European Agency for Safety and Health at Work

Inventory of socioeconomic costs of work accidents

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Foreword

Work-related accidents are still a major safety and health problem in Europe. Every year, approximately 5 500 people are killed in accidents in their workplace. In 1998, 4.7 million workers suffered work-related accidents leading to more than three days of absence from work. Probably around 150 million working days are lost each year due to work-related accidents. This is a huge cost for businesses and a huge cost in terms of human suffering for the victims and their families.

Workplace accidents can mean pain and disability and can affect the worker's life, both in and out of work. Disruptions to production and bad publicity following an accident are just some of the costs for businesses and organisations. Demands on public services, such as healthcare and social security, also increase. Estimated Member State costs due to work accidents vary from 1–3 % of gross national product.

The European Commission is concerned about the costs of 'non-social policy' for Europe and they have prioritised the need to develop knowledge of the economic and social costs arising from occupational accidents and illnesses in their communication about a new Community strategy on safety and health at work for 2002–06.

This report from the Agency aims to contribute to this knowledge. It includes an inventory of socioeconomic costs of work accidents. It also provides an insight into what economic assessments are and how they are made and includes practical guidance on carrying out estimations of accident costs and the benefits of preventive activities. The key issues are summarised in two Agency 'Facts' publications.

We hope that this report will contribute to the Commission's strategy and will also be of practical benefit to anyone interested in costing accidents, whether from a national institution or within an individual workplace.

The Agency's Topic Centre on Research — Work and Health, a consortium of European research institutions, prepared this report. TNO from the Netherlands coordinated the work. The Agency would like to thank Jos Mossink and Marc de Greef for drafting the report and all those who contributed to the report.

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Summary

Accidents at work and occupational injuries represent a considerable economic burden to employers, employees and to society as a whole. Some of these costs, like lost workdays or lost income, are clearly visible and can readily be expressed in monetary value. For a large part however, economic consequences of accidents are somewhat hidden or cannot be priced. Administrative activities following an accident for example may be forgotten, damage to the company image is hard to quantify and pricing human suffering and health damage is subject to discussion.

Nevertheless, it is possible to get an adequate insight into the costs of accidents and the potential benefits of accident prevention.

An important notion is that accidents (and accident prevention) have simultaneous effects on both employee health (such as injuries) and company performance (e.g. detrimental effects on company image). In addition, the employee health effects have an additional effect on health performance (e.g. absence spells result in lower productivity).

This report is aimed at clarifying the process of making and understanding economic assessments. To this end, the following subjects are discussed and explained.

- Overview of economic consequences of accidents: what are the costs and for whom; which cost factors are relevant at the level of the individual, the company and society as a whole; how can monetary values be obtained.
- The effect of time: how can results be corrected for the time value of money and how does this relate to the often limited planning horizon in companies; how can risk of investments be dealt with.

The following are also very relevant.

- The causal relationship between the working conditions and accidents and between prevention and its effects: in general, these relations are hard to quantify in precise figures, but estimations can be valuable as well.
- The way health, well-being and human life can be expressed in terms of money.

In practice, it is often useful to pay attention to the process of making assessments as well. Some planning can prevent discussions about the results or putting too much work into the assessment. A five-step approach can help to plan for an adequate economic evaluation in which the goals of the assessments, the interests of stakeholders, the availability of data and the resources to be put into the evaluation itself can be balanced.

1. Introduction

Improvements in safety and health at work can bring economic benefits to both companies and societies as a whole. Accidents and occupational diseases can give rise to serious costs for a company. For small companies in particular, occupational accidents can have a major financial impact.

It is difficult, however, to convince employers and decision-makers of the profitability of improving working conditions. An often effective way is to make financial or economic estimations. Although making calculations or making an analysis of costs and future benefits need not be complicated, many safety and health professionals are put off by potential difficulties. Indeed, some issues in economic appraisal like the value of health or human life are sometimes complicated. However, the basic principles are quite straightforward and can easily be performed by safety and health professionals and managers.

The aim of this report is to offer some guidance in making estimations of the costs of accidents and the benefits of preventive activities. To this end, Section 2 gives an inventory of costs and discusses how costs are divided over stakeholders. Section 3 describes some issues related to making cost estimations. Attention is given to estimating the (monetary) value of health, well-being and human life, cause and effects of relationships and the issue of time. Also, the effects of national legislation and systems of social insurance are briefly discussed. Section 4 has a more practical orientation. In this section, some guidelines for preparing and making cost estimations are presented. A number of examples illustrate the cost of work accidents and occupational injuries.

2. Socioeconomic costs

2.1. Economic consequences of work accidents

Work accidents are a burden for many parties in many ways. Accidents and occupational injuries lead to costs for other companies, individual workers, and for society as a whole. The economic effects of accidents and injuries can sometimes be identified as financial expenditures, damages or loss of resources, but often there are adverse effects (such as health damage) that are difficult to express in terms of money.

In several countries, estimations of the costs of accidents or occupational injuries have been made. Table 2.1 gives an overview of some of the results of these studies. In general, the cost estimations require careful interpretation. For instance, definitions may differ from country to country.

Table 2.1: **Summary of estimations of costs of accidents at society level in some countries**

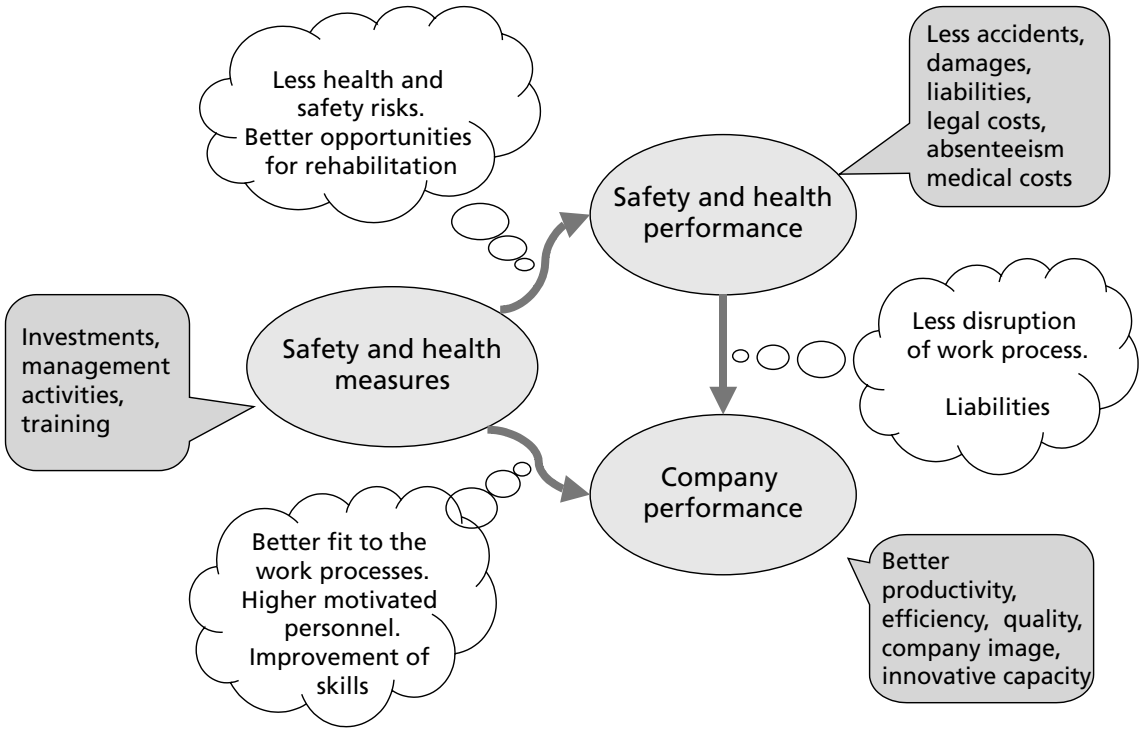
Country	Ref	Year	Costs (million EUR)					'Number of workers (x 1 000 000)'
			Lost workdays	Damages	Medical costs	'Administration, recruitment'	Loss of welfare	
United Kingdom	– 1	1995/6	739	9– 58	77–337	251– 279	2 109	25
Germany	– 2	1998	5 905					32
Netherlands	– 3	1995	158	363	122			6
Belgium	– 4	1999	865					2,7

([1]) HSE statistics (www.hes.gov.uk/statistics/dayslost.htm).
([2]) Koningsveld, E. A. P., Mossink, J.C.M., *Societal costs of occupational safety and health in the Netherlands (Kerncijfers maatschappelijke kosten arbeidsomstandig-heden in Nederland)*, The Hague, VUGA, 1997.
([3]) Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Dortmund (www.baua.de/info/statistik/stat_1998/kost98.htm).
([4]) *Statistics occupational accidents in occupational diseases* (*Statistieken Arbeidsongevallen en beroepsziekten*), Prevent, Brussels, 2001.

In this report, 'costs' refers to all loss and burden that result (directly or indirectly) from work accidents and occupational injuries.

At company level, accident prevention can have benefits in the form of reducing anticipated losses, savings in expenditures or additional gains. In many situations, additional (or unintended positive side-effects of prevention) benefits are even more important than the benefits that are directly related to reduction of sick leave and disability (see Figure 2.1).

Figure 2.1. **Economic effects of safety and health at company level.**



2.2. Costs and benefits for whom?

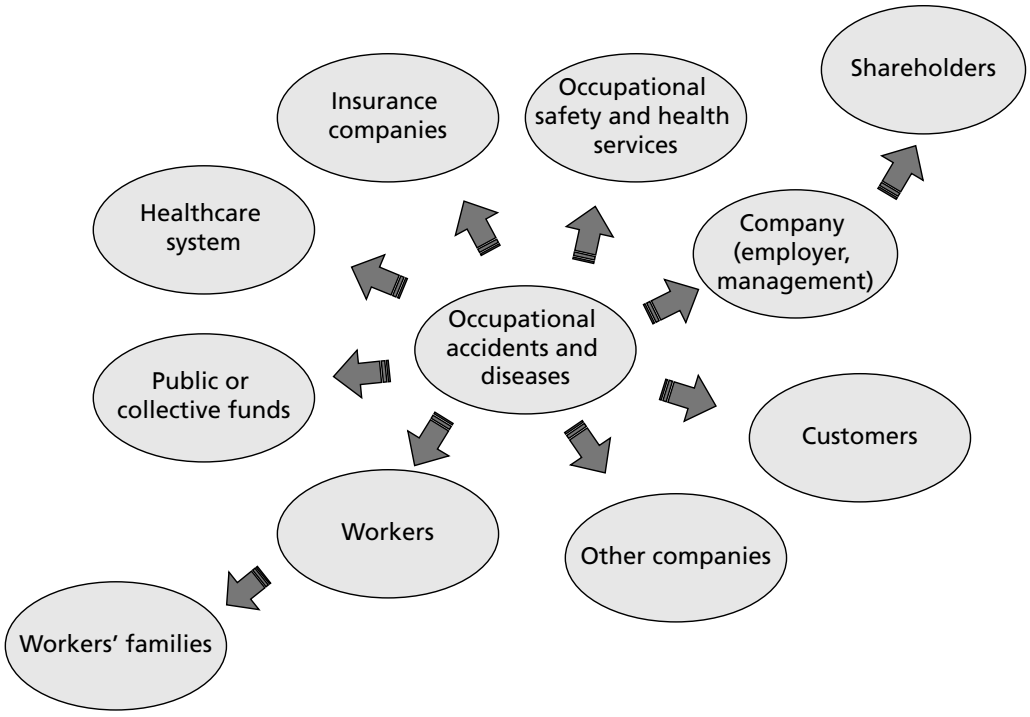
Occupational safety and health is as much an issue in the social and public health domain as it is in the economic or business domain. The motives to pursue better safety and health at work stem from social goals as well as from economic goals.

It is clear that work accidents cause a burden to employees, companies and society as a whole. However, there are large differences in both the nature of the burden and the costs thereof. Table 2.2 gives a brief overview of costs and benefits of work accidents and their prevention which illustrates the variety of costs and benefits.

Table 2.2: **A classification of safety and health costs and benefits, as well as examples of methods to evaluate the costs and benefits (adapted from: Aaltonen & Söderqvist, 1988)**

	Examples of prevention activities (preventive costs)	Examples of consequences or effects of an accident and diseases	Possibilities of analysis or evaluation of costs and benefits
Individual employees:	• using personal safety equipment • effort in adopting safety attitudes and healthy life and workstyles	• pain and suffering • consequence to relatives and friends • losses in second job or household	• evaluation of own safety and health activities
Enterprises:	• developing safety and health management • carrying out workplace safety and health inspection • developing a safety climate • planning production • measures to improve working conditions	• production losses • insured and uninsured costs of accidents • quality losses • legal sanctions	• evaluation of effects of preventive measures, efficiency measurement • insurance: compensations and premiums • evaluation of production process • costs and benefits in decision-making techniques • profit–loss analyses
Society as a whole:	• social attitudes and values • safety and health legislation and inspection • trade union and sector organisation activities • safety and health research, education and information	• medical treatment and rehabilitation • accident investigation and administrative and legal actions • insurance activities • costs to the national economy • social costs	• evaluation of national safety attitudes and safety programmes • cost–benefit analysis of new regulation • evaluation of trade union and sector organisation activities

Figure 2.2: **Work accidents inflict costs on many parties (adapted from Krüger, 1997)**



In most decisions on prevention, companies (or company management) are the key actors. It is for this reason that much information on cost, benefits and economic incentives is aimed at companies. It should be borne in mind that occupational accidents inflict many costs on various parties (see Figure 2.2).

Companies often do not bear the full costs of occupational accidents, diseases, occupational injuries, or work-related illnesses. For instance, healthcare costs (inflicted by work accidents) may not be covered by the company or disability pensions may be borne by collective funds.

The costs of occupational safety and health for companies, but also for individual workers, are very much influenced by the national system of social security. Also, the national healthcare system may have cost effects. In many countries, regulations exist that somehow bring back the costs to the company or person who inflicted the costs (so-called cost internalisation). This may work as an economic incentive to prevent future injuries or diseases. The most relevant issues in social security and the healthcare system are the following.

- Is there a national compensation system for disability due to occupational illnesses and injuries; if so, which illnesses are accepted as occupational?
- Can employees claim damages and financial consequences; are employers liable to damage claims of their (former) employees?
- Do funds or subsidies for improvement of working conditions exist?
- Are social security or insurance premiums dependent on safety and health risks or past performance of the company?

The extent to which costs of work accidents are borne by those who caused the accident or those who are in a position to prevent hazardous situations differs between the EU Member States. As indicated in Table 2.3, systems of social security, insurances and legislation can have an influence on how costs and benefits are divided between companies, workers, insurance and collective funds.

Table 2.3: **Overview of instruments that can be used to internalise the costs of work accidents and occupational injuries**

Method of cost internalisation	Principle or examples
Liabilities	Workers or insurance companies can claim damages due to occupational injuries or diseases.
Legal sanctions, fines	Labour inspectorates can give financial penalties, demand improvements or temporarily stop production.
Differentiation in premiums	Insurance companies or public funds adjust premiums for increased risk of accidents, occupational injuries and diseases. Premiums may also be adjusted according to past performance.
Payment of sick leave	Obligation to (partly) pay wages during period of sick leave or disability.
Market regulation	Attractiveness for new personnel, advantages in obtaining government orders. Improvement of the 'accident rating' for subcontractors in case of calls for tenders. Effects of company image.

2.3. Indicators, costs factors and pricing

There is no ultimate or definitive list of cost factors to be included in an assessment of socioeconomic costs of work accidents and occupational injuries. Nevertheless, a common set of cost factors has emerged from practice and theory. Additions or modifications are to be made depending on the purpose of the assessment, the structure of social security in a country, the company's possibilities to find adequate data, the company's business, interests of stakeholders and so on.

There is a large number of variables that can be included in an economic assessment. In most situations, only part of the variables may be relevant for a particular situation. Therefore, constructing the list of cost factors is one of the key activities in any economic appraisal. With it, one decides which kind of costs are used and which are (deliberately) left out. As the selection of variables may have a major impact on the results, it is important to involve all relevant stakeholders in the selection process. Checklists can be very helpful to identify the cost components and potential benefits in practical situations. The following criteria for selection of variables can be used:

- relevance to the situation, company or national context;
- relevance to the type of work;
- anticipated possibility of finding relevant data (if no data seem to be available, try to find ways to estimate);
- interests of stakeholders.

Sections 2.4 to 2.6 present variables or indicators that are usually included in economic analyses concerning occupational safety and health. It is hardly possible to compile a list of variables that is both complete (all costs are included) and avoids double counting at the same time.

2.4. Costs for individuals

The (economic) effects for individual workers are extremely hard to express in terms of money, in particular for serious injuries with long-term (irreversible) effects. Future effects (and the value thereof for the individual) cannot be estimated in a reliable and general way. Less serious work accidents in which the victims fully recover from the injuries and which result in a limited period of incapacity can be costed more easily as, in these cases, grief and suffering and future effects are relatively unimportant.

The most important elements that add up to the total burden of work accidents for the individual are summarised in Table 2.4. Note that the burden that relates to grief, suffering and health is very difficult, if not impossible, to express in monetary values. Pricing techniques, like the willingness to pay or willingness to accept, do not give any reliable results.

Table 2.4: **Cost factors at individual level**

Variable	Description	How to obtain money value
Health	Hospitalisation (bed-days) Other medical care, such as non-hospital treatment, medicines Permanent disability (numbers, age of patient) Non-medical (e.g. vocational) rehabilitation, house conversions	Expenditures for healthcare that are not compensated by insurance or employer
Quality of life	Life expectancy, healthy life expectancy Quality adjusted life years (QALY) Disability adjusted life years (DALY)	Willingness to accept, willingness to pay Height of claims and compensations
Grief and suffering	For victims, but also for relatives and friends	No reliable method available
Present income losses	Loss in income from present and second job	Reduction in present income, loss of wages
Loss of potential future earnings	Also including the second job	Differences between total expected future income and total compensation or pensions
Expenses that are not covered by insurances or compensations	Examples are costs for transportation, visits to hospitals, costs arising from fatalities such as funerals	Sum of all other expenses for a victim and his/her family (that are not compensated)

2.5. Costs at company level

At company level, costs are related to the immediate health effects but also to the effects of disruption of production. In many cases, this disruption accounts for the highest part of the total costs. Table 2.5 summarises cost categories related to work accidents and occupational injuries at company level.

Table 2.5: **Overview of the most important cost categories related to work accidents at company level**

Variable	Description	How to obtain money value
Effects of incidents that cannot directly be expressed in monetary value		
Fatalities, deaths	Number of fatalities	Sum of costs of subsequent activities, fines and payments
Absenteeism or sick leave	Amount of work time lost due to absenteeism	Sum of costs of activities to deal with effects of lost work time, such as replacement and lost production; indirect effect is that sick leave reduces flexibility or possibilities to deal with unexpected situations
Personnel turnover due to poor working environment, or early retirement and disability	Percentage or number of persons (unwanted) leaving the company in a period of time	Sum of costs of activities originated by unwanted turnover, such as replacement costs, additional training, productivity loss, advertisements, recruitment procedures
Early retirement and disability	Percentage or number of persons in a period of time	Sum of costs of activities originated by disability or early retirement, fines, payments to the victim
Effects of incidents, injuries and diseases that can readily be expressed in a monetary value		
Non-medical rehabilitation	Money spent by the employer to facilitate returning to work (counselling, training, workplace adjustments)	Invoices
Administration of sickness absence, injuries, etc.	(Managerial) activities that have to be performed by the company related to sick leave	Total wages of time spent
Damaged equipment	Damages or repair costs of machines, premises, materials or products associated with occupational injuries	Replacement costs
Other, non-health-related costs (e.g. investigations, management time, external costs)	Time and money spent for injury investigation, workplace assessments (resulting from occurrence accidents or illnesses)	Total wages of time spent
Effects on variable parts of insurance premiums, high-risk insurance premiums	Changes in premiums due to the incidence of injuries and occupational illnesses	Invoices
Liabilities, legal costs, penalties		Invoices, claims, costs of settlements; fines, penalties
Extra wages, hazardous duty pay (if the company has a choice)	Extra spending on higher wages for dangerous or inconvenient work	Additional wages
Lost production time, services not delivered	Production time lost as a consequence of an event which results in injury (e.g. because it takes time to replace machines, or production has to be stopped during investigation)	Total production value
Opportunity costs	Orders lost or gained, competitiveness in specific markets	Estimated production value, representing lost income for the company
Lack of return on investment	Non-realised profit because of accident costs, i.e. expenditure due to accidents and not invested in a profitable activity (like production, stock market or saving) generating interests	Interests of the expenditure amount, invested during x years, with an interest rate of y %

Prevention not only results in reduction of (potential) damages but can also enhance production processes in the company. The costs of preventive activities can be estimated from cost quotations and the time investments of personnel (see Table 2.6).

Table 2.6: **Overview of costs of preventive activities at company level ([1])**

Variable	Description	How to obtain money value
Investments	Costs of specific 'OSH' equipment or additional costs of other investments related to top OSH	Market prices, quotations, invoices
Additional investments	Changes in non-OSH-related capital goods to facilitate functioning of OSH equipment (e.g. reconstruction of buildings)	Market prices, quotations, invoices
Engineering, consultancy and planning costs, related to investments	Expenditures for internal and external activities for design and implementation of new equipment or working procedures	Market prices, quotations, invoices, total wages of time spent
Additional costs of substitution products (recurring costs)	Price difference (e.g. 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 (e.g. extra costs to work according to safety standards)	Market prices, quotations, invoices
Extra work time of direct personnel (recurring costs)	Time spent on meetings, training, safety inspections, participatory developments	Total wages of 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 of time spent
Other workplace costs	Anything that is not covered in the previous headings	Market prices, quotations, invoices, total wages of time spent

([1]) Note that the cost factors have to be selected according to the intervention.

Table 2.7: **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; reliability of deliveries	Value depends on company strategy. Reduction in repair costs and warranties
Improved well-being, job satisfaction and working climate		Only indirect effects, e.g. on productivity, quality or flexibility. Increased capabilities to deal with unexpected situations
Compensations and subsidies received from insurance or authorities	Support for prevention only, compensations received for sick leave or disability are to be excluded	Compensations and subsidies received
Company image effects	Attractiveness to customers, attractiveness on labour market, attractiveness to contractors, 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 processes	Indirect, long-term effects. No operational benefits

Preventive activities generate benefits over several years. Such benefits must be converted to current values with an ex ante present value factor.

For most organisations, the bottom line in company performance is financial balance. Even non-profit organisations need to break even. Yet, in some situations, overall financial indicators may not be appropriate:

- non-profit or not-for-profit organisations may be less interested in financial indicators, whereas quality and efficiency can be more important;
- financial statements look back, but the ability of a company to generate attractive results in the (near) future is as important;
- financial results are influenced by many factors, and effects of safety and health are very hard to isolate.

It should be clear, however, that economic appraisal should not be limited to financial aspects only. An assessment should concentrate on the contribution of occupational health to the company's competitive strength (or the company's goals). Assessments in non-profit organisations can focus on effectiveness and the quality of services. Recent developments in assessing company performance make it clear that occupational health contributes to a company's success in many ways. In this respect, the financial costs or benefits offer too narrow a view.

Modern methods (like the balanced scorecard) in company performance measurement aim to define and measure indicators that contribute to the success of a company. In addition to financial indicators, it is very useful to define indicators with respect to:

- the attractiveness of a company (and its products) for customers or for potential employees;
- internal organisation, the efficiency and flexibility of the production processes;
- the ability to innovate products, services and production processes.

As markets, visions and goals differ enormously among companies, each organisation has to define its own indicators and establish for itself how safety and health at work contribute to each of the indicators.

2.6. Total socioeconomic burden of work accidents at society level

The total societal costs of work accidents roughly consists of two components:

- total loss of resources and productive capacity;
- reduction of welfare and health.

This means that making cost estimates of work accidents and occupational injuries should include health variables as well as variables with respect to economic performance of companies (see Table 2.7.b).

There are several methods to make cost estimates in which roughly two different principles can be used:

- all costs within one year are taken (prevalence method);
- all present and future cost effects of new cases in one year (incidence method).

The choice is generally made on grounds of availability of data. The incidence method is preferred for most uses. However, finding the required data (such as long-term effects) is often difficult.

Note that compensations and pensions paid by social insurances are not adequate for making cost estimates at society level for a number of reasons:

- as concerns transfer payments (payments that are not related to some kind of output), such compensations are not a part of the gross national product;
- the size of payments is not necessarily related to either the loss of productive capacity, or the extent of health effects and of grief and suffering.

However, compensations are money spent due to work accidents.

Table 2.7.b: **Summary of variables related to costs of work accidents at society level**

Variable	Description	How to obtain money value
Health-related costs		
Health	Hospitalisation (bed-days) Other medical care, such as non hospital treatment, medicines Permanent disability (numbers, age of patient) Non-medical (e.g. vocational) rehabilitation, house conversions	Actual expenditures on medical treatment and rehabilitation
Fatalities (numbers, age of patient)		Willingness to pay or willingness to accept.
Quality of life	Life expectancy, healthy life expectancy Quality adjusted life years (QALY) Disability adjusted life years (DALY)	Willingness to pay or willingness to accept. Total amount of indemnities and compensations
Grief and suffering	For victims, but also for relatives and friends	Willingness to pay or willingness to accept Total amount of indemnities and compensations
Present production losses	Lost earnings due to sick leave, absenteeism and disability	Total lost earnings during period of absence
Loss of potential future earnings and production	Lost earnings during the whole period of permanent disability	Sum of lost income during expected disability period, in which both the income and the period are estimated on statistical data
Non-health-related costs and damages		
Administration of sickness absence, etc		Total wages spent on the activity
Damaged equipment (by accidents)		Replacement costs, market prices
Lost production due to incapacity of personnel and production downtime		Market price of lost production

The estimation of the money spent on prevention at society level can best be regarded as the sum of (Table 2.8):

- all expenditure and wages for time spent on preventive activities by companies;
- cost and expenditure for policy-making, research and promotion, enforced by authorities;
- cost and expenditure for policy-making, research and promotion, enforced by sector organisations.

Also, the activities of individual workers can be included. However, no practical studies are available to make an estimate. It can be anticipated that these costs are rather small in comparison to all other categories.

Table 2.8: **Cost factors regarding the cost of preventive activity at society level**

Variable	Description	Method of costing
Investments	Costs of specific 'OSH' equipment or additional costs of other investments related to top OSH	Market prices, quotations, invoices
Additional investments	Changes in non-OSH-related capital goods to facilitate functioning of OSH equipment (e.g. reconstruction of buildings)	Market prices, quotations, invoices
Engineering, consultancy and planning costs, related to investments	Expenditures for internal and external activities for design and implementation of new equipment or working procedures	Market prices, quotations, invoices, total wages of time spent
Additional costs of substitution products (recurring costs)	Price difference (e.g. for non-toxic chemicals, lighter product)	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 (e.g. extra costs to work according to safety standards)	Market prices, quotations, invoices
Extra work time of direct personnel (recurring costs)	Time spent on meetings, training, participatory developments	Total wages of time spent
Costs of internal or external OSH services, other preventive services (recurring costs)	Including occupational health services	Market prices, quotations, invoices
In-company activities	Human resource management, health promotion, OSH policy and management	Total wages of time spent
Other workplace costs	Anything that is not covered in the previous headings	Market prices, quotations, invoices, total wages of time spent
Costs of policy-making, research and enforcement at national or sector level	Including labour inspectorates	Total expenditures and wages of relevant authorities and sector organisations

The benefits of prevention at national level should best be estimated by reduction of the burden. There are no examples that show an estimation of the total benefits for companies in terms of productivity, quality, image and the like.

2.7. Costs and benefits for whom? comparison of perspectives

As can be noted from the overview of costs for different actors, perspectives and interests can be quite different or even opposite. Table 2.9 illustrates some of the differences. As a consequence, any attempt to make cost estimates has to address the question of differences in interests and perspective.

Table 2.9: **Overview of differences in perspective between companies, individual workers and society as a whole on several issues in assessment of costs of work accidents and occupational injuries**

Issue	Examples from the societal perspective	Examples from the employers' perspective	Examples from the workers' perspective
Target audience	Government decision makers, society as a whole	Company management, ownership	Individual workers and their families
Problem or question	Framed in terms of society, includes vulnerable sub-populations, the environment,	Framed in terms of the company, includes mostly healthy workers	Personal health, well-being and welfare
Intervention strategies	Economic controls, regulatory intervention	Procurement, e.g. substitution of raw materials, safe equipment, investments, management systems and control	Adaptation of behaviour
Time frame	Years to decades	Months to years	Months to decades
Analytic horizon	Years to decades	Months to years (probably does not include full life-cycle of chronic diseases)	Unsure (from ultra short in behaviour to very long with respect to personal income)
Gross indication of costs	Implementing and managing a regulatory controls programme, social security payments to injured workers, subsidies, national welfare, healthcare costs	Lost work days due to employee illness, repair of damaged equipment, liabilities, intangible effects	Reduced health and well-being, reduced income, medical costs
Benefits	Higher gross national product resulting from lower injury rates [Note: this rather specific item could be deleted: improved ecosystem health from proper disposal of toxic wastes]	Lower insurance premiums associated with reduced injury rates, improved worker morale and productivity, better quality	Health and well-being, employability (better personal economy?)
Health outcomes	Chronic injuries and illnesses which result in early retirement and collection of benefits	Injuries, acute health conditions which are readily associated with occupational exposures	Injuries and chronic ill health
Discount rate	Very important to consider in long analytical horizon	Not as critical to include in short analytical horizon	Generally not considered (except for determining future income losses)
Terms and / or measures	Related to societal impacts	Related to company finances	Related to personal income
Distributional effects	More important, as more difficult to determine the distribution patterns of costs and benefits	Less important, as easier to identify who benefits and who does not	Limited importance

3. Some issues in making economic assessments

3.1. The value of health, well-being and human life

The power of a cost–benefit analysis resides partly in the fact that the value of incomparable concepts is expressed in a common denominator: money. Therefore, it is presumed that every cost and every benefit has a market value. In practice, it is often very difficult and sometimes merely impossible or even undesirable to put a price on the benefits of better safety and health at work. Important questions in this respect are the following.

- Is there a value of a statistical human life, and if so, how can that value be assessed?

- What is the value of health or of not being ill?
- How much are job satisfaction and well-being at work worth?
- Why are these prices not the same for everybody?

There are more benefits of better working conditions than the absence of illnesses or injuries. Improved job satisfaction, well-being at work, welfare and a longer healthy life expectancy are additional benefits. For these benefits, no reliable or generally accepted pricing method is available. Some techniques have been developed to find some indications (e.g. by asking people what they would be willing to pay for good health).

3.2. Multiple causes, multiple effects

An essential step in estimating the costs of work accidents and making a cost–benefit analysis of prevention is to make a causal link between the event (accident or preventive intervention) and the effects. Often, this causal relation is not (entirely) clear. For example, unintended exposure to chemical substances can have health effects that are difficult to relate to the exposure. Also, the (economic) effects of an accident can be aggravated by circumstances that have nothing to do with the accident itself. As an example, the duration of sick leave following an injury can partly be determined by the possibilities and incentives the worker experiences on their return to work.

Likewise, preventive measures often have different benefits. Adequate preventive maintenance and high reliability of machines not only improve safety but also reduce production downtime. Measures to prevent dust explosions also reduce exposure to dust, resulting in fewer health problems.

3.3. Time

In economic assessments, time poses some interesting dilemmas and problems for which no ready-made answer exists.

The value of money, depreciation

The key element is that an amount of money you have now is worth more than the same amount next year. Economic evaluation techniques that take money depreciation into account and adjust for the future value of money (discounting) are available. Health effects need to be discounted as well if a cost-effectiveness analysis is being done.

Risk

Money you have now is more certain than what you may have in the future. Investing money always involves some risks; no investment is absolutely safe. The longer the span of time before you get the revenues of an investment, the greater (in general) the risk. Furthermore, some investments are riskier than others and future benefits may be difficult to predict.

Investing in safety and health at work involves (within the context of present knowledge) a rather high risk, as little is known about the efficiency and efficacy of interventions in this area. In addition, there is no way to make sure that preventive action has actually prevented an accident.

In practice, decision-makers deal with risks by applying high interest rates or requiring very short payback periods. Conventionally, intervention effectiveness studies do not deal with risk, other than to conduct sensitivity analyses or to calculate different scenarios to address uncertainty.

Occupational safety and health and planning horizon in companies

The time period during which an occupational safety and health intervention takes place (time frame) is typically much shorter than the time period during which the consequences of the intervention take place (analytic horizon). The analytic horizon should thus be long enough to capture all the economic consequences. Some diseases, for example asbestos-related diseases, have latency periods of more than 20 years. From the societal perspective, the analytic horizon could be 40 years for an illness which affects a worker for the rest of his/her life, or even longer if there are effects for future generations.

These periods are far too long in the context of company decision-making. Planning horizons (at operational and tactical level) are usually three to four years. In many industries, investments have payback periods of two to three years. The risk of having new, more effective and cheaper methods available within a few years is too big.

4. Preparing assessments

4.1. Why assessments?

The economic importance of occupational safety and health is what decision-makers believe it to be. Information and perceptions about future effects of decisions, preferably expressed in terms of money, help employers in the decision-making process. The true value of economic appraisal is influencing the beliefs of decision-makers and policy-makers. For maximum effectiveness in this respect, economic appraisal should be a joint activity of all stakeholders.

Making cost–benefit analyses is essentially about predicting the future. Applying scientific techniques may give the impression that the predictions are quite exact, but in reality the predicted outcomes are generally uncertain. Uncertainties and assumptions give the opportunity to criticise or even reject the assessment. If the outcomes of an economic analysis are uncertain, then why is it done? The process of making an assessment gives many insights. Beside the final answers, positive effects of economic assessments are that:

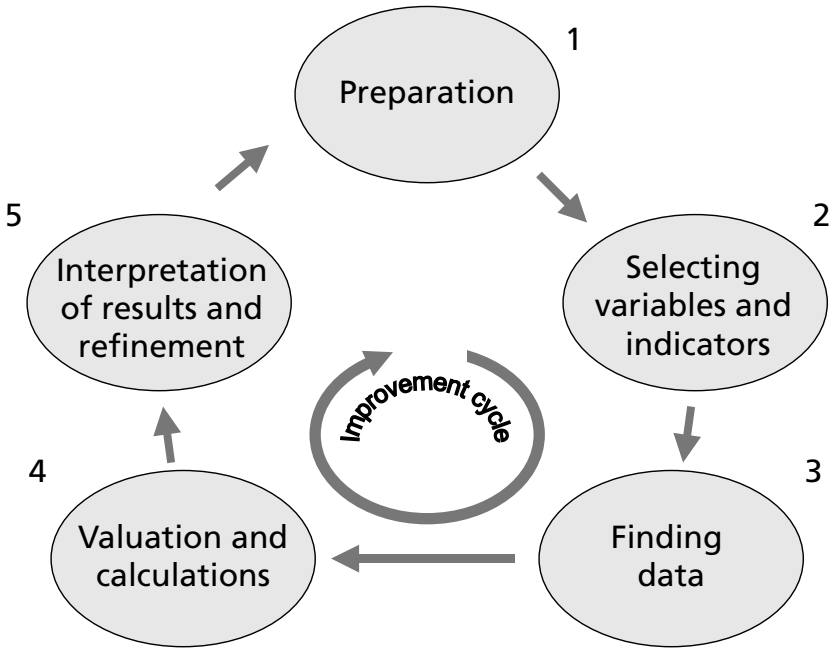
- potential costs and benefits are treated in a structured way;
- the structured approach diminishes the effect of prejudice;
- all stakeholders are given the opportunity to bring forward their interests.

Economic analyses are not neutral. Experienced users may well be able to manipulate the outcomes by overemphasising certain cost factors or leaving others out of the assessment.

4.2. A five-step improvement cycle

Basically, any process of making an economic assessment consists of five steps, including a preparation (see Figure 4.1). The way in which each of the steps is performed depends on the situation at hand. Some steps take very little time; others may take more. The order of the steps is not necessarily fixed, it is possible to perform a step quickly first and than later come back to it. This is useful if some information is missing and becomes available later. If necessary, some cycles of refinement can be performed, for instance by adding cost factors in a later stage, or by modifying some parameters and seeing what happens.

Figure 4.1: **Five-step improvement cycle for making estimations of costs of work accidents and preventive activities**



4.3. Preparation

For maximum effectiveness, economic appraisal should be a joint activity between workers (or their representatives), OSH specialists, financial experts and decision-makers.

- Determine the target audience for the economic appraisal, and consider how they will use the results.
- Define the problem or question to be analysed (e.g. yearly analysis of OSH costs or cost–benefit analysis of a specific safety investment).
- Describe the intervention strategies to be evaluated, including the 'no action' alternative for comparison.
- Identify the perspective of the analysis. It is perfectly acceptable for the analysis to be conducted from the perspective of the employer, but this must be clearly communicated in the report.

4.4. Selecting variables and finding data

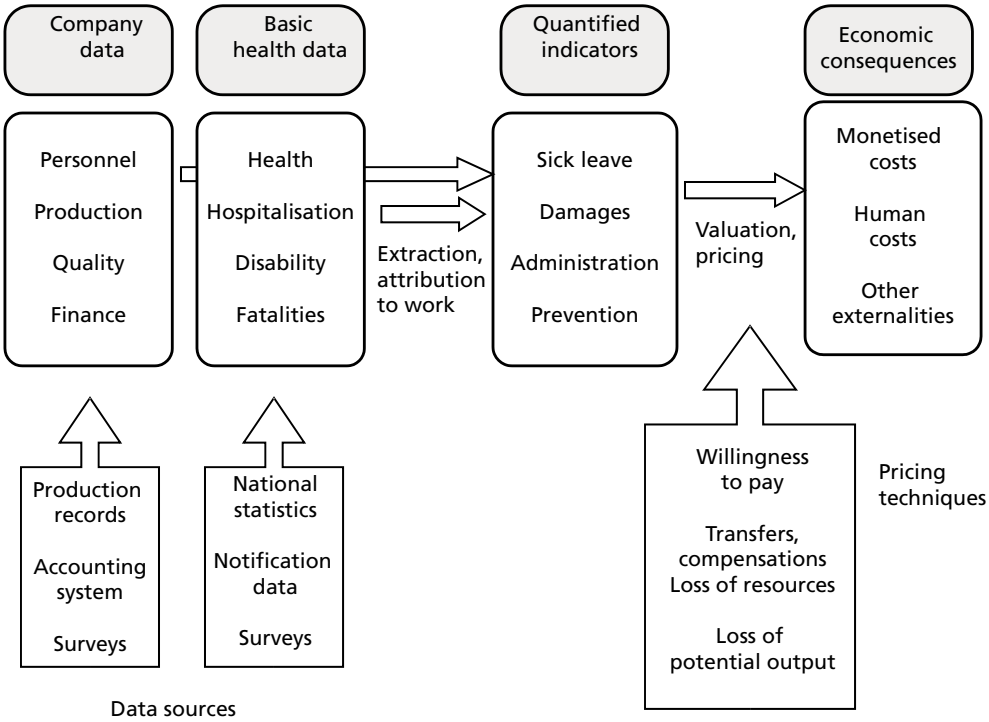
One of the major problems in economic assessment of OSH is that neither companies nor authorities keep track of OSH costs. Furthermore, there are no data on cost effects of interventions. As a consequence, economic consequences of work accidents have to be estimated in an indirect way. Collecting data for economic assessment is therefore a difficult task. Figure 4.2 shows how economic effects can be derived from basic data. Data sources are not uniform in any way. At company level, large differences exist between companies. With respect to data sources at society level, it is noted that data sources differ between countries to a large extent.

For pilot projects or research, it may sometimes be possible to define two or more groups, one target group on which prevention actions are being set up, the other groups being control groups. This approach removes exogenous effects (principally the market effects) and allows a better evaluation of the only prevention effects. (See European Foundation for the Improvement of Living and Working Conditions, *Stress prevention in the workplace: assessing the costs and benefits to organisations,* 1996.)

For practical cost assessments, it is therefore necessary to construct specific lists of variables.

- Find the most important variables first.
- Be aware that some costs are hidden or indirect; consider all possible effects of injuries and diseases.
- Some variables may represent the same effect in a different way; make sure that double counting of costs and benefits is avoided.
- The national system of social security or legislation may cover only part of the work-related accidents and illnesses. In some countries, occupational diseases are very strictly defined as a result of which certain work-related illnesses (in particular stress-related) are not recognised as occupational. Also, differences exist in the definition of work accidents (e.g. in some Member States commuting accidents are work accidents).
- Agree with most important stakeholders which variables are to be included in the economic evaluation.

Figure 4.2: **From basic and general data sources to relevant indicators and economic valuation**



Most economic assessments suffer from lack of adequate data. Although there are different possibilities to obtain data (see Table 4.1), in practice, none of these give optimal data.

Table 4.1: **Possibilities to obtain data for making cost estimations**

Data source, technique	Application at company level	Application at society level
Use of existing data sets	For instance, the costs of personal protective equipment will be included in the company's accounting system. Sick leave and personnel turnover may be registered already.	Use of national statistics and statistics of occupational insurance system. In practice, data suffer from several shortcomings such as under-reporting. In general, not all relevant cost variables are included.
Estimations and projections, starting from available data or technical analysis	The number of work-related illnesses can be estimated from absenteeism records in the company. Also, estimation from epidemiological data at sector or national level are viable options. Estimation of future effects of policies or investments can be derived from the description and goals of the intervention. Sometimes data from similar situations in other companies can be used.	Estimation from health statistics and epidemiological data
Specific generation of new data	Registration systems. Usually hard to implement and rather expensive.	Registration systems, surveys

With respect to occupational injuries, occupational diseases and work-related illnesses, it is important to know when injuries or illnesses can be attributed to work. Also, in the case of work accidents, the attribution to work or conditions at work is sometimes problematic. In many countries, the compensation system has precisely defined which injuries or diseases are occupational. In these circumstances, many illnesses that are (for the larger part) related to work may not be counted. New diseases, for instance certain forms of cancer, allergic reactions, muscular-skeletal disorders or mental problems due to work stress, may not be accepted yet as occupational.

4.5. Valuation, calculation

Several methods and techniques are available to put a monetary value on effects of work accidents and on the benefits of prevention (Table 4.2, see also Section 2).

Table 4.2: **Common pricing principles**

Variable	Common way to find money value
Safety and health management	Wages during time spent on OSH Invoices of external services and equipment
Lost working time	Total amount of wages
Damaged equipment	Repair or replacement costs, market price of new equipment
Time spent for OSH activities	Wages of total amount of time spent
Productivity	Total value of additional units produced
Quality	Value of lost products Value of time spent due to rework Warranties
Workers' diseases, injuries	Medical costs Indemnities Effects on premiums Willingness to pay, willingness to accept
Workers' health, well-being and job satisfaction	No reliable method available
Company image (to customers or labour market)	No reliable method available

For a number of variables, market prices are available or can be derived. For human health and well-being, however, there is no market value. In practice, the monetary value is sometimes constructed by asking people of their willingness to pay to avoid injuries. The results of these methods, however, are often criticised.

In general, it is best to express as much as possible in terms of money. If that is not possible or not wanted, try to quantify or use ranking methods. This can also help in decision-making and can show improvement in safety and health management.

4.6. Interpretation of results

The results of a cost estimation have little meaning without the context. Sometimes, the figures need no explanation, but often the interpretation deserves some attention. At company level, the use of economic indicators can help in deciding which investments are financially attractive. Furthermore, it is very useful to have some information about the reliability and accuracy of an assessment. This section briefly discusses the most relevant issues in this respect.

There are several economic indicators that can be used as a decision-making aid. Simple and easy to use are the 'payback period (PP)' and the 'cost–benefit ratio (C/B)'. The payback period is the amount of time before the initial investments are earned back. A payback period of two to three years is usually acceptable in industry. The cost–benefit ratio is the ratio between the sum of all costs and the sum of all benefits. The smaller the ratio, the better. In more advanced analyses, it is possible to calculate indications like the return on investment in which depreciation is accounted for.

At society level, the time horizon is long (20 years or more). In order to deal with these periods, depreciation of money is important. It is conventional practice to use net present values in calculating cost–benefit ratios. At society level, a discount rate of 3 or 5 % is usually applied to account for the time preference for money (it is preferable to have money now rather than in the future). At company level, much higher discount rates are common. In general, the discount rate should be the sum of the inflation rate, the no-risk interest rates for lending money to a bank and the compensation for risk taking. Practical discount rates at company level are as high as 10 to 15 % but higher values are not uncommon.

Decision-making at company level about investments often includes comparison of multiple alternatives in which the 'do nothing' alternative is always included. In fact, most cost–benefit analyses of OSH activities are based on the difference between the results of prevention and an estimation of costs when no prevention takes place.

5. Practical instruments

This section offers some practical instruments and examples that can be helpful in making cost evaluations of work accidents, occupational injuries and their prevention thereof.

5.1. Checklist for preparation of an assessment

Table 5.1 gives an overview of a five-step approach for making economic assessments. In general, the issues are relevant to cost estimations (what are the yearly costs of prevention and accidents and the consequences thereof?) and to cost–benefit analysis (is an investment in improving safety profitable?).

Table 5.1: **A five-step approach for making economic assessments**

Step 1 Preparation
(a) Establish: — purpose of the economic assessment — goal of the project — who the stakeholders are, what their interests are, what their influence is — what kind of results are needed — how much time should be spent making an economic assessment
(b) Select a suitable technique (e.g. yearly costs, cost–benefit analysis or cost–effectiveness analysis)
(c) Plan the assessment and involve relevant parties
Step 2 Selection of variables and indicators
(a) Choose variables: — that are in line with the selected criteria — that reflect the purpose of the assessment — for which data will probably be available (with acceptable effort to obtain and with adequate accuracy) — that are agreed upon by stakeholders
Step 3 Finding data for selected variables
(a) Data: — use readily available data from company records and accounting system — estimations from epidemiological studies, external data sources, extrapolations from company data — generate new data
(b) Determine which part is to be related to work (e.g. sick leave) and the intervention in question
(c) Quantify effects (of injuries, diseases and/or of interventions) by estimation or analysis techniques, such as: — information from similar cases — scenario calculations — impact analysis (extrapolation from the goals of an intervention)
Step 4 Make calculations
(a) Attach money values to quantified indicators and variables
(b) Create understandable presentation of results, for instance: — tabular format (injury costing, cost-benefit analysis) — graphs or time series (monitoring applications) — comparisons to other companies (benchmarks)
Step 5 Interpretation and refinement
(a) Present caveats for presented results: — refer to assumptions, goals, limitations of estimations, quality of data and the like — use sensitivity analysis to estimate effects of assumptions
(b) Decide on further action

5.2. Estimation of the cost of accidents

The aim of Table 5.2 is to offer guidance for an estimation of company spending on occupational safety. The table gives an overview of the most common cost factors. Bear in mind that the cost factors are rather general. For specific situations, some factors need not be relevant. For a yearly summary, all costs related to occupational accidents should be collected.

Table 5.2: **Most common cost factors related to the yearly costs of safety and health at work (adapted from Mossink et al., 1998)**

Yearly costs related to safety and health at work			
I. Safety and health management	**Days spent**	**Average cost per day**	**Amount**
Extra work time (meetings, coordination)			
— direct personnel			
— management, specialists			
External OSH services			
Protective equipment			
Substitution products			
In-company activities (promotion)			(+)
TOTAL (OSH management costs)			
Subsidies and compensations			(–/–)
NET (safety and health-management costs)			
II. Safety and health-related costs	**Days spent**	**Average cost per day**	**Amount**
Work-related absenteeism (workdays)			
Excessive personnel turnover due to poor working conditions			
Administrative overhead			
Legal costs, fines, indemnities			
Damaged equipment and materials			
Investigations			
Effect on insurance premiums			(+)
TOTAL (OSH-related costs)			
Compensations from insurance			
NET (OSH-related costs)			**(–/–)**
III. Consequences of accidents to company performance	**Days spent**	**Average cost per day**	**Amount**
Production effects due to OSH			
— lost production (reduced output)			
— orders lost			
Quality effects directly related to OSH			
— rework, repairs, rejections			
— warranties			
Operational effects			
— more work (e.g. due to safety procedures)			
Intangible effects (company image)			
— attractiveness to potential customers			
— position on the labour market, attractiveness to new personnel			
— innovative capacity of the firm			
TOTAL (effects on company performance)			

5.3. Cost–benefit analysis

This section offers an instrument that can assist in preparing a cost–benefit analysis for investments in safety and health at work. The instrument consists of three parts.

— Part 1 (Table 5.3): Overview of costs related to the investment of intervention. For each cost factor the relevance to the situation can be checked. If relevant, an estimation of costs can be made, for instance according to the options presented in Table 2.7.

— Part 2 (Table 5.3): Overview of potential benefits, summary of annual benefits or savings. Only benefits that are directly related to the investment in question have to be summarised here.

— Part 3 (Table 5.3): Cash-flow table, summary of expenditures and income for a number of years.

Table 5.3: **Checklist and approach for making cost–benefit analysis of investments in safety and health at work**
Part 1: Investment or intervention costs

Category	Cost items	Relevance yes/no	Cost estimate (EUR)	Description, remarks
Planning	Consultancy costs			
	Engineering			
	Internal activities			
Investments	Buildings, dwellings, foundations			
	Land property			
	Machines			
	Test equipment			
	Transportation equipment			
	Facilities, work environment			
	Workplaces			
Removals	Equipment			
	Transportation			
Personnel	Costs of dismissal			
	Recruitment			
	Training			
Preliminary costs	Loss of quality			
	Additional wages (overtime)			
	Materials			
	Additional operations			
	Organisational activities			
	Production losses, downtime			
Income	Sale of redundant production equipment			
Total				

Table 5.3: **Checklist and approach for making cost–benefit analysis of investments in safety and health at work**
Part 2: Annual cost effects

Category	Cost items	Relevance yes/no	Cost estimate (EUR)	Description, remarks
Productivity	Number of products			
	Production downtime reduction			
	Less balance losses			
	Less stocks			
	Other, to be specified			
Personnel costs	OSH services			
	Savings due to reduction in staff			
	Temporary replacement personnel			
	Costs of turnover and recruitment			
	Overhead reduction			
	Reduction of costs related to sick leave			
	Effects on premiums			
	Other, to be specified			
Maintenance	Cost changes			
Property, facilities and material usage	Cost changes of use of property			
	Heating ventilation			
	Lighting			
	Changes in material usage			
	Energy, compressed air			
	Waste and disposal costs			
Quality	Changes in amount of rework			
	Production losses			
	Price changes due to quality problems			
Total				

Note that in order to avoid double counting it is very important to be precise in the definition of cost items and the way these are estimated.

Table 5.3: **Checklist and approach for making cost–benefit analysis of investments in safety and health at work**
Part 3: Summarising cash-flow table

	Year				
	0	1	2	3	4
Planning					
Investments					
Removal					
Personnel					
Preliminary costs					
Incidental income					
Productivity					
Personnel					
Maintenance					
Use of property, facilities and materials					
Quality costs					
Total					
Cumulative cash flow					

By convention, all expenditures have a negative sign, cost savings and additional income have a positive sign. All investments are assumed to have taken place at the end of year zero.

The cumulative cash flow over the years gives an indication of the profitability of the investment. The payback period is the period when the cumulative cash flow is back to zero (the expenditures equal income or savings).

The (non-discounted) financial earnings of the project is the cumulated cash flow and the end of the economic or technical lifetime of the investment.

The cost–benefit ratio is the expenditure (total of year zero costs) divided by the sum of all subsequent income or savings during the lifetime of the investment.

Modern spreadsheet software like Microsoft Excel and Lotus 123 offer ample possibilities to calculate all kinds of financial indicators very quickly. As calculation of discounted indicators is complex, spreadsheets are extremely useful for this task.

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Annex 2. Examples

Example 1: Cost–benefit analysis of new types of scaffolds

Introduction

The most important goal of scaffolds is to allow people to work safely on heights. In relation to safety, the scaffolds have to have a number of intrinsic qualities like handrails and kick plates, stability, structural aspects and accessibility.

Three types of scaffolds were compared:

- *Type A: scaffold with platform at one single level*
- *Type B: scaffold with an additional level at 70 cm (materials)*
- *Type C: scaffold with working platform on a console*

The question is whether Types B and C, which offer safer and healthier working conditions, are economically feasible. To this end, a comparison between the three types of scaffolds is made.

Economic analysis

The economic analysis is presented in three parts. First, the annual costs and benefits are summarised (Table A). In this table, only costs that differ between the three types of scaffolds are included. For instance, transportation costs are equal and do not influence the comparison.

Second, a number of cost calculations is elaborated. Third, the question of whether the additional investments in new types of scaffolds can be earned back is addressed.

Table A: Economic analysis

	Type A	Type B	Type C
Total turnover (productivity)	4 489 207	4 673 695	4 528 116
Operation and construction costs	279 077	312 068	303 177
Personnel (annual costs)	2 356 650	2 356 650	2 226 779
Materials (annual costs)	1 267 931	1 320 037	1 278 920
Costs of work accidents	9 304	1 720	1 596
Costs of occupational injuries	183 969	165 572	165 572
Total costs	4 096 930	4 156 047	3 976 044
Profits (turnover –/– costs)	392 277	517 648	552 073
Yearly additional profit in comparison to Type A		125 371	159 796

NB: All amounts in EUR.

Total turnover (productivity)

The company has 52 employees that produce a brick wall of a length of 27.4 m and a height of 1.5 m per day on a Type A scaffold. Types B and C allow for higher productivity due to the working at two levels. The yearly production is estimated as follows:

Type A: 39 133 m^2
Type B: 39 700 m^2
Type C: 39 464 m^2

Personnel costs

Type C scaffold allows for a slight reduction in staffing. Whereas Types A and B are (in total) operated by 39 bricklayers and 13 assistants, Type C requires 39 bricklayers and 10 assistants. As a result, personnel costs of Type C are reduced.

Cost of work accidents

It is estimated that Type A will result, on average, in one accident resulting in sick leave for 22 workdays. For the safer Types B and C, the annual amount of incapacity due to accidents is estimated at five workdays.

The average daily costs are EUR 440 and consist of: wages of the victim, production losses, replacement costs and efficiency losses. In addition, the lower number of accidents will result in premium reduction for accident insurance of about EUR 500 (Type B) or EUR 615 (Type C) per year.

Cost of back injuries

Based on data of construction firms, it is estimated that a company of 52 employees is confronted with 152 workdays of sick leave to be paid by the employer and an additional 667 lost workdays (covered by insurance, but worker is not available). It is anticipated that Types B and C will result in a reduction in the number of complaints and sick leave by 10 % in the first year and an even further reduction thereafter.

Investments

The total amount of scaffolds to produce walls with a total height of 8 to 9 m with 13 shifts of 4 persons is about 2 860 m^2. The total investments are:

Type A: EUR 789 100
Type B: EUR 875 900
Type C: EUR 939 100

Economic feasibility

A quick insight into the feasibility of Types B and C can be obtained by comparing the additional investments of Types B and C (in comparison to Type A) with annual additional benefits.

The additional investment in Type B scaffold amounts to EUR 86 800, the annual benefits EUR 125 371. For Type C, the additional investment is EUR 150 000, whereas the additional benefits are EUR 159 800 per year. From these figures, it can be concluded that investment in both Types B and C scaffolds is economically attractive.

Source: Prevent (Brussels, Belgium).

Example 2: Costs and benefits of outsourcing security services

An engineering company has its own security service for 24 hours per day. In order to create flexibility in services and to reduce costs, a number of alternatives are evaluated. The security service has an important role in safety at work:

- *preventing incidents that may lead to injuries, in particular related to aggression and violence;*
- *follow-up on accidents: offering first aid and, if necessary, alerting and coordinating outside assistance (ambulances, fire brigades).*

All alternatives take full account of legal requirements and obligations imposed by insurance. The alternatives are:

- *no permanent surveillance, patrols and inspections during weeknights;*
- *no permanent surveillance, patrols and inspections during weeknights and weekends;*
- *no outsourced security services during weeknights, but security service is performed by own employees;*
- *no outsourced security services during weeknights and weekends, but security service is performed by own employees;*
- *no permanent surveillance, replacement by patrols during weeknights and standby service during weekends and holidays.*

The alternatives are evaluated with respect to effects on insurance and first aid.

Costs and benefits can be estimated as follows (all amounts in EUR).

Cost factor	Amount (EUR)
Wages of personnel performing fire inspection patrols	
Production losses because worker performs other tasks (one hour per shift, 251 nights per year; six shifts for 57 weekends/holidays)	10 300
Training cost: 3 workers per shift (5 shifts) results in 15 training days per year (4 hours production time, 4 hours overtime) and 2 hours per year of extra training	5 400
Intervention costs during alarms There are five alarms per week, resulting in one-hour action per alarm. However, exact calculation is not possible. Therefore, total burden is estimated at 100 alarms per year.	
Training costs first aid Training for groups of five employees, updates and lost working time amounts	(per year) 7 870
Intervention costs first aid 12 interventions of 15 mins	(per year) 100
Investment in fire alarm system (five-year depreciation)	20 700
Cost reduction due to stopped outsourcing:	
— permanent surveillance during weeknights	42 000
— patrols during weeknights	22 200
— permanent surveillance during weekends	75 600
— surveillance with stand-by during weekends and holidays	33 800
— stand-by for interventions	1 100
Interventions	(per hour) 30

In the financial analysis, five alternatives are compared, taking into account that personnel costs increase by 2.5 % per year, external service costs increase by 1.5 %, first aid by 5 %, and the cost

of initial activity for first aid increases by 3.3 %. Discount rate is set at 10 %. The table below shows three economic indicators for each of the alternatives.

	Net present value (EUR)	Internal rate of return (%)	Payback period (years, months)
Alternative 1	365	10.6	4y, 11m
Alternative 2	104 550	145.92	9m
Alternative 3	37 560	63.2	1y, 7m
Alternative 4	188 840	248.9	5m
Alternative 5	96 300	135.9	9m

It is concluded that all alternatives are in themselves profitable. An alternative that has both the highest net present value and internal rate of return is the most attractive.

Source: Prevent, Brussels, Belgium.

Example 3: Costs of falling accidents for a construction company

Though the number of accidents in most companies is low, the costs may be considerable. In this example, the cost to a small construction company of a single falling accident is calculated. By making an ex ante estimation of accident costs of companies or sector, organisations can get some insight into the cost effectiveness of accident prevention. One frequent problem is that reliable accident data are often missing, in particular at company level. In order to estimate incidence of accidents, branch surveys and national statistics have to be used.

Falling accidents are the most common in the construction industry in the Netherlands. In 2000, 2 820 falling accidents were reported out of a total of 20 030 accidents of which 1 892 resulted in sick leave. The number of workers in the sector is 226 680. This implies that, every year, one in every 80 workers has a falling accident and one in 117 workers has an accident that leads to absence for one or more days (Arbouw, 2001).

The mean duration of resulting sick leave is estimated at 14.7 workdays per accident. Roughly, about six of the accidents lead to long periods of sick leave and require investigation by the labour inspectorate as a result of which the work is interrupted for a longer period of time. From disability statistics in the Netherlands, it is estimated that about 1 % of the accidents that result in sick leave end with a permanent disability.

The yearly accident costs of a construction company with 100 employees can be estimated as the sum of a number of cost factors. The selection of the cost factors is based on practice in the Netherlands and the availability of adequate data. An explanation of the calculation is added.

Cost factor	Explanation	Cost estimate (EUR)
Costs of sick leave	The cost depends on the way the company deals with sick leave. On average 100/80 accidents with 14.7 lost workdays may be expected.	
Replacement costs	In 22 % of cases of sick leave the worker is replaced. Interim personnel and overtime lead to costs that are about 120 % of gross daily wages. 28 % replacement * 120 % replacement costs * 14.7 lost workdays * EUR 124.8 gross daily wages * 100/117 falling acc"	527
Lost production	About 28 % of cases of sick leave leads to subcontracting of lost turnover. The costs (wages + overhead + profit) are estimated at twice the gross wages. 28 % lost income * 200 % costs * 14.7 workdays * EUR 124.8 gross daily wages * 100/117 accidents "	878
No costs	In 34 % of cases of sick leave, the work is done by colleagues or by the injured worker when recovered. In these cases, there is no additional costs for sick leave. No costs	—
Administrative and organisational overhead	Total of administration, occupational safety and health services and planning of rehabilitation 100/80 accidents * 0.5 workdays * EUR 124.8 administration costs + EUR 25 OSH service costs + 100/117 accidents * 6 % with a long period of sick leave * EUR 500 cost of a rehabilitation plan	129
Cost for disability, increase of future premiums	In the Netherlands, every case of permanent disability leads to an increase of future premiums for a period of five years. The total amount of extra premiums can be discounted for its present value. 100/117 accidents with sick leave * 1 % leading to disability * EUR 60 610 (total discounted future extra premiums)	518
Lost income as a result of interrupted production	It is assumed that an accident with no sick leave leads to one hour of lost production that is made up in overtime, accidents with sick leave give half a workday of lost production on a construction site and severe accidents interrupt production on the site for three days 100/117 * 0.5 lost workdays * 10 assumed number of workers on a site * EUR 124.80 gross daily wages * 200 % costs of lost income + 100/117 * 6 % severe accidents * 3 lost production days * 10 assumed number of workers on the site * 200 % costs of lost income	1 451
Liabilities	In the Netherlands, workers can claim compensation if the employer has been negligent. Claims vary with the severity of the injury. Compensations are given for both injuries and lost future earnings. 100/117 * 1 % accidents leading to permanent disability * EUR 20 000 assumed compensation.	171
TOTAL estimated yearly falling accident costs		5 253

In the Netherlands, companies have ample possibilities for insurances of costs and losses due to sick leave, disability and liabilities. The effects of insurance are left out of the cost estimations as the financial effects of insurance vary enormously. The effect of accidents on premiums depend on the conditions of the insurance.

From this estimation, it can be shown that investments in safety of EUR 10 000 are profitable and have a payback period of less than three years.

Source: TNO Work and Employment, Hoofddorp, the Netherlands.

Example 4: Lifting aid for nurses

A nursing home started to rearrange its policy for transportation of the 230 inhabitants of the home by the 145 nurses. In the new policy, lifting aids were introduced. Reasons for the investment in lifting aids were the large number of hazardous manual lifting activities, the high absenteeism (10 %) and the number of muscular-skeletal complaints.

The implementation of the new lifting policy included an evaluation of all lifting activities. Activities were counted and an assessment of risk was made based on the NIOSH guideline for manual lifting (table below).

Cost factor	Building 1	Building 2
Number of lifting activities per day	208	546
Cooperation of inhabitant		
— none	76	31
— limited	14	52
— cooperative	10	17
Percentage of lifting activities		
— high risk	82	46
— moderate risk	11	30
— low risk	7	24
Percentage of lifting without aid		
— 1 person	87	57
— 2 persons	8	27
Percentage of lifting with aid		
— 1 person	2	11
— 2 persons	3	5

This evaluation was used to determine the number of lifting aids required and the need for training. After implementation, the changes were evaluated by a survey and followed by a second assessment of lifting activities.

The survey indicated that much of the lifting was still performed manually, but lifting aids were used where practicable. The vast majority of the nurses (90 %) were in favour of the lifting aids, but indicated a number of practical problems (such as manoeuvring in narrow spaces). The sick leave still amounts to about 10 %. However, causes are unclear. In similar nursing homes where lifting aids were introduced earlier, sick leave fell to about 8 %.

Comparison of annual costs and benefits

Old situation	Risk assessment	Lifting aid	Risk assessment using lifting aid
Manual lifting (one person from bed to chair)	High risk	Lifting largely eliminated, replaced by push and pull	Low to moderate risk (lifting actions) Low to moderate risk (pushing actions)
Manual by two persons	High risk	Lifting largely eliminated, replaced by push and pull	Low to moderate risk for both lifting and pushing

Costs		Amount (EUR)
Investments and maintenance of two lifting aids		16 340
Specialised assistance	Six people, EUR 23/month	1 630
Training and consultants	Six people, four hours/month	2 940
Total costs		**20 910**
Benefits		
Reduction of sick leave	Anticipated reduction from 10 to 9 % *	43 230
Total benefits		**43 230**

Source: Prevent, Brussels, Belgium.

Example 5: The removal of hot water: the choice of the best preventive measure

Statement of the problem

A vegetable-canning firm has problems with the drainage of hot water during the production process. This is done via a draining system that is too small to handle all the hot water. The result is that the hot water comes out of the grills and floods the shop floor. For the employees, there is a real risk of burns and falling. Burn wounds occur at a frequency of once a year with an average of 14 days of disability. Slipping and falling occur with a frequency of 0.5 times per year with 17 calendar days of work disability.

Possible preventive measures

- *Modification of the present drainage system.*
- *Placing a retention container under the cookers.*
- *Installing a pump that would take the hot water directly from the cookers to the main drain.*
- *The best preventive measure is to be determined by means of a cost–benefit analysis.*

Costs

The modification of the present drains would only require investment. This would be EUR 31 854. There would be no maintenance or hygiene costs.

The investment costs for retention containers under the four cookers would be EUR 17 848. The hygiene costs (cleaning of the containers) come to EUR 306 per year. There are no maintenance costs.

The installation of a pump to take the water to the main drain would cost EUR 24 789. The maintenance costs come to EUR 1 041 per year. There are no hygiene costs.

When a pump breaks down, production losses occur. With the assumption that each pump will break down once a year, the loss is estimated at EUR 1 239 per year.

Benefits

The benefits are classified into qualitative and quantitative benefits.

The quantitative benefits can actually be calculated (insurance, compensation for disability, training of interim workers, etc.). They are obtained because the costs that are presently generated by the industrial accidents, the maintenance, and the cleaning of the floor are reduced to virtually nothing. This comes to EUR 5 081 (EUR 1 115 for the industrial accidents, EUR 1 735 for the repair of the floor because of the thermal load of the water and EUR 2 231 for the cleaning of the floor).

Qualitative benefits are difficult or impossible to express in figures. By estimation, however, these benefits rise quickly to a factor of 6 or 7 of the quantitative benefits. Examples of qualitative benefits are:

- *a neat work environment: this leads to working neatly, improves the company image, and enhances the production environment;*
- *quality and production losses: reduced because experienced people remain in the production process;*
- *the work pressure due to the absence of an employee is reduced.*

Cost–benefit analysis

The cost–benefit analysis was done with three different parameters: the net present value, the internal rate of return, and the payback. The determination of these parameters was based on a number of assumptions:

- *the increase of wage costs amounts to 2 % per year;*
- *the depreciation period is five years;*
- *taxation is 45 % if profit is made;*
- *for the calculation of the payback, a depreciation of the money of 2 % per year is assumed.*

Net present value (NPV)

When we calculate the NPV at 7 % (bank interest rate) and 15 % (interest rate assumed for investment projects), the second preventive measure emerges each time as the best option by a large difference (EUR 826 and EUR 3 350 respectively).

Internal rate of return (IRR)

The IRR is the interest rate whereby the NPV of an investment is equal to zero. If account is only taken of the quantitative benefits, none of the measures will satisfy the established criterion of 15 %. Considered purely economically, none of the measures comes into consideration for execution. All in all, the second measure is to be chosen over the other two.

Payback

This is the time in which the invested amount is re-earned. Here, too, the second preventive measure emerges as the best choice.

In summary, although none of the alternatives meets the economic criteria, the second preventive measure — the use of retention containers — deserves preference.

Source: Prevent, Brussels, Belgium.

Example 6: The modification of a refuse container: study of the relationship between the degree of risk and the benefits of the preventive measure

The object of the study is to determine whether there is a link between the degrees of risk and the costs and benefits when a specific risk is reduced. In order to be able to study this, a risk analysis was first conducted for an existing installation (a press for compressing polyethylene packaging waste in a refuse container connected to this press). The risks were weighed with the Kinney method, and a selection of them was subjected to cost–benefit analysis. This selection consists of one item with a high degree of risk, one with a moderate degree of risk, and two with a low degree of risk. These four 'sub-studies' are discussed below.

1. Foot control is to be covered

The top of the operation pedal was not covered. This could lead to an employee depressing the pedal unintentionally with the result that somebody doing a manual operation could be crushed in the receptacle.

Kinney: R = W x B x E = 6 x 3 x 3 = 54

R = degree of risk, W = probability factor; B = exposure factor; E = seriousness. Higher values of R represent a higher risk.

Solution: cover the pedal on the top to avoid unintentional operation. After modification, the following degree of risk was obtained: R = 1 x 3 x 3 = 9

2. The clamping point needs to be protected

On the long side of the container, the refuse containers are emptied by means of a forklift and the empty packaging is thrown onto the container. In this way, the clamping point of the container can be reached. If the waste is clamped, there is a danger that the operator can reach the waste too quickly and thus get stuck when removing the waste.

Kinney: R = W x B x E = 3 x 6 x 7 = 126

Solution: installation of protection that makes it impossible to reach the clamping point if instructions are followed correctly. When the press is opened, it stops automatically. For this, two safety switches are provided. The new degree of risk would be the following: R = 0.5 x 6 x 7 = 21

3. An additional wall should be built

At the operation panel, there is no wall. This makes it possible for one to fall about one metre.

Kinney: R = W x B x E = 3 x 6 x 3 = 54

Solution: installation of an additional wall. The new degree of risk would be the following: R = 0.5 x 6 x 3 = 9

4. The doors need to be positively secured

Two non-secured maintenance doors offer access to the internal portion of the press container when it is in operation. There is thus a real risk of being caught by the moving parts. When the doors open, the moving parts should no longer function.

Kinney: R = W x B x E = 6 x 6 x 7 = 252

Solution: a switch with positive security should be placed on each maintenance door. The new degree of risk would be the following: R = 0.5 x 6 x 3 = 9

Comparison

The costs and benefits are also calculated (in EUR) for each risk and placed alongside the degree of risk.

Sub-study	Investment costs	Benefits	Remaining costs	Present costs	Kinney before measures	Kinney after measures	Net present value
Covering of foot pedal	397	1 698	340	2 037	54	9	2 745
Clamping point reachable	885	5 268	1 050	6 319	126	21	7 722
Height of wall	847	1 698	340	2 037	54	9	2 408
Positive securing of doors	975	11 590	1 054	12 644	252	9	20 174

Even though it is difficult to draw conclusions because of the sparseness of the data, it could be concluded that there is a link between the degree of risk and the risk reduction, on the one hand, and the investment cost, on the other. The link between costs in the event of an accident and the degree of risk is clear: a high degree of risk results in high costs if an accident occurs; a low degree of risk gives low costs if an accident occurs. Further, there seems to be a clear link between risk reduction on the one hand, and the benefits of investments to obtain risk reduction on the other: large risk reduction, great benefit; small risk reduction, little benefit. Finally, it should be stressed that attention should continue to be paid to the remaining risks by means of immaterial control measures (training, procedures, warning panels, etc.).

Source: Prevent, Brussels, Belgium.

Example 7: The use of capstans in docks

Background

Prior to this study, a job analysis was conducted. Seven sub-processes as regards the lockage of a ship were examined by means of the Fine–Kinney method. This indicated that the personnel in the subtasks 'mooring and unmooring of the ship' were subjected to high loads on the back in the handling of the ship's ropes and there was a great risk of industrial accidents in the 'paying out' and 'heaving' of the ropes.

The capstan (an electrically driven winch that takes over the 'hauling in of the rope' and 'paying out of the rope' from the worker) emerged as an immediate improvement of the work safety and reduced the risk index from scale 4 (immediate improvement required) to scale 2 (attention required).

The present project

The present study builds on the job analysis and is intended to determine whether the use of the capstans, which could be completely justified according to the objectives of the Fine–Kinney

method for the improvement of work safety, could also be justified financially and economically.

Two kinds of capstans were purchased: fixed and mobile. Because of the capstans:

- *the physical effort of the nautical workers was reduced to a minimum (by the reduction of the effort, it is estimated that 80 % of the accidents due to handling the ropes can be avoided);*
- *the number of personnel can be reduced by 30 %, so the tasks can be performed more efficiently.*

Costs–benefits

A cost–benefit analysis was conducted of Alternative A 'The acquisition of fixed capstans' and Alternative B 'The acquisition of mobile capstans'. The benefits of Alternatives A and B with (A1 and B1) and without (A2 and B2) the reduction of personnel have also been compared.

For this, they used the following methods.

- *The 'net present value' (NPV): here, the present value of future cash flows are compared with the initial investment. In order to generate sufficient cash flows, the NPV has to be positive.*
- *The 'payback period' (PP) method: the time between the investment and the time at which the cash flow is evaluated positively.*
- *The 'internal rate of return' (IRR) method: the project is feasible when this internal yield is greater than what is considered acceptable from the business point of view.*
- *The 'accounting rate of return' (ARR): here, the average annual actual net present yield (accounting profit after taxes) is divided by the investment.*

				Gross cash flow			Net cash flow	
	Investment (EUR)	**Depreciation period**	**Reduction of disability time (man days)**	**IRR (%)**	**PP (year)**	**NPV (EUR) (r = 15 %)**	**IRR (%)**	**ARR (%) (I = 6 %)**
A1	265 419	25	167	18.94	5.80	67 901	13.52	3.6
A2		25	167	63.93	1.57	881 399	43.24	20.9
B1	398 441	25	167	5.47	14.65	– 226 167	3.92	– 0.8
B2		25	167	36.79	2.76	612 120	25.72	10.7

Evaluation criteria

	Investment (EUR)	**Depreciation period**	**Costs (maintenance, energy consumption, etc.)**	**Yield (by reduction of disability, sickness, and use of reserve personnel)**
A1	265 419	25	124 828	99 039
A2		25	124 828	283 516
B1	398 441	25	45 733	99 039
B2		25	45 733	283 516

Detail: cost–benefit with and without personnel reduction by two nautical workers.

Conclusion

The calculations show that Alternative A1 'Fixed capstans without personnel reduction by two nautical workers' is financially feasible. Alternative B1 'Mobile capstans without personnel reduction by two nautical workers', however, is not financially feasible. With Alternatives A2 and B2, the net yields are very clear.

With a view to work safety and operations, the researchers came to the conclusion that Alternative A1 with a depreciation period of 10 years was the best investment.

Considerations

Most companies would probably reject measures that promote occupational safety and health but of which the financial/economic feasibility rests on dismissing personnel. Investments that increase productivity and improve occupational safety and health at the same time will presumably be able to rely on more acceptance.

Source: Prevent, Brussels, Belgium.

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