even if profitable.

The effects of economies of scale on SMEs are also important in relation to OSH interventions. Fixed prevention costs are much less affordable for SMEs (Giuffrida, Fiunes and Savedoff, 2002). Walters (1996) argues that prevention services are more likely to be cost-effective in large enterprises than in small enterprises.

SMEs have problems implementing an OSH policy

A number of characteristics of SMEs have been identified in the literature as constraints on the implementation of a comprehensive OSH policy.

SMEs tend to have a lean and flexible (sometimes informal) management structure that places less emphasis on OSH (Bailey et al., 1995; Biggins, 1996; Clifton, 2005) but helps the business to be more competitive and keep administrative costs for OSH low (Rikhardsson and Impgaard, 2004). Such enterprises are also more dependent on precarious labour (Larsson and Betts, 1996).

SMEs usually have a largely reactive approach to OSH, carrying out less formal safety and health training (Biggins, 1996; Clifton, 2005); there tends also to be more suspicion or hostility towards enforcing authorities ((Gallina, 2009)).

Their small size of their businesses can make entrepreneurs believe that their risks are also small (Biggins, 1996), mainly because they have less direct experience of accidents and work-related ill health (although incident rates for SMEs in general are higher). Furthermore, the potential costs of accidents and diseases are usually poorly appreciated because of a lack of experience.

SMEs can suffer from a lack of knowledge about OSH, especially when it comes to legislation, which can be complex and obscure to some employers (Biggins, 1996; Clifton, 2005), combined with a lack of easy access to appropriate safety and health services and advice. A low degree of participation in employer/industry unions and a low level of trade unionism (Costa, 1996; Antonsson, Birgersdotter and Bornberger-Dankvardt, 2002) is also a problem.

Governments face difficulties in implementing an OSH policy for SMEs

Because of their size, SMEs also have difficulties with experience-rated occupational risk insurance systems, where insurance premiums change depending on the number of accidents the enterprise has experienced. SMEs are rarely reclassified because of the low occurrence of accidents (as a result of the low number of workers and in spite of the fact that their incidence rates are higher). However, when an accident does occur, it causes a reclassification resulting in a steep rise in premiums. Thus, some authors argue, SMEs are more likely to attempt to underreport accidents (Schneider, 2008) and externalise (that is shift to society or the victim) their accident costs (Andreoni, 1986).

Legislation and enforcement is not as effective as for large enterprises. SMEs (because of their size and number) are less frequently inspected (Biggins, 1996; Fenn and Ashby, 2004), whereas even the impact of an inspection may not the same effective as in large businesses (Dorman, 2000).

Of course such phenomena may vary between countries with different insurance systems. As Walters (1996) argues, harmonisation of OSH legislation does not mean that all workers in Europe are currently experiencing the same standards of OSH.

2 Business case

2.1 Costs and benefits of OSH investments

Like all investments, OSH interventions include intervention costs (expenditure required to implement the intervention) and costs or benefits related to the outcome of the intervention (including improved health).

Intervention costs can be divided into initial investments and recurring costs.

- Initial investments include purchasing (as a one-off) new equipment and materials directly related to the intervention. This also includes planning, preparation and installation. In addition, the organisation has to adapt to the intervention. The (one-off) costs for training, implementation and adaptation are also included in the initial investment. This includes external trainer or consultant fees and working time spent by employees on training. Subsidies are subtracted, the cost of time spent on gaining subsidies is added.
- Recurring costs include maintenance and energy costs and yearly equipment, material and training costs. Depreciation and interest expenses related to the investment should also be included.

Benefits can be divided into three groups: two types of monetary benefits and other benefits.

- Productivity gains are benefits related to a more efficient working process, resulting in extra production, lower costs or less time spent by employees on a particular task. The idea is that an OSH intervention can result in greater productivity or efficiency. However, it is not unusual for OSH interventions to decrease productivity; for example, the use of aids to prevent back pain can lower productivity.
- Avoided costs are related to adverse events that are prevented by OSH interventions. In this case, the costs do not occur and can thus be considered benefits. There are three main categories of avoided costs that are related to safety and health outcomes (De Greef et al., 2011).
    - Human: costs of reduced productivity, absence, replacement or overtime, and medical and rehabilitation costs.
    - Organisations: time spent to investigate and discuss the adverse event (both in team, by management and by external organisations), work reorganisation and follow-up costs of administration and replacement.
    - Potential side effects in certain types of enterprises or of certain safety outcomes, often involving equipment, the working environment or products: repair, replacement and depreciation of equipment, products and the environment (buildings, surroundings), and both external services and internal time used to deal with such issues.
- Other benefits can be important to consider in decision-making on OSH interventions but are often difficult to express in monetary units, such as job satisfaction, corporate image and staff turnover. (These benefits will not therefore be included in the return on investment (ROI).) However, decision-makers can still decide what they are willing to pay to accomplish these benefits. Even if their economic dimension cannot be easily estimated by an enterprise (especially an SME), it can be intuitively assessed. Nevertheless, such benefits will not necessarily define the final decision, as other costs and benefits described in this section may dominate the decision-making process.

Common cost and benefit categories for business cases for OSH interventions are explained below. It is important to note that the use of the word ‘costs’ may be confusing in some cases, as it may refer both to the costs of the intervention and to costs that can be prevented by the investment (for example costs incurred as a result of sick leave), that is benefits.

The investment costs and benefits involved in an OSH intervention are listed by EU-OSHA (see Tables 7 and 8).

Table 7: Overview of costs of preventive activities at company level

Variable	Description	How to obtain money value
Investments	Costs of specific OSH equipment or additional costs of other investments related to OSH	Market prices, quotations, invoices
Additional investments	Changes in non-OSH-related capital goods to facilitate functioning of OSH equipment (for example reconstruction of buildings)	Market prices, quotations, invoices
Engineering, consultancy and planning costs related to investments	Expenditures on internal and external activities for design and implementation of new equipment or working procedures	Market prices, quotations, invoices, total wages for time spent
Additional costs of substitution products (recurring costs)	Price difference (for example for non-toxic chemicals, lighter products)	Market prices, quotations, invoices
Purchase of personal protective equipment (recurring costs)	Costs of protective equipment	Market prices, quotations, invoices
Additional costs for changed working procedures and maintenance (recurring costs)	Price difference between old ways of working and new, directly related to the preventive action; note that new ways may also result in cost savings	Market prices, quotations, invoices
Extra work time of employees (recurring costs)	Time spent on meetings, training, safety inspections, participatory developments	Total wages for time spent
Costs of internal or external OSH services, other preventive services (recurring costs)	Also includes occupational health services	Market prices, quotations, invoices
In-company activities	Human resource management, health promotion, OSH policy and management	Total wages for time spent
Other workplace costs	Anything not covered under the previous headings	Market prices, quotations, invoices, total wages for time spent

Source: EU-OSHA, 2002a

Table 8: List of potential additional benefits from preventive activities at company level

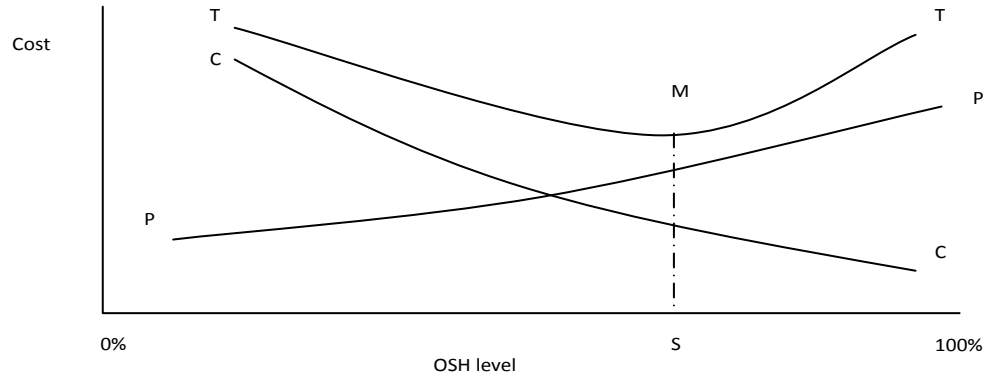
Variable	Description	How to obtain money value
Increased productivity and other operational effects	Reduced costs for facilities, energy, materials; increased productivity; reduced personnel costs	Total of cost reduction directly related to intervention to be estimated from effects on the company's operation
Improved quality of products and services	Changes in product or service quality; greater reliability of deliveries	Value depends on company strategy. Reduction in repair costs and warranties

Variable	Description	How to obtain money value
Improved well-being, job satisfaction and working climate		Only indirect effects, for example on productivity, quality or flexibility. Increased capability to deal with unexpected situations
Compensations and subsidies from insurance companies or authorities	Support for prevention only; compensation received for sick leave or disability are to be excluded	Compensation and subsidies received
Company image effects	Increased attractiveness to customers, and to contractors, improved ability to recruit personnel	Indirect effects
Impact on non-economic company values	To be derived from mission statements and the like, typically strategic considerations	Indirect, long-term effects
Innovative capacity of the firm	Ability to innovate in products and production process	Indirect, long-term effects. No operational benefits

Source: EU-OSHA, 2002a

These costs and benefits can be aggregated to a total OSH cost with or without the investment. This allows for the evaluation and comparison of alternative interventions. In this respect, Andreoni (1986) proposed a theoretical set of curves for total OSH costs (see Figure 1).

Figure 1: Preventive cost, subsequent cost, total cost



P = costs of preventive activities
C = costs of accidents and diseases
T = total costs
M = minimum cost

Source: Andreoni, 1986

According to this diagram, the total cost of OSH consists of costs of preventive activities (interventions) and costs of consequences of accidents and diseases. To improve the level of OSH in the workplace, expenditure (investment) is required. The cost of prevention (curve P) increases with the OSH level. On the other hand, the cost of poor OSH (C curve) decreases as the OSH level improves. The aggregation of these cost categories defines a total cost: an intervention is worth undertaking when it leads to a lower total cost (curve T). The economically optimal level of OSH (S) is that where the aggregate total cost is minimum (M).

However, calculations of this kind rely on oversimplified assumptions (ROWER, 2010). Risks involve too much variability and complexity to allow enterprises to be ranged on a one-dimensional safety scale. Moreover, even if a safety level can be defined, it cannot be seen as a function of preventive expenditure alone. Moreover, different OSH measures have different degrees of efficiency, which does not allow for a univocal relationship between a (hypothetical) 'level of prevention' and expenditure on prevention; the correspondence of an OSH level (S) to every level of OSH expenditure is simply impossible.

In general, it has been widely discussed (Owen, 1996; Miller, Whynes and Reid 2000; Miller, Rossiter and Nuttall, 2002; Mossink and Nelson 2002) that it is not easy to show a causal and quantifiable relationship between interventions and actual improvement in OSH, and in fact this might not even be necessary for an SME.

2.2 Decision-making for OSH investments

Most decisions about investments in healthier and safer workplaces are taken at company level. Therefore, the main question is how decision-makers in companies can be provided with the best information on the cost-effectiveness of OSH interventions (Verbeek, 2009). When presenting convincing arguments for investments in OSH in a business case, there is a need to make the link between OSH and the company's business strategy and bottom line. This link with the business's core activities is essential to obtain commitment and to integrate OSH into business processes.

The decision-making process for OSH investments generally consists of three stages. In the initial stage, the need for the intervention is established by employees responsible for OSH in their company and may be triggered by, for instance, high costs resulting from sick leave, injuries or fall incidents, or by legislation or funding opportunities (Tompa, Culyer and Dolinschi 2008). The second stage is the planning of the intervention and the preparation of a business case for management approval. The last stage is the implementation and evaluation process (Dongen et al., 2013). Especially in the decision-making stage, information on the financial implications was found to be of great importance (Dongen et al., 2013). In particular, the costs and benefits to the employer are important in the decision about whether the intervention is worthwhile or not, although in small businesses such decisions can also be affected by the factors described in section 1.2.

As widely mentioned in the literature (Deacon, 1998; Smallman and John, 2001; EU-OSHA, 2009; Miller and Haslam, 2009) and also observed in this research, enterprises do not usually initiate OSH interventions purely for economic reasons and therefore rarely evaluate them in economic terms. Schneider (2008) quotes a typical statement by a CEO:

'If any of you ever calculate how much money we save as a consequence of being excellent in safety and health, you're fired. And the reason you're fired is because we're not going to be able to accomplish the zero that I intend for us to accomplish if the people think this is another management scheme to make money or save money. This needs to be about human value.'

In their survey of British companies, Smallman and John (2001) found no companies that calculated ROI for OSH spending, as spending for OSH was not assessed in monetary terms, at least not in board-level reports or thinking.

It is possible that some enterprises do in fact take into account the economic dimension of their OSH interventions but do not wish to declare it.

The impact of economic evaluations on decision-making (which is one of the principle reasons for the importance of a business case in getting an OSH intervention implemented) is discussed in the

literature. Taimela (2009) identifies inconsistencies in the communication of OSH-related information to top management (true decision-makers) as an important weakness in relation to the impact of economic evaluations of OSH interventions. The information required by top management is presented as 'benefit-to-cost' (ROI) data, with analyses on the uncertainty of the estimates from the company's perspective in an understandable format, in order to enable management to decide what policies to choose to keep their employees productive at work. This is barely covered by the research and practice in evaluation of OSH interventions so far.

In the same vein, the motive provided by economic profitability is also criticised in the relevant literature. Smallman and John (2001) found no substantive literature that directly linked excellence in safety and health with competitive advantage. Unless OSH performance forms a major part of a company's corporate objectives, and an input into managerial performance appraisal, it is bound to take a back seat to more 'commercial' matters. In general, OSH is rarely seen as a core business function but rather as a burden on operating costs (Deacon, 1998).

These conclusions are also supported by a similar study (Miller and Haslam, 2009). Cost is rarely the motive for OSH intervention; reputation and compliance with the law appear to be more influential. The European Survey of Enterprises on New and Emerging Risks (ESENER, EU-OSHA 2010) also supports the view that legal requiements and demands from employess and clients are the major drivers for addressing OSH in companies. The topic of OSH is established at board level as important and potentially dangerous to reputation and profits. OSH performance does affect corporate reputation asymmetrically (Deacon, 1998): if poor, it will have a negative impact on the enterprise's reputation; if good, there will be no proportionate improvement in reputation. Accordingly, it has been argued in an EU report (EU-OSHA, 2009) that OSH is not viewed as a contributory factor for the economic viability of an organisation; OSH policies mainly aim for compliance.

Culyer and Sculpher (2008) summarise three ends of returns in OSH investment: improved health, the inherent value of greater security (per se) and improved productivity. The authors also discuss the philosophical aspect of OSH investment evaluation on the basis of consequentialism. This is especially important if non-linearities such as the value of reliability are taken into account. For example, a 'healthy' enterprise is in a better situation to take advantage of market opportunities that appear, whereas an enterprise of uncertain reliability may suffer disproportionate losses (for example if it fails to make an urgent delivery).

Although there is no scientific evidence to prove the profitability of such effects, these views find support in enterprises, as shown in section 1.2. As Köper (2009) argues, 'these studies … cannot answer the question of whether an enterprise is financially more successful because of its orientation toward the employees or whether this enterprise has a strong human capital orientation because it can afford it'.

After profitability, investment risk is generally the second variable considered when making a decision on an investment. These two variables are usually inversely proportional, as usually risk increases with ROI; in general, between two investments of equal profitability, the more attractive investment is the one with the lower risk.

Two types of risk (in economic terms) have been identified for OSH investments (EU-OSHA, 2002b):

Risk resulting from the nature of the investment: investment in preventing occupational accidents and diseases involves great uncertainty, as there are certain limitations (see section 2.2) on the evaluation of the efficiency and efficacy of such interventions, despite important existing research.

Risk resulting from a long time horizon: the benefits of an investment in OSH (especially those related to health improvement) have a much longer time horizon (decades) than the duration of the intervention. In economics, long periods have an inherent uncertainty because of fluctuation of the economic environment (the economic cycle, political events and so on). In industry, a payback period of two or three years is usually acceptable with practical discount rates of 10 to 15 % (Dorman, 2000).

Finally, two further conclusions can be drawn from the literature: first, that the effectiveness of OSH interventions (in terms of improvement in OSH) cannot be taken for granted (Owen, 1996; Miller, Whynes and Reid, 2000; Miller, Rossiter and Nuttall, 2002; Mossink and Nelson, 2002); and, second, that SMEs do not hope to influence the size of their premiums by improving their safety performance over a period of years (Leopold and Leonard, 1987). It has even been proposed (Ministry of Social

Affairs and Health, 1999) that the economic profitability of workplace intervention should not be used as an argument for SMEs and that the benefits of undisrupted production and ethical arguments should be emphasised instead, although recent research (Dongen *et al*., 2013) indicates that economic assessments have had an increasing impact on decision-making about OSH interventions as related factors (such as productivity) have started to gain more attention.

According to Antonelli *et al*. (2006), the most important reasons why SMEs invest in OSH are:

- understanding that health and safety is an integral part of being a 'good business';
- maintaining their reputation;
- achieving higher productivity — especially by reducing absence;
- keeping within the law, hence avoiding punitive action from government bodies;
- avoiding the expense of accidents;
- containing insurance costs;
- meeting client demands; and
- being a 'good' employer.

Some qualitative findings of the new case studies developed in this research show that although enterprises generally reported that interventions took place for the improvement of OSH per se, leaving economic considerations aside, most of them could and did estimate the economic costs and benefits of the interventions, at least ex post.

2.3 The business case

Reliable information on the financial implications of OSH interventions is usually available only through scientific research. However, scientific economic evaluations (see Appendix IV) do not always fit the needs of decision-makers within companies, either for reasons described in section 1.2 or because economic evaluations are often performed from a societal perspective and therefore lack insight into the (decision-supporting) financial consequences at organisational level. An economic evaluation performed from the employer's perspective can provide this type of information (De Greef and Van den Broek, 2004; Oxenburgh and Marlow, 2005), although cost externalities can still misrepresent the situation.

In some cases, the costs associated with an OSH intervention may reside primarily with the company, though the benefits for the workers and their families may be substantial and their costs small. For example, in some occupational diseases the burden for the worker is much higher than that borne by the company. If the corporate perspective is the only one taken into account in an evaluation, the intervention might not appear worthwhile, yet from a broader perspective it may indeed be worth undertaking. In such cases, sector support incentives, through subsidies or legislation, may be considered (Tompa et al., 2010).

In other words, decisions are usually taken at the company level, where some health-related costs or benefits (those borne or accrued by society or the worker) are irrelevant (external), whereas some non-health-related benefits (for example those related to increased productivity) may become relevant. An intervention with positive OSH effects will be profitable (and attractive to decision-makers in the company) if the overall related benefits exceed the overall relevant costs. This trade-off at enterprise level (where non-economic or non-economically quantifiable parameters should also be taken into account) comprises the business case.

A business case could be an alternative, additional instrument in the context of a mixture of tools (such as central incentives, law enforcement and so on) for dealing with OSH in SMEs, since no instrument alone can tackle all these challenges. The scope and application must be adapted to the particular requirements of SMEs.

SMEs cannot be expected to analyse and transfer the whole concept of the business case for good OSH management in general to their particular context, as they lack the knowledge and resources that would be required. A feasible alternative for policy-makers is to prioritise, standardise and present common interventions that are relevant to a large number of enterprises (for example interventions

relating to ergonomics, conditions in microclimates and so on) and to provide all necessary information. The present study has attempted to follow this approach.

The difficulty in assessing ROI in OSH lies rather on the side of benefits than on the side of costs, which can be more easily identified through market research and process analysis. Therefore, emphasis should be placed on the side of benefits. Presenting the economic benefits of an investment (which are usually more difficult for an SME to estimate) allows an SME to compare them with the costs in its particular context.

Communication of these case studies is another important issue, as entrepreneurs need to be supported to receive necessary OSH information. The role of intermediaries (such as social partners and trade unions) is important in establishing the 'unofficial global standards' for certain work practices that are acceptable among SMEs in a sector (Antonsson, Birgersdotter and Bornberger-Dankvardt 2002; Hasle and Limborg, 2006; EU-OSHA, 2009).

Research on the economics of OSH interventions generally examines whether improved OSH alone is enough to make an intervention profitable. However, if economic benefits of the intervention that are not related to improved health (for example productivity related to greater efficiency) are left out of calculations, many interventions having a positive effect on OSH will be erroneously seen as unprofitable.

As the aim of this study is to present economically evaluated OSH-related interventions (rather than proving the economic profitability of improved health per se), all aspects were taken into account in the context of the business cases.

These remarks imply that the slogan 'Prevention is profitable' oversimplifies matters. The myth that an enduring knowledge gap prevents enterprises from taking prevention measures (any prevention measures) that are always profitable contradicts fundamental economic principles (Tompa, Dolinschi and Laing, 2009). Some interventions are profitable from the company perspective, and their profitability should be emphasised; for the rest, other incentives should be put in place.

The issue of externalisation was not evident in the new case studies examined in this report. The enterprises did not encounter difficulties in identifying costs and benefits, in addition to recognising the costs that would directly affect them. It was apparent, however, that there might be a different allocation of costs in different countries in relation to absenteeism. Many cases were profitable mainly because of their non-health-related benefits.

3 Methodology

The aim of this report is to present an overview of case studies of OSH-related interventions in SMEs.

This chapter describes the methodology followed in the two aspects of the research carried out for this study: (a) research into literature on (reviews of) case studies of OSH-related interventions in SMEs and (b) an in-depth analysis of 13 case studies that had not yet been published in the scientific literature in this form.

3.1 Research on existing case studies

3.1.1 Aims

The aim of this part of the research was to present the existing research on the topic, and to describe the issues and conclusions arising from the research. The existing literature was reviewed with the aim of identifying and listing existing case study research (particularly on EU cases), regardless of differences in research context.

3.1.2 Search strategy

A search was conducted to identify reviews and studies evaluating the cost-effectiveness/cost–benefit ratio of interventions aimed at improving the health or safety of workers. Scientific databases (PubMed, EMBASE) were searched for studies published up to 20 November 2013, using the following groups of keywords: participant/setting type (for example 'workplace', 'employee', 'workforce'), intervention type (for example 'health' and 'safety') and study design (for example 'business case', 'cost-benefit analysis', 'cost-effectiveness analysis' and 'economic evaluation').

Most of these case studies were found to have been included in recent reviews (all the case studies meeting the criteria set in this research had been included in a review, many of them in more than one). Therefore, the existing literature was examined mainly through its presentation in existing reviews, as:

- They concentrate and present concisely an extensive literature.
- They allow for some comparisons, at least in terms of demographics and methodology.

3.2 Research on new case studies

As the scientific literature on business case studies for OSH interventions in SMEs is limited, EU-OSHA used its Topic Centre (TC-OSH) and network of national focal points to collect unpublished case study information. The aim was to identify, analyse and present new business cases for OSH interventions in SMEs in the European Union. A number of institutions from various EU countries were involved in the identification of case studies throughout EU: (in alphabetical order) ELINYAE (Greece), EUROGIP (France), INAIL (Italy), IGA-DGUV (Germany), KOOP (Germany) and TNO (the Netherlands).

3.2.1 Aims

A search for and an in-depth analysis of case studies and a clear report with reliable conclusions is necessary to help managers and representatives within SMEs to realise the benefits of the interventions and to replicate them, after adjusting them to their own requirements. The scope of the case studies in the current report may be diverse, but there are similarities between these various OSH interventions, especially with regard to the benefits for the employer.

The approach chosen in this study was to find typical standalone interventions, applicable to many kinds of SMEs (in terms of sector, size and so on), that had been economically evaluated, aiming to encourage SMEs by demonstrating that such interventions also have an economic benefit, or at least will not add significant costs, even if the motive is not a return on investment. In other words, the aim of this study was to present successful cases of interventions, rather than to prove that OSH interventions are generally beneficial in economic terms.

3.2.2 Search strategy

Case studies were identified from four main sources: through the focal points, grey literature, contacts of the project partners in several sectors and research projects of the partners (such as the benOSH project). The search covered all 27 EU countries. Keywords used for the literature search for case studies were related to study design (such as 'business case', 'cost benefit analysis', 'cost effectiveness analysis', 'impact assessment', 'return on investment'), setting (such as 'SME', 'small business', 'organisation', 'organisation perspective') and intervention (such as 'OSH', 'safety', 'working conditions', 'ergonomics', 'adverse events', 'risks', 'accidents'). Keywords were translated into different languages as much as possible.

3.2.3 Selection criteria

1. Case studies were included only if they met the following six criteria:
2. *Enterprise size:* the enterprise was an SME according to the terms of the European guidelines or an independent business unit of a larger enterprise that met these guidelines.
3. *Data collection:* all relevant costs and benefits had been identified and calculated and were available or could be obtained from the corresponding person within the company. As the research was on *ex post* case studies, only interventions already completed with a sufficient period for occurrence of benefits were accepted. Projection and extrapolation of benefits and costs were not accepted, except extrapolation from already realised benefits. Benefits and costs were taken into account only if they had occurred in the period since the implementation of the intervention (at least one year); these could be extrapolated for the following years (up to four).
4. *Evaluation of data:* data compatible with the cost model of the benOSH tool was available for processing, in other words costs were clearly presented and structured.
5. *Reliability of the case:* there was a corresponding person within the company with good knowledge and data (accounting) to support the case.
6. *Written consent:* the enterprise could provide written consent for publication of its case (without anonymisation).
7. *Publication:* only case studies that were not scientifically published before in this form, or were substantially changed since their previous publication (for example if the *ex post* implementation was different from the published *ex ante* plan), were taken into account.

All case studies on business cases for OSH interventions that met the six criteria described above were collected and sent to the task leader for this project. The final selection was made by the task leader in close collaboration with EU-OSHA. Based on the criteria, 13 cases studies were selected for further in-depth analysis (nine case studies were rejected).

3.2.4 In-depth analysis of 13 case studies

Four institutions were involved in the in-depth analysis of the case studies. A predefined template was used to obtain uniformity and comparability between the cases (Appendix I). This template included, among other things, a description of the intervention, the known costs and benefits, the time horizon, the implementation process, information on transferability and the company name and contact person. Comparability has been also enhanced when issues related to local regulations (for example fines, compensation, insurance premiums) other than those harmonised are adjusted or excluded.

Analyses of the case studies were conducted, in most cases, by tracking back the data provided by the company in a common framework (see Appendix II). Data already available was checked and filled in by the researchers. When data or information was incomplete, the corresponding person at the SME was contacted for supplementary data or information. These people were also given a chance to revise the completed template.

All the in-depth reports on the case studies were sent to the task leader, who checked the reliability of each case and comparability and uniformity between all cases.

The focus of the in-depth analysis was on the results of all the case studies by using the benOSH tool. The costs and benefits were determined for each case study, including initial investments, annual costs, productivity gains and additional avoided costs (benOSH, 2011). The ROI was also assessed.

The selection of a discount rate is inevitably an assumption in any study. In this study, the 4 % discount rate proposed as a 'default' rate in the European Commission's evaluation and impact assessment system was used (Renda et al., 2013). The selection of the time horizon for costs and benefits was also an important decision. Following the example of the benOSH project, a period of five years (the year of the intervention plus four years) was used for all cases (although the benefits of most of them have extended or will extend over a longer period).

The most important feature in the value of the results of this study is that they were all assessed using the same model (the benOSH model), the same assumptions (depreciation rate, tax rate and so on) and the same data collected.

4 Key factors

A business case examines an OSH intervention, considering all the aspects that would concern the enterprise in setting it up and including an analysis of the costs and benefits (although it is not simply a cost–benefit analysis (CBA), as non-monetised aspects may be included). Several issues have to be considered.

4.1 Identification of costs and benefits of OSH interventions

A business case compares two alternatives. Either the intervention is compared with no intervention (the 'do-nothing scenario') or the consequences of two alternative interventions are compared. The cost and benefit variables chosen to support decision-making, depend on the perspective taken. Particularly in an SME (compared with a non-private or non-profit, or large and unionised, enterprise), the perspective will usually be that of the employer (Tompa, Dolinschi and de Oliveira, 2006).

As discussed in section 2.2, both costs and benefits may be related either to OSH improvement or to other (non-OSH-related) improvement (such as in productivity or efficiency in the work process), as long as they are internal to the company and related to the intervention. A business case examines an individual intervention, rather than solely its health effects.

According to Koopmanschap (2009), it is difficult to put a monetary value on productivity-related benefits because of under-researched factors, such as general information (health, demography, income), profession, working situation, functional limitations, absence from work, compensation mechanisms (absence from work), productivity costs at work (efficiency loss) and productivity costs at the organisational level, such as administrative and management costs, hindrance at paid work — quality of life and hindrance at unpaid work — substitution.

Defining or measuring productivity (actual and self-reported productivity), taking quantity and quality of production together into account, the interplay of health, functional limitations, physical/psychological burden, production system on productivity costs and so on are issues that need to be further researched, before making any sound conclusions about costs and benefits of productivity.

Uegaki et al. (2007), trying to standardise the process of estimating productivity costs, identified presenteeism, short-term absenteeism and long-term absenteeism as the key determinants of lost productivity costs.

In the new case studies developed in the context of the present study, enterprises had remarkable success in identifying and estimating economic costs and benefits related either to absenteeism, or to improved productivity, which were the two main cost categories (although they did not manage to quantify all the relevant costs and benefits).

4.2 Attribution of costs and accounting issues

A business case requires information on the effects of the OSH intervention. In other words, to estimate the profitability of an intervention, costs and benefits arising from OSH improvement, as well as those related to the intervention but not to OSH improvement, need to be taken into account, as described in section 2.2.

Defining what is actually related to the intervention is also difficult for a number of reasons. Regardless of whether each cost or benefit derives from an OSH improvement, it needs to be directly attributable to the intervention: that is, it necessarily occurs if the intervention is performed but does not occur if the intervention is not undertaken. Although such attribution is also difficult for non-health-related outcomes (such as an improvement in productivity), the main difficulties come from difficulties in the attribution of health-related effects.

Translating the economic consequences of the results of an intervention into monetary values and processing them also involves a number of issues.

Not all costs and consequences can be easily valued

The accurate valuation (by arriving at monetary values to reflect the value of the resources used) of costs and consequences can be difficult, as benefits from primary prevention are often qualitative aspects requiring specific pricing techniques to put them into monetary values (Kohstall, 2008).

Inflation and time preference must be taken into account

Discounting is another issue widely discussed in the literature. Future costs should be adjusted both for inflation and time preference. However, this adjustment is not sufficient to prove that a proposed intervention is profitable. Taking scarce resources (capital) into account, an investment should be considered profitable when it yields a higher ROI than the alternative proposed interventions competing for the same capital. As Johns, Baltussen and Hutubessy (2003) argue, the economic definition of costs (also including opportunity costs) rather than the accounting definition of costs should be applied. Laporte, Dolinschi and Tompa (2008) argue that a common error in many studies is confusion over the costs of in-house operations (market price is not an adequate measure if no competitive market exists).

Mistakes in assumptions can be serious

Assumptions should be well reasoned and their justification should be transparent. Particular attention should be paid to fixed and variable costs, as well as to indirect costs, where the impact of assumptions is significant. Some common mistakes in assumptions include:

Extrapolations: repetition of costs and benefits in the future must not be taken for granted.

Double counting: some costs or benefits are sometimes double-counted (sometimes once as costs and once as benefits) if assumptions are not properly set.

Fixed and variable costs: taking some variable costs as fixed (or vice versa) on the basis of mistaken assumptions can lead to erroneous decisions.

Direct–indirect cost ratios: sometimes ratios of direct–indirect costs from the literature are used to estimate 'hidden' costs, which can sometimes lead to significant errors (as indirect costs are considered to be a multiple of direct costs).

A common cost model

Common tools of analysis (a common economic model) for all cases examined are therefore a prerequisite for reliable business case studies. Several cash-flow templates or lists of costs that can lead to such templates have been used in the literature to estimate ROI for OSH interventions.

However, in the course of this study, it was identified that 'soft' parameters (that do not always show in such strict cost categories) significantly affect the outcome of interventions, especially when this outcome falls into the category of increased productivity. This is usually the case for ergonomic interventions, which are the type of OSH interventions that appear most frequently in the literature.

On the other hand, many of the cost items required in a strict before–after list of costs, while difficult (and uncertain) to estimate, actually have a minor effect in the evaluation, as they do not change a great deal (at least not as a result of an OSH intervention). Therefore, such templates can be used as a basis for a business case, as long as enough flexibility is allowed for irrelevant cost data to be omitted and other data added, given that their effect will be documented, quantified and put into the same cash flow.

The results of a cost calculation make little sense if they cannot be interpreted and compared. Therefore, economic indicators should be used. Examples of such indicators are payback period (PP), net present value (NPV), internal rate of return (IRR), profitability index (PI) and benefit–cost ratio (BCR). The most commonly used are PP and BCR. The payback period is the amount of time before the initial investment is earned back and a PP of two to three years is usually considered acceptable for enterprises (Mossink, 2002). The benefit–cost ratio is the ratio of the benefits of an intervention to

its costs. Both benefits and costs are expressed in discounted present values. If the BCR is larger than 1, the intervention is profitable.

Moreover, OSH is usually not a core issue for enterprises, especially SMEs. Interventions related to OSH are usually on a small scale (at least compared with other interventions performed by the enterprise) and they are usually not the dominant influence on the parameters examined in an economic evaluation (productivity, slack and so on). Even in micro enterprises, where practically any intervention is likely to be on a comparatively small scale, OSH interventions are hardly likely to be the most significant ones in terms of size.

In the new case studies developed in this study, a common cost model (with common assumptions) was followed, based on an extensive list of cost elements used in the benOSH project. This approach was found very promising, as the results are comparable. If such a common model were applied on a greater scale, further generalisable conclusions could be extracted.

4.3 Generalisability: transferability of results

Apart from the issues presented in section 2.1, the small size of the enterprises (in terms of numbers of personnel employed) entails certain difficulties related to small samples. Since the numbers of employees are small, the numbers of accidents and diseases experienced are also small.

For example, if the probability of a certain accident is 10–4 (a usual order of magnitude for accident risk), which will be reduced by half after an intervention, then in an enterprise of 20,000 workers there will be two accidents annually to be reduced to one (expected values), resulting in a noticeable reduction in accident costs. However, in an SME employing 20 people the equivalent expected values would be 2 x 10–3 and 10–3 accidents per year; in other words, there would probably be no accidents for many years before or after the intervention, and therefore no noticeable reduction in costs.

Of course, the occurrence of a serious accident in such an enterprise would be catastrophic, but still difficult to be perceived in advance or to be observed in research, unless a very large sample of similar enterprises was surveyed for a long period of time (this would also add uncertainties relating to variations among sample enterprises and changes over a long observation period).

When it comes to occupational diseases, the situation is even more difficult because of the long latency period of most diseases (during which only non-acute symptoms are experienced), which can result in uncertainty about attributing the disease to the worker's occupation and means that an even longer surveying period is required than is needed in relation to accidents.

The issues already mentioned in the introduction (SMEs rarely have available management resources to provide accurate and homogeneous data and are more likely to be reluctant to be surveyed) make the application of the usual research protocols even more difficult. Taking into account also the difficulties of making a study of an individual SME relevant to other such businesses, because of the variety of scope, structure and size of SMEs, it is clear that a different and more focused approach is required to address the OSH policies of smaller businesses.

According to Koopmanschap (2009), sample size calculation is a matter that requires special attention in interventions. OSH involves addressing a variety of risks, each of which can be mitigated using a number of alternative interventions. Each particular type of intervention will have many different forms and different outputs depending on the characteristics of the SME where it is applied. Therefore, an infinite sample of enterprises would be required to systematically evaluate what are generally described as 'OSH interventions'.

Obviously, randomisation was not feasible in the SME OSH business case studies developed in this project. However, the aim was to present OSH interventions (rather than to prove certain relations), and this was achieved through the presentation of 13 replicable interventions.

4.4 Time-related factors

Time-related factors (the timeframe of the analysis, the time chosen to perform the evaluation and so on) are very important for the assessment of an intervention (De Greef and Van den Broek, 2004; Tompa et al., 2008).

Outcomes may occur over a long period after the intervention

Substantial costs and consequences may occur after the measurement period (for example in the case of occupational diseases with a long latency period); the projection of costs and consequences beyond the measurement period is difficult.

Ex ante or *ex post*

An important issue for the evaluation of an OSH intervention is whether data are estimated before the intervention (ex ante) or after the intervention (ex post). In general, costs measured ex post are considered more reliable, if measurement has taken place properly (although not all costs in ex post studies are measured; some are still estimates).

The research performed in this study (the new case studies) was determined from the beginning to be exclusively ex post; the cases selected all involved interventions that had already been implemented and evaluated.

The time horizon after the intervention was four years, which was not enough to earn back the investment costs in two cases. Although there were also interventions aiming to improve health (which usually requires a longer period of time to present results), the alleviation of direct (acute) symptoms, along with increased productivity, was enough to present economic benefits.

5 When an intervention is profitable

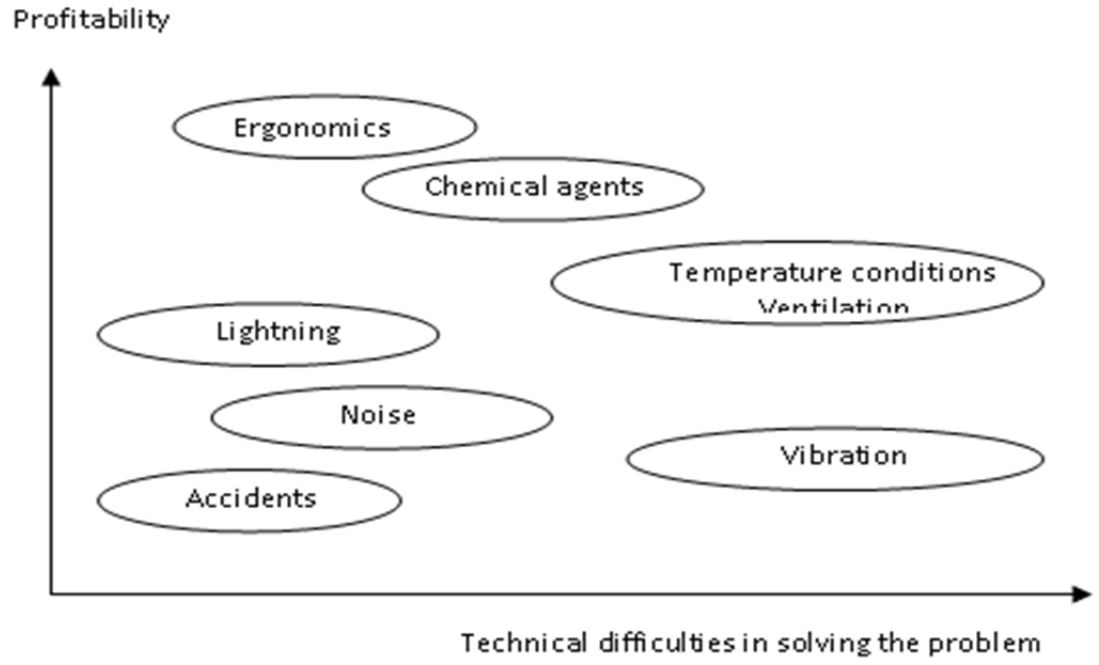
It would be an oversimplification to argue that safety and health investments are always profitable; this argument would be misleading and could, in the end, have the opposite effect from that intended. Not all investments in the working environment are financially profitable, and nor should they be (Eurofound, 1998; Bjurstrom, 1999; Tompa et al., 2010).

During the European Conference on the Costs and Benefits of Occupational Safety and Health in Hague (Eurofound, 1998), some key factors affecting returns on investment in OSH improvement were identified:

Existing OSH practice: it has been argued that the existing level of OSH (generally speaking) is a factor that affects returns. According to Eurofound (1998), an enterprise with very poor working conditions will be more likely to have a higher marginal return on its first OSH interventions than an enterprise that already has good working conditions that performs the same interventions, as the scope for improvement in the enterprise with the higher general level of OSH is more limited. However, the contrary has also been argued (Lees, 1996) in the sense that a good general level of OSH facilitates returns on future safety and health investments, as major improvements in OSH can be achieved at no additional cost (through synergies).

The type of OSH-related issue that the intervention aims to address: it seems that ergonomic interventions (which are also the economically evaluated interventions that appear most frequently in the literature (Tompa et al., 2007; Verbeek, Pulliainen, and Kankaanpää, 2009; Uegaki et al., 2010)) are the most profitable (as shown in Figure 2), regardless of whether this profitability results from health improvement or improved efficiency. Generally, ergonomics are a privileged category of OSH-related interventions in the relevant literature, in terms not only of frequency (as shown above) but also of profitability, as various studies (Oxenburgh, 1991; Schneider, 2008) indicate very short payback periods for ergonomic interventions (up to two years). This can be attributed to the generally low cost of ergonomics interventions (training, simple equipment, changes to work organisation and so on), the existence of ergonomic issues in all kinds of workplaces and the relevance of ergonomics to major causes of absenteeism or low productivity (such as musculoskeletal disorders).

Figure 2: The profitability of improvements in working conditions according to a Swedish study



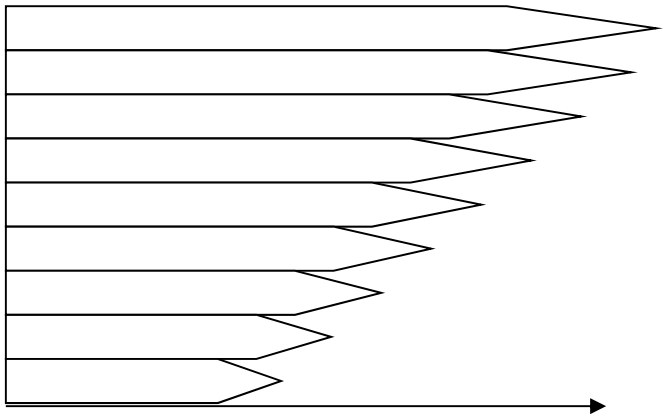
Source: Ministry of Social Affairs and Health, 1999

The amount of investment: the marginal returns on OSH investments (as for investments in all areas) is expected to reduce as the amount of investment rises. Very cheap investments in OSH often create large returns (however, it cannot be said that OSH investments in general result in large returns).

The factors taken into account when making CBA calculations: in general, costs tend to be more visible, whereas benefits tend to be underestimated.

The type of OSH intervention: especially when benefits are examined, technical interventions appear to have a lower ROI than management and participatory interventions, which usually improve productivity.

Figure 3: The impact of factors of the working environment on productivity



Source: Ministry of Social Affairs and Health, 1999

As shown in Figure 3, factors, such as participation, work content and so on, that are often involved in OSH interventions can significantly enhance productivity, which is the most important benefit for the employer (Lahiri, Gold and Levenstein 2005). According to Köper (2009), health-related interventions contribute significantly to performance aspects such as increased quality and productivity and decreased absenteeism, which may lead to cost reductions.

Based on these elements, profitable and unprofitable activities have been recorded in Table 9.

Table 9: Economic profitability in OSH interventions

What is more profitable?	What is less profitable?
Concentration on larger issues and important aspects from an operational viewpoint ▪ tidiness and order ▪ routes and passages ▪ production arrangements and material processes ▪ improvement of the flow of information ▪ improvement of the workplace atmosphere	Technical changes implemented in isolation from other operations ▪ safety of machinery ▪ chemical problems and dust ▪ noise abatement (afterwards)
Listening to the personnel and personnel participation	Orders from inspectors or company officials

What is more profitable?	What is less profitable?
Employees taking responsibility for their own health and safety	Statutory OSH organization and patronage
Analysis of problems and identification of the basic causes	Requiring technical solutions based on laws and standards
Ergonomics ▪ applying ergonomics to planning and purchases	Ergonomics ▪ correction of separate work stations without considering the work processes
Occupational health service ▪ -active occupational health care aimed at prevention and rehabilitation	Occupational health service ▪ occupational health care only meeting the minimum statutory requirements ▪ concentration on medical treatment

Source: Ministry of Social Affairs and Health Department for Occupational Safety and Health Finland 1999

Work-initiated wellness and healthy lifestyle programmes are also frequently reported in the literature (Ministry of Social Affairs and Health, 1999; EU-OSHA, 2002b; Nighswonger, 2002; Toran, 2003; Kreis and Bödeker, 2004; Van Dongen et al., 2011), especially owing to the link between the general well-being of workers and productivity. However, such interventions were outside the scope of this study.

Some qualitative results from the present study (the new case studies) indicate that:

- **General-scope interventions appear to be more profitable than interventions targeting a particular issue related to the sector of the enterprise.**
- **Interventions that mainly concern training and organisational change appear to be more profitable than interventions based on technical changes (involving new equipment, for example).**
- **Interventions that include direct worker (participatory) involvement appear to be more profitable, regardless of whether or not increased productivity benefits are taken into account in the economic evaluation.**

In most cases, the enterprises managed to estimate benefits related to increased productivity. It should be emphasised that increased productivity does not always come as a result of improved safety and health, but it is taken into account in the context of a business case.

6 Case study research on occupational safety and health interventions

6.1 Main issues in case study research on occupational safety and health interventions

Research in OSH economics involves two main branches: the macro level, including policies, legislation, social security and centrally planned incentives; and the micro level, which focuses on individual enterprises. The micro level has gained more attention lately, although it is considered a part of the OSH policy as a whole, rather than a standalone policy itself: 'Safety and health is a public good and desire, which cannot be obtained through normal market economy mechanisms' (Bailey et al., 1995).

Economic theory (in terms of the Von Neumann–Morgenstern utility theorem) suggests that individuals and organisations will aim to make rational decisions that maximise the utility (benefits) obtained from an optimal allocation of available resources. Non-optimal decisions (such as failing to undertake a beneficial investment) are attributed to an information deficit (a knowledge gap that distorts this motive–action relation); this conclusion has been largely supported for OSH investments at the enterprise level, especially for SMEs.

Therefore, better information could function as an 'eye-opener', revealing the economic benefits of improved OSH and thus encouraging SMEs to initiate interventions without the need for external motivation (for example in the form of state intervention). This process would allow for a better use of central resources (from government and the insurance sector) by enabling them to be focused only on those aspects of OSH, where prevention is not economically beneficial. A combination of existing motives (profitable OSH interventions) and central incentives could help to improve OSH without excessive requirements for further regulation and enforcement or central resources. Moreover, this combination would have a positive effect on issues related to unfair competition as a result of poor working conditions.

Although cases of economically beneficial OSH investments can be found in the literature, such a conclusion requires large generalisations that could never be supported in a scientific manner, regardless of any case study findings. This section outlines the theoretical background and case study research that can be found in the literature. The aim is to briefly present the current state of the art, rather than providing an exhaustive literature review, which would be overwhelming in scope.

The most important issues in case study research on the economic profitability of OSH investments are outlined in the following paragraphs.

Randomisation and control

Ideally, the health outcomes and economic consequences of an intervention should be measured in a randomised controlled trial (RCT), because this design best enables causal inferences. A problem is that several measures and programmes (not only OSH initiatives) are often initiated at the same time in a workplace. In fact, OSH investments are usually minor in scale compared with other interventions. This makes it difficult to link a specific outcome with a particular measure. When setting up the study design, special attention must be given to this issue by isolating the intervention and its outcomes and by considering only the outcomes that can be attributed to the OSH intervention. If in an economic modelling study assumptions are made about the health effects of an intervention, these should be based on sound systematic reviews of intervention studies.

The use of a control group to assess the effectiveness of the intervention is a widely used and accepted approach in intervention studies.

However, in this context the use of RCTs and of randomisation in general poses a number of problems (Tompa et al., 2007), especially when it comes to SMEs. Experimental or quasi-experimental study designs involving randomisation techniques and/or the use of control groups result in stronger evidence, but they are more difficult to put into practice, especially for SMEs.

Ex ante or ex post?

A business case can examine a proposed intervention (ex ante) or an intervention that has already been implemented (ex post). In ex post studies, costs are not hypothetical, which should make estimates of them more reliable (although the evaluation design and the quality of the study still remain important influences on the reliability of cost estimates). According to Niven (2002), savings cited in many OSH intervention studies are anticipated and not real. Ex post studies avoid this problem. However, difficulties in the identification and calculation of costs reduce the value of this advantage.

The main advantage of ex ante studies is greater availability (as the burden of an intervention does not need actually to be borne). It should be easier for researchers to find enterprises willing to provide information than enterprises that have already performed and evaluated an intervention. Customisation is also possible, and this could provide useful information that could help enterprises to take decisions. The benOSH project (De Greef et al., 2011), for instance, assessed the costs and benefits of 56 OSH interventions from an ex ante perspective. The results of the study showed that ex ante cost–benefit analysis offers added value for decision-making at company level. However, in the literature ex post studies prevail. For example, in their review, Verbeek, Pulliainen and Kankaanpää (2009) found 23 ex post and only 3 ex ante studies.

The before–after approach

Several approaches to measuring the effectiveness of an OSH intervention, exist (Robson et al., 2001). The before–after approach is the one that is used most, as it fits well with the workplace.

The before–after approach is acceptable as long as the intervention is the only source of changes (that is the only essential aspect that changed) throughout the intervention, or at least the only source of changes that could affect the parameters examined. Of course, in a dynamic context such as enterprises, many things change that can affect the parameters examined before and after. A common error according to Laporte et al. (2008) is attribution to the intervention itself of all costs after the intervention rather than only incremental costs resulting from the intervention. Implicitly, the comparator is the status quo prior to intervention (Tompa et al., 2008). To give an example of a possible misattribution of benefits, a reduction in absenteeism attributed to an OSH intervention may also have been affected by other factors, such as presenteeism (for example as a result of job insecurity during the economic crisis) or changes in workload or working conditions.

Kankaanpää et al. (2008) propose that taking incremental rather than total investment costs into account can compensate for uncertainty in the attribution of costs. However, even for incremental costs, attribution remains a difficult and uncertain process.

To compensate for such confounding factors, some cases use extrapolation, simple regression analysis or multivariate regression analysis (also referred to as interrupted time series analysis in the literature). However, according to Verbeek, Pulliainen and Kankaanpää (2009) and Tompa et al. (2007), only a few of the business case studies in the literature use such provisions.

Publication bias

Publication bias is another common drawback in scientific studies including an economic evaluation (Tompa *et al.*, 2007, Verbeek, Pulliainen and Kankaanpää, 2009). It is rather unlikely that a study showing an economic loss as a result of an intervention would be published, or even reported by the enterprise in question. Of course, this does not mean that enterprises are always willing to demonstrate the economic profitability of an OSH intervention that they have undertaken, as described in section 2.1.

As Tompa et al. (2007) argue, most interventions are proposed as worth making; however few such interventions happen in the real world. Generally, such phenomena reduce the scope of available information and raise the unsolved issue of bias in data.

Evidence on the effectiveness of interventions can also be retrieved from the scientific literature. The Cochrane Collaboration, for instance, offers valuable information on the effectiveness of OSH interventions (http://osh.cochrane.org/osh-reviews).

6.2 Existing case study research

The relevant literature shows a significant lack of formal economic evaluations of OSH intervention, both quantitative and qualitative, since little emphasis is placed on effectiveness and there is a general absence of cost-effectiveness or cost–benefit analysis (Watts, 1995; Niven, 2002). This is also the conclusion of this section, as can be seen below.

This report aims to present business cases for individual OSH-related interventions that were evaluated in monetary terms. The review of the existing literature aimed to find and outline some business cases that had already been published. Some of these cases were properly researched interventions (for example RCTs) that were assessed for their health impact, which was then translated into economic values, whereas other cases were evaluated in different and less standardised terms (like the cases explored in this report), but were nonetheless OSH-related interventions that could be replicated or adapted by other enterprises.

Therefore, all types of case studies of OSH-related interventions are presented as examples, without further categorisation based on quality of research and generalisability of conclusions. A list of existing case studies, with short descriptions, is presented in Table 20, Appendix V)

Three literature reviews were found on business case studies/economic evaluations of OSH interventions from a corporate perspective. Two were exclusively about OSH interventions, whereas one also involved wellness programmes at work (almost half of the examined cases). All the reviews mentioned a large variety of possible interventions (targeting OSH risks, enterprise features, etc.), the lack of a common methodological framework and other related factors (such as publication bias, quality of research), concluding that, therefore, it was not feasible to draw sound conclusions.

Tompa et al., (2007) identified 72 ex post studies of economic evaluations of OSH interventions in the context of nine sectors of economic activity: healthcare (25 cases), manufacturing and warehousing (16), administration (eight), transportation (three), public administration (four), mining (three), accommodation and food (two), retail trade and education (one), multiple sector (seven). Six types of OSH intervention were involved: ergonomic, occupational disease prevention, disability management, health promotion, violence reduction, multifaceted or other topics. They identify ergonomic and musculoskeletal interventions, and disability management interventions in certain sectors, as usually worth making from an economic point of view. Of the studies, 40 were about ergonomic interventions, 18 rehabilitation/disability management, seven prevention of occupational diseases and injuries, and seven other topics (multifaceted, pre-employee screening and so on). The authors found that there was strong evidence to support the profitability of disability management interventions, moderate evidence to support the profitability of ergonomic interventions, and occupational disease interventions in the health sector; their findings for multifaceted interventions in the manufacturing and warehousing sector, on the other hand, were negative. Of the cases, 14 were from EU countries. The authors combined sector and type of OSH to sort the interventions into clusters which were evaluated on their profitability. Of the 72 possible combinations, sufficient interventions (in quality and quantity) were found in only 24. In most (17 out of 24) industry–intervention clusters there was no sufficient evidence to support the profitability of the interventions.

In a later review, Verbeek, Pulliainen and Kankaanpää (2009) found 26 studies (14 were also included in Tompa et al., 2007) that met their qualitative criteria. Nineteen studies were about ergonomic interventions, two about rehabilitation, two about pre-employment screening and three about injury prevention. Of the 23 cases, 19 were found profitable. Only three of the studies included ex ante business cases for management decisions on OSH; such a deficit is also concluded by Pot and Koningsveld (2009).

Uegaki et al. (2010) published a review that mainly focused on issues to do with the methodological quality economic evaluations of occupational health interventions from a company's perspective. They included 34 studies, of which 17 were about musculoskeletal disorders (10 were included in the two

previous reviews) and 17 about wellness programmes. The main conclusion was that, overall, methodological quality was in general poor.

Several other reviews about wellness programmes initiated at work (for example Kreis and Bödeker, 2004; Griffin, Hall and Watson, 2005; Van Dongen et al., 2011) were not included, as this research focused on OSH interventions only. Although previous reviews described several business cases for OSH interventions, none of these focused on company size, which is attempted in the present study.

Most of the existing studies are included (partly overlapping) in the three reviews (Tompa et al., 2007; Verbeek, Pulliainen and Kankaanpää, 2009; Uegaki et al., 2010). All these reviews report flaws in study design, lack of assumption soundness, insufficient provisions for uncertainty, poor application of economic evaluation (depreciation and so on) and overall poor research quality.

These cases can be divided into five categories, similar to those used by Tompa *et al*. (2007), by sector: healthcare (seven), administration (one), manufacturing (fifteen), transportation (two) and public administration (one). Only eight of the case studies were from EU. Nineteen cases involved ergonomic interventions, three involved accident prevention and one aimed to prevent drug abuse.

Most healthcare interventions (four out of seven, all four being related to musculoskeletal disorders) present negative profitability (which contrasts with the findings of Tompa et al., 2007). Similarly, the negative findings of Tompa et al. (2007) do not replicate. Generally, the study found 19 profitable cases (out of 26).

The review by Uegaki et al. (2010) adds some more cases, but their results were not comparable in terms of using the same financial indicators of investment.

When the reviews by Tompa et al. and Verbeek, Pulliainen and Kankaanpää are combined (taking into account overlaps) 84 case studies of economic evaluation of OSH interventions can be found (plus seven cases from Uegaki et al.). Table 10 presents the case studies on enterprises in Europe found in these three reviews, after removing overlaps.

Table 10: Case studies in enterprises in Europe

Country	Study	Type	Sector
Sweden			Manufacturing
	Kemmlert, 1996	Ergonomic	Manufacturing
			Healthcare
			Public administration
	Gundewall, Liljeqvist and Hansson, 1993	Ergonomic	Healthcare
	Linton and Bradley, 1992	Rehabilitation	Healthcare
	Abrahamsson, 2000	Ergonomic	Manufacturing
	Jensen *et al*., 2005	Rehabilitation	Other
	Arnetz *et al*., 2003	Rehabilitation	Other
	Kärrholm *et al*., 2006	Rehabilitation	Public administration
	Landstad *et al*., 2002	Ergonomic	Healthcare
Norway	Kjellén, Boe and Hagen, 1997	Multifaceted	Manufacturing

Country	Study	Type	Sector
Finland	Bergström, 2005	Ergonomic	Manufacturing
	Karjalainen *et al*., 2003	Rehabilitation	Other
United Kingdom	Shearn, 2003	Ergonomic	Manufacturing
			Manufacturing
Netherlands	Hlobil *et al*., 2007	Ergonomic	Aviation
	Versloot *et al*., 1992	Ergonomic	Transportation
	Burdorf *et al*., 2005	Ergonomic	Construction

Another important review of case studies (but only ex ante case studies) was the benOSH project, where ex ante cost–benefit analyses were performed on 56 proposed interventions (in two scenarios, conservative and optimistic). The cases covered many sectors (33 manufacturing or related fields 14 construction, eight health, three mining, seven transportation and one service). There is significant variation in terms of evaluation parameters depending on the scenario envisaged (see Table 11).

Table 11: Results of the benOSH project

Parameter	Conservative scenario	Optimistic scenario
Net present value	€ 1,434.87	€ 9,218.81
Profitability index	1.29	2.89
Benefit–cost ratio	1.21	2.18

In a review of UK case studies (Antonelli et al., 2006) examining the economic benefits of OSH interventions, six cases were presented; however, no systematic economic evaluation of the investments was performed (ROI) to allow for meaningful conclusions.

6.3 The present research

6.3.1 Summary of findings

This section outlines the main findings of the research on new case studies conducted as part of this project. The aim is to present ex post business case studies of SMEs in Europe that performed OSH-related interventions and to evaluate their profitability.

Finding proper SME case studies proved to be very difficult for a number of reasons:

The conclusion of Smallman and John (2001) was verified, as many enterprises strongly declared that OSH interventions are not performed for economic reasons and that therefore such evaluations had not taken place.

SMEs do not have sufficient data (for example on absenteeism and costs related to OSH interventions) or management time to economically evaluate OSH interventions, especially when the interventions in question were not motivated by economic profitability.

The difficulty of finding (and sometimes failure to find) SMEs involved in OSH interventions has been observed and discussed in previous primary research (Griffin, Hall and Watson, 2005).

The context of the study (ex post) and the small number of unpublished case studies identified excluded the possibility of randomisation and of achieving a representative sample. Inevitably, no generalisation could take place; therefore, the aim is to present evaluations of OSH interventions, rather than to test hypotheses and draw universal conclusions. The results are only indicatively presented, without aggregation or any other attempt at generalisation. Nevertheless, some qualitative results can be highlighted as success factors.

Despite this drawback, the possibility of using common tools and forms of analysis for all cases was a great opportunity to enhance the contribution of the study to the existing literature. An evaluation spreadsheet model, used in a previous project (benOSH (De Greef et al., 2011)) was selected as the common analysis tool. The model uses an analytical list of cost elements before and after the intervention, but it is flexible enough to allow further costs and benefits to be added to the cash flow. The evaluation parameters calculated by the spreadsheet are:

- payback period (years)
- internal rate of return
- net present value
- profitability index
- benefit–cost ratio

Common principles (taxation, depreciation rate and so on) were used to enhance comparability and transferability of cases, leaving out as many country-specific factors as possible.

In accordance with the selection criteria, 13 case studies of SMEs from five EU countries were identified and analysed. These cases (with reference to the parameters listed above) are listed in Table 12 (for an analytical presentation of case studies, see Appendix III).

Table 12: Summary of examined business cases

Case number	Enterprise's name	Country	Person	Sector	Type	Short description of the intervention	Results	Payback period (years)	IRR (%)	NPV (€)	Profita-bility index	Benefit–cost ratio
Case 1	Statga	Lithuania	90	Manufacturing (metal)	Chemicals	Purchase of individual air cleaning and supply systems, in collaboration with workers	Improved productivity due enhanced protection and ergonomics of new persor protective equipment (PPE	1.00	69.4	64,791	2.64	1.50
ase 2	Bäckerei Hans Gebert	Germany	10	Manufacturing (bakery)	Chemicals	Implementation of equipment to reduce concentration of flour particles in the air	Elimination of baker's asthma cases	3.40	7	3,577	1.07	1.28
Case 3	HAW	Germany	135	Waste management	Safety	Training and improved PPE to reduce slip and trip accidents	Reduction in accidents (20 %)	1.3	70.5	8,751	2.90	1.70
Case 4	Fussboden Brandenburg	Germany	6	Construction (floor coverings)	Ergonomics /musculoskeletal	Training in correct lifting, exercises (taught by a gymnast), lifting equipment, reminders about safe lifting, incentives (from health insurance)	Reduction in back pain ar sick leave due to back p	2.16	31	6,864	1.71	1.80
Case 5	Steiskal	Germany	60	Manufacturing (bakery)	Road safety	Training and issuing of instructions	Reduction in delivery accidents (67 %)	<1.00	949	80,153	35.85	59.1
Case 6	Bouwbedrijf Kamphuis BV	Netherlands	50	Construction (houses)	Ergonomics /musculoskeletal	Individual visits from a physiotherapist, a rest break tool, training (in empowerment)	Reduction in musculoskeletal disorder and related absenteeism	<1.00	300	363	4.08	6.20
Case 7	Swinkels	Netherlands	18	Construction (window panes)	Ergonomics /musculoskeletal	Renting equipment for handling window panes during deliveries (charged to customers)	Elimination of absenteeism due to occupational accide and ill health, improved productivity.	2.62	20	3,402	1.40	1.20

Case number	Enterprise's name	Country	Person	Sector	Type	Short description of the intervention	Results	Payback period (years)	IRR (%)	NPV (€)	Profita-bility index	Benefit–cost ratio
Case 8	Stijlvolle Tuinen	Netherlands	4	Construction (agriculture)	Ergonomics /musculoskeletal	Implementation of equipment to reduce physical strain in load handling	Reduction of related incidents, improvement in quality of work	<1.00	157	9,750	6.00	4.60
Case 9	Kwekerij de Lindenborg	Netherlands	3	Agriculture (cucumbers)	Ergonomics /musculoskeletal	Implementation of equipment to reduce physical strain in load handling	Improvement in job tenure improvement in productivit	>4	–30	–112,794	0.34	0.5
Case 10	Glass Handling Technic	Netherlands	4	Agriculture /construction	Safety /ergonomics	Implementation of equipment to reduce accident risks and physical strain	Reduction in accident risks and physical strain, improvement in productivit	>4	–14	–11,650	0.61	0.6
Case 11	Nota Straatmakers	Netherlands	150	Construction	Ergonomics /musculoskeletal	Automatisation through provision of equipment	Reduction in accident risks and physical strain, improvement in productivit	3.20	9.8	117,215	1.14	1.3
Case 12	Viotros	Greece	110	Manufacturing (food)	Ergonomics /musculoskeletal	Use of lifting equipment and a film-stretching machine in the packaging sector.	Reduction in back pain and improvement in productivit and reliability.	2.00	35	19,053	1.81	2.10
Case 13	Artbau Zagler GmbH	Austria	90	Construction (pipes, houses)	Ergonomics /musculoskeletal	Use of a material lift, continuous training, OSH awareness raising initiatives.	Productivity raised by up to 30 %, Improvement in qua of work and working conditions (noise, dust), reduction in sick leave.	1.31	66.1	35,257	2.76	3.10

Given the paucity of existing literature on OSH business case studies, particularly in relation to SMEs, this study adds a significant number of cases. Moreover, all these studies were evaluated using a common model, common assumptions and common evaluation indices. Another factor differentiating this study is the strong presence of the construction sector, which is not reflected in previous studies. Finally, as shown in the next section (section 6.3.2), this report adds significantly to the existing case studies in EU. Taking into account that these case studies were all unpublished and uniformly analysed, this impact is particularly important with regards to the goal it aims to serve.

More than half of the interventions (eight) were about ergonomics, which was expected because of the privileged role of ergonomic interventions in OSH economics and particularly in construction. Only three aimed to improve safety and only two to improve health (chemicals).

As expected (especially given the effects of publication bias), most of the case studies appear to have been economically beneficial within the five-year period examined. Only two of the cases appear to have had negative economic returns, and they were economically profitable over a longer period. As all of the cases were found to be beneficial (11 of them within the five-year period), there is reason to believe that the presence of publication bias was verified.

Some of the cases were extremely profitable (a payback period of less than one year for four cases); however, it should be borne in mind that these were mostly small-scale interventions or interventions with a significant non-OSH dimension. It is also remarkable that the two largest-scale interventions (over €100,000) showed low profitability (a payback period of more than three years).

6.3.2 Overview of the existing literature

Although the methods of analysis and the parameters chosen for listing existing case studies are different in the existing reviews, it was found to be very useful to present their results in a comparative manner. This required seeking analytical data from these case studies and, therefore, some differences due to interpretation might appear with the examined reviews. As boundaries between the types of intervention are not always discrete, there was some room for subjectivity in deciding to which category some of the interventions belonged.

Moreover, there was an effort to exclude overlaps by finding the cases that were included in more than one review. Thus, another column is presented with the aggregate results. The findings of the existing report are included in this overview.

One important finding is that there are only a few case studies (an estimated 19 before the present report, regardless of the number of publications) from EU countries. The countries (or in a few cases regions) of origin of the case studies are presented in Table 13.

Table 13: Case studies by country or region

Country	Tompa *et al.*, 2007	Verbeek, Pulliainen and Kankaanpää, 2009	Uegaki *et al.*, 2010	Present report	Aggregate (no overlaps)
United States	40	10	10		50
Canada	11	7	2		14
North America	1				1
Australia	6				6
Malaysia		1			1

Country	Tompa *et al.*, 2007	Verbeek, Pulliainen and Kankaanpää, 2009	Uegaki *et al.*, 2010	Present report	Aggregate (no overlaps)
Sweden	11	4	2		11
Norway	1				1
Finland	1	1			2
UK		2			2
Netherlands	1	1	3	6	9
Germany				4	4
Austria				1	1
Lithuania				1	1
Greece				1	1
Total Europe	14	8	5	13	33
Grand total	72	26	17	13	104

It is obvious that most of the existing case studies come from North America. The present study has a significant impact on the EU literature, both quantitatively (13 more cases added to the existing 19, and an even higher proportion when SME case studies are considered) and qualitatively (in terms of the use of common assumptions and analytical methods).

In terms of sectoral distribution (see Table 14), this study differs from the previous ones in that there is a much larger contribution from the construction industry, whereas studies from the healthcare sector are absent, like other (less represented) sectors of previous studies. This is perhaps to be expected, as this study focused on SMEs, where manufacturing and construction are major sectors (although it might have been expected that there would be some representation of the accommodation and food sector).

Table 14: Case studies by sector

Sector	Tompa *et al.*, 2007	Verbeek, Pulliainen and Kankaanpää, 2009	Uegaki *et al.*, 2010	Present report	Aggregate (no overlaps)	benOSH (*ex ante*)	Total aggregate
Healthcare	25	7	6		30	8	38
Manufacturing and warehousing	16	15	4	4	28	11	39
Administration	8	1	1		9	1	10
Transport	3	2	2		7	7	14
Public	4	1	1		5		5

Sector	Tompa *et al.*, 2007	Verbeek, Pulliainen and Kankaanpää, 2009	Uegaki *et al.*, 2010	Present report	Aggregate (no overlaps)	benOSH (*ex ante*)	Total aggregate
administration							
Mining	3				3	3	6
Accommodation and food	2				2	4	6
Construction			1	6	7	14	21
Other and multiple	11		2	3	13	8	21
Total	72	26	17	13	104	56	160

Ergonomics are the dominant type of OSH intervention, making up more than half of all interventions in every study. Rehabilitation studies are represented more in the reviews of Tompa et al. and Verbeek, Pulliainen and Kankaanpää, but no such cases appear in the other two studies. Finally, prevention and multifaceted interventions are almost equally represented in all studies (see Table 15).

Table 15: Case studies by type of OSH intervention

	Tompa *et al.*, 2007	Verbeek, Pulliainen and Kankaanpää, 2009	Uegaki *et al.*, 2010	Present report	Aggregate (no overlaps)
Ergonomics	40	19	13	7	60
Prevention	7	3	1	5	15
Rehabilitation	18	2			19
Other and multiple	7	2	3	1	10
Total	72	26	17	13	104

This is in accordance with the existing literature (see section 3.1.2) on ergonomic interventions. It is notable that rehabilitation studies are also well represented, although most of these cases come from outside the EU. More specifically, 12 of the cases from the EU were about ergonomic interventions, five about disability management/rehabilitation and one was multifaceted.

Although most published case studies are profitable (publication bias), it should be mentioned that the existence of published studies does not indicate similar conclusions for the actual number of interventions performed or the profitability or these interventions in countries or sectors. Such conclusions can only come from research that is designed (and accordingly structured) to test such a hypothesis.

7 Conclusions

Small and medium-sized enterprises, often referred to as the backbone of the European economy, account for 67 % of employment and 82 % of occupational injuries. Since SMEs have very limited resources to invest in OSH, good information on how interventions might both improve safety or health and reduce or maintain costs is of great importance. Research has shown that once SMEs understand the relationship between OSH and productivity, they are then able to see the link between OSH and economic performance. EU-OSHA has identified the need for further research and case studies on the business case for good OSH management, particularly with a focus on SMEs.

The aim of this report is to provide clear case studies that can act as 'eye-openers' for SMEs, raising awareness of the costs of non-existent OSH at enterprise level and addressing the need to change the perception of OSH, so that it is viewed not as a cost factor but as a beneficial investment. Furthermore, policy-makers should understand that costs at enterprise level are often shifted to the societal level, and that this is a strong argument for promoting OSH in SMEs through public programmes.

The business case was examined in order to better serve these aims. In the case of each intervention studied, all the costs and benefits to the SME were examined, regardless of whether they were purely OSH-related or not, as in a business case such investments need to be assessed as a whole, from the enterprise's point of view.

This study had two main strands: identifying case studies of OSH interventions in the existing literature and developing new case studies on OSH initiatives in European SMEs. Regarding the first strand, previous reports and reviews showed that several *ex ante* and *ex post* studies, each with its own advantages and disadvantages, had been performed. Of the 91 case studies identified in the existing literature, 20 were from enterprises within Europe. To these, 56 *ex ante* case studies from the benOSH project could be added. Based on the existing literature, the key issues identified in this branch of the study were the following:

Ex ante case studies are scarce and showed significant variation in terms of evaluation parameters depending on the scenario envisaged. Three scientific systematic reviews on economic evaluations from a corporate perspective showed a large variety of OSH interventions (for example disability management programmes, ergonomics interventions, health promotion programmes and multifaceted interventions). The strongest evidence for the profitability of interventions was found in relation to disability management programmes and ergonomic interventions in a variety of sectors; however, there was a lack of evidence of profitability for other types of interventions. However, this absence of proof can be attributed as well to the difficulty of evaluation rather than related to the effectiveness of the intervention.

The authors of all the systematic reviews expressed concerns regarding the methodological quality of the economic evaluations; for instance, case studies lacked a clear time horizon, failed to take into account costs resulting from inflation or did not perform sensitivity analyses. The main reasons for the low methodological quality could be attributed to the fact that most of the studies were primarily focused on the effectiveness of the outcomes rather than on their economic benefits.

The second strand of the study involved the development of new, unpublished case studies of economically evaluated OSH-related interventions in European SMEs. The project team consisted of members of different institutes working in the area of OSH in Europe. Being very well cross-linked to companies, including SMEs, these institutes had the best preconditions to detect good cases from all over Europe. However, the researchers faced difficulties in finding such case studies for several reasons: (a) OSH interventions are not usually performed for economic reasons and therefore they are not economically evaluated, (b) SMEs lack the data and time required to perform an economic evaluation and (c) published data on economic evaluations among SMEs are scarce.

Finally, 13 business case studies from SMEs in Europe that had performed OSH-related interventions and evaluated their profitability were identified. Significant variation exists among the business cases in terms of quality, target sector (for example, the construction industry, manufacturing and agriculture), type of intervention (for example ergonomics, safety, and chemicals) and outcomes targeted (for example reductions in asthma, accidents, sick leave and musculoskeletal complaints). The unpublished cases studies were more often performed in the construction industry than the case

studies in the systematic reviews, which were more often performed in healthcare and manufacturing and warehousing, as shown in Table 16.

Table 16: Comparison between existing literature and unpublished case studies by sector

Sector	Existing case studies	Present report
Healthcare	30	
Manufacturing and warehousing	24	4
Administration	9	
Transport	7	
Public administration	5	
Mining	3	
Accommodation and food	2	
Construction	1	6
Other and multiple	10	3
Total	91	13

Like the cases included in the systematic reviews, most of the new business cases were conducted for interventions related to ergonomics, as shown in Table 17.

Table 17: Comparison between existing literature and unpublished case studies by type of intervention

Type of intervention	Existing case studies	Present report
Ergonomics	53	7
Prevention	10	5
Rehabilitation	19	
Other and multiple	9	1
Total	91	13

It should be noted that including outcomes such as productivity and presenteeism was rare among the business cases in the present report. Most of the interventions appeared to be economically beneficial within the five-year period examined because of increased productivity or lower costs, as presented in Table 18. However, from a comparison of the results of the different business cases, it is clear that no generalisation is possible.

Table 18: Unpublished business cases including description, results and payback period

Case number	Sector	Short description of the intervention	Results	Payback period (years)
Case 1	Manufacturing (metal)	Purchase of individual air cleaning and supply systems, in collaboration with workers	Improved productivity due to enhanced protection and ergonomics of new personal protective equipment (PPE)	1.00
Case 2	Manufacturing (bakery)	Implementation of equipment to reduce concentration of flour particles in the air	Elimination of baker's asthma cases	3.40
Case 3	Waste management	Training and improved PPE to reduce slip and trip accidents	Reduction in accidents (20 %)	1.3
Case 4	Construction (floor coverings)	Training in correct lifting, exercises (taught by a gymnast), lifting equipment, reminders about safe lifting, incentives (from health insurance)	Reduction in back pain and sick leave due to back pain	2.16
Case 5	Manufacturing (bakery)	Training and issuing of instructions	Reduction in delivery accidents (67 %)	<1.00
Case 6	Construction (houses)	Individual visits from a physiotherapist, a rest-break tool, training (in empowerment)	Reduction in musculoskeletal disorders and related absenteeism	<1.00
Case 7	Construction (window panes)	Renting equipment for handling window panes during deliveries (charged to customers)	Elimination of absenteeism due to occupational accidents and ill health, improved productivity	2.62
Case 8	Construction (agriculture)	Implementation of equipment to reduce physical strain in load handling	Reduction of related incidents, improvement in quality of work	<1.00
Case 9	Agriculture (cucumbers)	Implementation of equipment to reduce physical strain in load handling	Improvement job tenure, improvement in productivity	>4
Case 10	Agriculture/construction	Implementation of equipment to reduce accident risks and	Reduction in accident risks and physical strain, improvement in	>4

Case number	Sector	Short description of the intervention	Results	Payback period (years)
		physical strain	productivity	
Case 11	Construction	Automatisation through provision of equipment	Reduction in accident risks and physical strain, improvement in productivity	3.20
Case 12	Manufacturing (food)	Use of lifting equipment and a film-stretching machine in the packaging sector.	Reduction in back pain, improvement in productivity and reliability.	2.00
Case 13	Construction (pipes, houses)	Use of a material lift, continuous training, OSH awareness raising initiatives.	Productivity raised by up to 30 %, improvement in quality of work and working conditions (noise, dust), reduction in sick leave	1.31

The difficulties experienced in finding good cases indicate that there is still a lot of progress to be made in the area of economic evaluations within European SMEs. On the other hand, the 13 cases and the previous scientific research described in this report give some indications for future directions.

A number of key issues related to OSH-related interventions and their profitability were identified and discussed in this study.

Are investments in OSH intervention driven by financial factors within SMEs?

The extent to which companies and organisations in general allocate their limited resources, such as time, facilities and money, to OSH interventions is driven by a combination of legal, financial and moral factors. Among other considerations, information on the costs and consequences of an intervention in the form of a business case is likely to be a valuable input into the decision about whether or not to implement it.

With regard to SMEs, different views exist in the literature about the extent to which SMEs take economic returns into account when making decisions about OSH interventions. Although a large part of existing literature shows that SMEs do not perform economic evaluations (or do not make decisions based on them) some recent literature indicates that economic evidence is receiving more attention in such decisions. In any case, economic implications (for example the low cost of an intervention, even if it will not be profitable) can affect a decision on an intervention, even if they are not the main factor determining whether the intervention will be undertaken or not. Accordingly, most enterprises in the case studies presented in this study stated that interventions were not mainly motivated by the economic return they would provide. This might be attributable to a social desirability effect: that is, that enterprise managers want to demonstrate to the outside world that they are strongly interested in the well-being of their workers and not only in making profit.

In the context of a business case, where all costs and benefits related to the enterprise are examined, a decision about whether or not to undertake an OSH-related intervention is the product of a multidimensional examination, where profitability, capital required and economic aspects in general are important factors but not the only ones.

How should an OSH intervention be economically evaluated?

An enterprise should take into account all costs and benefits affecting it, and only these costs and benefits (internal). These considerations comprise the business case. The business case will not take into account costs or benefits that are shifted to the worker, the insurance fund or the state (external). Moreover, the business case will take into account all costs and benefits related to the intervention whether they have to do with improved safety and health or not (for example improved efficiency resulting from an intervention that was performed to improve OSH would be taken into account). Although this might fall outside the scope of OSH in certain cases, there is only one way to assess the economic viability of an investment: a holistic evaluation.

A number of pitfalls and constraints in the economic evaluation of OSH-related interventions have been identified in the literature, as costs are sometimes difficult to identify, attribute and measure. Moreover, mistakes in assumptions, as well as time-related issues (inflation, time preference, period of examination), can have a serious impact on the economic evaluation.

Although a few case studies have been described in the existing literature, no universal accounting model has prevailed. In the current study, a common accounting model (adapted from the benOSH project) was adopted and applied in all cases for uniformity. An evaluation period of 'year of intervention plus four years' was chosen.

The main non-health-related factor is improved productivity or efficiency (although improved productivity may also be health-related), which, according to the literature, is not always visible to SMEs.

In the majority of the new case studies examined in the current research (seven out of 13), productivity gains were quantified and explicitly taken into account. More specifically, in four cases economic benefits were measured mainly in terms of productivity and in three cases in terms both of productivity and sick leave. For example, in Case 6, a multifaceted intervention was offered to construction workers in a small company. Besides sick leave, productivity during the working day ('presenteeism') was also measured and incorporated into the results. In the other six case studies, productivity gains were identified but not measured. For instance, Case 4, involving a small floor-laying company in Germany, productivity was not included, as it was difficult to measure and non-tangible. Even then, the business case proved that, from a purely economic point of view, the intervention was profitable. Moreover, all the enterprises managed to identify their internal costs and none had externality errors (that is, taking into account costs or benefits borne or enjoyed by third parties).

When should such an evaluation be performed?

In order to help decision-makers, an economic evaluation should be made before the intervention (*ex ante*). However, an *ex post* assessment as a follow-up is useful to take into account any unforeseen factors, as, when it comes to investments affecting workers, not all costs are predictable. Therefore, many interventions are (also) assessed after they have been implemented (*ex post*). In the literature, the majority of case studies are *ex post*.

Three of the case studies in the present study had also been evaluated *ex ante* (as part of the benOSH project), but the form in which they are presented is as *ex post* evaluations, as many changes took place during and after the interventions.

Apart from cash-flow issues, the period for the economic evaluation is also important for the realisation of OSH results (and the related economic benefits). Especially when it comes to occupational health improvement, the results may take more time to appear (have a long latency period), which requires a long observation period, which can be difficult for SMEs, which usually have a shorter life span and fewer formal measurement tools.

The five-year observation period used in the cases reported in this study might not be sufficient to show long-term health implications in some of the cases, but it is a fair compromise taking into account issues of data availability and accuracy, as predictions looking at longer periods can involve high levels of uncertainty.

Does prevention pay?

Despite the oversimplifications of grey literature, investments in OSH (like other types of investment) are sometimes profitable and sometimes not. It is not easy to evaluate interventions that affect health; however, it is a result of basic economic principles that OSH interventions will not always be profitable.

It should also be emphasised that the economic benefits of OSH are sometimes the result of external conditions (for example through fines, insurance premiums and so on) designed to provide economic incentives to improve OSH. Such parameters are different between different countries and sectors and can significantly affect the economic evaluation of an intervention.

Most of the cases examined in this study (11 out of 13) involved a profitable intervention. However, over a longer period of examination (7–10 years) even the two interventions that were not profitable after five years turned a profit, which is indicative of the effect of the examination period. The profitable interventions ranged between 1.07 and 35.85 on the profitability index. The profitability of the intervention analysed in business case 5, concerned with bakery deliveries, was exceptional compared to the other included business cases, with a profitability index of 35.85; the intervention (training and instructions) focused on reducing accidents, and as a result the accident rate dropped to zero in 2012 and 2013.

When is an OSH intervention profitable?

The economic profitability of an OSH-related intervention does not necessarily derive from its OSH results. Most interventions also affect other aspects of the enterprise that also contribute to profitability. Sometimes, the economic effect of the changes to these other aspects is greater than that of improved OSH.

The literature indicates that some types of intervention tend to be more profitable than others. In general, 'soft' interventions (involving training, management, empowerment, motivation) and ergonomic interventions tend to be more profitable than other interventions (such as those involving equipment, building infrastructure and so on or those aiming to reduce certain types of accident). This is sometimes attributed to the fact that soft and ergonomic interventions have lower costs and a greater impact on productivity. It should be borne in mind that, as SMEs have relatively small workforces, interventions targeting low-probability incidents (such as serious accidents) might be underestimated in their profitability.

Some other factors that affect the profitability of OSH-related interventions are pre-existing OSH practice (the lower the level, the more effective and profitable the intervention tends to be) and the amount of investment (the lower it is, the higher the returns tend to be). Direct involvement of workers in the intervention also has a positive effect on profitability.

Some qualitative conclusions from the interventions included in the cases developed in the present study are:

Eight out of the 13 cases involved a sector-specific intervention that focused on a specific problem related to a certain enterprise/sector. Generally, this type of intervention does not appear to be as profitable as interventions targeting more widely present OSH factors (such as load lifting).

Six cases were multifaceted (Cases 1, 2, 4, 6, 12 and 13), five cases mainly involved installation of equipment (Cases 7, 8, 9, 10 and 11) and two cases involved training and organisational measures (Cases 3 and 5). This last appeared to be the most profitable type of intervention, followed by multifaceted interventions. Those restricted to changes in equipment appeared to have the lowest returns.

In four cases, there was explicit involvement of workers in the intervention, which appeared to be an important factor in profitability. In Case 8, for example, gardeners were actively involved in sourcing and testing a new tool for easier paving. Based on the case studies presented in the paper, company size, sector and country of origin do not show any particular trend in terms of ROI.

The size of the investment (the total expenditure involved in the intervention) did not show any particular trend.

An obvious conclusion of this report is that further research is required on the business case for OSH in SMEs. With respect to a qualitative finding of this research (that general-scope interventions suitable for many types of enterprises appear to be more profitable), properly designed research into widely applicable OSH interventions (such as automatic palletising and use of common load-handling equipment) that will allow for generalised conclusions is proposed to examine and present certain beneficial interventions that are widely applicable.

Concluding remarks

If SME owners are to be encouraged to invest in OSH interventions, the subject will need to be addressed in a pragmatic way, taking into account all the factors that are relevant to SME owners. Therefore, the overview of 13 good example case studies offered in this report will provide a useful tool to allow SMEs to gain an insight into the key factors involved in conducting a business case.

By providing information about business cases from the scientific literature and showing good practices for calculating the costs and consequences of OSH interventions across European SMEs, this report gives decision-makers in SMEs an idea of the value of business cases for their company and how to put them into practice.

The SME case studies can be found in Appendix II of this report and will be presented to enterprises and intermediary organisations at suitable events. This report is accompanied by an executive summary and a PowerPoint presentation in order to facilitate the communication of stakeholder organisations to their target groups.

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9 APPENDICES

9.1 Appendix I: Full case study presentation template

Short description

Title of example and country

Organisation and contact person: *the possible or identified source of information (including URL if available)*

A short description of the enterprise *(including number of employees and sector of economic activity)*

Introduction

A short description of the intervention (3–10 sentences)

Keywords *(your own keywords)*

Aims

What the problem was and what the intervention was intended to achieve, by whom, for whom

What was done and how

Description of the intervention, including challenges that were faced and how they were tackled, success factors

Costs of intervention per cost category according to the common cost model

Description of the cost items involved in the intervention and clarification of primary data (how the cost items were estimated)

What was achieved

The results of the intervention, including goals that were achieved and those that were not achieved, etc., with particular discussion of parameters that are not easily quantifiable (productivity, health, etc.)

Economic benefits of the achievements

Identification and description of the economic benefits (and information on how each economic benefit was estimated)

Further information

Including technical details of the project, such as lists of all partners and participants,, contact details, URL, funding arrangements

Transferability

Information on how this case can be transferred to other sectors and what elements have to be considered when transferring

Summary

9.2 Appendix II: Common cost model (adapted from benOSH)

PreventMatrix

prevent
Institute for occupational safety and health

Investment Analysis: Calculation

	Year 0	1	2	3	4
Investment	€ -				
Benefits		0,00	0,00	0,00	0,00
Annual Costs		0,00	0,00	0,00	0,00
Earnings before taxes and depreciation		0,00	0,00	0,00	0,00
Earnings (cumul.)		0,00	0,00	0,00	0,00
Depreciation (4 years)		0,00	0,00	0,00	0,00
Earnings before tax		0,00	0,00	0,00	0,00
Taxes (40%)		0,00	0,00	0,00	0,00
Earnings after tax		0,00	0,00	0,00	0,00
Depreciation		0,00	0,00	0,00	0,00
Netto Cashflow		0,00	0,00	0,00	0,00
Cumulative Netto Cashflow		0,00	0,00	0,00	0,00
Discount Rate 10%	4%	1,04	1,08	1,12	1,17
Present Value		0,00	0,00	0,00	0,00
Total Present Value		0,00			
Net Present Value		0,00			
Discounted annual benefits	0,00	0,00	0,00	0,00	0,00
Discounted annual costs	0,00	0,00	0,00	0,00	0,00

Investment Analysis: Results

pay-back period (years)		-1: less than a year	The investment pays back in ....
internal rate of return			On the initial investment of ... Euros the company can achive a return of .... %
net present value			Describes the savings for the company when implementing the prevention measures, based on assumptions made under "CBA"
profitability index			Division of needed initial investment by the benefits, i.e. the net present value. For each euro invested in the project, the return will be ... €
benefit-cost ratio			The total discounted benefits are divided by the total discounted costs. Projects with a benefit-cost ratio greater than 1 have greater benefits than costs

9.3 Appendix III: Analytical presentation of case studies developed in this report

9.3.1 Case 1: Statga

Short description

Title of example and country	Business case: improved protection against dust, metal particles and welding fumes in an ergonomic furniture factory, Lithuania
Organisation and contact person: the possible or identified source of information (including URL if available)	Contact: Petras Sreiva, OSH specialist, petras.sereiva@rolgroup.com Elnio g. 2, LT-76247 Šiauliai, Lithuania, tel. + 370 630 00211 Vitalijus Rudenko, Quality Manager, vitalijus.rudenko@rolgroup.com, tel. + 370 650 11995 Lithuanian focal point: Nerita Sot, nerita.sot@vdi.lt
A short description of the enterprise (including number of employees and sector of economic activity)	UAB Statga (www.statga.lt) manufactures ergonomic office furniture. The total number of workers is around 90. Some time after the project described had been implemented, the company joined the ROL Ergo group — a Swedish company providing 'sit and stand' technology. The aim of ROL Ergo is, according to its mission statement, to support its clients to sell and promote a healthier and more productive work environment. The products — multifunctional table stands, accessories and special purpose furniture — are designed, produced and presented to distinguish for their ergonomic qualities. C-25.50 Forging, pressing, stamping and roll-forming of metal; powder metallurgy Manufacturing of metal products

Introduction

A short description of the intervention (3–10 sentences)

There were complaints from workers that the ventilation system that had been implemented and the respirators and protective glasses that were in use did not protect them sufficiently from dust, fumes and metal particles. When the complaints were looked into, it was found that respirators and protective glasses could not fully protect the workers. The glasses often clouded up and visibility worsened. The skin under the respirators moistened, so it was necessary to change them frequently, and also it was difficult to breathe. At the same time, part of the face still was not protected from physical injuries caused by metal particles. In addition, productivity was negatively affected.

When in 2010 a rapid growth in production volume began, more workers had to face conditions and occupational risks such as inhalation of dust, fumes and metal particles and physical injury to the face and eyes from metal particles.

The management and the workers collaborated to improve the situation by finding sound and sustainable solutions for the protection of the workers against, dust, fumes and particles. Suitable suppliers of improved personal protective equipment (PPE) were identified and several systems tried out until a good solution was found.

Keywords (your own keywords) Business case, metal production, welding fumes, particles, dust, prevention, respiratory protection, safety goggles, workplace health

Aims

The efforts of both management and workers were directed towards finding sound and sustainable solutions for the protection of the workers against, dust, fumes and particles.

What was done and how

Situation before implementing the new preventive measures

The calculations that follow were made on the basis that €1 = LTL 3.4528.

There were 84 workers, comprising 42 metalworkers, 36 welders, and six metal painters.

1. Protective glasses

Glasses lasted for one month and cost (LTL 14.85) €4.30

Cost per worker per day: (LTL 0.74) €0.21

Cost per worker per year (225 days): (LTL 166.50) €48.22

2. Respiratory protection

Respirator lasted half a day and cost (LTL 7.60) €2.20

Cost per worker per day: (LTL 15.20) €4.40

Cost per worker per year (225 days): (LTL 3,420.00) €990.50

TOTAL

Per worker: (LTL 3,586.50) €1,038.72

Per 84 workers: (LTL 301,266.00) €87,252.70

Measures taken

In 2011, the enterprise managers got together with the workers and started to analyse how to improve the situation. Some workshops and safety system presentations were conducted and calculations made.

The company's staff did not have enough competent knowledge about the kinds of protection systems required; therefore, they began to search for advice and attended various PPE presentations. The system presented by official representatives of a specialised manufacturer and vendor in Lithuania, UAB Serpantinas, was considered suitable for the company. The vendor provided training and testing in real conditions and made some calculations.

Different kinds of protective systems were given to the workers to be tried out, and only after the advantages of the systems became clear to all involved was it decided to buy the individual air cleaning and supply systems Versaflo M-106 and Adflo from Versaflo Powered & Supplied Air Respirator Systems for 42 metalworkers, 36 welders and six metal painters.

Costs of intervention per cost category according to the common cost model

Individual air cleaning and supply systems consisting of 34 full Versaflo systems and 14 additional spare parts (face shields, accumulators and accumulators charges) and 36 Diablo individual air filtration systems for welders.

Total per worker per year (225 days): (LTS 2,034.00) €589.09.

Total spent on purchasing the systems for all 84 workers: (LTS 170,856.00) €49,483.32.

What was achieved

Before the project began, measurements of the dust were taken in the most problematic places and during the worst conditions (working peak): 42 mg/m3 in the grinding workplace and 31.8 mg/m3 in the painting workplaces. This is about 3–4 times more than the maximum allowed by Lithuanian hygiene standards. At the welders' workplaces, the chemical pollution did not exceed the allowed maximum. In September 2012, after the project had been completed, new measurements were conducted that showed that the occupational risk was acceptable under the Lithuanian risk assessment regulation.

The workers feel safer and more comfortable. The system is easy to use, saves on costs for spare parts, tools and accessories, and enables greater productivity.

In the opinion of the workers, the Versaflo system bears no comparison with the previous system: it is much better. The equipment is easier to put on and more comfortable to wear; the feeling of pressure which was characteristic of the previous respiration systems is no longer there.

Economic benefits of the achievements

Savings achieved

An average saving of LTS 1,552.50 or €450.64 per worker per year, or approx. 43.3 %, was made.

For 84 workers, LTS 130,410.00 or €37,769.35 (annually) was saved.

These savings were calculated by comparing the costs of the old and the new protection systems. Possible lower absence rates and so on were not considered.

Non-tangible benefits

Working conditions were improved; productivity and workers' motivation were increased. The large choice of spare parts for the new equipment allows for prolonged equipment usage time and maintenance.

A cost–benefit analysis using the benOSH tool, calculated for 2011 and the following four years at a discount rate of 4 %, gave the following results:

Costs before intervention

€87,252.70

These costs were completely avoided by the investment.

Investments

Filter systems and protective equipment' (lasting c. two years): €39,533.00

Recurring follow-up costs of investment

€28,026.00 annually (filters etc.)

€39,533.00 in Year 2 and Year 4 (new filter systems and protective equipment')

Results

Payback period: 1 year

Return on investment: 69.4 %

Net present value: €64,791.19

Profitability index: 2.64

Benefit–cost ratio: 1.50

Further information

Success factors

Involvement of workers in the purchasing process: workers decided which systems were best for them after trying out various options.Training: workers were shown what kinds of chemical substances are in their working environment and how their health can be damaged.

Additional information

There are plans to buy more such safety systems. Furthermore, in 2013 the company started to build new premises, expand its activities, hire more workers and implement the effective collective protection system even more widely.

This project was nominated for the national good practice award and achieved third place. The jury's opinion was very positive.

Transferability

This intervention could be implemented in other organisations where additional air supply systems are necessary (for example in sectors such as pharmacy, chemistry, painting and car repairs) in all countries.

Summary

When production volume increased, workers complained about the PPE in the metal workshop. The management involved the workers in selecting new equipment to meet their requirements. After studies, pre-selections, trials and repeated discussions, a solution was found that was welcomed by the workers. On the financial side, it turned out that the new solutions led to considerable savings in the company.

Picture 1: Grinder

Picture 2: Painter

Picture 3: Welder

Picture 4: Air filtration unit

Picture 5: Face shield

9.3.2 Case 2: Bäckerei Hans Gebert

Short description

Title of example and country	Business case: prevention of baker's asthma, Germany
Organisation and contact person: the possible or identified source of information (including URL if available)	Bäckerei Gebert Hans Gebert, Weetgasse 6, D-97340 Marktbreit-Gnodstadt, tel: + 49 9332 8637, fax + 49 9332 500311 Supported by Berufsgenossenschaft Nahrungsmittel und Gastgewerbe (BGN) (the German accident insurance association for the food, hotel and restaurant industry), prevention department Dr.-Ing. Peter Rietschel, Dynamostr. 7–11, D-68165 Mannheim, tel. + 49 621 4456 3450, fax 0800 1977 553 16422, email peter.rietschel@bgn.de Supporting materials: BGN publications (for example http://www.bgn.de/10015/34564/1); Product presentation by Reimelt (MoisTec System), http://www.agfdt.de/loads/bt06/dellmabb.pdf.
A short description of the enterprise (including number of employees and sector of economic activity)	Bäckerei Gebert: a bakery and sales room in a small town in southern Germany, with 10 workers. NACE (second revised edition) C-10.71 Manufacture of bread, manufacture of fresh pastry goods and cakes

Introduction

A short description of the intervention (3–10 sentences)

So-called baker's asthma is an immune system response to normally harmless flour dust. Initial symptoms usually include watery eyes and coughing; later symptoms are rhinitis and sputum. Often, the disease worsens and the baker has to constantly sneeze and has difficulty breathing. Finally, asthma develops. Then, usually, the affected worker has to give up their job.

According to BGN, 772 suspected cases of baker's asthma were reported in 2012 (occupational disease BK 4301: obstructive pulmonary disease caused by allergenic substances).

Of these, 522 cases were confirmed (that is, in these cases, a recognition was effected, with or without pension, or dues were rejected because of a failure to meet preconditions, such as a failure to give up the profession).

With a total of 330,049 workers in the German baking industry, the incidence (new cases per year) is calculated at 1.58 per 1,000 (in reality, the rate among those workers who are actually exposed to flour dust is likely to be higher, especially as less serious cases are probably underreported).

This would indicate a prevalence figure (all cases of baker's asthma) of around 7 %, calculated on the basis of 45 years of occupational exposure.

At Gebert, the management developed comprehensive measures to prevent baker's asthma (training, exhaust ventilation and flour moistening) when the then junior manager began to suffer from the disease.

Keywords (your own keywords) Baker's asthma, flour dust, business case, prevention, health in the workplace

Aims

The aim was to drastically reduce flour dust in the bakery to prevent the occurrence of baker's asthma. These measures were intended to allow the then junior manager, who was suffering from baker's asthma, to continue working in the business.

What was done and how

In 1998, a worker at Bäckerei Gebert had to take 28 days' sick leave due to baker's asthma. As a result, the company incurred the following costs:

240 h x €35: €8,400

240 h x €30 extra time of colleagues: €7,200

3 h x €35 reorganisation of work: €105

5 % overhead costs

TOTAL: €16,435.50

Preventive measures

The company then decided to carry out the measures described below:

Training: each year one worker is sent to a three-day course *run by BGN.*

Technical developments (in collaboration with BGN and other partners):

1. Exhaust ventilation systems were installed at workstations. In parallel with the suction provided by these systems, an air conditioning unit creates a flow of air throughout the room.
2. The company participated in the development of a flour-moistening machine (see Pictures 6 and 7). The flour is transported to the mixing head from the hopper by means of a screw conveyor. There, the powder is moistened with an adjustable amount of water. The water combines the fine dust particles into particles of a harmless size; in this way, the development of fine particles is reduced by up to 98 %.
3. Low-dust separating rye flours were developed. The separating flour is moistened and then heated in the oven, which reduces dust content by 86 %.

Costs of intervention per cost category according to the common cost model

Investment costs

Project design: €600

Training: €720

Exhaust system: €33,000

Flour-moistening machine: €15,000

Additional costs for using dust-reduced separating flours: €500

TOTAL: €49,820.00

Recurring costs for the following three years

Training: €720 x 3

Separating flours: €500 x 3

TOTAL: €3,660.00

What was achieved

Since the measures were introduced, there have been no more cases of baker's asthma.

Economic benefits of the achievements

A cost–benefit analysis using the benOSH tool, calculated for four years at a discount rate of 4 %, gave the following results:

Payback period (years): 3.40

Return on investment: 7.00 %

Net present value: €3,577.48

Profitability index: 1.07

Benefit–cost ratio: 1.28

Although the company took more measures than were strictly necessary' (either the combined ventilation and extraction system or the moistening machine would have produced a sufficient preventive effect on its own), the overall package has proved to be, from a purely economic point of view, successful and profitable.

Effects which are difficult to calculate have not been included in the calculation, but they increase the profitability of the intervention:

• The moistening machine led next to the prevention of flour dust also to increased productivity, because it is easier to process the dough and it can stay for a longer time (shorter mixing times, easier removal, longer processing time)

• The effort required to clean the bakery was significantly lower

• The quality of wheat bread and wheat-mixed bread increased.

Further information

Success factors

The success factors include a sound knowledge of the industry, high motivation to drastically reduce the dust and integration into a professional network.

The accident insurance association BGN gave credit to the baker (BGN report, 4 August2008): 'With his meticulous practice tests Hans Gebert made an important contribution to the basic research of the BGN. The tests provided insights for practical solutions in the areas of:

- Air conditioning/ventilation in the bakery

- Dust-free working processes in the bakery

- Flour dust exhaustion

- Flour moistening.'

Additional information

Important steps have been made at the bakery; about five years later, however, work on further developments and improvements continues.

More information on baker's asthma and flour moistening

- BGN publication 'Tüftler wider das Bäckerasthma': http://www.bgn.de/10015/34564/1

- Product presentation by Reimelt (MoisTec System), http://www.agfdt.de/loads/bt06/dellmabb.pdf

Transferability

The intervention is transferable under the conditions described: implementation of an exhaust system by an external professional, purchase of a flour-moistening machine and training of workers by an accident insurance association.

Summary

A small bakery developed comprehensive measures to prevent baker's asthma, such as training, a sophisticated exhaust system and a moistening machine for dough preparation. The measures proved to be very effective: no more cases of baker's asthma developed. The measures were also economically successful: they led to savings and improved productivity.

Picture 6: The flour-moistening machine (source: Reimelt)

9.3.3 Case 3: HAW

Title of example and country	Case study: measures against slip and trip accidents, Germany
Organisation and contact person: the possible or identified source of information (including URL if available)	HAW (Havelländische Abfallwirtschaftsgesellschaft mbH) Sven Himburg Manager of vehicle fleet Schwanebecker Weg 4 D-14641 Nauen Phone + 49 3321 7462 15 Fax + 49 3321 7462 66 Mobile + 49 175 2280 678 www.haw-mbh.de sven.himburg@alba.info
A short description of the enterprise (including number of employees and sector of economic activity)	The company HAW is operated by the county of Havelland and the ALBA Group plc & Co. KG. The company employs 135 professionals and eight apprentices. The main area of business is the disposal of various types of waste for both private companies and municipalities. In addition, HAW, as a partner of the district of Havelland, collects and disposes of household waste. HAW also carries out many other services, such as container, loading, repairs, and winter service. The company always uses the latest technology, both for vehicle applications and vehicle equipment, as well as in office communications and in the evaluation of vehicles and of disposal data. NACE (second revised edition): E-38 Waste collection, treatment and disposal activities; materials recovery

Introduction

A short description of the intervention (3–10 sentences)	Slip and trip accidents occurred relatively frequently, especially during mounting and dismounting from vehicles, loading and unloading, and collection of waste. The managers analysed the accidents and developed specialised measures to prevent accidents.
Keywords (your own keywords)	Business case, slips and trips, loading and unloading accidents, waste collection, prevention

Aims

Through discussions of the accidents during the usual briefings, presentation of photographs of the accidents, and improved PPE (safety boots), accidents were to be reduced, thus protecting workers' health and cutting down on lost working time.

What was done and how

In 2009, before the intervention, there were 30 accidents, most occurring during mounting and dismounting from vehicles, loading and unloading, and collection of waste, resulting in workers reporting sick for periods between one day and 30 days.

Typical accidents involved missing the steps on the vehicles, slipping off the steps, tripping at the kerb and tripping while collecting waste.

These incidents led to costs for the company of €48,039.17.

These costs include those of the team stopping work, first aid, accident reporting and analysis, and reorganisation of work.

Prevention measures

The accidents were discussed during the usual briefings (during which photographs of the accidents were presented), analysed and appropriate conclusions drawn.

The company purchased improved, more stable safety boots for the workers.

Costs of intervention per cost category according to the common cost model

The enterprise was subjected to the following costs:

Additional costs of appropriate training: €500

Additional costs of improved PPE: €4,000

Total: €4,500

Annually recurring costs: €4,500

What was achieved

In 2010 and the following years the number of accidents went down by 20 %.

It is likely that there were productivity gains, but this could not be quantified.

Economic benefits of the achievements

The application of the benOSH tools to carry out a cost–benefit analysis on the intervention for a period of four years with a 4 % discount rate produces the following figures:

Pay-back period (years): 1.30

Internal rate of return: 70.50 %

Net present value: €8,751.80

Profitability index: 2.90

Benefit–cost ratio: 1.70

Thus, even in strict economic terms, the measures have been shown to be very useful.

Further information

Success factors

The goal has been achieved particularly through the discussions, presentation of photos and analyses of the accidents in which the workers participate.

Additional information

The measures are being continued.

Transferability

The measures, especially taking photographs and discussing the accidents with the workers, are transferable without any restrictions.

Summary

Slip and trip accidents during mounting and dismounting from vehicles, loading and unloading, and collection of waste were significantly reduced through the discussion of the accidents with the workers, and through the use of improved safety boots. The investment involved resulted in major savings.

Picture 7: HAW mbH's vehicle fleet (courtesy of HAW)

Investment analysis: calculation

	Year 0	1	2	3	4
Investment	4,500.00€				
Benefits		9,607.83	9,896.07	10,192.95	10,498.74
Annual costs		4,500.00	4,635.00	4,774.05	4,917.27
Earnings before taxes and depreciation		5,107.83	5,261.07	5,418.90	5,581.47
Earnings (cumul.)		5,107.83	10,368.90	15,787.81	21,369.27
Depreciation (4 years)		–1,125.00	–1,125.00	–1,125.00	–1,125.00
Earnings before tax		3,982.83	4,136.07	4,293.90	4,456.47
Taxes (40 %)		–1,593.13	–1,654.43	–1,717.56	–1,782.59
Earnings after tax		2,389.70	2,481.64	2,576.34	2,673.88
Depreciation		1,125.00	1,125.00	1,125.00	1,125.00
Net cash flow		3,514.70	3,606.64	3,701.34	3,798.88
Cumulative net cash flow		–985.30	2,621.34	6,322.68	10,121.56
Discount rate (4 %)	4 %	1.04	1.08	1.12	1.17
Present value		3,379.52	3,334.54	3,290.48	3,247.30
Total present value		13,251.84			
Net present value		8,751.84			
Discounted annual benefits	36,423.64	9,238.30	9,149.47	9,061.50	8,974.37
Discounted annual costs	17,059.66	4,326.92	4,285.32	4,244.11	4,203.30

9.3.4 Case 4: Fussboden Brandenburg

Short description

Title of example and country	***Business case: prevention of back problems, Germany***
Organisation and contact person: the possible or identified source of information (including URL if available)	Fussboden BRANDENBURG, Director Klaus Brandenburg Schulstraße 23 D-51645 Gummersbach, Tel. + 49 2261 77267 www.fussboden-brandenburg.de, planet.julia@fussboden-brandenburg.de Supported by: IKK Nordrhein (health insurance association, formerly IKK classic), Stefan Ammel, www.ikk-classic.de, Tel. + 49 2204 912 483, stefan.ammel@ikk-classic.de REHAKTIV Oberberg GmbH, Björn Stark, Tel. + 49 2261 81755 16, www.rehaktiv-oberberg.de fpz@rehaktiv-oberberg.de Supporting materials INQA Database (http://www.inqa.de/DE/Lernen-Gute-Praxis/Top-100-Gute-Unternehmenspraxis/Gesundheit/fussboden-brandenburg-Den-Ruecken-staerken.html) IKK report ▪ EU-OSHA booklet on Management Leadership 2012: 'Verantwortung und Führung im Bereich Sicherheit und Gesundheitsschutz bei der Arbeit' (https://osha.europa.eu/de/publications/reports/management-leadership-in-OSH_guide)
A short description of the enterprise (including number of employees and sector of economic activity)	Small company that lays floor coverings, with six workers (including the owner), in the German town Gummersbach. NACE (second revised edition): F-43.3 Building completion and finishing

Introduction

A short description of the intervention (3–10 sentences)	*Laying parquet, linoleum or carpeting is a tough job and strains the back: floor layers often work in awkward postures and carry heavy materials on site. Accordingly, there is a high risk of injury-related work incapacity.* *The managing director of Fussboden Brandenburg wanted to act early in order to prevent these problems. It was decided to offer back-strengthening training, and various lifting aids were purchased.*
Keywords (your own keywords)	MSD, business case, back strengthening training, health in the workplace

Aims

The main objective was to maintain the performance of older employees in particular and to *keep them involved in* the company's operations for as long as possible. The demographic change was a consideration, and the aim was to ensure the continued activities of the valuable *senior* skilled workers. *T*he company wanted to keep their knowledge and skills.

In the case of a possible increase in sickness rates among workers, *the company* expected serious problems *with* dissatisfied customers, who might even discontinue the relationship with the firm. The company wanted to act early in order to prevent these problems.

What was done and how

*T*he work requires a high level of physical exertion*: workers* kneel when laying the flooring, they often have to carry the material themselves and they even often *have to* move furniture. All this *puts* strain on the joints and the spine.

An investigation by the *health insurance association* IKK revealed that the trunk muscles *of* all the workers were only averagely developed at best, and that workers often complained about backache.

Average absence figures *due to work incapacity i*n the German crafts (*2003):* workers were on sick leave for 14.9 days*, of which* one-quarter *(*3.7 days *or* 29.6 hrs*) were attributed to* musculoskeletal disorders (MSDs*)*.

For *Fussboden* Brandenburg *this would result in the following costs:*

3 skilled workers (€35/h): €2,664.00

1 manager (€100/h): €2,960.00

1 apprentice (€23/h): €681.00

1 office worker (€30/h): €888.00

TOTAL: 7,193.00

In addition, €150 was considered necessary for reorganisation of work, so the company *had total costs in* 2005 (before the introduction of prevention measures) of €7,343.00.

Preventive health measures

*I*n order to improve health and prevent diseases, the company decided to offer its workers back-strengthening training. In addition, various lifting aids were purchased.

With the support of the health insurance association IKK, a training programme was designed to reduce back pain and prevent chronic problems. Another aim of the programme was for workers to learn to work in a manner that would not excessively strain their backs.

Once a week, they had a training session with a qualified sports instructor (12 units in total) who showed them strengthening and stretching exercises which they could practise at work and at home. Thereafter, the same number of training sessions were conducted within the company. To help workers to remember to use the correct lifting methods in everyday life, and not overstrain their backs, there were reminders such as stickers on toolboxes. They were also taught about the correct use of lifting aids and the importance of using them whenever possible.

Incentives were given in the form of a bonus–malus system. For example, workers could do the training during their working time. In turn,workers became 'back supervisors' and ensured that their colleagues followed the advice of the trainer. Someone who still did not lift loads properly was nominated the 'dogsbody' of the week. The health insurance association reimbursed each worker a monthly fee. Annual refresher training was organised to help workers not to forget what they had learned.

For transporting heavy rolls of carpeting, workers now use a forklift with thorn, and on construction sites furniture can be easily moved with a crank lift. Moreover, the consistent use of lifting aids and a new high-rack storage system help in their everyday work.

Costs of intervention per cost category according to the common cost model

Investment costs

Training: paid for by the health insurance association IKK

Exemption from work 0.5 h x 24 d:

Skilled workers (3 @ €30/h)

Apprentice (1 @ €23/h)

Office worker (1 @ €30/h)

Owner (1 @ €100/h)

TOTAL: €2,916,00

Work equipment:

High-rack storage: €1,500

Second-hand forklift with carpet pole: €5,000

Crank lift: €200

Recurring costs

Annual refresher training (c. €1,500)

Breakfast for all (no additional costs)

What was achieved

The training enabled the workers to significantly strengthen their trunk muscles. At the same time, the new design of the work processes helped them to to put less strain on their backs. Thus, the workers unanimously confirmed in a final survey that they had back pain less and less frequently.

This matches the result reported by the health insurance association, which certified in its final report that there had been no cases of work incapacity during the two years of the project (2005 and 2006), and therefore also no absence as a result of back problems.

Five years later (in 2011), it was found that during these five years only one case of spinal disorder (dorsopathy) had occurred, resulting in two days' absence from work.

In 2013, the head of the company, Mr Brandenburg, was able to confirm that the senior skilled workers remained in their jobs with the company until they turned 65.

Economic benefits of the achievements

A cost–benefit analysis using the benOSH tool, calculated for four years at a discount rate of 4 %, gave the following results:

Payback period (years): 2.16

Return on investment: 31.00 %

Net present value: €6,864.50

Profitability index: 1.71

Benefit–cost ratio: 1.80

Thus, the measures proved, even from a purely economic point of view, to be successful. Non-tangible, difficult to calculate effects, such as improved motivation and increased productivity, have not been considered.

Further information

Success factors

The owner of the company, Klaus Brandenburg, has shown himself to be committed to improving the health of his workers. He could rely on a solid team structure, and he sought expert support: the health insurance association IKK not only helped in designing and supporting the training programme but also offered an economic incentive in the reimbursement of a monthly fee for participation. Another factor in the success of the intervention was that workers were exempted from their usual daily tasks for training.

Additional information

The company continues to conduct annual refresher training sessions and to encourage workers, for example through mutual motivation, to do exercises to strengthen the back at work and at home and to apply correct lifting techniques.

Transferability

Transferable under the conditions described.

Summary

Fussboden Brandenburg developed several measures to prevent back problems, including a training course, regular gymnastic exercises, lifting aids and motivation. It turned out that the measures not only improved the workers' health but were also economically viable.

Picture 8: Physical training at Fussboden Brandenburg

9.3.5 Case 5: Steiskal

Short description

Title of example and country	**Prevention of traffic accidents during deliveries, Germany**
Organisation and contact person: the possible or identified source of information (including URL if available)	Steiskal Eckhardt Schütz, Managing Director Radewisch 160 D-24145 Neumeimersdorf (Germany) Tel. + 49 431 54554 20 schuetz.steiskal@bela.de www.baeckerei-steiskal.de Supported by: ADAC (Allgemeiner Deutscher Automobil Club, German Automobile Association), training in safe driving: http://www.adac-sh.de/verkehr/fahrsicherheits-training.html
A short description of the enterprise (including number of employees and sector of economic activity)	Steiskal is a medium-sized regional enterprise with a long tradition of baking. Its head office and main bakery is located in Kiel, Germany, with a staff of 60 workers. There is a chain of 49 stores in and around Kiel, with an additional 290 workers. NACE (second revised edition): C-10.71 Manufacture of bread; manufacture of fresh pastry goods and cakes

Introduction

A short description of the intervention (3–10 sentences)	A relatively high number of traffic accidents occurred during the delivery of bakery products to the company's stores and customers. To reduce the number of accidents, the enterprise developed specific instructions and has sent its drivers on training courses. The results were a marked reduction in accidents and, in addition, significant economic benefits.
Keywords (your own keywords)	Business case, car accidents, road safety training

Aims

Specific instructions were developed and drivers were sent on safety training courses, in order to reduce the number of car accidents during delivery, thus protecting workers' health and decreasing lost working hours.

What was done and how

Before the intervention, in 2009, a number of traffic accidents and resulting lost working days were recorded. There were nine cases, with an average of 17 working days lost. To give two examples, in a

car accident in April, the driver received bruises, and 14 working days were lost, and in a car accident in June the driver also received bruises, and 21 working days were lost.

These incidents led to increased costs for the company, includingovertime for workers covering for the injured drivers, reporting the accidents and first-aid measures, and time spent reorganising work. The total costs incurred amounted to €47,062.85.

Health protection measures

The company analysed the situation and how the accidents occurred. It was decided to develop specific instructions on transport safety. In addition, the company sent its delivery drivers on training courses on road safety (12 people for one day). The courses took place at the ADAC training ground near Kiel.

The road safety training provided by ADAC enables drivers to test their capabilities and those of their vehicles without any risk. Under the supervision of experienced trainers, each trainee is encouraged to test a number of driving techniques in order to ensure that they can cope with any critical driving condition. ADAC continually improved the quality of its road safety training.

The accident insurance association partly funded the training.

Costs of intervention per cost category according to the common cost model

The cost for the enterprise of the road safety training was €2,300.

The costs of the specific instructions were covered by the normal instructions to the workers, as the specific instructions became part of the normal instructions.

What was achieved

The number of traffic accidents fell by 35 % in 2010 and by 67 % in 2011, and there were no more accidents in 2012 and 2013.

It is likely that there were productivity gains, but this could not be quantified.

Economic benefits of the achievements

A cost–benefit analysis (see www.kooperationsstelle-hh.de/?page_id=52&lang=de*) using the benOSH tool, calculated for a period of four years at a discount rate of 4 %, gave the following results:*

Payback period (years): <1

Internal rate of return: 948.90 %

Net present value: €80,152.80

Profitability index: 35.85

Benefit–cost ratio: 59.10

Given this analysis, it is obvious that even in strict economic terms the measures implemented have proved to be particularly beneficial for the company.

Success factors

A key factor in the success of the intervention was the training provided by ADAC at their training ground.

Additional information

The measures will be repeated in 2014.

Transferability

The measures described in this intervention may be implemented in comparable cases, where similar professional training is available.

Summary

Traffic accidents during deliveries of goods were decreased dramatically through the provision of a set of guidelines and, above all, through practical training courses on safe driving. The savings made have far outweighed the costs of implementing the measures.

Investment analysis: calculation

	Year 0	1	2	3	4
Investment	€2,300.00				
Benefits		16,708.32	17,209.56	17,725.85	18,257.63
Annual costs		2,300.00	2,369.00	2,440.07	2,513.27
Earnings before taxes and depreciation		14,408.32	14,840.56	15,285.78	15,744.35
Earnings (cumul.)		14,408.32	29,248.88	44,534.66	60,279.02
Depreciation (4 years)		–575.00	–575.00	–575.00	–575.00
Earnings before tax		13,833.32	14,265.56	14,710.78	15,169.35
Taxes (40 %)		–5,533.33	–5,706.23	–5,884.31	–6,067.74
Earnings after tax		8,299.99	8,559.34	8,826.47	9,101.61
Depreciation		575.00	575.00	575.00	575.00
Net cash flow		8,874.99	9,134.34	9,401.47	9,676.61
Cumulative net cash flow		6,574.99	15,709.33	25,110.80	34,787.41
Discount rate (4 %)	4 %	1.04	1.08	1.12	1.17
Present value		8,533.64	8,445.21	8,357.87	8,271.61
Total present value		33,608.33			
Net present value		31,308.33			
Discounted annual benefits	63,341.81	16,065.69	15,911.21	15,758.22	15,606.70
Discounted annual costs	8,719.38	2,211.54	2,190.27	2,169.21	2,148.36

9.3.6 Case 6: Bouwbedrijf Kamphuis BV

Short description

Title of example and country	A worksite prevention programme to promote work ability and health in the construction industry, the Netherlands
Organisation and contact person: the possible or identified source of information (including URL if available)	Contact: TNO (Netherlands Organisation for Applied Scientific Research) Karen Oude Hengel Postbus 718 2130 AS Hoofddorp Karen.oudehengel@tno.nl
A short description of the enterprise (including number of employees and sector of economic activity)	Bouwbedrijf Kamphuis BV Mr M. Haafkes (director) Beekstraat 3 NL-7678 AZ Geesteren Ov This small construction company, with 50 workers in total, specialises in house building, maintenance and renovation. At the time of the interventions, 36 construction workers (that is, blue-collar workers) were working across a number of worksites.

Introduction

A short description of the intervention (3–10 sentences)	A prevention programme was developed to promote the work ability and health of construction workers. This intervention was developed in close collaboration with trade organisations and other participating companies of this study. The six-month intervention consisted of two individual training sessions with a physiotherapist to reduce the impact of the physical workload, a rest break tool (an instrument to raise awareness of the importance of rest breaks to reduce fatigue) and two empowerment training sessions to increase construction workers' influence at worksites.
Keywords (your own keywords)	Construction industry, work ability, health

Aims

Sustainable employability will be one of the major challenges for the construction industry in the next decades. Because construction workers generally run an increased risk of lower work ability and poor health, many of them currently retire when they are younger than the official retirement age. Therefore, there was a need to implement a prevention programme to improve the work ability and health of construction workers.

What was done and how

Two training sessions per worker with a physiotherapist were provided. The sessions lasted approximately 30 minutes. During the first session, a quick scan questionnaire was administered, followed by a 15-minute observation at the worksite. Based on this, a maximum of three individual recommendations on how to reduce one's physical workload were written down on a pocket-sized card for the worker to take away. During the second training session, which took place after four months, the physiotherapist discussed the worker's experiences so far and evaluated the impact of the advice.

The rest break tool was introduced to raise awareness of the importance of reducing fatigue by taking flexible rest breaks, and to prompt workers to actually take them. The rest break tool is a flowchart consisting of four steps and giving advice about rest breaks and how to methodically reduce fatigue.

The sessions with the empowerment trainer were aimed at increasing construction workers' influence at worksites. During the first training session, workers created a list of things they wanted to change during the intervention period (for example more communication with supervisors, more celebration of goals achieved and less need for recovery). Finally, they signed an action plan. After four months, the empowerment trainer and the workers discussed and considered the action plan and the results that had been achieved.

Costs of intervention per cost category according to the common cost model

Intervention costs were valued using the market prices that a company would have had to pay for the intervention. Intervention costs included costs related to the training sessions with the physiotherapist and the empowerment trainer (including travel time, training time and the trainers' materials), and material costs (rest-break tool, posters and pocket-sized advisory cards). The costs of the trainers were based on the commercial rates of the trainers themselves. Material costs were estimated using invoices.

Costs of training sessions

Two visits by physiotherapist

€60.00

Two visits by empowerment trainer

€53.00

Costs of materials

Rest break tool

€3.70

Poster €0.10

Pocket-size advice card

€1.00

Total costs per worker ([2]) *€118.00*

The four training sessions took place at worksites as part of the existing 'toolbox education system'. The toolbox education system consists of at least 10 obligatory safety and health training sessions for workers each year; these sessions have to be organised by employers in the construction industry. Participation in the scheme is necessary in the construction industry to obtain an official safety and

([2]) Time spent by workers participating in the programme was not included, as the intervention was part of the toolbox education system, for which sessions have to be organised at least 10 times a year by employers.

health certificate. Therefore, the time spent by the workers on participating in the intervention was not included in the cost–benefit analysis.

What was achieved

Process and qualitative results of the intervention:

Because the training sessions were held at worksites, 61 % of the construction workers attended at least three out of four training sessions.

The rest break tool was hardly used by the workers. The study showed varying degrees of satisfaction with the programme: workers were moderately satisfied with the training sessions by the physiotherapist and the empowerment trainer, whereas they rated the rest break tool as unsatisfactory. Overall, 64 % of the construction workers recommended the intervention to their colleagues. The training sessions by the physiotherapist were recommended by 76 % of the construction workers.

Effectiveness, quantitative results

The intervention improved neither social support nor work engagement, nor was it effective in reducing the physical workload or the need for recovery among construction workers. Furthermore, no improvements in work ability, physical health or mental health were recorded.

In general, an overall decline in the prevalence of musculoskeletal symptoms was found in the intervention group at one of the time measurements.

Prevalence of back symptoms

Baseline

20 %

3 months

14 %

6 months

14 %

12 months

16 %

Prevalence of neck/shoulder symptoms

Baseline

13 %

3 months

9 %

6 months

12 %

12 months

12 %

Prevalence of symptoms in upper extremities

Baseline

12 %

3 months

11 %

6 months

15 %

12 months

10 %

Prevalence of symptoms in lower extremities
Baseline

19 %

3 months

10 %

6 months

19 %

12 months

18 %

In addition, a decline in the prevalence of long-term sick leave was found in the intervention group.

Baseline

No/short term

75 %

Long term (>5 days)

25 %

6 months

No/short term

82 %

Long term (>5 days)

18 %

12 months

No/short term

76 %

Long term (>5 days)

24 %

When comparing these data that for the control group, who were construction workers from other companies where no intervention took place, the decline in musculoskeletal symptoms and sick leave was greater in the intervention group. However, it was not statistically significant.

Economic benefits of the achievements

Savings

Less absenteeism: €760 per worker (when comparing the sick leave costs of the intervention group with those of the control group)

Return on investment

Absenteeism savings/intervention costs: 760/118 = 6.4

Thus, €1 invested in the intervention gained €6.4.

The relevant indices for economic evaluation, as used in the benOSH tool, are:

Payback period (years)	–1.00
Internal rate of return	299.7 %
Net present value	363.29
Profitability index	4.08
Benefit–cost ratio	6.2

Further information

The development and evaluation of this intervention within a cluster RCT has been described in a thesis: Sustainable employability in the construction industry by K. M. Oude Hengel.

Transferability

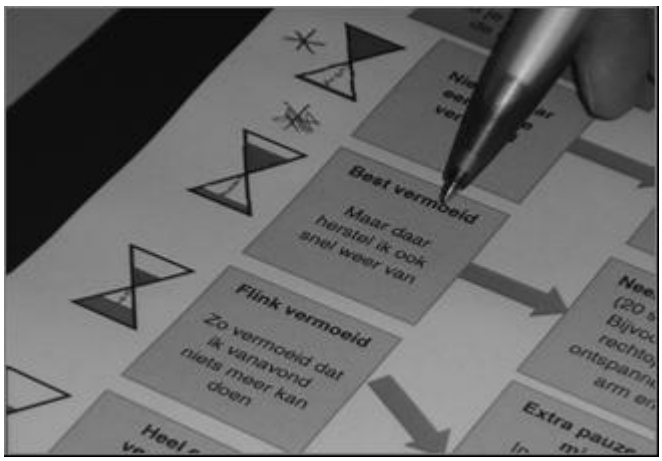
A Dutch protocol on the project is available. However, it is not advisable to implement the intervention on a larger scale yet.

Summary

Although the return on investment was positive, no effects on the phsycial and mental health and work ability of the workers were found. Therefore, the intervention will not be implemented on a larger scale in the Dutch construction industry. However, the statistically non-significant reductions in the prevalence of musculoskeletal symptoms and sick leave and the finding that the non-significant reduction in sick leave resulted in a positive financial impact for the employer is intriguing. This, in combination with the fact that the construction workers were overall rather positive about the intervention, indicates that interventions focusing on physical and psychosocial work factors have potential.

Picture 9: Visit from physiotherapist

Picture 10: Rest break Tool



Picture 11: Empowerment trainer

Investment analysis: calculation

	Year 0	1	2	3	4
Investment	€ 118.00				
Benefits		760.00	0.00	0.00	0.00
Annual costs		0.00	0.00	0.00	0.00
Earnings before taxes and depreciation		760.00	0.00	0.00	0.00
Earnings (cumul.)		760.00	760.00	760.00	760.00

Depreciation (4 years)		–29.50	–29.50	–29.50	–29.50
Earnings before tax		730.50	–29.50	–29.50	–29.50
Taxes (40 %)		–292.20	11.80	11.80	11.80
Earnings after tax		438.30	–17.70	–17.70	–17.70
Depreciation		29.50	29.50	29.50	29.50
Net cash flow		467.80	11.80	11.80	11.80
Cumulative net cash flow		349.80	361.60	373.40	385.20
Discount rate (10 %)	4 %	1.04	1.08	1.12	1.17
Present value		449.81	10.91	10.49	10.09
Total present value		481.29			
Net present value		363.29			
Discounted annual benefits	730.77	730.77	0.00	0.00	0.00
Discounted annual costs	0.00	0.00	0.00	0.00	0.00

9.3.7 Case 7: Swinkels

- **Short description**

Title of example and country	Ergonomics and safety in window pane mounting, the Netherlands
Organisation and contact person: the possible or identified source of information (including URL if available)	Contact: Willy Swinkels Swinkels Glas Willem Rosestraat 5 NL-5622 GH Eindhoven www.swinkelsglas.nl
A short description of the enterprise (including number of employees and sector of economic activity)	Swinkels Glas, Eindhoven, the Netherlands, is a leading company in the sector, employing 18 trained glaziers. Swinkels specialises in replacing damaged glass.

Introduction

A short description of the intervention (3–10 sentences)

Mounting window panes manually is physically demanding work, and safety is a constant concern. In the early years of this century, new equipment was introduced, resulting in less physical effort and safer work. Today, a few companies work innovatively using telescopic handlers, tower wagons, cranes and other sophisticated machinery. The effects are low physical workloads and optimal safety at competitive costs.

Keywords (your own keywords)

Ergonomics, safety, glaziers

Aims

Swinkels is a family business. The new generation, in the person of Willy Swinkels, took over management of the company in 2005. He had studied economics and then gone through all the stages of the vocational training required to become a glazier. Thinking differently is one of his core competencies. He considered the equipment developed 10 years ago a step towards a more innovative way of working. His aim is to avoid any work-related physical complaints. He changed the organisation of work dramatically, with highly positive effects on working conditions, in particular physical workloads and safety.

What was done and how

The changes began in 2005. Today almost all work is carried out using mechanical equipment (such as cranes, telescopic handlers and tower wagons).

All staff are trained to perform well and act safely (VCA certificates). They are motivated to take responsibility for safety at work.

For each job, a plan is made, detailing the most suitable equipment and safe working conditions.

If the client is not willing to pay for the rental of a crane, telescopic handler, hydraulic work platform or other necessary item of equipment, the company refuses the order.

It should be pointed out that for all jobs ordered by the insurance companies there is no discussion on the cost of equipment. Such discussions are more common with individual clients. Every job is analysed with regard to how it can be done safely and ergonomically. Equipment and machines are rented for jobs.

Costs of intervention per cost category according to the common cost model

The investments are (a) training of staff, which is a normal part of developing skilled workers and (b) one day per worker for getting to know the new way of working. Costs are eight hours at €58.50 per hour for 18 workers: €8,424.

The company decided not to invest in machines or equipment. For each job, the best equipment for working safely and without physical strain is selected, and the machines are rented. The costs of the equipment are charged to the client and compensated for by lower labour costs. As a result, an average job is about 24 % cheaper when carried out using machines than it would be if done manually. For example, an everyday job might be the replacement of one piece of glass weighing 103 kg and costing €350.00. Working manually, four men might spend 1.5 hours at a rate of €58.50 = €351.00. Working mechanically, a crane is rented for €150.00. In this case, only two men do the job in one hour, costing €117.00. The total costs of the mechanical method are €267.00. These savings, of between €351 and €267 (€84) are not entirely attributable to the intervention and therefore not taken into account in the business case.

Other advantages of working mechanically are less damage to window frames and less broken glass.

What was achieved

All jobs are done mechanically. The effects are a very low absenteeism rate and almost zero occupational accidents (only minor ones, not resulting in absenteeism).

The work is safe and workloads are below limit values. For several years, the work-related absenteeism rate has been 0 %. The company has an excellent market position and is economically healthy. The number of workers has grown over the years.

Economic benefits of the achievements

The fact that (work-related) absenteeism is zero at Swinkels saves the company a lot of costs. Swinkels' overall absenteeism rate is very low. The 2.1 % absenteeism at Swinkels is 2.6 % lower than the mean in the sector (4.7 %). This corresponds to a saving of up to €14,000 per year. However, it is unlikely that the low rate of absenteeism is entirely caused by the safe and ergonomic work organisation.

A more conservative estimate of the savings attributable to the intervention follows. Mechanisation reduces work-related MSDs and occupational accidents. MSDs are responsible for 50 % of absenteeism among glaziers; 45 % of these MSDs are work-related. So, if the sector's mean absenteeism rate is 4.7 %, 1.06 % is caused by work-related MSDs. It can be estimated that 50 % of these work-related MSDs can be prevented by ergonomic work organisation, resulting in a reduction in absenteeism of 0.53 %.

A conservative estimate is that 80 % of occupational accidents are prevented by safe work organisation. Of absenteeism, 4 % is caused by occupational accidents, so 3.2 % of 4.7 % (0.15 %) of absenteeism can be prevented.

Therefore, a total of 0.53 % + 0.15 % (0.68 %) of absenteeism can theoretically be prevented by ergonomic and safe work organisation. For Swinkels, this has a value of €12,279.00 per year.

- Costs of absenteeism are: 0.68 % x 18 FTE x 1.760 hours per year x €28.50 per hour = €6,140.
- Costs of providing a replacement are the same.
- Together that makes €12,279.

Swinkels' prevented absenteeism has an estimated value of €12,279 (conservative scenario) to €14,000 (optimistic scenario) per year. The value of €12,279 is used in the business case.

In addition, using the new equipment results in much more efficient work (an increase of about 24 %). This was not included in the business case, because it blurs the results on safety.

The relevant indices for economic evaluation, as used in the benOSH tool, are:

Internal rate of return

19.9 %

Net present value

3,402.87

Profitability index

1.40

Benefit–cost ratio

1.2

Further information

There were only few problems to overcome. At first, not all jobs could be done mechanically because of a lack of adequate equipment. Over the years, new and improved machines and equipment became available.

The company rents the best equipment or machine, including a driver, for a specific task. This prevents suboptimal solutions being accepted simply because the company owns a particular machine.

Today, it is clear that the innovative way of working is cost-effective; initially, this was not the case, or at least it could not be proved to be so.

Transferability

The basic idea is 'work smart', which is transferable to any company. However, Swinkels choose to be different; they accept only work that can be done safely and without physical strain. They search for solutions that fit with this philosophy. There are no exceptions: all jobs must be done smart.

Summary

Window panes are heavy; double-glazed panes weigh around 25 kg/m². Transport and placing can be done using mechanical equipment. The glass is picked up using a vacuum unit that is connected to a hydraulic arm or a crane and placed in the window frame without physical effort.

Picture 12: Vacuum equipment

Picture 13: Lifting window panes

Investment analysis: calculation

	Year 0	1	2	3	4
Investment	€ 8,424.00				
Benefits		12,279.17	12,647.54	13,026.97	13,417.78
Annual costs		8,424.00	8,676.72	8,937.02	9,205.13
Earnings before taxes and depreciation		3,855.17	3,970.82	4,089.95	4,212.65
Earnings (cumul.)		3,855.17	7,825.99	11,915.94	16,128.58
Depreciation (4 years)		–2,106.00	–2,106.00	–2,106.00	–2,106.00
Earnings before tax		1,749.17	1,864.82	1,983.95	2,106.65
Taxes (40 %)		–699.67	–745.93	–793.58	–842.66
Earnings after tax		1,049.50	1,118.89	1,190.37	1,263.99
Depreciation		2,106.00	2,106.00	2,106.00	2,106.00
Net cash flow		3,155.50	3,224.89	3,296.37	3,369.99
Cumulative net cash flow		–5,268.50	–2,043.61	1,252.76	4,622.75
Discount rate (10 %)	4 %	1.04	1.08	1.12	1.17
Present value		3,034.14	2,981.60	2,930.46	2,880.68
Total present value		11,826.87			
Net present value		3,402.87			
Discounted annual benefits	46,550.76	11,806.89	11,693.36	11,580.93	11,469.57
Discounted annual costs	31,935.68	8,100.00	8,022.12	7,944.98	7,868.59

9.3.8 Case 8: Stijlvolle Tuinen

Short description

Title of example and country	Heavy slabs? Vacuum lifting! (The Netherlands)
Organisation and contact person: the possible or identified source of information (including URL if available)	Edwin van der Weijden Stijlvolle Tuinen Bethelehemlaan 18, 2181 HN Hillegom info@stijlvolletuinen.nl www.stijlvolletuinen.nl Tel. + 31 (0)23 58 48 808
A short description of the enterprise (including number of employees and sector of economic activity)	Stijlvolle Tuinen is a small company in the Netherlands specialising in gardening. At the time of the intervention, it had 4 employees.

Introduction

A short description of the intervention (3–10 sentences)	The intervention was intended to reduce the physical workload (from lifting) during paving. A tool lifts stone slabs using a vacuum and makes it possible for two workers to lift tiles without adopting awkward postures for long periods.
Keywords (your own keywords)	*Physical workload, gardening, lifting, vacuum, musculoskeletal symptoms*

Aims

One of the most physically demanding tasks for gardeners is paving. Gardeners have to work with heavy paving stones and slabs. The owner of the company, also one of the gardeners, found that paving, particularly with larger slabs, was too physically demanding.

Customers were increasingly asking for larger and heavier slabs (from 20 kg up to 140 kg). Because many gardens in the Netherlands are small or have uneven ground or the stones are too large, workers usually have to pave manually. When the intervention began, most of the workers in the company were experiencing back problems. Sick leave was at 3.82 %.

Therefore, Mr van der Weijden and his workers searched for a tool that would reduce the burden of lifting heavy slabs and was usable in any garden.

What was done and how

Several tools existed to lower physical workloads. However, most of them were not sustainable or convenient for the workers in practice. Eventually, the company found a good-quality tool that was sustainable and practical. The company first rented the tool to experience how it would function in practice. After all workers reported that they were satisfied with the tool, the company bought it.

Implementation is, therefore, an important aspect of such an intervention. It should be noted that the workers needed some training to use the tool. Younger workers in particular were hesitant about using the tool in the beginning. In this company, since the owner is a gardener himself, it was easy to set the right example.

The tool still has some disadvantages, such as: (a) regular cleaning of the tool is required, (b) when the tool is used there is still some heavy work involved in lifting slabs, since the lifter is 14 kg, and (c) the tool does not work when stones are dirty or porous.

Costs of intervention per cost category according to the common cost model

The initial investment was €1,952. €1,400 was for the vacuum lifter and €552 was for four afternoons of training for four workers (€34.50 per hour per employee). Total depreciation (over four years) was €488 per year. Yearly costs were €39 interest, €100 maintenance, €25 insurance and €35 energy costs. Total annual costs are €687.

In return, the company experienced more efficient working, which made it possible to earn back the investment. The tool is used about 10 times per year and makes working about 40 % more efficient. So instead of spending 400 hours on those 10 jobs, the company spends only 240 hours with the vacuum lifter. This saves them 160 hours at €34.50, or €5,520, per year.

What was achieved

The physical workload was reduced when using the tool during paving. Moreover, workers experienced more job satisfaction. The tool improved safety at worksites as the chance of accidents involving injury to hands and fingers decreased. There is still some heavy lifting involved in paving, but it requires less bending and working in uncomfortable positions.

Paving is done to a higher standard because it is easier to place stones horizontally. Therefore, a successful element of the intervention is that fewer stones are damaged. In addition, as the stones are lifted by vacuum from the top, workers can pave more efficiently.

Economic benefits of the achievements

The cost of the vacuum lifter was earned back within less than a year.

CBA results

Payback period (years)

<1.00

Internal rate of return

157.3 %

Net present value

9,749.80

Profitability index

5.99

Benefit–cost ratio

4.6

Further information

This case study has already been published in a different form.

Jong, T. de, Hiemstra, S., 'Heavy slabs? Vacuum lifting!', in Good practices: From heavy to sustainable working*, TNO, 2013.*

Transferability

Vacuum lifting is easily transferable to other companies in gardening (the tool can be rented or bought). However, the tool could also be used in other sectors, such as the construction industry.

Investing in the new tool is quite a big decision for a small company. The possibility of renting the tool for a period of time was, therefore, an important aspect. After positive experiences, the company bought the tool.

Summary

Paving is one of the most physically demanding tasks for gardeners. Nowadays, more and more customers ask for large and heavy stones, which makes the work even more arduous.

A gardening company experienced this trend and invested in a vacuum lifting tool which makes it possible to lift heavy stones with only two workers. Not only was the physical workload reduced, the quality of the paving and the efficiency of the work improved. The cost–benefit analysis showed that the investment in the tool can be earned back within a year.

Picture 14: Vacuum lifting tool

Investment analysis: calculation

	Year 0	1	3	4
Investment	€ 1,952.00			
Benefits		5,520.00	5,856.17	6,031.85
Annual costs		687.00	728.84	750.70
Earnings before taxes and depreciation		4,833.00	5,127.33	5,281.15
Earnings (cumul.)		4,833.00	14,938.32	20,219.47
Depreciation (4 years)		–488.00	–488.00	–488.00
Earnings before tax		4,345.00	4,639.33	4,793.15
Taxes (40 %)		–1,738.00	–1,855.73	–1,917.26
Earnings after tax		2,607.00	2,783.60	2,875.89
Depreciation		488.00	488.00	488.00
Net cash flow		3,095.00	3,271.60	3,363.89
Cumulative net cash flow		1,143.00	7,596.59	10,960.48
Discount rate (10 %)	4 %	1.04	1.12	1.17
Present value		2,975.96	2,908.44	2,875.47
Total present value				
Net present value		9,749.80		
Discounted annual benefits	20,926.51	5,307.69	5,206.11	5,156.05
Discounted annual costs	2,604.44	660.58	647.93	641.70

9.3.9 Case 9: Kwekerij de Lindenborg

Short description

Title of example and country	Cultivating cucumbers in an efficient and healthy way, the Netherlands
Organisation and contact person: the possible or identified source of information (including URL if available)	Contact person: Twan Prinse Kwekerij de Lindenborg Sprundelsebaan 35 4838 GM Breda The Netherlands info@delindenborg.nl www.delindenborg.nl Contact person: Cor Taks Taks Tuinbouwtechniek BV Leursebaan 304 4839 AN Breda The Netherlands info@taks.nl www.taks.nl
A short description of the enterprise (including number of employees and sector of economic activity)	The company employs two-full time employees, one self-employed freelance worker and contract workers depending on the workload. The company employs two employees, one self-employed worker flex workers, depending on the workload. The company, based in the Netherlands, specialises in cultivating cucumbers.

Introduction

A short description of the intervention (3–10 sentences)	The intervention aimed to replace an old trolley bearing several boxes (around 16) containing cucumbers after picking. The new system consists of a new type of trolley with only two fixed containers and the possibility of putting an extra unit on top of it. Each container has a moveable bottom, so workers do not have to bend so much. Workers do not need to adopt awkward postures as much as before and, at the same time, dropping the cucumbers into the boxes is more comfortable. On top of this, the cucumbers are less likely to be damaged. In addition, a system was developed to empty the containers automatically into the processing machine.
Keywords (your own keywords)	*Health, cucumbers, physical workload, trolley, efficiency*

Aims

Picking and processing cucumbers is physically demanding. Employees have to lift and move boxes of cucumbers, adopting awkward postures and performing many repetitive movements for a long period of time each day. Picking the cucumbers, moving the boxes of cucumbers and sorting them are the most physically demanding tasks. No technique existed for moving the boxes easily. Solutions developed previously lacked efficiency.

In 2010, the company was planning to increase its surface area from 1.7 hectares to 3 hectares. This growth of the greenhouse triggered the director of the company to invest in a new picking and processing system for two reasons: (a) to create more efficiency in picking the greater number of cucumbers, and (b) to provide less physically demanding work for the employees. Lowering the amount of physically demanding work was of particular interest to the employers, as most of the workers (including the flex workers) were older. In addition, the manager wanted to improve the efficiency of the production process. In other words, he hoped to produce more cucumbers and fewer damaged cucumbers.

What was done and how

The new system was developed in close collaboration with a partner specialising in technical solutions for greenhouse cultivation. Taks Tuinbouwtechniek, also based in Breda, was already worked on the concept of the system and was searching for a company to implement and optimise the system in practice. Several prototypes were tested in practice. The final prototype not only made physically demanding tasks easier for the workers but also improved the efficiency of the work (fewer working hours used to pick and sort a given number of cucumbers).

The new system consists of a new type of trolley with only two fixed containers and the possibility of putting an extra unit on top of it. Each container has a movable bottom, so workers do not have to bend so much. Workers do not need to adopt awkward postures as much as before and, at the same time, dropping the cucumbers into the boxes is more comfortable. On top of this, the cucumbers are less likely to be damaged. In addition, a system was developed to empty the containers automatically into the processing machine.

The success of the system was the result of the collaboration of the supplier with the company, which brought about a technical solution that was practical for both the workers and the manager. The close collaboration between the companies meant that the new system could be implemented quickly.

Costs of intervention per cost category according to the common cost model

The investment consisted of the new trolley system and the new cucumber processing system. No additional time was needed for training the staff.

The costs of the systems were invoiced to the cucumber grower and compensated for by reduced labour costs. A total of €172,000 was invested in developing and installing the new system. It depreciated over four years at €43,000 per year; the interest rate was 3.6 % (€6,192 per year). Other annual costs were maintenance at €3,440 per year. Total annual costs were €52,632 in the first year, rising slightly in the following years because of 3 % inflation rate. On the other hand, some sick leave costs were avoided and the costs of the picking and sorting processes were reduced.

Work-related sick leave as a result of MSDs was 0.61 % and was reduced by 20 %. This equals an average of two hours per year less sick leave per employee. With an average number of 20 employees, 40 hours would be saved. Including replacement costs, this saves €1,360 per year.

Picking became 15 % and sorting 5 % more efficient. This means that 2,932 hours per year were saved, resulting in a saving of 2,932 at €17 per hour, or €49,852.50, per year.

The investment was earned back in a little over four years.

What was achieved

The number of working hours used to pick and process a given number of cucumbers decreased under the new system.

Qualitative results showed a positive impact on the workers:

- Work became less physically demanding (less lifting and less awkward postures).
- Sustainable employability increased among the workers.
- Workers were more comfortable during working time.

Processing the cucumbers became more efficient and less time was needed for picking and processing them. The intervention also had a positive influence on the quality of the cucumbers, as it resulted in less damage. In addition, packaging the cucumbers became less physically demanding.

Economic benefits of the achievements

The investment was earned back in a little over four years.

CBA results

Payback period (years)	>4
Internal rate of return	–30.0 %
Net present value	–112,794.63
Profitability index	0.34
Benefit–cost ratio	0.5

Further information

This case study has already been published in a different form.

Jong, T. de, 'Harvest cucumbers easier' in Good practices: From heavy to sustainable working, TNO, 2013.

Transferability

This project could be implemented by any similar organisation. The cost benefit is evident.

Summary

Picking and processing cucumbers is physically demanding. Because his workers were getting older, a Dutch cucumber grower expected more musculoskeletal complaints caused by awkward postures, repetitive movements and lifting during picking and processing cucumbers. Therefore, together with a supplier, he developed a new system for picking and processing cucumbers more easily. After developing concepts and testing the prototypes, a new system using an ergonomic container was developed which was not only healthier for the workers but also more efficient for the production

process (both picking and sorting). These two benefits made implementation easier. The results showed that the investment was earned back in a little over four years.

Picture 15: Picking

Picture 16: Sorting

Investment analysis: calculation

	Year 0	1	2	3	4
Investment	€ 172,000.00				
Benefits		51,212.50	52,748.88	54,331.34	55,961.28
Annual costs		52,632.00	54,210.96	55,837.29	57,512.41
Earnings before taxes and depreciation		–1,419.50	–1,462.09	–1,505.95	–1,551.13
Earnings (cumul.)		–1,419.50	–2,881.59	–4,387.53	–5,938.66
Depreciation (4 years)		–43,000.00	–43,000.00	–43,000.00	–43,000.00
Earnings before tax		–44,419.50	–44,462.09	–44,505.95	–44,551.13
Taxes (40 %)		17,767.80	17,784.83	17,802.38	17,820.45
Earnings after tax		–26,651.70	–26,677.25	–26,703.57	–26,730.68
Depreciation		43,000.00	43,000.00	43,000.00	43,000.00
Net cash flow		16,348.30	16,322.75	16,296.43	16,269.32
Cumulative net cash flow		–155,651.70	–139,328.95	–123,032.52	–106,763.20
Discount rate (10 %)	4 %	1.04	1.08	1.12	1.17
Present value		15,719.52	15,091.30	14,487.47	13,907.09
Total present value				59,205.37	
Net present value		–112,794.63			
Discounted annual benefits	194,148.39	49,242.79	48,769.30	48,300.36	47,835.94
Discounted annual costs	199,529.77	50,607.69	50,121.08	49,639.15	49,161.85

9.3.10 Case 10: Glass Handling Technic

Short description

Title of example and country	Safe repair device for greenhouses, the Netherlands
Organisation and contact person: the possible or identified source of information (including URL if available)	Glass Handling Technic Naaldwijkseweg 5-A 2291 PA Wateringen Contact: John Bergman Tel. + 31 (0)174 290717 http://www.ghtec.nl/eng/index.html
A short description of the enterprise (including number of employees and sector of economic activity)	Glass Handling Technic is a collaboration between three organisations involved in the agricultural sector. They requested a group of companies to develop a safe repair device for greenhouses that would meet all current standards. The bundling of expertise resulted in a strong collaboration with a lot of knowledge at its disposal. Participating in the group are: Batist Aluminium Constructions, TST Total Service, and Van der Waay Machine Constructors.

Introduction

A short description of the intervention (3–10 sentences)	Greenhouses allow effective cultivation of various crops, such as tomatoes, cucumbers and flowers, in various climatic conditions. When erecting a new greenhouse, as an extra investment the grower can choose to install a repair shuttle. This is a kind of a cart/work platform that is mounted on top of the greenhouse. From this cart, the whole surface of the greenhouse can be reached safely and effectively to mount and replace panes of glass and carry out other repairs and maintenance.
Keywords (your own keywords)	*Safety, greenhouses, construction, cultivation of crops*

Aims

For the safety of its own employees, the greenhouse construction company prefers to install the repair shuttle. However, the owner of the greenhouse has to pay extra for this investment. He or she may see only the burden of a higher investment, not the value of the safety features. The construction company wanted to prove the cost-effectiveness of the repair shuttle for greenhouse owners.

What was done and how

The repair shuttle was developed by a consortium of different companies. With the help of AVAG (the Trade Organisation for Contractors and Fitters in Glasshouse Horticulture), a cost–benefit calculation tool was developed to help convince owners of greenhouses that safe construction benefits not only the construction company but also their cultivation business. A generic tool for all greenhouse construction tasks was developed; pilots performed for 12 different safe working methods showed that the tool works. Pilots were set up, for instance, for the repair shuttle on the roof of the greenhouse, safety glass, high-quality piping for liquid fertilisers.

Not all cases turned out to be cost-effective, making it clear that safety may have its price. Please note that in the calculations the costs of accidents are not taking into account, as no accidents occurred during the pilot period. The probability of an accident happening in the long term is unknown, and the costs resulting from possible accidents are therefore hard to estimate.

Costs of intervention per cost category according to the common cost model

One of the calculations concerns a greenhouse of 4 hectares for tomatoes. The extra investment in a repair shuttle and the additional construction costs amount to €30,000. The repair shuttle has an economic life of 10 years. The interest rate over the investment is 6 %, resulting in extra depreciation costs plus interest of €3,990 per year. The annual maintenance costs are €250.

The repair shuttle is used for different tasks, for example:

a) *Cleaning the glass on top of the greenhouse. This is done once a year. With the repair shuttle, this can be done (safely) in two days by one worker, costing €560 per year. Without the repair shuttle, the worker would need to balance on the steel beams of the greenhouse. The job would take 10 days for one man to complete, resulting in costs of €2,800 per year.*
b) *Cleaning drains. This task is done annually. With the repair shuttle, it is done in three days, costing €840. Without the repair shuttle, it takes five days and costs €1,400.*
c) *Application of chalk to the glass. This task is also done annually. With the repair shuttle, this takes eight hours and costs €280. Without the repair shuttle, it takes 16 hours, and costs €560.*
d) *Replacing broken glass. This is required four times per year as an average. With the repair shuttle, glass can be replaced from the roof of the greenhouse, taking two men five hours for two men per case, while without the repair shuttle this has to be done from the inside of the greenhouse, in which case it takes seven hours for four men. The costs of labour are €1,814 with the repair shuttle and €5,184 without it. When replacing glass from the inside, damage to the crop is likely, with average costs of €100 per case, or €400 per year. In addition, equipment needs to be disinfected when working from the inside, which costs €45 per case, resulting in €180 additional costs per year.*

What was achieved

Working with the repair shuttle is far safer than the traditional way (walking over the beams of the greenhouse). Furthermore, the repair shuttle is cost-effective. Physical workloads are reduced and working with the repair shuttle is more comfortable.

Economic benefits of the achievements

The resulting cost–benefit calculation shows that safety glass saves €3,280 per year.

CBA results

Payback period (years)	*>4*
Internal rate of return	*–14.0 %*
Net present value	*–11,649.56*
Profitability index	*0.61*
Benefit–cost ratio	*0.6*

Further information

The repair shuttle won the 2011 Dutch Good Practice Award, granted by EU-OSHA.

For more information, see: https://osha.europa.eu/fop/netherlands/en/Nieuws/nl_focal_point/dutch-good-practice-winners-2010/?searchterm=repair shuttle.

Transferability

The calculation tool can be used for any task related to safe greenhouse construction works. Not all safe working methods will be cost-effective compared with unsafe working. Basically, the price of safe working should not be a matter for discussion, but we all know that the reality is that business owners try to minimise investments and costs.

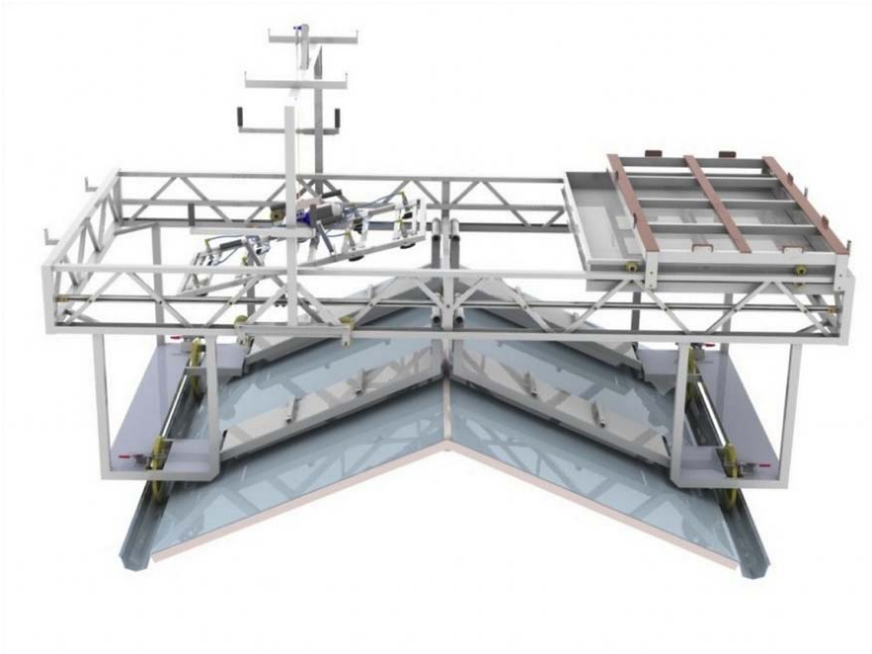
Summary

Greenhouse construction and maintenance can be dangerous. Over the years, the dimensions of the panes of glass used in greenhouses have increased, resulting in more serious safety hazards and greater physical loads when mounting glass during initial construction and when replacing broken glass.

The repair shuttle was developed to perform tasks such as these safely. Although the repair shuttle requires a substantial investment, the cost–benefit calculation results in a positive business case to help persuade the owner of the greenhouse.

Picture 17: Greenhouse construction and maintenance

Picture 18: Repair shuttle



Investment analysis: calculation

	Year 0	1	2	3	4
Investment	€ 30,000.00				
Benefits		7,520.00	7,745.60	7,977.97	8,217.31
Annual costs		4,240.00	4,367.20	4,498.22	4,633.16
Earnings before taxes and depreciation		3,280.00	3,378.40	3,479.75	3,584.14
Earnings (cumul.)		3,280.00	6,658.40	10,138.15	13,722.30
Depreciation (4 years)		–7,500.00	–7,500.00	–7,500.00	–7,500.00
Earnings before tax		–4,220.00	–4,121.60	–4,020.25	–3,915.86
Taxes (40 %)		1,688.00	1,648.64	1,608.10	1,566.34
Earnings after tax		–2,532.00	–2,472.96	–2,412.15	–2,349.51
Depreciation		7,500.00	7,500.00	7,500.00	7,500.00
Net cash flow	€ (30,000.00)	4,968.00	5,027.04	5,087.85	5,150.49
Cumulative net cash flow		–25,032.00	–20,004.96	–14,917.11	–9,766.62

Discount rate (10 %)	4 %	1.04	1.08	1.12	1.17
Present value		4,776.92	4,647.78	4,523.08	4,402.66
Total present value				18,350.44	
Net present value		–11,649.56			
Discounted annual benefits	28,508.58	7,230.77	7,161.24	7,092.38	7,024.19
Discounted annual costs	16,073.99	4,076.92	4,037.72	3,998.90	3,960.45

9.3.11 Case 11: Nota Straatmakers

Short description

Title of example and country	Mechanisation in paving reduces physical strain, the Netherlands
Organisation and contact person: the possible or identified source of information (including URL if available)	Contact: Mr Albertus de Vries Nota Straatmakers BV Wagenmakersstraat 18 8601 VA Sneek Tel. +31(0)515 443816 http://www.notastraatmakers.nl/
A short description of the enterprise (including number of employees and sector of economic activity)	Nota Straatmakers (Paviours) was founded in 1992. The company grew quickly as the result of both quality work and two mergers. Today, the company employs about 150 workers and is the largest in the sector in the Netherlands. Paving small elements is their principal activity (making pavements with bricks). They have their own vocational training scheme, which is organised with the cooperation of vocational education institution.

Introduction

A short description of the intervention (3–10 sentences)	Paving is physically demanding work. When working manually, the trade is amongst the four construction trades with the highest incidence of back complaints. In 2005, Nota introduced mechanical ways of working, initially for placing kerbstones (100–140 kg and more). This was soon followed by mechanical equipment for laying the bricks, for transport and to create the profile of the road (a road needs to be curved to allow rainwater to drain away). Today, Nota have several machines to optimise working conditions.
Keywords (your own keywords)	*Ergonomics, safety, road construction, pavers*

Aims

Nota is a family business. The main owner, Toussaint Nota, is convinced of the need to innovate. 'Our trade could become part of a museum if we don't improve the work organisation.' He wants to ensure that the work does not overstrain his pavers, and that their health is protected. 'About 400 pavers per year get occupational injuries resulting in permanent incapacity to work in the Netherlands. This is not acceptable.'

However, it is not easy to achieve safe and healthy conditions. Working with machines and mechanical equipment is more expensive than working manually, and you need more focus on organising the work. National regulations require that the road owner (usually a community) specifies how the work is performed, manually or mechanically; this is to prevent unfair competition. The labour inspectorate ensures that manual work is discouraged, but nevertheless some private sector companies still try to acquire work for extremely low prices.

What was done and how

The changes in the company began in 2005. Today most of its work is done using mechanical equipment: paving machines and shovels. The company bought several machines.

All staff are trained to perform well and act safely; all of them have the VCA certificate or are working towards one). The company has its own training facilities, including a large piece of land where practical training takes place.

Costs of intervention per cost category according to the common cost model

Initial investments in machines and equipment were substantial: five machines at €125,000 each and five shovels at €40,000 each: a total of €825,000. Depreciation time is four years.

there were additional costs for annual maintenance (€2,500), equipment (€1,000) and training of all pavers (€5,840).

When working with machines, the team numbers four men. When working manually, the team consists of only two pavers. The costs for these additional pavers are paid for by the customer and therefore not included in the business case.

What was achieved

Jobs are done mechanically if the client is willing to pay for it. Financially (from the point of view of the customer), working mechanically cannot compete with working manually. Advantages of working mechanically are:

- The health of the pavers is protected. As a result, absenteeism caused by occupational injuries is almost zero at Nota. Because this might be influenced by other factors, only a small amount of absenteeism reduction was attributed to the project in the business case.
- The lead times for jobs are reduced (for example, five days versus 12.5 days). Therefore, roads are closed for shorter periods and inconvenience for residents is minimised.

Economic benefits of the achievements

The case analysed is a street 200 m long and 5 m wide, with parking spaces along the road and pavements on both sides. Two situations are compared:

a) working manually; and

b) working with machines where possible.

The comparison results in prices per square metre.

a) *Manually: two pavers do the job, with an average production of 8 m² per day. The cost of labour is 2 x €36.50 per hour (incl. overhead) = €584.00 per day. The costs are €7.30 per m².*

b) *Mechanically: 2 pavers + 1 machine operator + 1 assistant produce 200 m² per day. The cost of labour per hour is 2 x €36.50 (pavers) + €36.50 (operator) + €30.00 (assistant), resulting in €1,116.00 per day. The paving machine costs €5.00 per hour and the shovel €15.00 per hour, both including fuel and transport. Machine costs are €520.00 per day. Therefore, the total costs per day are €1,636.00, resulting in costs of €8.18 per m².*

This illustrates that safe and healthy working conditions can be a somewhat (12 %) more expensive. Of course, the company benefits from a lower absenteeism rate, but this accounts for is a relatively small saving compared with the extra costs.

As stated above, the road owner is obliged to specify the manner in which the work will be done, taking into account guidelines on good working conditions. In reality, however, this does not always work well.

In terms of the business case, the company works with surcharges on the cost price when a machine is being used, for example €50.00 per hour for a paving machine, €15.00 per hour for a shovel. The equipment is used in approximately 500 hours per year (of a total of 1,200 working hours per year for paving). So 5 machines x 500 hours x €65 = €162,500 extra income per year.

The relevant economic evaluation indices, as used in the benOSH tool, are:

Payback period (years)	3.20
Internal rate of return	9.8 %
Net present value	117,215.38
Profitability index	1.14
Benefit–cost ratio	1.3

Further information

The older pavers prefer the traditional manual work, while younger pavers prefer working with machines.

In 2009, Nota Paviours won the Golden Paving Brick, awarded by the largest union of construction workers, and it was nominated for the same award in 2011 and 2013. In 2010, Nota was named the best company for vocational training.

Over the years, the company has selected, trained and employed several youngsters who were in a bad position in the labour market.

The motto of the company is 'Always a way ahead'.

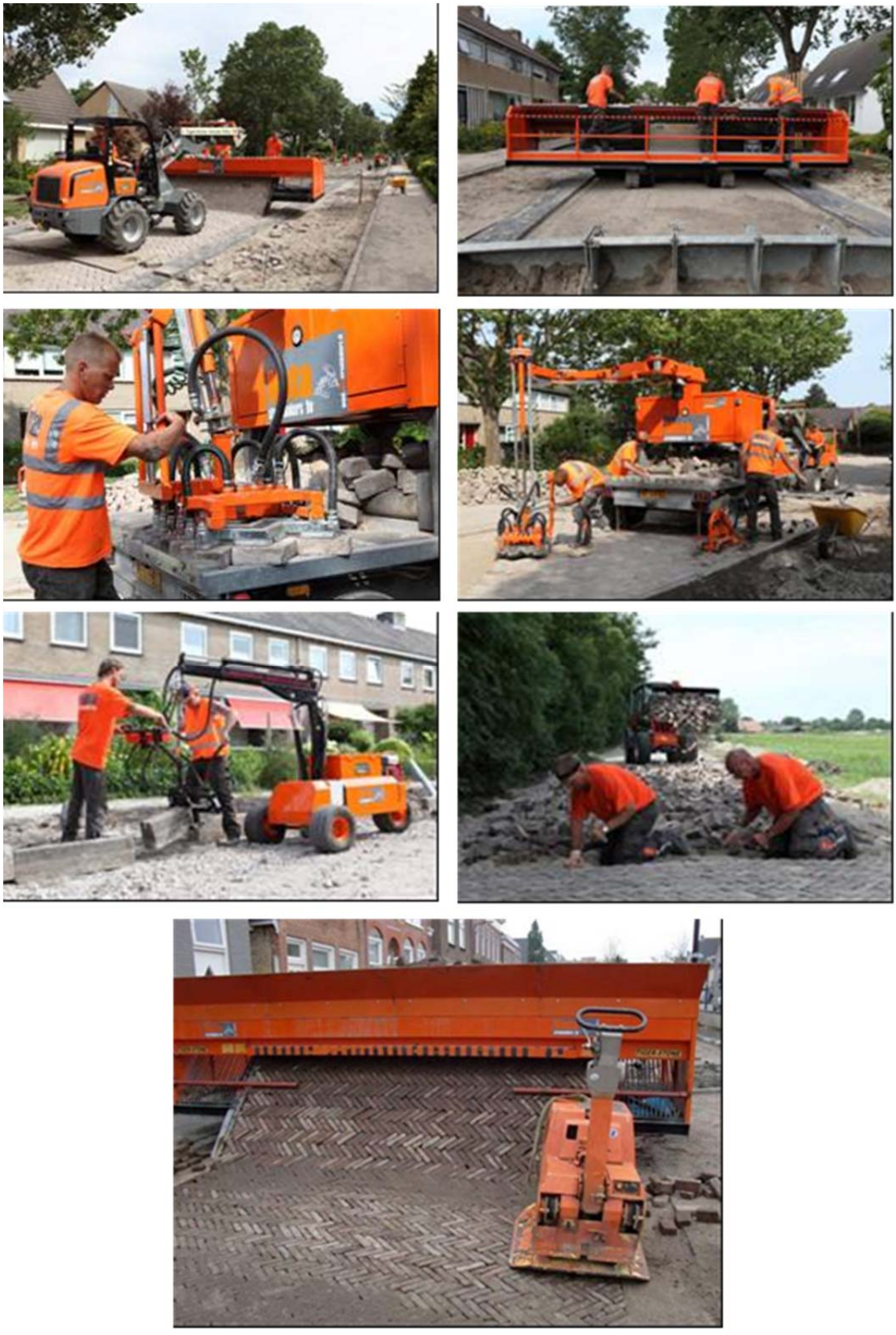
Transferability

The basic philosophy—take care of the health of your workers — can be transferred to other companies. However, some prefer to compete only on price, and for those companies working mechanically may not be desirable.

Summary

Paving manually is highly physically demanding. Paving elements are heavy, working postures are awkward and it is highly repetitive work. Several organisations in the Netherlands promote working mechanically, for example the labour inspectorate, CROW (a national body for regulation in road construction) and some local authorities. However, working mechanically is more expensive, and in these economically difficult times, many road owners do not choose to have the work done in this way.

Picture 19: New paving equipment



Investment analysis: calculation

	Year 0	1	2	3	4
Investment	€ 830,840.00				
Benefits		293,549.60	302,356.09	311,426.77	320,769.57
Annual costs		9,340.00	9,620.20	9,908.81	10,206.07
Earnings before taxes and depreciation		284,209.60	292,735.89	301,517.96	310,563.50
Earnings (cumul.)		284,209.60	576,945.49	878,463.45	1,189,026.96
Depreciation (4 years)		–207,710.00	–207,710.00	–207,710.00	–207,710.00
Earnings before tax		76,499.60	85,025.89	93,807.96	102,853.50
Taxes (40 %)		–30,599.84	–34,010.36	–37,523.19	–41,141.40
Earnings after tax		45,899.76	51,015.53	56,284.78	61,712.10
Depreciation		207,710.00	207,710.00	207,710.00	207,710.00
Net cash flow		253,609.76	258,725.53	263,994.78	269,422.10
Cumulative net cash flow		–577,230.24	–318,504.71	–54,509.93	214,912.17
Discount rate (10 %)	4 %	1.04	1.08	1.12	1.17
Present value		243,855.54	239,206.30	234,690.40	230,303.14
Total present value				948,055.38	
Net present value		117,215.38			
Discounted annual benefits	1,112,856.87	282,259.23	279,545.20	276,857.27	274,195.18
Discounted annual costs	35,408.27	8,980.77	8,894.42	8,808.89	8,724.19

9.3.12 Case 12: Viotros

Short description

Title of example and country	Automation of palletising and the pallet-handling processes, Greece
Organisation and contact person: the possible or identified source of information (including URL if available)	www.viotros.gr *Mr Kyriakos Ferentidis* *Plant Director* *Email:* kferentidis@viotros.gr *Tel.* + 30 25220 22223 *Fax* +30 25220 21019 *Postal address:* *Viotros S.A.* *PO Box 15* *Prosotsani Industrial Park* *66200 Prosotsani* *Drama, Greece*
A short description of the enterprise (including number of employees and sector of economic activity)	VIOTROS S.A., one of the most dynamic enterprises of **ELGEKA GROUP**; it is the largest Greek manufacturing company that produces and packages processed cheeses and cheese alternatives based on vegetable fat. It holds a leading position in the European market. VIOTROS employs 110 workers.

Introduction

A short description of the intervention (3–10 sentences)	The intervention involves automation and reduction of manual handling of loads at the packaging stage and particularly during palletising. It includes the installation of a film-stretching machine for wrapping and nine electrical lifting machines for pallet-handling. The intervention was planned to reduce musculoskeletal problems caused by manual handling of pallets, but it also proved to be economically feasible, as the reduction in labour costs (workers' occupation time) resulted in a payback period of two years for the whole intervention.
Keywords (your own keywords)	Ergonomic intervention, automation of processes, manual handling, palletising, packaging

Aims

The packaging process in Viotros includes palletising and film wrapping of packages. This process used to be conducted manually, which involved manual handling and/or awkward postures. Complaints of lower back pain from workers were frequent, which was a significant problem for the enterprise and the workers.

Although the motivation for the enterprise to undertake an intervention was the improvement of working conditions per se (n accordance with the enterprise's overall policy of commitment to OSH), an economic cost was also present, although it was obscure. Although back problems rarely resulted in absenteeism (either because of the long latency period of these problems or as a result of presenteeism), the impact of back strain on packaging speed was evident, as workers could not maintain the nominal packaging speed. In addition to the measurable delay (lower productivity), the risk of discontinuous events (accident, failure to meet dispatch deadlines) was assessed as particularly high.

After an internal dialogue with workers, it was decided to proceed to semi-automatisation of the process of packaging. The aim was to reduce manual handling and awkward postures and cut back the involvement of workers in the process from a manual to a mainly supervisory role. Workers have richer work content with semi-automation.

What was done and how

The intervention involved semi-automatisation of the process of packaging, changing the role of workers from manual handling to supervision.

- *This type of intervention is common, taking place in many enterprises, and no significant innovation was involved. The necessary steps were simple: preparation of packaging area, installation of new equipment, training.*
- *The new equipment installed was a film-stretching machine for wrapping packages on pallets and nine electrical lifting machines. The equipment was chosen after a simple market research exercise comparing a number of alternative suppliers. Installation and training was conducted by the suppliers.*
- *Because of the low cost of the intervention and the evident nature of the (other than economic) benefits, no extended studies took place. The cost was borne by the enterprise without any external financing.*

Costs of intervention per cost category according to the common cost model

The main costs involved in the intervention were:

Film-stretching machine

- Intervention costs (these costs occurred during the intervention):

- procurement of equipment: €6,000 (the price of the machine including transportation cost)
- installation of equipment: €150 (extra cost for installation of equipment by the supplier)
- training: €50 (brief training session for operators by the supplier).

- Annual costs (these costs are repeated every year after the year of intervention):

- maintenance: €400 (annual maintenance fee charged by the supplier)
- consumables/spare parts: €150 (average estimate)
- electrical power: €35

Electrical lifting machines

- Intervention costs (these costs occurred during the intervention):

- procurement of equipment: €17,100 (nine lifting machines at a cost of €1,900 each)
- training: €100 (brief training session for operators by the supplier)
- electrical power: €105.

- Annual costs (these costs are repeated every year after the year of intervention):

- maintenance: €220 (annual maintenance fee charged by the supplier)
- consumables/spare parts: €1,350 (average estimate)
- electrical power: €140.

In total

Intervention costs: €23,400

Annual costs: €2,260

What was achieved

The main outcome of the intervention was the improvement of working conditions in terms of ergonomics. This outcome has several benefits for the enterprise (whether quantifiable or not).

The intervention took place to improve working conditions per se, without any expectations of economic returns. The enterprise is committed to continuous improvement of working conditions, which suffices itself to trigger such interventions, especially when costs are easily affordable.

However, the intervention also had some economic benefits (both visible and not).

The 'invisible' dimensions include:

- reducing the risks of future musculoskeletal problems (results will be visible in the long term but are not yet visible because of the long latency period)
- reducing the risk of accidents during manual handling (results will be visible in the long term, when the comparison of incidence rates will be reliable in terms of sufficient samples)

The 'visible' dimensions include:

- reducing the burden of acute symptoms caused by manual handling and awkward postures
- reducing and stabilising processing time in the packaging section, eliminating failure to meet target processing times by overstrained workers.

Quantification can take place only for the last point, as all the others are too difficult to quantify.

Economic benefits of the achievements

The whole spectrum of economic benefits cannot be estimated in such an intervention. However, the most important implications recognised are as follows.

- Potential reduction in absenteeism as a result of musculoskeletal problems: although musculoskeletal strain is one of the most important causes of absenteeism, the long latency period for the incidence of symptoms and potential presenteeism issues do not allow for an accurate estimate of such costs in the short term.
- Reduction in the risk of accidents: in addition to causing musculoskeletal strain, manual handling of weight involves a high risk of accidents involving packages falling on workers. Because of the small size of the enterprise, however, such incidents were not frequent. Therefore, the actual reduction of risk (and estimated related cost) will take too much time for a representative observation period and sample of accidents.
- Reduction in costs due to unstable and increased processing times in the packaging section. Although musculoskeletal diseases have a long latency period, some acute symptoms (temporary fatigue or pain) appear immediately, affecting the productivity of workers. Increased processing times caused by the failure of workers to meet schedules (because of such symptoms) are measurable and can be used to assess the economic feasibility of the intervention. Moreover,

there is also a non-measurable aspect, involving the costs of discrete failures to meet strict deadlines (resulting in cancelling of orders, damage to reputation and so on), which has not been taken into account in this estimation.

- Regardless of nominal time, the average wrapping time before the intervention was 1.73 min per pallet, which fell to 0.826 min. per pallet after the intervention. With a total cost of €11 per hour and about 130 pallets daily, this leads to €5,712 savings annually. Similarly, 1,103.64 hours are saved annually by the use of lifting equipment as a result of an improved true average processing time (including deviation from nominal time as a result of fatigue). At €11 per hour, this leads to savings of €12,140.40 annually. Total annual savings are €17,852.40.

Payback period (year	2.00
Internal rate of return	34.9 %
Net present value	19,053.22
Profitability index	1.81
Benefit–cost ratio	2.1

The estimated benefit is only a part of the overall sum saved, as further (non-measurable) costs have been avoided.

Further information

The problem was evident and easy to explain, especially in an SME. The intervention was also simple and the costs were low. Therefore, it was planned and executed internally, without external consulting or funding.

Transferability

This intervention is common in terms of both the problem and the solutions applied, so it can be replicated in many enterprises, regardless of size or sector and without many adaptations. Packaging sections exists in many enterprises and palletising is the most common practice. Although the size and weight of the packages vary, this practice generally involves weight handling and/or awkward postures.

Such poor working conditions from an ergonomic point of view can cause musculoskeletal disorders, which are the major cause of absenteeism at work. However, the long latency period of such problems, as well as the phenomenon of presenteeism, especially in times of high unemployment, could make these problems less noticeable, at least in the short term.

Nevertheless, musculoskeletal problems also have some short-term consequences, such as unstable or increased processing time, as workers cannot keep to scheduled times due to acute symptoms (fatigue, pain). This potentially has a significant economic impact.

The intervention is simple and easily transferable, as the items (equipment) and costs involved are likely to be the same, with small variations, for different enterprises. The overall cost is generally low, which makes the intervention generally feasible, even without taking into account absenteeism problems (which may vary in different countries, sectors or sizes of enterprise).

Summary

Aiming to reduce ergonomic problems in the packaging section, caused by manual handling and awkward postures, Viotros proceeded to semi-automatisation of the process through the installation of electrical lifting equipment and a wrapping machine. In addition to the positive effects on working conditions and reduction in musculoskeletal complaints, there were also economic benefits as a result of the stabilisation and reduction of processing time in this section.

Picture 20: Wrapping before intervention

Picture 21: Wrapping after intervention

Picture 22: Lifting before intervention

Picture 23: Lifting after intervention

Investment analysis: calculation

	Year 0	1	2	3	4
Investment	€ 23,400.00				
Benefits		17,852.40	17,852.40	17,852.40	17,852.40
Annual costs		2,260.00	2,260.00	2,260.00	2,260.00
Earnings before taxes and depreciation		15,592.40	15,592.40	15,592.40	15,592.40
Earnings (cumul.)		15,592.40	31,184.80	46,777.20	62,369.60
Depreciation (4 years)		–5,850.00	–5,850.00	–5,850.00	–5,850.00
Earnings before tax		9,742.40	9,742.40	9,742.40	9,742.40
Taxes (40 %)		–3,896.96	–3,896.96	–3,896.96	–3,896.96
Earnings after tax		5,845.44	5,845.44	5,845.44	5,845.44
Depreciation		5,850.00	5,850.00	5,850.00	5,850.00
Net cash flow		11,695.44	11,695.44	11,695.44	11,695.44
Cumulative net cash flow		–11,704.56	–9.12	11,686.32	23,381.76
Discount rate (10 %)	4 %	1.04	1.08	1.12	1.17
Present value		11,245.62	10,813.09	10,397.20	9,997.31
Total present value				42,453.22	
Net present value		19,053.22			
Discounted annual benefits	64,802.34	17,165.77	16,505.55	15,870.72	15,260.31
Discounted annual costs	8,203.56	2,173.08	2,089.50	2,009.13	1,931.86

9.3.13 Case 13: Artbau Zagler GmbH

Short description

Title of example and country	**Business case: innovative hoist for flat conversion (as part of other preventive measures to increase safety and health at work), Austria**
Organisation and contact person: the possible or identified source of information (including URL if available)	Artbau Zagler GmbH, Zagler Strasse 4 2111 Tresdorf, Austria Sabine Trnka (office@artbau.at) www.artbau.at
A short description of the enterprise (including number of employees and sector of economic activity)	The company is a building company in the remediation sector. It has about 90 employees, among them builders, pavers, tilers, plumbers, heating installers and ventilation installers The business portfolio comprises pipe rehabilitation, repair of fire or water damage, home refurbishments, annexes and rebuilding.

Introduction

A short description of the intervention (3–10 sentences)	A specially designed material lift was developed in 2010 to facilitate the transportation of heavy goods and debris at construction sites. Productivity increased, and positive side effects included shorter construction times and less exposure to noise and dust in staircases. Sickness absence rates are continually falling.
Keywords (your own keywords)	Goods hoist, transportation and lifting of heavy goods, training, employee involvement, continuous activities

Aims

During inspections of the company's working processes, the executive board, the construction management and the workers determined that the work predominantly consisted of carrying, lifting, stooping and manual transportation of huge amounts of materials and debris. Per flat conversion, an average of 16 m^2 of broken-down materials and 2,000 kg of building materials are moved. Floor tilers handle an average of 1,100 kg of material per flat. The loads were carried manually up and down stairways. These activities were not value-adding, put strain on the workers and led to frustration, demotivation and high sickness absence rates. This problem was identified internally and a team of employees was appointed to find a solution. The aim was to eliminate as far as possible manual transportation and its negative influence on workers' health, the number of accidents and the working atmosphere, as well as to improve net added value at building sites.

What was done and how

A transportation method that suited the requirements of work in the urban housebuilding sector was needed. Furthermore, the device needed to be easily be moved and transported. The company found a builder's hoist supplied by a German company to use as a basis and converted it to meet the firm's specific needs. A team of workers used auxiliary devices to construct a prototype that was subsequently remodelled by the German supplier. Finally, the builder's hoist was certified in accordance with Austrian guidelines. The lifting device is dismountable and can therefore be readily handled and transported to different sites.

Costs of intervention per cost category according to the common cost model

Intervention costs: about €20,000 (planning, design, implementation, and acquisition of six material lifts).

Annual maintenance costs: €1,000 to €1,500, average estimate €1,250. Annual training costs of €1,000 should also be added. The total annual costs of the intervention are €2,250

What was achieved

The material lift largely removed the physical burden on workers during the transportation of building materials and demolition waste. In particular, strain on the back was reduced to a large extent, and workers regarded the lifting device as a great help. The intervention resulted in increased levels of worker satisfaction and motivation and a reduction in sickness-related absenteeism. A considerable number of staff members have made further suggestions for improvements. Other improvements are shorter construction periods, less dirt on construction sites and staircases, and increased client satisfaction.

In addition, the company offers continuous training for all employees (for example on appropriate lifting and carrying techniques on construction sites) and workplace health promotion initiatives to underline the significance of OSH and to achieve a paradigm change in the attitudes of workers towards a better awareness of safety at work. Employees are requested to contribute actively to different kinds of improvement activities. The company's figures on OSH attainments are discussed in frequent meetings, and measures for further improvements are arranged.

Economic benefits of the achievements

Since other measures were implemented at the same time, it is not possible to assign the economic benefits specifically to the intervention implementing the material lift. The percentages refer to the effects of all OSH efforts.

- Productivity grew by 30 % between 2010 and 2012.
- The number of occupational accidents decreased by 70 % between 2010 and 2012.
- Sick leave fell by 20 % between 2010 and 2012.

Because of the difficulty of estimating the economic benefits of improved productivity, the benefits are estimated taking into account only the reduction in absenteeism. The sick leave rate before the intervention was 12.73 days per year per employee. After the intervention, this dropped to 9.97 days. So the sick leave avoided amounted to 2.76 days per employee per year, which is 1.1 % of the number of working days in they year in Austria (250). Taking into account the relevant labour costs, this reduction in sick leave days amounts to a saving of €24,288 annually.

According to the benOSH tool, the evaluation results are:

Payback period (years)	1.31
Internal rate of return	66.1 %
Net present value	35,257.17
Profitability index	2.76
Benefit–cost ratio	3.1

Further information

The company meets the BS OHSAS 18001 standard and was received awards for serving as a role model for other enterprises:

winner of the Goldene Securitas 2012 for special achievements in OSH, in the category 'Working safely and healthily'

third place in the state award for safety at work 2011.

The company strives for continuous improvement of the builder's hoist.

Transferability

A prerequisite for the success of the measure is a general emphasis on OSH activities and continuous improvement processes in relation to working methods and workers' health. The crucial point in this case was the experience and the identification of the problematic situation of the workers on site. In such conditions, the deployment of the hoist described or a similar lifting device is transferable to all enterprises, including in different areas and countries.

Summary

The company Artbau Zagler decided to develop and implement a hoist for material lifting to reduce physical strain on workers. To ensure the safe movement of materials, the hoist's transport cage was replaced with a closed container. Before the reconstructed hoist was put into service at construction sites, it was inspected and TÜV-certified. The main result was healthier and more motivated workers: there is no longer any need to carry heavy goods during remediation activities, so MSDs and back disorders generally have been vastly reduced.

Picture 24: The material hoist

Picture 25: Use of the material hoist

Picture 26: The situation before the implementation of the hoist

Investment analysis: calculation

	Year 0	1	2	3	4
Investment	€ 20,000.00				
Benefits		24,288.00	24,288.00	24,288.00	24,288.00
Annual costs		2,250.00	2,250.00	2,250.00	2,250.00
Earnings before taxes and depreciation		22,038.00	22,038.00	22,038.00	22,038.00
Earnings (cumul.)		22,038.00	44,076.00	66,114.00	88,152.00
Depreciation (4 years)		–5,000.00	–5,000.00	–5,000.00	–5,000.00
Earnings before tax		17,038.00	17,038.00	17,038.00	17,038.00
Taxes (40 %)		–6,815.20	–6,815.20	–6,815.20	–6,815.20

Earnings after tax		10,222.80	10,222.80	10,222.80	10,222.80
Depreciation		5,000.00	5,000.00	5,000.00	5,000.00
Net cash flow		15,222.80	15,222.80	15,222.80	15,222.80
Cumulative net cash flow		–4,777.20	10,445.60	25,668.40	40,891.20
Discount rate (10 %)	4 %	1.04	1.08	1.12	1.17
Present value		14,637.31	14,074.33	13,533.01	13,012.51
Total present value				55,257.17	
Net present value		35,257.17			
Discounted annual benefits	88,162.90	23,353.85	22,455.62	21,591.94	20,761.48
Discounted annual costs	8,167.26	2,163.46	2,080.25	2,000.24	1,923.31

9.4 Appendix IV: Methods of economic evaluation of health interventions

Economic evaluation

Economic evaluation is a tool to help decision-makers allocating scarce resources by making economic information available. In OSH research, interest in economic evaluations has steadily grown as researchers realise that resources for OSH interventions are limited and health problems in the working population bring with them a significant socioeconomic burden (Burdorf, 2005 Uegaki, 2010). It is, however, unclear if these evaluations are used in practice by decision-makers.

Despite a number of limitations and methodological issues (see section 2.2) a (formal or informal) economic evaluation is the only way to clarify and evaluate choices among alternatives. Furthermore, it can make estimates of costs and benefits — and the assumptions on which they are based — explicit (Myers *et al*., 2008). If properly used, economic evaluation methods can lead to clear and easily understandable results that can be directly linked to company decision-making, the conditions being that the methods are correctly used and combined with professional OSH expertise (Frick, 1999). However, it is a fact that there is a shortage of formal economic evaluations in OSH literature.

Methods of economic evaluation

Economic evaluation methods evaluate not only the health effects of an OSH intervention or measure but also its monetary consequences. Depending on the way the consequences of the intervention are valued, evaluation methods include cost-minimisation analysis, cost-effectiveness analysis, cost–utility analysis and cost–benefit analysis. Each method involves costs to be measured in monetary terms, but the key differences between them lie in how health and other consequences or outcomes are measured. This is why a choice between the methods should be based on the objective of the intervention and the question addressed by the study (Hoch and Dewa, 2008; Kankaanpää *et al*., 2008). An overview of these methods is presented in Table 19.

Table 19: Different types of economic evaluations and their characteristics

Kind of economic evaluation	Outcome measurement: how valued?	Advantages	Limitations
Cost-minimisation analysis	Outcomes are not valued because the assumption is that they are similar	Focus only on costs, selecting the cheapest alternative	Health benefits are supposed to be identical
Cost-effectiveness analysis	Natural/common units such as cost per health outcome	Outcomes are measured in natural units to facilitate understanding of health effects	Different health outcomes from different programmes are not comparable
Cost–utility analysis	QALYs or DALYs	QALY/DALY make programmes comparable	There are many ways to estimate QALY/DALY and different methods can yield different answers
Cost–benefit analysis	Monetary units only	Both benefits and costs are valued in monetary units	May be difficult to obtain objective monetary values for non-monetary consequences

Sources: Hoch and Dewa, 2008; Maynard, 2011

In ***cost-minimisation analysis (CMA)***, the only measure of interest is the difference in cost of an intervention, because the assumption is that the health outcomes are similar. CMA assesses which choice is cheapest (Hoch and Dewa, 2008; Maynard, 2011). Therefore, it is sufficient only when the outcomes of the alternatives compared are identical.

Cost-effectiveness analysis (CEA) compares the costs and monetary consequences per unit of health outcome between two OSH measures, with cost-effectiveness expressed as an incremental cost-effectiveness ratio (ICER). However, the denominator can be other units as well, such as cost per employee or cost per unit of production (Biddle, 2009). Hoch and Dewa (2008) refer to it as natural units. Maynard (2011) speaks of common units. CEA is most useful for outcomes that are difficult to express in monetary units, given that these outcomes are one-dimensional, such as cases of cancer or a decrease in pain levels.

Cost–utility analysis (CUA) is similar to cost-effectiveness analysis but it uses utilities instead of health outcomes. The health outcome is transformed into generic units, usually quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs). The method makes a comparison possible between interventions or projects that have different health outcomes, such as pain or cancer, by calculating the cost per QALY or DALY gained. CUA is seldom used in the context of workplaces (Kankaanpää et al., 2008).

Cost–benefit analysis (CBA) translates all outcomes into monetary units. The recommended measure is the net present value, measuring all costs and benefits of the intervention as present values using a discount rate (Kankaanpää et al., 2008). The results can also be presented as a cost–benefit ratio or a payback period. Therefore, CBA allows for the assessment of multidimensional outcomes (because they are all translated in monetary units), as well as assessing whether an investment is worth making or not, regardless of other alternatives (in other words whether outcome exceeds input, both in monetary units). Its main disadvantage is the uncertainties involved in translating all outcomes into monetary units.

An alternative, fifth method of economic evaluation (Tompa, Culyer and Dolinschi, 2008) is the cost–consequence analysis (CCA), where costs and consequences are calculated, although not added or combined into a summary measure.

The organisation can choose the outcome measures that suit its need for information and the resources available. Usually this means that only monetary outcomes are taken into account (CBA), because enterprises (being solely economic entities, regardless of their stakeholders' feelings and motives) can perceive only economic costs (Antonopoulou and Targoutzidis, 2010), although they may be indirect (damage to reputation, fines and so on). Similarly, in the benOSH study (De Greef *et al*., 2011) it was demonstrated that CBA is useful for providing evidence of the profitability of a specific measure within the context of a specific company — in other words, a business case.

9.5 Appendix V: Short descriptions of existing case studies

Table 20: Short descriptions of existing case studies in the literature

Author	Country	Sector	Description	Reviews
Abrahamsson, 2000	Sweden	Manufacturing	Development of a new ladle service department by a consultant company, which used different participatory and pedagogical methods in the process of designing the new department. The intervention addressed issues related to the environment, climate factors, and the role of the ladle service in the steelworks, transport routes and production flows. The new ladle service department had an advanced climate and ventilation system that kept the heat and smoke from the ladles out of the working area.	Tompa *et al*., 2007
Alamgir *et al*., 2008	Canada	Healthcare and social assistance	Installation of overhead lifts to reduce the risk of musculoskeletal injury in healthcare workers.	Verbeek, Pulliainen and Kankaanpää, 2009
Alexander *et al*., 1977	United States	Telecoms	'No' pre-placement medical examination: examination conducted, however, all results reported as 'no risk for work performance or attendance'.	Uegaki *et al*., 2010
Amick *et al*., 2003, DeRango, 2003	United States	Administration	Highly adjustable chairs and a one-time office ergonomic training workshop with a series of educational follow-ups conducted concurrently with the distribution of the chairs.	Tompa *et al*., 2007
Arnetz, 2003	Sweden	Multiple sectors	A disability management programme that included early medical, rehabilitation and vocational interventions, as well as ergonomic improvements and adaptation of workplace conditions.	Tompa *et al*., 2007
Banco *et al*., 1997	United States	Retail and trade	Three ergonomic interventions were implemented in three groups of stores: ▪ Group A stores: new safety case cutters with education; ▪ Group B stores: old cutters with education; and	Tompa *et al*., 2007; Uegaki *et al*., 2010

Author	Country	Sector	Description	Reviews
			▪ Group C stores: status quo (old cutters) — control group.	
Bergström, 2005	Finland	Manufacturing	Participatory ergonomics to find good solutions for ergonomic changes in layout and work rotation; included purchasing lifts.	Verbeek, Pulliainen and Kankaanpää, 2009
Bernacki and Tsai, 2003	United States	Healthcare and social assistance	Integrated workers' compensation claims management system to allow safety professionals, adjusters, and selected medical and nursing providers to collaborate in a process of preventing accidents and expeditiously assessing individuals, teaching them and returning them to productive work.	Tompa *et al*., 2007
Bradley, 1996	United States	Administration	An ergonomic programme consisting of training and workstation redesign.	Tompa *et al*., 2007
Brophy, Achimore and Moore-Dawson, 2001	United States	Healthcare and social assistance	Introduction of patient-lifting equipment and a five-step ergonomic programme: (1) create a resident transfer evaluation team; (2) establish an accident review committee; (3) mandatory ergonomic training for new nursing aides; (4) regular maintenance checks for lifting equipment; and (5) direct access to the management and budget process.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Brown *et al*., 1992	United States	Public administration	A back school programme consisting of six weeks of education and training.	Tompa *et al*., 2007
Bunn *et al*., 2001	United States, Canada and Mexico	Manufacturing	The intervention included ergonomics, disability management and health promotion.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
			A health, safety and productivity group was given the task of expanding the management of safety, workers' compensation, disability, absenteeism, medical services, preventive care and disease management, and indirect costs as a result of loss of health and productivity.	
Burdorf *et al*., 2005	Netherlands	Construction	Ergonomic equipment (hydraulic clamp/vacuum unit for street making; automated pump or silo/trunk with pump for laying cement flooring).	Uegaki *et al*., 2010
Cameron, 1997	Canada	Healthcare and social assistance	Conversion from powdered latex gloves to powder-free latex gloves.	Tompa *et al*., 2007
Caulfield, 1996	Canada	Healthcare and social assistance	A comprehensive programme consisting of health promotion, disease prevention and disability management.	Tompa *et al*., 2007
Charney, Zimmerman and Walala, 1991	United States	Healthcare and social assistance	A lifting team to reduce the number of lifts performed by nurses by 95 %.	Tompa *et al*., 2007
Chhokar *et al*., 2005	Canada	Healthcare and social assistance	Introduction of mechanical ceiling lifts and training.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Collins *et al*., 2004	United States	Healthcare and social assistance	A musculoskeletal injury prevention programme consisting of mechanical lifts and repositioning aids, a zero lift policy and worker training on lift usage.	Tompa *et al*., 2007; Uegaki *et al*., 2010
Collins, 1990	Australia	Healthcare and social assistance	Major components of the intervention were risk identification, assessment and control strategies, education and training strategies and injury management strategies.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
Daltroy *et al*., 1997	United States	Transportation and warehousing	A back school programme consisting of two training sessions. The programme included principles of back safety; correct lifting and handling; posture exercises; and pain management. The therapists (instructors) also examined each workstation and suggested physical and procedural modifications. The therapists provided additional reinforcement training six months after the first sessions and yearly thereafter.	Tompa *et al*., 2007
Davis, Badii and Yassi, 2004	Canad	Healthcare and social assistance	A programme that combines three components: (1) primary prevention; (2) early intervention (prompt follow-up of injured workers, targeted workplace modifications and clinical treatment, when required); and (3) extensive evaluation	Tompa *et al*., 2007
Dollard, Forgan and Winefield, 1998	Australia	Public administration	A multifaceted intervention to reduce work stress that included: (a) job redesign; (b) enrichment of psychological health services; (c) training and education; (d) surveillance of psychological distress and risk factors; (e) implementation research and evaluation; (f) appointment of a safety consultant; (g) a health, safety and welfare incentive award; and (h) development of a stress management policy.	Tompa *et al*., 2007
Engst et al, 2005	Canada	Healthcare and social assistance	Introduction of mechanical ceiling lifts and training.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009; Uegaki *et al*., 2010

Author	Country	Sector	Description	Reviews
Estill and MacDonald, 2002	United States	Manufacturing	Purchasing mechanical equipment for production workers to prevent future musculoskeletal injuries.	Verbeek, Pulliainen and Kankaanpää, 2009
Evanoff, Bohr and Wolf, 1999	United States	Healthcare and social assistance	Introduction of a participatory ergonomic team.	Tompa *et al*., 2007
Feuerstein *et al*., 2000	United States	Education services	A multi-component intervention consisting of 11 1.5-hour group meetings designed to reduce the impact of work on upper-extremity symptoms/disorders and lost time.	Tompa *et al*., 2007
Franzblau, Werner and Yihan, 2004	United States	Manufacturing	Pre-placement nerve testing for carpal tunnel syndrome and employment offers honoured despite abnormal test results.	Uegaki *et al*., 2010
Goodman, 1992	United States	Manufacturing	The intervention consisted of surgical release for workers with carpal tunnel syndrome, followed by an aggressive return-to-work programme.	Tompa *et al*., 2007
Greenwood *et al*., 1990	United States	Mining and oil and gas extraction	Very early intervention (VEI), a form of a disability management programme, consisting of health and psychosocial evaluation post-injury (eight days after injury) and recovery management/case management.	Tompa *et al*., 2007
Gundewall, Liljeqvist and Hansson, 1993	Sweden	Healthcare and social assistance	An exercise programme with training/supervision and advice on back problems.	Tompa *et al*., 2007
Guthrie *et al*., 2004	United States	Healthcare and social assistance	Introduction of patient-lifting equipment and other mechanical equipment, a back school and a lift team.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
Halpern and Dawson, 1997	United States	Manufacturing	A participatory ergonomic programme was introduced based on a suggestion from a risk management consulting firm. The intervention included a number of engineering changes and related training to use new tools/equipment, a stretching programme, return-to-work activities (for example increased use of a modified duty programme), and an awareness education effort. A steering committee, a design committee and a medical and claims management committee worked together, with top management participation at the implementation stage.	Tompa *et al*., 2007
Hilyer *et al*., 1990	United States	Public administration	Introduction of a designated 30-minute exercise period and a formal two-hour training session on flexibility exercises and flexibility testing for exercise leaders and alternates.	Tompa *et al*., 2007
Hlobil *et al*., 2007	Netherlands	Aviation	A graded-activity intervention for workers sick-listed because of lower back pain, compared with care as usual.	Verbeek, Pulliainen and Kankaanpää, 2009; Uegaki *et al*., 2010
Hochanadel and Conrad, 1993	United States	Manufacturing	An on-site industrial physiotherapy programme for all injuries, both work-related and not. Services included evaluation, treatment, physiotherapy referrals and education in the form of a back school.	Tompa *et al*., 2007; Uegaki *et al*., 2010
Hocking, 1991	Australia	Information and cultural industries	An intervention consisting of workplace ergonomic assessments and the introduction of new equipment and training. Three teams of engineers were trained in ergonomics, and then progressively assessed and improved the equipment and associated work practices for a range of projects, which were subsequently released in the field with instructions, presentations and publicity.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
Jensen *et al*., 2005	Sweden	Multiple sectors	The intervention had four aspects: 1. behaviour-oriented physiotherapy (PT) aimed at enhancing physical functioning and facilitating a lasting behaviour change; 2. cognitive behavioural therapy (CBT), aimed at improving the subjects' ability to manage pain and resume a normal level of activity; 3. behavioural medicine (BM) rehabilitation, consisting of behaviour-oriented physiotherapy and cognitive behavioural therapy; and a treatment-as-usual control group (CG)	Tompa *et al*., 2007
Karjalainen *et al*., 2003	Finland	Multiple sectors	Mini-intervention (Group A) consisting of an interview with a physician specialising in physiatry; the aim of consultation was to reduce patients' concerns about their back pain by providing accurate information and to encourage physical activity. Mini-intervention and worksite visit (Group B), the latter consisting of a 75-minute visit to the worksite by a physiotherapist; the aim of the visit was to ensure that the patient had adapted to the information and practical instructions on appropriate ways of using the back at work, to involve the supervisor and company health-care professionals, and to encourage their cooperation. Usual care (Group C), consisting of patients receiving treatment from general practitioners (GPs) in primary healthcare. Groups A and B underwent one assessment by a physician and a physiotherapist. Group B received a worksite visit in addition. Group C served as a control and was treated in municipal primary healthcare. All patients received a leaflet on back pain.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
Kärrholm *et al*., 2006	Sweden	Public administration	A vocational rehabilitation programme that included a one-day course for the disabled worker's immediate superiors and a meeting between the rehabilitation team, the worker, the worker's immediate superior, a social insurance office representative, a representative from the employer's personnel department, a company physician and a support person for the worker.	Tompa *et al*., 2007
Kemmlert, 1996	Sweden	Administration	An ergonomic programme consisting of workplace assessment and redesign: new chairs, manuscript supports, wrist supports, change in workplace layout to reduce reaching and viewing distances; ergonomic training; more frequent breaks and pauses for variation	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Kemmlert, 1996	Sweden	Healthcare and social assistance	An ergonomic intervention consisting of workplace assessment and redesign and including: increase in workspace by means of reducing patient admissions by 15 %, thus allowing proper use of electric hoists; old hoist repairs and wheel replacements, and purchase of new hoists; training courses on lifting techniques; and electing a back health representative to monitor the ergonomic situation.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää , 2009
Kemmlert, 1996	Sweden	Manufacturing	The ergonomic intervention consisted of workplace assessment and redesign and included mechanisation of manual tasks consisting of wiring and stretching spirals about once every minute.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Kemmlert, 1996	Sweden	Manufacturing	The ergonomic intervention consisted of workplace assessment and redesign and included purchase and introduction of shallower and less heavy hampers, resulting in a more comfortable working height, and an electrical adjustable hoist, as well as reorganisation of work so that workers rotated between several jobs.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009

Author	Country	Sector	Description	Reviews
Kjellen, 1997	Norway	Manufacturing	Safety, health and environment (SHE) management systems based on internal control (IC) principles. This included clarification of SHE responsibilities, especially related to order and housekeeping, improved reporting of accidents and near accidents and of safety inspections, establishment of safety committees, defining and following up on yearly goals, and development of improved OSH policies and procedures. The intervention included education and training for various personnel, as well as hiring new SHE personnel and external consultants to assist in the development of a new SHE programme, and investment in equipment for the emergency squad.	Tompa *et al*., 2007
Korniewicz *et al*., 2005	United States	Healthcare and social assistance	Conversion from powdered latex gloves to powder-free latex gloves.	Tompa *et al*., 2007
Koviack, 2004	United States	Healthcare and social assistance	An accommodation programme to support workers during their period of work-related or personal injury or illness, to promote healing and to facilitate their return to work.	Tompa *et al*., 2007
Lahiri, Gold and Levenstein, 2005	United States	Manufacturing	Lumbar pads and backrests were made available to employees to reduce back discomfort. ‘Back school’ workshops were also conducted.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Lahiri, Gold and Levenstein, 2005	United States	Manufacturin	Engineering controls and workstation modifications were instituted following ergonomic evaluations. New equipment introduced included adjustable chairs, conveyors, lift tables, anti-fatigue matting, grabbers and catwalks to minimise the use of ladders.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009

Author	Country	Sector	Description	Reviews
Lahiri, Gold and Levenstein, 2005	United States	Manufacturing	A number of engineering controls were implemented. Ergonomic dollies were redesigned (to reduce the amount of bending), lift and tilt tables (to allow adjustment of workstation height) and mechanical lift assists were installed, and various platforms and risers were introduced (to reduce loads and awkward back postures).	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Landers and Maguire, 2004	United States	Accommodation and food services	An intervention consisting of ergonomics (modification of work environment); training (didactic classroom and practical on-the-job education, practice and testing); and disability management (light duty programme).	Tompa *et al*., 2007
Landstad *et al*., 2002	Sweden	Healthcare and social assistance	An intervention consisting of group development, leadership development, massage, improved cleaning methods, training in floor care, lectures, fitness activities, development of the suggested activities, working out a work environment programme, and development of cooperation with other authorities.	Tompa *et al*., 2007; Uegaki *et al*., 2010
Lanoie and Tavenas, 1996	Canada	Wholesale trade	A participatory ergonomic intervention to reduce back disorders at an alcohol distributor. Six principal problems were addressed by the joint worksite safety committee.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Laufer and Chiarello, 1994	United States	Healthcare and social assistance	A needlestick injury prevention programme consisting of safety syringes, recessed needles and use of needleless intravenous access systems.	Tompa *et al*., 2007
Lemstra and Olszynski, 2003	Canada	Manufacturing	The intervention consisted of :	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
			(1) An occupational management protocol for primary and secondary prevention. Primary prevention strategies included worker rotation schedules, reduced load lifting and ergonomic redesign of tasks. Secondary prevention strategies consisted of independent on-site management of injuries with a physiotherapist that included reassurance of good prognosis, encouragement to resume normal activities, simple exercises and recommendation to resume work as soon as safely possible on either full duties or time-limited modified or light duties. (2) An early intervention programme. Rapid and expanded rehabilitation services for injured workers to facilitate their return to the workplace. Injured workers were required to immediately participate in expanded physiotherapy and work-hardening programmes. If the worker was not at work after six weeks, broader secondary or tertiary treatment protocols, including psychosocial intervention, were initiated (following a multidisciplinary assessment).	
Lewis *et al*., 2002	United States	Administration	A training programme for proper computer use.	Tompa *et al*., 2007
Li, Wolf and Evanoff, 2004	Unites States	Healthcare and social assistance	Introduction of mechanical patient lifts and training.	Tompa *et al*., 2007
Linton and Bradley, 1992	Sweden	Healthcare and social assistance	Five-week physical and behavioural preventive intervention consisting of: (a) physiotherapy, including ergonomic education in the form of a 'lower-back school' and practising high-risk manoeuvres on the job; and (b) behavioural therapy to help workers learn to better control their pain and maintain healthy, low-risk lifestyles, which included group meetings with a psychologist and training on pain control, lifestyle management, risk analysis and application training (practising strategies learned during training sessions, at work and at home).	Tompa *et al*., 2007; Uegaki *et al*., 2010

Author	Country	Sector	Description	Reviews
Littleton, 2003	United States	Education	Post-offer screening programme: people hired based on results of a post-offer functional capacity screening test based on five to seven essential tasks; offer withdrawn as a result of failure on any of the screening tasks.	Uegaki *et al*., 2010
Loisel *et al*., 2002	Canada	Multiple sectors	The intervention had four aspects: 1. Standard care. 2. Clinical intervention: clinical examination by a back medical specialist, participation in a back school after eight weeks of absence from regular work, and, if necessary, a multidisciplinary work rehabilitation intervention after 12 weeks of absence from work. 3. Occupational intervention: visits to the study occupational medicine physician, and a participatory ergonomic intervention with the study ergonomist, the injured worker, his supervisor, and management and union representatives. 4. Sherbrooke model intervention: clinical intervention combined with occupational intervention (the main intervention under consideration).	Tompa *et al*., 2007
Maniscalco *et al*., 1999	United States	Mining and oil and gas extraction	A wellness programme was established with the goal of reducing the number of work-related injuries, especially back injuries. It focused on risk factors that might be modifiable through planned interventions: namely, nutrition and exercise. It included a health assessment, fitness programmes, education programmes and incentives.	Tompa *et al*., 2007
Martin, 1995	United States	Healthcare and social assistance	Development of a team approach to aggression management and education of all staff in verbal and physical management of the potentially or actually aggressive patient using the team approach.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
Matheson *et al*., 1995; Matheson and Brophy, 1997	United States	Multiple sectors	The programme used a multidisciplinary team approach that focused on immediate identification and treatment of soft-tissue injuries. At-home rest was avoided by the assignment of the patient to transitional light duty work, provided there was no medical contraindication. The patient participated in treatment during work hours. This model was based on the premise that workers' compensation medical care must be focused on return to work from the initial contact. Everything that can be done to maintain the injured worker within the work role and to avoid the patient role should be done.	Tompa *et al*., 2007
Melhorn, Wilkinson and Riggs, 2001	United States	Manufacturing	A musculoskeletal injury risk management programme in which new hires were assessed for their risk of injury based on an individual risk-assessment instrument. New hires were assigned to a specific group of risk reduction strategies based on their risk assessment category.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009; Uegaki *et al*., 2010
Miller, Zaloshnya and Spicer, 2007	United States	Transportation	A peer-care-based workplace substance abuse programme to prevent injuries in a transportation company.	Verbeek, Pulliainen and Kankaanpää, 2009
Mitchell *et al*., 1994	United States	Defence	Company policy for back belt use: back belt use mandated for particular tasks and those with a history of back injury; back injury prevention training for all new hires; annual instruction period for proper lifting techniques; back belt issue paired with two 30-minute instruction sessions.	Uegaki *et al*., 2010
Moore and Garg, 1998	United States	Manufacturing	A corporate participatory ergonomic programme was introduced that included the following elements: (a) workplace analysis, (b) hazard correction, prevention and control, (c) medical management and (d) training and education.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
Nelson *et al*., 2006	United States	Healthcare and social assistance	A multifaceted back injury prevention programme consisting of an ergonomic assessment protocol; patient-handling assessment criteria; peer safety leaders; patient-handling equipment; an after-action review process; and a no lift policy.	Uegaki *et al*., 2010
Ore, 2003	Australia	Healthcare and social assistance	Thirty-five hours of manual handling training provided by an ergonomist, involving on-site assessment of manual handling tasks, training on specific techniques, and equipment design and correct use.	Tompa *et al*., 2007
Orenstein *et al*., 1995	United States	Healthcare and social assistance	A needlestick injury prevention programme consisting of safety syringes and a needleless intravenous access system.	Tompa *et al*., 2007
Perry, 1996	United States	Retail and trade	A return-to-work programme, called the REACH programme (an acronym for recovery, employment and community help), consisting of temporary employment at the regular place of employment, if possible, or in 'sheltered workshops,' until the worker is able to resume regular duties.	Tompa *et al*., 2007
Rempel *et al*., 2006	United States	Healthcare and social assistance	Four workplace interventions compared.	Tompa *et al*., 2007
Ridyard and Hathaway, 2000	United States	Manufacturing	A multidisciplinary participatory ergonomic team was given training by an external consultant.	Tompa *et al*., 2007
Ryan, Krishna and Swanson, 1995	Australia	Mining and oil and gas extraction	The intervention had multiple components and consisted of education of the entire workforce, acute back care by first aid officers, early referral to a general practitioner and facilitation of early return to work, as well as attention to psychosocial perceptions of the work environment.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
Seeley and Marklin, 2003	United States	Manufacturing	Converting a manually operated press and cutter used by line workers into battery-operated tools to avoid musculoskeletal complaints.	Verbeek, Pulliainen and Kankaanpää, 2009
Shearn, 2003	United Kingdom	Manufacturing	Change from traditional footwear to slip-resistant footwear to prevent slip-related injuries.	Verbeek, Pulliainen and Kankaanpää, 2009
Shearn, 2003	United Kingdom	Newspapers	Improvement of office equipment to reduce upper limb disorders.	Verbeek, Pulliainen and Kankaanpää, 2009
Shearn, 2003	United Kingdom	Manufacturing	New work routines and improvement of fleshing machine to prevent cumulative trauma disorders.	Verbeek, Pulliainen and Kankaanpää, 2009
Shi, 1993	United States	Public administration	An integrated back injury programme, which consisted of a combination of education, training, physical fitness activities and ergonomic improvements.	Tompa *et al*., 2007; Uegaki *et al*., 2010
Spiegel *et al*., 2002	Canada	Healthcare and social assistance	Installation of a ceiling lift system, adoption of a 'no-lift' policy, training and coordination.	Uegaki *et al*., 2010
Tadano, 1990	United States	Administration	An ergonomic programme consisting of training, workstation redesign and health promotion (exercises and mini-breaks).	Tompa *et al*., 2007
Tompa, Dolinschi and Laing, 2009	Canada	Manufacturing	A participatory ergonomics programme implemented 10 ergonomics change projects to prevent injuries and workers' compensation claims.	Verbeek, Pulliainen and Kankaanpää, 2009

Author	Country	Sector	Description	Reviews
Tracz, 1992	Canada	Healthcare and social assistance	An early intervention and occupational rehabilitation programme to identify and assess factors that might delay recovery, and to assist the injured worker in their recovery, aiming to return them to work earlier than might otherwise be achieved. The occupational health nurse explains the programme; determines how the worker is progressing and provides counselling during recovery; establishes an expected date for return to work; refers the worker to the occupational health physician; and arranges for the worker to attend a hospital back-care programme.	Tompa *et al*., 2007
Tuchin and Pollard, 1998	Australia	Transportation and warehousing	A comprehensive lecture of approximately 120 minutes covered topics such as spinal anatomy; pain-sensitive structures; causes of back pain and injury; types of back injuries; spinal biomechanics; correct lifting techniques; methods of care for back problems; effective exercises; analysis and explanation of ergonomics; relationship of back pain to occupation and tasks involved; and effects of static posture. Prior to giving lecture, the instructor took a tour of the workplace so that potential problem areas could be identified and brought to the workers' attention during the lecture.	Tompa *et al*., 2007
Versloot *et al*., 1992	Netherlands	Transportation and warehousing	A back school programme consisting of three training sessions. The first session covered topics such as motivation; responsibility for one's own health; mind-body interactions in relation to illness; stress, coping strategies and relaxation training; and body mechanics, including sport, working posture and seat adjustment. The second and third sessions reviewed participants' experiences since the first session and included a summary of the first session.	Tompa *et al*., 2007; Uegaki *et al*., 2010
Wahl, 1998	United States	Administration	A workstation evaluation which consisted of an interview (to determine tasks performed and gauge workers' understanding of risk factors for cumulative trauma), observation of workers performing their regular duties; explanation of risk factors for cumulative trauma; and adjustment of workstation.	Tompa *et al*., 2007

Author	Country	Sector	Description	Reviews
Wickizer *et al*., 2004	United States	Multiple sectors	Introduction of the Washington Drug-Free Workplace Program, which consisted of: a written workplace policy on substance use; an employee assistance programme for an approved provider list; paid drug testing pre-employment, post-accident and post-treatment; an annual education programme on substance abuse; a minimum of two hours' training for all supervisors and managers on substance abuse, treatment referral and drug testing.	Tompa *et al*., 2007
Wiesel, Boden and Feffer, 1994	United States	Utilities	An intervention consisting of an injury surveillance system with the use of quality-based standardised diagnostic and treatment protocols. All occupational injuries were to be reported within 24 months; workers were examined at a central medical facility as soon as it was practical, and data on the injury was added to the computerised database. Based on clinical data, a diagnosis was obtained and a course of management was recommended according to the standardised diagnostic and treatment algorithm specific to the injury's anatomical region. Time-loss injuries were reviewed on a weekly basis during the acute phase.	Tompa *et al*., 2007
Yassi *et al*., 1995	Canada	Healthcare and social assistance	A disability management pilot programme consisting of prompt assessment, treatment and rehabilitation through modified work.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Yassi, McGill and Khokhar, 1995	Canada	Healthcare and social assistance	A needlestick injury prevention programme consisting of a needleless intravenous access system.	Tompa *et al*., 2007; Verbeek, Pulliainen and Kankaanpää, 2009
Yeow and Sen, 2003	Malaysia	Manufacturing	Ergonomic interventions such as better arm support and training for an electronics factory's workers.	Verbeek, Pulliainen and Kankaanpää, 2009
Zwerling, Ryan and Orav, 1992	United States	Postal Service	Pre-employment drug screening intervention for potential employees of the Postal Service.	Verbeek, Pulliainen and Kankaanpää, 2009

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The European Agency for Safety and Health at Work (EU-OSHA) contributes to making Europe a safer, healthier and more productive place to work. The Agency researches, develops, and distributes reliable, balanced, and impartial safety and health information and organises pan-European awareness raising campaigns. Set up by the European Union in 1996 and based in Bilbao, Spain, the Agency brings together representatives from the European Commission, Member State governments, employers' and workers' organisations, as well as leading experts in each of the EU Member States and beyond.

European Agency for Safety and Health at Work

Santiago de Compostela 12, 5th floor - 48003
Bilbao · Spain
Tel. +34 944 358 400 · Fax +34 944 358 401
E-mail: information@osha.europa.eu

http://osha.europa.eu

Publications Office