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Socio-economic costs of accidents at work and work-related ill health **Full study report**

Socio-economic costs of accidents at work and work-related ill health

Full study report



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European Commission

Final Report

Socio-economic costs of accidents at work and
work-related ill health

European Commission

Directorate-General for Employment, Social Affairs and Inclusion

Unit B.3

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Foreword

This report aims to shed light on the socio-economic costs of accidents at work and the incremental benefit of prevention for companies if they develop and implement effective health and safety management policies.

Accidents at work and work-related ill health have an impact on individuals, companies and on society. Each of these groups is confronted with economic consequences. The report discusses the uneven distribution of costs among these three groups and the different cost categories. Systematic information on costs of accidents or work-related ill health is not available from administrative statistical data sources or regular surveys on health and safety at work. The methodological considerations for valuing the consequences of accidents and ill-health are based on an extensive review of the available literature.

The calculation of costs and benefits for companies can increase awareness at management level that may help to stimulate the introduction of preventive actions which, in turn, will result in the reduction of accidents and work-related ill-health. Therefore, the special focus of the study is the calculation of costs at company level. The report presents the results of the multiple case studies with the cost-benefit analysis of the suggested prevention measures. A key message of the report is the need to consider the calculation of costs and benefits as a management issue with an added value on company management practices. The evidence collected in the case studies shows that investing in occupational safety and health makes good business sense.

The report is accompanied by a publication presenting the key messages illustrated by case studies.

The report and the publication are meant to enable employers and workers organisations and representatives, policy makers, managers and authorities to get an overview of the economic aspects of health and safety management. The reports shows that investing in prevention pays back and the calculation of costs and benefits on company level may be a helpful and convincing economic argument on the prevention choices.

0 Summary

The benOSH (Benefits of Occupational Safety and Health) project is aimed at evaluating the costs of accidents at work and work-related ill health and at demonstrating the incremental benefit to enterprises if they develop an effective prevention policy in Occupational Safety and Health. The research project relied on a two-track approach including a desk research (scoping study/ literature review) and a field research based on multiple case studies.

Providing companies an insight in the costs and benefits of occupational safety and health can contribute to healthy work but also to a healthy economy. According to the ILO the total costs of work-related accidents and ill-health amount to approximately 4 per cent of the world's GDP (ILO, 2006). A considerable loss that has a negative impact on economic growth and puts a burden on society. Thus preventing occupational accidents and diseases should make economic sense for society as well as being good business practice for companies.

Literature review

Global burden

Although the emphasis of the benOSH study lies on company level the literature review first depicts the global burden of accidents at work and work-related ill-health by providing some data and showing the impact on economic growth. Many workers in Europe continue to perceive that their jobs pose a threat to their health or safety. According to a recent Eurostat study (2010) 3.2% of the workforce in the EU-27 reported an accident at work in the past 12 months (data from 2007). This means that approximately 6.9 million workers were confronted with an accident at work. The figures for work-related health problems are even higher. No less than 8.6% of the workers in the EU-27 reported a work-related health problem in the past 12 months (data from 2007). This means that no less than 1 out of 10 European workers is every year affected by an accident at work or a work-related health problem.

All these cases of accidents at work and work-related ill-health hinder economic growth. If the proportion of people with ill-health increases, economic growth will slow down. A correlation can also be noticed (ILO, 2006) between national competitiveness and the national incidence rates of occupational accidents. Countries with the best records on accidents at work are the most competitive leading to the conclusion that poor working conditions put a heavy burden on the economy. This leads to economic losses. The ILO has estimated that the total costs of accidents at work and work-related ill-health amount to approximately 4 per cent of the world's GDP (ILO, 2006). According to the European Agency for Safety and Health at Work, the costs to Member States of all work-related accidents and diseases range from 2.6% to 3.8% of GDP (European Agency, 1997).

Different levels and perspectives

Costs of accidents at work and work-related ill-health need to be analysed on three levels: the society, the company and the victim. These three levels are affected by the consequences of poor working conditions and bear the costs. The costs are not equally distributed between the three groups. Furthermore, the costs are not perceived in the same way. The difference in perspective on costs of accidents at work and work-related ill-health has several consequences. First, it means that other assessment methods must be used on all three levels to make realistic cost estimates. Moreover, when using economic arguments based on these costs, one has to take into account this difference in perspective. The decision-making process of a government is totally different from a decision-making process of a company. This means that other cost arguments will have to be developed.

Individuals: a diminished quality of life

On an individual level, victims, their family and friends are confronted with important social consequences affecting their quality of life. Especially if the victims are confronted with disability and long-term absence, the consequences are considerable and can affect a wide community. Physical and psychological functioning in everyday activity can be affected, self-esteem and self-confidence reduced and family relationships stressed. Assessing these consequences is a difficult task and requires specific techniques. Qualitative methods are the most promising. Financial costs for individuals are lost wages during the period of absence and reduced wages after the return to work. Also medical treatment brings about a financial burden.

Identifying macro-economic costs

All of the accidents at work and cases of work-related ill-health potentially impose costs on employers, workers and their families, and society at large. Providing estimates for the societal costs of work-related accidents and ill-health is not an easy task. Weil (2001) reviewed the methods for valuing the economic costs of accidents at work and work-related ill-health and found that most studies tended to underestimate the true economic costs from a social welfare perspective, particularly in how the studies accounted for occupational fatalities and losses arising from work disabilities. Many of the estimates of costs of accidents at work and work-related ill-health depend on a combination of methodological assumptions, extrapolation methods, and known and unknown biases (Weil, 2001; Schulte, 2005).

The estimates found in various studies tend to differ depending on the data sources that are used, the cost categories that are included and the measuring method. These differences relate to the aims of the studies. Most of the macro-level studies serve different purposes, which in turn affect their selection of data sources and methodologies.

Regarding the framework and cost categories, macro-level studies are mostly based on social insurance costs (costs compensated by national social security bodies), and sometimes making extrapolations to other cost categories. Researchers found that this could lead to under-estimates since the loss of productive capacity, or the extent of health effects and of grief and suffering, are often not (are not sufficiently) considered. Therefore other frameworks have been developed in order to come to a more comprehensive approach (e.g. Weil, 2001; Koningsveld, 2004; Suhrcke et al. 2008).

The data sources of macro-level studies often rely on available administrative data. Apart from the fact that the information within these data is limited (e.g. on the causes of cases) administrative data are associated with problems of underreporting and making comparisons between countries.

Also the methods to measure the macro-economic costs tend to differ. The two methods that are most used are the Human Capital method and the Willingness to Pay method. The Human Capital approach is an approach to valuing life in which productivity is based on market earnings and an imputed value for housekeeping services. The Willingness To Pay approach measures the amount an individual would pay to reduce the probability of illness or mortality. The Willingness To Pay approach is preferred given it is more comprehensive (the Human Capital method tends to underestimate costs by ignoring costs for non-wage earning persons and omitting psychosocial costs, e.g. pain and suffering, from the calculations) but since the method requires a lot of data, it is often more difficult to put the approach in practice (Rice, 2000; Suhrcke et al., 2008; Shalini, 2009).

Costs are unevenly distributed between individuals, companies and society

Studies show that society bears the largest part of the costs created by accidents at work and ill-health, followed by individuals. Employers bear the smallest part of these costs (Pathak, 2008). Leading to the conclusion that employers will continue to have weaker than optimal incentives to reduce occupational safety and health risks. The way the costs are distributed between the groups depends on the severity of the case but is also influenced to some extent by the workers' compensation system that is in place.

The workers' compensation systems can be distinguished as public or private on the one hand and monopolistic or competitive on the other hand. All these systems are characterised by aspects related to the risk, coverage, benefits, claims handling, admission and control of insurance carriers, financial aspects and taxation aspects. Between the countries several differences can be noticed. Especially the aspects related to risk, coverage and benefits influence the cost distribution of accidents at work and work-related ill-health between the victims, the companies and society at large. For instance, regarding benefits, examples from European Workers' Compensation Systems show that not only there is a difference in the amounts paid (in % of salary) but also in the duration of the payments.

Since a lot of the costs are borne by society the motivation for intervention should also be attractive to policy makers. An increased insight into the costs on societal level could have an impact on priorities and willingness to intervene, for example by making funds available for initiatives in this field or by implementing financial incentives to change business behaviour.

Defining costs on the corporate level

On the corporate level, the costs of accidents at work and work-related ill-health are the costs of the harmful effects of accidents at work and work-related ill-health. However, the effects or consequences of accidents at work and work-related ill-health are not always straightforward and easy to identify. This has to do with the fact that the causal link between the accident/case of ill-health and the consequence is not always clear. The consequences do not all occur at the same time or in the same place.

Often the costs of accidents at work and work-related ill-health on corporate level are divided into costs categories in order to get an easily understandable argument to promote occupational safety and health. Dividing the costs into the categories external and internal costs shows that not all costs are borne by whoever is responsible for the costs. A distinction between direct and indirect costs (or insured/uninsured costs) points to the fact that not all costs are visible. Some of the costs are obvious and can be directly linked to the accident or the case of work-related ill-health. Others however are hidden. Fixed and variable costs emphasise the fact that a lot of costs vary with the incidence of cases of accidents at work and work-related ill-health. Tangible and intangible costs refer to the fact that some consequences of accidents at work and work-related ill-health can not be valued in monetary units. Often they refer to qualitative aspects such as staff morale, corporate image and customer relations.

The distinction between direct and indirect (or insured and uninsured) is the most common. In line with the theory of Heinrich most authors focus on estimating the indirect costs as a ratio of the direct costs. The direct costs form the top of the iceberg and are visible. All the rest, the indirect costs are hidden beneath the surface. Heinrich (1959) calculated the ratio at 1:4. Studies show that this ratio can't be generalised since the ratio depends on elements such as the severity of the cases, the type of industry, etc. as well as on the social security system.

Assessing costs on corporate level

The goal of calculating the costs of accidents at work and work-related ill-health is to show that investing in occupational safety and health makes good business sense. Therefore, calculating the costs of accidents at work and work-related ill-health can bring added value to the decision making process on company level. A company is an economic entity aimed at creating a - sustainable - profit. Linking occupational safety and health to an economic perspective should therefore be appealing for company management. In practice, companies rarely make cost assessments due to barriers such as limited resources and lack of expertise.

Several methods exist to calculate the costs of accidents at work and work-related ill-health at company level: insurance-based methods, activity based methods and labour capacity approaches. All these methods are facing similar methodological problems such as lack of data, inadequate human resources accountancy methods and insufficient pricing techniques.

The business case as a driver for OSH

Calculating the costs of accidents at work and cases of work-related ill-health may give an indication of their impact on company performance. However, it is much more interesting to know how we can effectively prevent the causes of such accidents and cases of ill-health and how much we can benefit from this prevention in monetary terms (Verbeek, 2009). This could provide a basis for putting forward a strong business case for occupational safety and health. Legal compliance is the most important driver for OSH on corporate level but higher-level activities and resources do require a business case (Miller, Haslam, 2009). Moving beyond legal compliance requires a sound strategy on occupational safety and health tying its outcomes to the overall business outcomes.

The theoretical framework (see figure 1, p. 19) offers an insight into the relationship between occupational safety and health prevention measures and programmes, the process and the outcomes. Occupational safety and health programmes generate effects and outcomes that influence company performance positively and which contribute to the company goals. Outcomes are noticeable on both organisational (less costs, improved company image, less job turnover and higher productivity) and individual level (healthier lifestyle, improved motivation and commitment). The outcomes as presented in the theoretical framework are demonstrated by several studies delivering evidence for these business arguments.

The fact that the business case can function as a driver for OSH emphasises the need to set-up economic assessments of occupational safety and health interventions on company level as part and in support of strategic business cases. Cost-benefit analysis is a useful assessment method since it compares benefits and costs of OSH interventions in monetary values. Calculating the benefits from preventive measures requires adequate assessment methods such as cost-benefit analysis and although these methods are useful in assessing the economic impact of interventions, they do present methodological limitations.

The scoping study

The scoping study was conducted to provide selections of accidents/occupational illnesses/ill health in relation to sectors, company sizes and appropriate prevention measures, thereby encompassing a relevant sample.

Methodology

The research excluded commuting accidents of employees. It included - besides the usual fatal accidents and accidents leading to more than three days absence - also accidents followed by three or less days of absence.

Cases of noise effects were excluded, because it turned out that it is very difficult to differentiate between work induced and non-work induced hearing problems. In addition effects on workers often appear fairly late in their working life and may lead to an early retirement. Disadvantages for the companies may thus be limited and a realistic balance was very difficult to be established. Also excluded were health problems which can be attributed mainly to environmental causes e.g. to maintenance problems of air conditioning.

The study was mainly based on various materials from

- Eurostat and Directorate-General for Employment, Social Affairs and Inclusion, European Commission
- European Agency for Safety and Health at Work
- Material from health and accident insurance companies
- Material from institutes like BAuA in Germany and INRS in France

During the study a matrix combining the following information was established and relevant aspects for the benOSH study were filtered:

1. Relevant sectors regarding financial turnover and numbers of employees
2. Relevant company sizes regarding number of employees (turnover)
3. Relevant categories of accidents (fatal, non-fatal- 3 days absence, general)
4. Relevant acknowledged occupational sicknesses (acute and chronic)
5. Relevant occupational ill health
6. Related relevant hazards and risks
7. Related prevention measures
8. Related companies and cases

From this matrix a list for proposed cases, companies, etc. was derived.

Study

From scrutinising the structure of the sectors and the sizes of companies it was concluded that this study would not consider those sectors that employ less than 5% of the workforce or respectively have less than 5% of total GVA (Gross Value Added). The general focus was put on SMEs and large industries would only be considered in special cases.

Subsequently the accidents at work and the different types of work-related ill-health were studied and related to their numbers and their effects like sick days and severity. They were listed in descending order and related to the identified sectors and company sizes. In the last step they were related to the causes and risks leading to these accidents or diseases.

For the purpose of this project the severity of accidents at work and work related ill health was defined based on Schüler (2001). Schüler's first two categories are combined for this project to form "low severity" (working days lost: 0-15), "medium severity" (working days lost: 16-35), as well as the last two to form "high severity" (working days lost: >35). Regarding work related ill health we considered the days of absenteeism, except for needle stick injuries involving patients with HIV and / or hepatitis C, which were classified also always as high severity.

During the study the following aspects were closely analysed:

- Fatal accidents
- Non-fatal accidents
- Occupational diseases
- Work-related ill-health
- Musculoskeletal problems
- Psychosocial health problems
- Respiratory, skin problems and infectious diseases
- Cardiovascular disorders (this issue was not considered for the field study)
- Violence and intimidation

Selection of sectors and cases for the field study

Summarised information from the above chapters was entered into the matrix mentioned above. This information was then closely analysed and relevant sectors together with occupations and causes were identified.

The selected cases were broken down further according to their severity. In the following step related prevention measures were discussed and assigned. The prevention measures are based on best

practice cases from the European Agency for Safety and Health at Work and from other relevant institutions like accident insurers and the German Federal Institute for Occupational Safety and Health BAuA (BAUA, 2004). For the prevention of accidents we also used the study from the European Commission, Directorate-General for Employment, Social Affairs and Inclusion, Causes and circumstances of accidents at work in the EU, which relied mainly on material from the French National Institute for Research and Safety, INRS (European Commission, 2009).

The measures follow the recommended order of prevention principles: elimination of risks, combating risks at source, technical and organisational measures (e.g. instructions) before applying personal protective equipment. It was also taken into consideration that e.g. technical prevention measures often need to be supplemented by instructions, training and motivation of workers. However the measures were discussed during the field study with the company OSH professionals and the accident insurer and/or labour inspection staff in charge.

Finally the companies to be selected (sectors, types, sizes) in relation to accidents or diseases as well as severity and preventive measures were described as specific as possible in a final table (see table 22). A large number of companies were contacted. Which companies in the end really took part in the project depended on various factors. The final selection of cases was also influenced by the discussions with the company professionals.

Case studies

Methodology

The field research relied on multiple case studies in several companies. For this study the Matrix (activity based method for cost calculation) and the cost-benefit analysis methods were selected.

For calculating the costs of the accidents at work and work-related ill-health, the Matrix was used. The Matrix was developed by Prevent in collaboration with the occupational accidents insurance organisations in Belgium (De Greef and Van den Broek, 2006). The Matrix is an activity based approach to calculate the cost of occupational accidents and work related ill-health. The cost categories are clustered along the main cost categories in the accountancy system: the operating costs such as goods, services and staff and depreciation. The costs centres are clustered in the HEEPO categories: Human, Equipment, Environment, Product and Organisation; the HEEPO clusters are familiar to OSH professionals. The result offers a basis for discussion for both OSH professional and (financial) decision makers. To facilitate the practical use of the method, a checklist was designed. This checklist brings together 40 cost items related to accidents at work or work-related ill-health subdivided into the 5 HEEPO clusters.

The cost-benefit analysis uses monetary values for costs and benefits of occupational safety and health. It offers a straightforward approach for decision-making on company level. For the interventions in the case studies economic indicators were calculated such as the Net Present Value, the Profitability Index, the Benefit-Cost Ratio, the Payback Period and the Internal Rate of Return (see box 14, p. 137).

The data were collected using a data-gathering tool. This tool in excel sheets allows bringing together the following information:

- worksheets based on the Matrix allowing to calculate several cases of accidents at work or work-related ill-health, according to severity (8 low severity, 3 medium severity and 1 high severity);
- a worksheet with the overview of the costs brought together in the Matrix;
- a cost summary allowing to calculate the avoided costs for the cost-benefit analysis;
- worksheets to insert data for the cost-benefit analysis (3 scenarios, see below); also intangible benefits were recorded if data were available;
- a worksheet showing the results of the cost-benefit analysis.

The field study was executed by telephone, on site visits and reporting. The scoping study formed the basis for the case studies. In order to attract companies both Prevent and KOOP communicated on the project through their normal communication channels such as website, e-zines, training sessions, etc. and through intermediary organisations such as accident insurers.

Interested institutions/companies were contacted by phone. Explaining the study, the contact persons were presented with arguments how companies could benefit from participating in the study. Interested persons contacted by phone would then be sent the benOSH information sheet. They would be again contacted after about a week and in case of a positive reaction the further steps would be discussed. In general the next steps consisted of

- contact by phone: collecting general information;
- on site visit: collecting cost information on specific cases and discussion about preventive measures;
- external expertise for identifying preventive measures;
- collection of data for preventive measures and cost-benefit analysis;
- analysis: reporting to the company.

Results

In total 401 cases of accidents at work and work-related ill-health were analysed: 276 with low severity, 73 with medium severity and 52 with high severity. For each of these accidents at work or cases of work-related ill-health the costs were calculated based on an analysis of the consequences. A cost-benefit analysis was carried out for 56 projects

Table – Overview of the cases (cost-calculations and cost-benefit analysis) according to sector

	cases of accidents at work and work-related ill-health								cost-benefit analysis	
	low		medium		high		total			
	#	%	#	%	#	%	#	%	#	%
chemical sector	3	1.1	0	0.0	1	1.9	4	1.0	1	1.8
cleaning	12	4.3	2	2.7	0	0.0	14	3.5	2	3.6
construction	74	26.8	20	27.4	21	40.4	115	28.7	14	25.0
distribution	1	0.4	2	2.7	0	0.0	3	0.7	1	1.8
energy	5	1.8	1	1.4	0	0.0	6	1.5	1	1.8
food	17	6.2	10	13.7	3	5.8	30	7.5	4	7.1
hospital/social	44	15.9	10	13.7	7	13.5	61	15.2	8	14.3
metal	37	13.4	2	2.7	8	15.4	47	11.7	9	16.1
mining	14	5.1	6	8.2	2	3.8	22	5.5	3	5.4
services	0	0.0	0	0.0	1	1.9	1	0.2	1	1.8
textiles	7	2.5	2	2.7	1	1.9	10	2.5	1	1.8
transport	51	18.5	13	17.8	6	11.5	70	17.5	7	12.5
waste	11	4.0	5	6.8	2	3.8	18	4.5	4	7.1
	276	100.0	73	100.0	52	100.0	401	100.0	56	100.0

The cost calculations showed that accidents at work and work-related ill-health bring about considerable costs. The case studies showed a median of €1,651.54 for cases of accidents at work and work-related ill-health with low severity, of €4,985.9 for cases with medium severity and of €11,661.69 for cases with high severity. These costs fall entirely on the employer. Most costs affect the category Human and to a lesser degree also the category Organisation of the HEEPO-classification. The areas Equipment, Environment and Product as used in the HEEPO classification, are negligible. Only in specific types of cases, such as car or forklift accidents, these areas are affected. The type of case also affects the monetary values. Falls from height entail overall the highest costs. The sector seems to have a limited impact on the cost level.

The costs mentioned are the costs borne by the employer. They have to be considered in light of the severity definition that was used for the study. For instance the cases with low severity also included very small cases with no absence and a limited impact. It can be argued that the study showed that these minor cases must not be ignored and bring about costs that seldom are noticed. Mostly they are not registered let alone reported to the insurer.

Furthermore, in valuing lost time it cannot be ignored that companies have buffers and spare capacity to deal with disruptions (see also Lehmann and Thiehoff, 1997). In the case studies this impact was valued to some extent (see case descriptions) but it is clear that these costs go beyond accidents at work and cases of work-related ill-health and affect the overhead costs of the company.

The cost assessments did not put monetary values to all consequences of accidents at work and work-related ill-health. Effects on staff morale, customer satisfaction, market share, etc. were not valued.

Therefore the costs must not be regarded as an absolute value (the price paid for a case) but seen in light of the possible benefits. Discussions with the companies confirm this.

The results of the cost-benefit analyses are summarised in table 34 (annex 5). The table gives a short description of the measure and the economic indicators that came out of the analysis: Net Present Value, Profitability Index and Benefit-Cost Ratio. If possible, each case study considered three scenarios. The first and second scenario assess the costs and benefits of the same set of prevention measures, but the first scenario is based on a conservative estimate of the costs of accidents at work or work-related ill-health that could be avoided, while the second scenario takes a more optimistic assumption. These assumptions of how many costs of accidents at work or work-related ill-health could be avoided are based on discussions with the company, expert opinions, data from research and good practice. This is then reflected in two estimates, a conservative one, calculated in the first scenario, and a more optimistic one, calculated in the second. The third scenario considered either an alternative measure or additional measures.

The measures were clustered along 6 main categories: substitution/avoidance (I), organisational measure (II), new equipment/auxiliaries (III), workplace adjustment (IV), training (V), personal protective equipment (VI). In many cases a set of preventive measures were considered but for clustering purposes, the main measure is indicated in the tables. In most projects the main measure was the purchase of new equipment, auxiliaries or adapting the equipment.

The median values of the Net Present Value, the Profitability Index and Benefit-Cost Ratio are listed in the table below. The highest values can be found for measures aimed at substitution or avoidance. The lowest values can be found for measures such as training and personal protective equipment. These results seem to support the case that measures considered to be the most effective according to the prevention principles are also more cost-effective (profitable).

Table – Overview of the projects according to type of measure (main measure) – median values

Measure	Code	#	%	Scenario 1*			Scenario 2*		
				Net Present Value	Profitability Index	Benefit-Cost Ratio	Net Present Value	Profitability Index	Benefit-Cost Ratio
substitution/avoidance	I	3	5.4	2,207.52	2.56	1.60	13,857.89	4.08	2.25
organisational measure	II	6	10.7	2,310.96	1.74	1.04	21,829.57	3.18	1.36
new equipment/auxiliaries	III	20	35.7	1,713.35	1.41	1.40	8,983.74	2.76	2.70
workplace adjustment	IV	6	10.7	2,389.38	1.37	1.22	8,984.01	2.15	1.66
training	V	16	28.6	605.02	0.95	1.12	8,092.65	3.39	2.51
personal protective equipment	VI	5	8.9	154.38	1.05	1.18	11,038.12	1.83	2.10
<i>all</i>		56	100	1,434.875	1.29	1.21	9,218.81	2.89	2.18

*Scenario 1 is based on a conservative assumption of the costs related to accidents at work and work-related ill-health that can be avoided; Scenario 2 takes a more optimistic assumption.

However, since the cost-benefit analyses derive from specific case studies the results have to be carefully interpreted. But, in general, the case studies support the fact that investing in occupational safety and health is profitable.

Methodological considerations

While conducting the case studies, several difficulties have been encountered such as

- the involvement of smaller companies;
- the lack of available data concerning work related diseases on company level;
- to obtain the necessary data to make the economic valuations;
- the assessment of the effectiveness of the OSH measure.

This study is to a large extent based on the results of case studies in companies. It is well known that companies cannot be compared to laboratories where all the parameters and variables can be perfectly controlled and managed. Based on the study it was possible to derive prerequisites that need to be fulfilled when making an economic assessment on company level:

- tailor-made to the needs and the practice of the companies;
- interventions based on effective solutions;
- using techniques that make actual calculations on company level (not relying on general estimates);
- outcomes presented in a language understandable and meaningful for management.

An interesting approach

Companies showed a great interest in the approach. Calculating the actual costs proved to be convincing and although the results did not always indicate large sums, they still were eye-openers. The study did reveal that the costs are mostly underestimated and that it is a useful practice to calculate costs. By using the Matrix, these costs can be made visible and linked to the consequences of health and safety risks as well as to the bookkeeping system on company level.

By conducting a cost-benefit analysis, in which all costs are balanced against future benefits, an economic assessment of the health and safety investment can be made. The majority of the case studies have clearly demonstrated that health and safety interventions lead to positive economic indicators. By doing so, the cost-benefit analysis technique is useful to provide evidence for the profitability of a specific measure within the context of a specific company. It is a robust approach in support of OSH practitioners when making their case for management.

Occupational safety and health practitioners have the need to be more acquainted with techniques such as cost-benefit analysis. Often they lack proper training in the process of making economic assessments. Training is also needed on communication strategies. In the end, the economic assessment has to be in support of a strategy to convince management to invest in safer and healthier workplaces.

To support occupational safety and health practitioners in making economic assessments, there is also a need for simple, easy to use tools that are accessible for practitioners. These tools would support the cost and benefit calculations as well as the process of economic assessments. If these data could be stored in a central database on national or even European level, they could offer interesting benchmarks for companies and institutions willing to perform economic assessments of health and safety measures.

Key Messages

Based on the results of the literature review and of the case studies key messages are defined. The key messages support the communication of the findings of the benOSH study and other studies in this field. The key messages are clustered into 3 headings. The headings and the key messages structure the publication of the benOSH project.

The impact of the costs of accidents at work and work-related ill-health

Accidents at work and work-related ill-health hinder economic growth

Consequences of accidents at work and work-related ill-health go beyond the workplace

Costs are partly shifted to society and individuals

The cost of accidents at work and work-related ill-health on company level

Consequences of accidents at work and work-related ill-health are not always noticed

Consequences of accidents at work and work-related ill-health increase company costs and decrease revenues

Calculating costs raises awareness about the necessity of prevention

Accidents at work and work-related ill-health bring about considerable costs

Prevention pays

Investing in occupational safety and health contributes to company performance through tangible outcomes

Evidence derived from practice: cost-benefit analysis studies show that investing in occupational safety and health yields positive results

1 Introduction

1.1 General framework

According to the ILO the total costs of work-related accidents and ill-health amount to approximately 4 per cent of the world's GDP (ILO, 2006). A considerable loss that has a negative impact on economic growth and puts a burden on society. Health on the other hand is a strong predictor of economic growth. Health leads to economic growth by increased savings, investment in human capital and labour market participation.

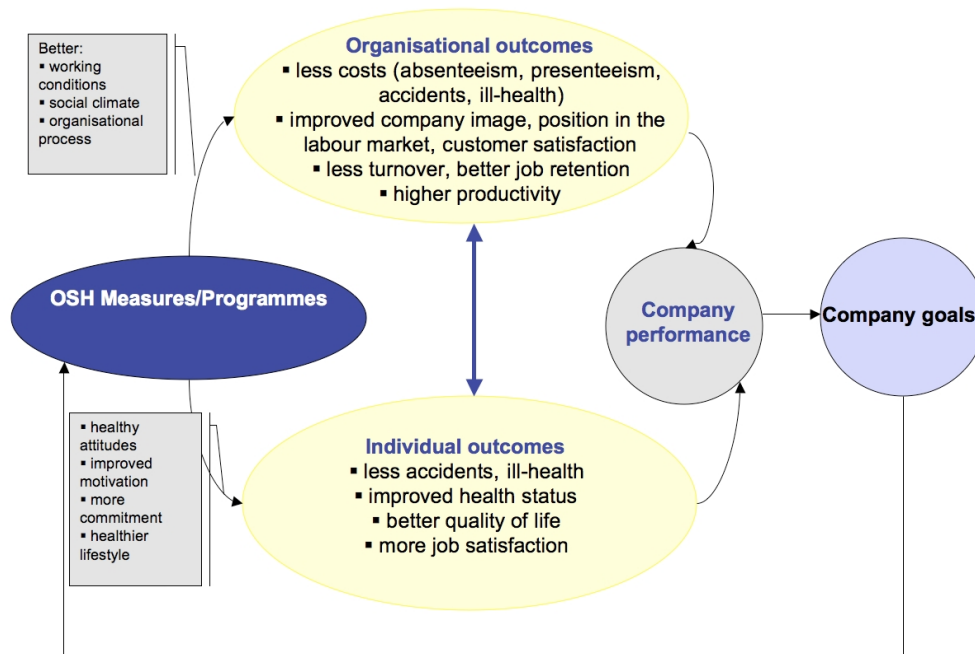
This is why it is important to provide companies an insight in the costs of accidents at work and work-related ill-health. It raises the awareness of the economic benefits of occupational safety and health. Companies investing in active prevention policies to protect and promote the health of the workers obtain tangible results: reduction in costs arising from absenteeism, reduction in staff turnover, greater customer satisfaction, increased motivation, improved quality and enhanced company image. In a healthy working environment, these positive effects can also be strengthened by encouraging the workers to adopt healthy lifestyles aimed at improving their general state of health (figure 1). By eliminating unnecessary and avoidable cost and by improving productivity, the company will finally increase its performance leading to an increase of shareholder value.

The Community Strategy 2007 – 2012 on Health and Safety at Work¹ acknowledges the major contribution that guaranteeing quality of work and productivity can play in promoting economic growth and employment. The strategy also acknowledges the importance of effective occupational health and safety policies to ensure that economic costs of problems associated with workplace accidents and work-related ill-health will not inhibit economic growth and affect the competitiveness of businesses in the EU. Investing in occupational health and safety contributes to the sustainability of social protection systems because it results in reduced costs for occupational accidents, incidents and diseases and enhances worker motivation. Moreover, occupational safety and health plays a vital role in increasing the competitiveness and productivity of enterprises. Therefore, it supports the main commitment of the Lisbon strategy to increase employment and productivity through greater competitiveness.

Integrating health and safety in company strategy and policy is key to business excellence and success, allowing businesses to contribute to sustainable growth enhancing welfare and innovation. Figure 1 offers an insight into the relationship between occupational safety and health prevention measures and programmes, the process and the outcomes. Occupational safety and health programmes generate effects and outcomes that influence company performance positively and which contribute to the company goals. In order to have an effective influence on company performance, the occupational safety and health programme must be aligned with the company goals. In this respect, it forms part of the business strategy and also the continuous improvement circle that drives a company towards excellence. Outcomes are noticeable on organisational level since occupational safety and health measures lead to change by creating better working conditions, improving the social climate and the organisational process. The results are positive organisational outcomes such as less costs, improved company image, less job turnover and higher productivity. On an individual level, an occupational safety and health programme leads to greater health awareness (healthier lifestyle) and an improved motivation and commitment. These changes result in several outcomes such as more job satisfaction. Moreover the framework shows that important additional effects and outcomes can be obtained since there is a clear link between the various outcomes and between the organisational and individual level.

¹ European Commission. Communication from the Commission COM (2007) 62 final. 'Improving quality at work: Community strategy 2007-2012 on health and safety at work. Improving the quality and productivity at work'

Figure 1 - Outcomes of OSH measures and programmes in relation with company performance and company goals



Source: De Greef and Van den Broek, 2004b

1.2 Aims, methodology and scope of the project

1.2.1 Aims of the project

This report brings together the results of the research project benOSH – Benefits of Occupational safety and health. This project is aimed at:

- evaluating the costs of accidents at work and work-related ill health; and
- evaluating the incremental benefit to enterprises if they develop an effective prevention policy in Occupational Safety and Health.

Systematic information on costs of occupational accidents and work-related health problems is not available from administrative statistical data sources or regular surveys on health and safety at work. Research studies have been conducted in the past to provide estimations for these socio-economic costs (see e.g. European Agency, 1997; Bödeker, 2002; Baigger, 2003; Eurostat, 2004b). The estimates that can be found in literature rest on a combination of methodological assumptions, extrapolation methods and known and unknown biases (Weil, 2001; Schulte, 2005). The focus of most studies lies on the macro-economic level and provide estimates for the costs on societal level. Thus, the importance of providing economic arguments on company level might be surpassed.

Information is also lacking on the benefits of prevention measures and investments in prevention policies. Case studies based on the technique of cost-benefit analysis show positive results for specific measures but it is not possible to draw general conclusions with regard to the effectiveness of different OSH measures (De Greef M. and Van den Broek K., 2004a).

However, providing an insight into the costs of occupational accidents and work-related health problems as well as into the benefits of OSH interventions can be considered a strong driver for company management for setting up safety and health management systems. This insight can only be obtained if it is based on research that is closely linked with company practices and that is easily transferable to other/all companies. The core of this project consists in providing cost estimates of multiple case studies using a uniform methodology. The conclusions will give an overview of the profits that can be generated on company level by investing in OSH measures.

1.2.2 Methodology and scope

The project analyses the socio-economic costs of accidents at work and work-related ill-health, the costs of prevention measures and the benefits of such measures. This analysis focuses on company level using case studies to calculate the costs of accidents at work and work-related ill-health and conduct cost-benefit analyses. Although this report focuses on the level of the individual company, it is clear that the consequences of occupational safety and health hazards such as accidents and ill-health, surpass the level of the individual company. Especially the individual worker/victim as well as his/her family and social network suffer from the consequences of accidents at work and work-related ill-health. Also society as a whole has to deal with these negative outcomes of the production process.

The research project relies on a two-track approach: firstly, a desk research comprising a statistical scoping study and a literature review, secondly a field research based on multiple case studies. The case studies provide on the one hand relevant data for making an analysis of the costs of accidents and work-related ill-health and on the other hand information of the profitability of preventive measures. The costs of accidents at work/ work-related ill health problems were calculated with Matrix. The financial benefits on company level of a specific prevention measure were calculated using the technique of cost-benefit analysis. Further explanation on these methods is given in the relevant chapters.

2 Literature review

2.1 Introduction

The review brings together information on the costs of accidents at work and work-related ill-health. Emphasis is put on corporate level but also the individual and the societal level are described. The costs of accidents at work and work-related ill-health support the case for investing in occupational safety and health. It is clear that this approach can never replace the fundamental commitment of a company to strive towards healthy workplaces. The motives for developing an effective occupational safety and health policy must stem from social, legal as well as from economic objectives. If one considers health and safety to be a basic right for every worker, the economic goals have to be embedded in the social policy at company and society level.

In reviewing the literature on costs of accidents at work and work-related ill-health, it became clear that, at least on company level, the studies on accidents at work are more abundant than those on work-related ill-health. Dorman states that this must be contributed to the fact that the causality between work and the event of an accident is evident which is not always the case for occupational diseases. Data however, seem to indicate that work-related ill-health represents even a bigger problem, also on company level, and that by focusing on accidents at work the economic consequences of poor working conditions are underestimated (Dorman, 2000b).

2.1.1 Methodology

The literature references were collected in steps. A relevant list of search terms served as a basis to consult specific databases: CISDOC², PreventDoc³ and OSH Update⁴. The search terms used were:

- cost(s)
- cost-benefit analysis, economic assessment
- occupational, workplace, work-related, work
- accident, disease, ill-health

These search terms were also used in Google to identify grey literature. In Google the search terms were also used in Dutch, French and German.

Further, Google Scholar was used to look for studies listed in the references of key works identified by the earlier mentioned searches.

A first screening of the literature resulted in a list of relevant material and also in a draft structure. Further analysis of the relevant studies was performed to complete the review.

2.1.2 Approach

The first part (2.2) of the literature review depicts the global burden of accidents at work and work-related ill-health by providing data on the occurrence and the costs. The second part (2.3) emphasises the fact that costs of accidents at work and work-related ill-health have an impact on several groups: individuals, companies and society at large. These groups suffer different consequences and perceive

² International occupational safety and health Information Centre (CIS), <http://www.ilo.org/dyn/cisdoc>

³ Documentation Database Prevent

⁴ Internet service with 19 OSH reference databases <http://www.oshupdate.com>

costs in a different manner. The next parts of the literature review focus on the corporate level. Under heading 2.4 theoretical issues on costs of accidents at work and work-related ill-health are brought together dealing with issues such as definitions and cost categories. Heading 2.5 addresses the importance of calculating the costs of accidents at work and work-related ill-health on company level and reviews the methods and approaches that are used. The last part (2.6) gives information about the benefits of prevention measures and economic assessments of OSH interventions.

2.2 Accidents at work and work-related ill-health: a global picture

The available data on accidents at work and work-related ill-health show that still a large number of workers are confronted with accidents at work at work-related ill-health (2.2.1). This places an important burden on society, on companies as well as on the individual workers (2.2.2).

2.2.1 Data on work-related risks

Many workers in Europe continue to perceive that their jobs pose a threat to their health or safety. Almost 28% of workers in Europe say that they suffer from health problems that are or may be caused or exacerbated by their current or previous job. This is shown by the results of the fourth European Working Conditions Survey⁵ (EWCS 2005) of working conditions.

These data from the European survey of working conditions on perceived exposure to work-related risks are confirmed by the statistics on health related outcomes such as accidents at work and work-related diseases. According to a recent Eurostat study (2010) 3.2% of the workforce in the EU-27 reported an accident at work in the past 12 months (Labour Force Survey (LFS) data from 2007). And although this figure represents a slight decrease in comparison with 1999 (3.5%, 10 EU countries), it still means that approximately 6.9 million workers were confronted with an accident at work.

The European Statistics on Accidents at Work (ESAW)⁶ showed a more positive evolution for the occurrence of non-fatal accidents with more than three days of sick leave. These figures declined from 4% in 1999 to 2.9% in 2007 (EU-15). Also fatal accidents decreased from 5,275 in 1999 to 3,580 fatalities in 2007.

Accidents at work bring about a vast number of sick leave days. 73.4% of the accidents at work result in a sick leave of at least one day and 22% in at least one month. In total, it was estimated that accidents at work caused 83 million calendar days of sick leave in 2007 (Eurostat, 2010, LFS data). According to the data registered in ESAW every year more than 100 000 accidents at work lead to permanent incapacity to work.

For work-related health problems, the figures are even more staggering. No less than 8.6% of the workers in the EU-27 reported a work-related health problem in the past 12 months (LFS data from 2007). This corresponds to approximately 23 million persons. Musculoskeletal problems were most often reported as the main work-related health problem (60%), followed by stress, depression or anxiety (14%).

Considering the 2007 LFS data it becomes obvious that no less than 1 in 10 workers is confronted with an accident at work (3.2%) or a work-related health problems (8.6%) every year.

⁵ Survey of the European Foundation for the Improvement of Working and Living Conditions, <http://www.eurofound.europa.eu/ewco/surveys/index.htm>

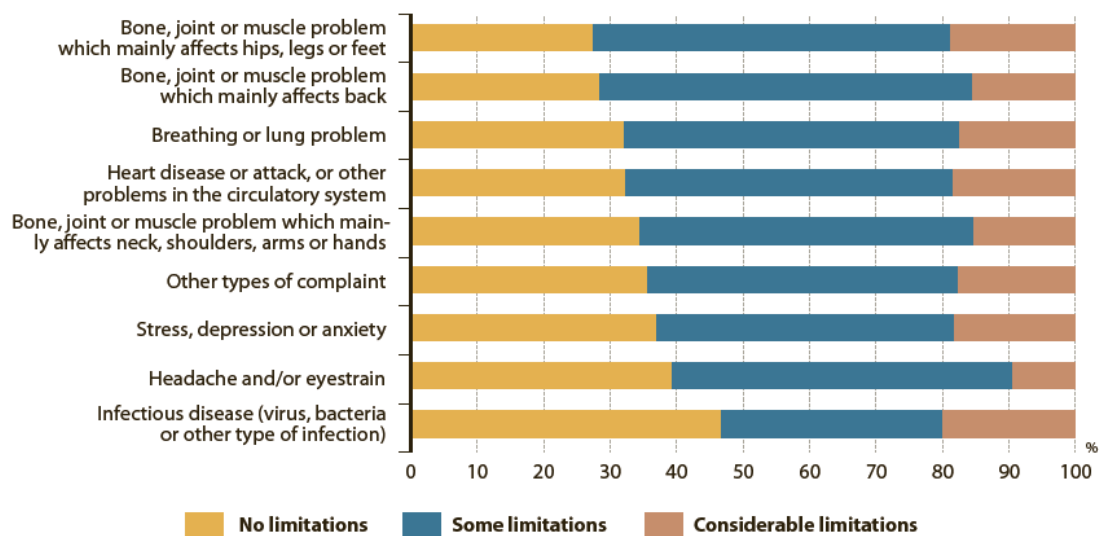
⁶ European Statistics on Accidents at Work (Eurostat), http://epp.eurostat.ec.europa.eu/portal/page/portal/health/health_safety_work/data

50% of persons suffering from a work-related health problem experienced some limitations in the ability to carry out day-to-day activities, and an additional 22% experienced considerable limitations. This percentage increases with age. Workers in the age group above 50 are more likely to experience considerable limitations due to work-related health problems. Limitations were most reported for musculo-skeletal disorders. Figure 2 shows that especially musculo-skeletal problems affecting hips, legs or feet are at the basis of considerable limitations.

62% of the persons with a work-related health problem stayed at least one day in the past 12 months at home; 22% of the persons at least one month. It was estimated that work-related health problems resulted in minimally 367 million calendar days of sick leave in 2007. This does not yet include 1.4 persons that expect never to work again because of their work-related health problem.

Furthermore, work-related health problems have an effect on early retirement. Eurostat findings indicate that workers with work-related health problems leave the workforce before the age of 55. This is based on data of the Labour force survey (LFS data 2007) and the European Working Conditions Survey (EWCS, 2005) showing that the occurrence of work-related health problems strongly increases with age. However, in the oldest workers group (55-64), the increase in the occurrence of work-related health problems slows down in men, and a decrease was found in women (Eurostat, 2010). Studies confirm these statistical data suggesting that important factors for early retirement include several work-related factors such as high physical work demands, high work pressure and low job satisfaction (van den Bergh et al., 2010).

Figure 2 - Limitations in employed persons by health problem in the EU27 (%)



Source: Eurostat, 2010 based on data from the Labour Force Survey Ad hoc module, 2007

Moreover the occurrence of work-related health problems is rising. Data showed that the occurrence of work-related health problems increased from 4.7% in 1999 to 7.1% in 2007 in nine European countries. However, the data for these nine countries suggest that the severity of the health problems declined since the figures on sick leave decreased between 1999 and 2007 (Eurostat, 2010).

More data on accidents at work and work-related ill-health can be found in the Chapter 3 that presents the underlying data for determining the scope of the field research (scoping study).

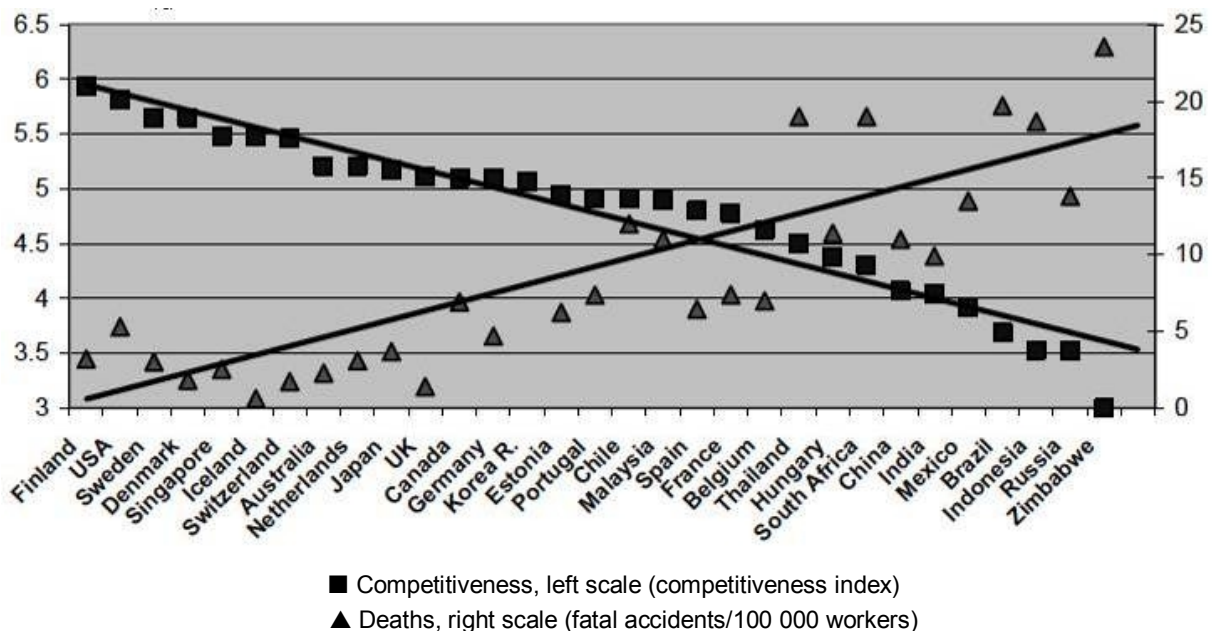
2.2.2 The impact on economic growth

Accidents at work and work-related ill-health hinder economic growth

Ill-health has a negative impact on economic growth. Ridge et al. studied the link between health and economic performance. They investigated whether health in general, and ill-health caused by work in particular, has an impact on various measures of economic performance such as GDP (Gross Domestic Product) growth, productivity and the level of employment. The results show that if the proportion of people with ill-health increases, economic growth will slow down. Furthermore, work-related factors play an important role since 11% of the impact of general health on economic performance is attributable to work-related ill-health (Ridge et al., 2008). On the other hand, the opposite is also true. Health is a strong predictor of economic growth. Health leads to economic growth by increased savings, investment in human capital, labour market participation, foreign direct investment and productivity growth (Suhrcke et al., 2008). However, the relation and influence of health on economy (and economic growth) is complex. It is clear that human capital matters for economic outcomes and since health is an important component of human capital, health also matters for economic outcomes. At the same time, economic outcomes matter for health. These interfering mechanisms make it difficult to determine the impact of health on the economy (Suhrcke et al., 2005).

The negative impact of outcomes of work-related problems is shown in the graph below (figure 3). The graph demonstrates the strong correlation between national competitiveness and the national incidence rates of occupational accidents. The graph is based on data from the World Economic Forum and the Lausanne International Institute for Management Development (IMD), coupled with data from the ILO (ILO, 2006). Countries with the best records on accidents at work are the most competitive leading to the conclusion that poor working conditions put a heavy burden on the economy and hinder economic growth.

Figure 3 - Correlation between competitiveness and the incidence of accidents at work



Source: ILO, 2006

The major impact of work-related problems is clearly demonstrated by figures on economic losses. The ILO has estimated that the total costs of such accidents and ill-health amount to approximately 4 per

cent of the world's GDP (ILO, 2006). Furthermore, social insurance expenditure on occupational safety and health constitutes an important sum. On average, OECD countries spend 2.4% of GDP on incapacity-related benefits. These benefits comprise cash benefits on account of complete or partial inability to participate gainfully in the labour market due to disability. It includes expenditures such as statutory sick pay, disability allowances, industrial injuries disablement and incapacity benefits (Adema and Ladaïque, 2009). 18% of the causes of long-standing health problems or disabilities are work-related (Dupré and Karjalainen, 2003). The fast increase in most OECD countries in the number of disability benefit claims because of mental health problems, often at a relatively young age, is an added challenge. Mental health problems are now the biggest single cause for a disability benefit claim in most countries and countries such as Denmark, the Netherlands, Sweden and Switzerland accounting for almost half of all new claims. Work-related factors cannot be ignored in this regard. One major explanation for the increasing number of inflows into disability benefits on grounds of mental health conditions can be attributed to changes in the workplace that have increased the prevalence of work-related stress. However, work is also beneficial to mental health. Mental health tends to deteriorate significantly when people leave employment and improve again when people move back into employment (OECD, 2010).

The fact that the cost of accidents at work and work-related ill-health accounts for 2 to 4% of the GDP can be found in a several estimates on the economic impact. According to the European Agency for Safety and Health at Work, the costs to Member States of all work-related accidents and diseases range from 2.6% to 3.8% of GDP (European Agency, 1997).

A study from the Netherlands confirms this figure estimating the multiple costs incurred by workplace accidents, illnesses and long-term absence in the Netherlands at 3% of total GDP. The estimate was based on factors such as absenteeism, occupational disability, work-related accidents, costs of risk prevention, safety at work and its enforcement, and health care (Koningsveld, 2004).

According to a calculation made at the Finnish Ministry of Social Affairs and Health, the costs of work-related diseases and occupational accidents were nearly 3 billion € in 2000 or nearly 2% of GDP. Almost half of the losses were caused by reduced production input resulting from disability. The average cost of an accident causing at least 3 days of absence was 6 900 € (Bjurström, 2009).

A Spanish study found a lower estimate. The Trade Union Confederation of Workers' Commissions (CC.OO) examined the economic costs of industrial accidents and occupational illnesses in Spain. The study puts the annual total cost at almost €12 billion, equivalent to 1.72% of GDP. The estimate was based on the costs of lost working days and the costs of social security cover (Espluga, 2004).

Accidents at work and work-related ill-health bring about huge costs

Eurostat has estimated that in the year 2000, the costs of accidents at work can be estimated at 55 billion € in EU 15. This estimate corresponds to 0.64% of the GDP (Eurostat, 2004). Only the costs of accidents at work are considered. Eurostat emphasises that the costs of non-accidental work-related health problems are probably much higher; they generate more costs of lost working time and costs of health care. Work-related health problems are estimated to cause 1.6 to 2.2 times more days of temporary incapacity to work than do accidents at work (Eurostat). Other authors (Monnery, 1999) confirm that ill-health costs outweigh the cost of occupational accidents.

The above-mentioned study by the Ministry of Social Affairs and Employment in the Netherlands (Koningsveld, 2004) calculated that the costs of work-related absence and disability, mainly resulting from psychological add up to € 6 billion. This figure correlates with a cost as a result of work-related ill health per worker of 1368 € (Koningsveld, 2004).

A research project in Germany showed that the costs of work-related diseases amount at least to 28 billion Euro. These figures are based on 15 billion euro direct costs (disease treatment) and 13 billion euro indirect costs (loss of productivity years by sick leave). The work-related aspects "heavy work/lifting" and "low control" account for the biggest share with respect to attributive risks and direct

and indirect costs (Bödeker et al., 2002). The fact that musculoskeletal disorders and psychosocial diseases are responsible for most of the costs is confirmed by other studies. Koningsveld states that 83% of the cost of work-related health issues in the Netherlands is due to these diseases (Koningsveld, 2004). Blatter et al. (2005) found that RSI results in € 2.1 billion costs each year. For psychosocial workload the costs amount to € 4 billion (NL).

Due to the work-related risk factors that correlate with these diseases, the authors found that especially the health care sector, the transport sector and the construction (rsi) suffer the consequences of these costs (Blatter et al., 2005). Leigh et al. (2004) carried out a study based on nationwide data (US) considering the cost for medical care, lost productivity, and pain and suffering as the main outcome measure. The analysis calculated the costs for a detailed list of sectors. Results showed that the following sectors were at the top of the list for average cost (cost per worker): taxicabs (11,528\$/worker), bituminous coal and lignite mining (8,600\$), logging (7,009\$), crushed stone (4,024\$), oil field services (3938\$), water transportation services (3,365\$), sand and gravel (3,365\$), and trucking (3350\$). Industries high on the total-cost list were trucking, eating and drinking places, hospitals, grocery stores, nursing homes, motor vehicles, and department stores. Industries at the bottom of the cost-per worker list included legal services (138\$), security brokers (137\$), mortgage bankers (136\$), security exchanges (137\$), and labour union offices (86\$).

2.2.3 Conclusions

Statistical data show that no less than 1 out of 10 European workers is every year affected by an accident at work or a work-related health problem. Health problems are more important and their occurrence is increasing. Both accidents and ill-health problems cause vast numbers of days of sick leave. In a limited, but nevertheless important, number of cases, workers are facing long periods of absence and permanent disabilities. Furthermore, work-related health problems have an effect on early retirement which in light of demographic change support the case of healthy ageing policies targeting the workplace.

Accidents at work and work-related ill-health place an important burden on global economy and hinder economic growth. Outcomes of poor working conditions are negatively linked to economic indicators such as competitiveness showing that health is a strong driver for economic growth. This is further demonstrated by the loss that emerges from accidents at work and work-related ill-health. According to the European Agency for Safety and Health at Work in Bilbao the costs from Member States of all work-related accidents and diseases range from 2.6% to 3.8% of GDP. Studies in several countries provide similar estimates. These figures show the potential benefit if these cases of accidents at work and work-related ill-health could have been prevented. Thus preventing occupational accidents and diseases should make economic sense for society as well as being good business practice for companies.

2.3 Costs of accidents at work and work-related ill-health: a question of perspective

Accidents at work and work-related ill-health have an impact on individuals, companies and the society. Each of these target levels is confronted with the economic consequences. Yet, what might be a cost for the individual is not necessarily perceived as a cost for society and vice versa. It is all a question of perspective (2.3.1). Victims and their family and friends face multiple consequences that are often difficult to quantify (2.3.2). On societal level, efforts have been made to make reliable estimates but the results heavily depend on the chosen methods, the cost categories and the data sources (2.3.3). In

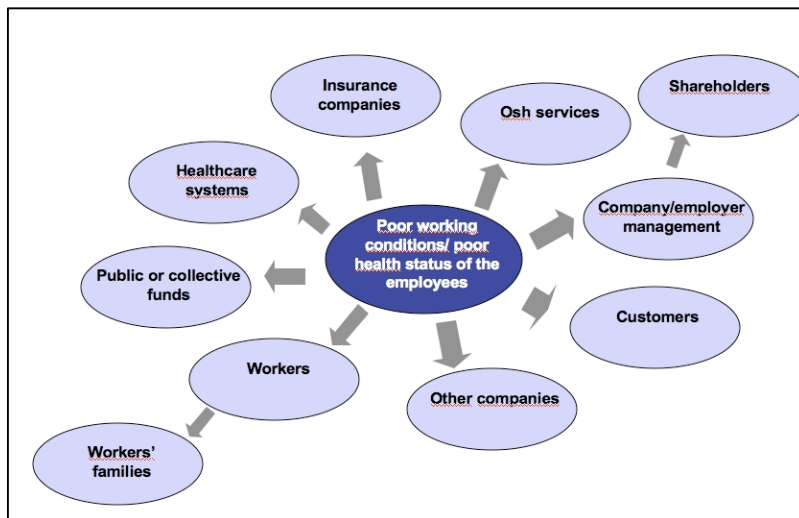
comparing costs between the affected levels, it becomes clear that costs are not evenly distributed and that victims as well as society are heavily burdened (2.3.4).

2.3.1 Costs affect different levels

Poor and hazardous working conditions affect several target groups (figure 4). These are also the groups that will benefit – directly or indirectly – if the working conditions improve and if the health of the employees improves. These target groups can be sorted into three levels:

- societal: public or collective funds, healthcare systems, insurance companies;
- company: OSH services, company/management, shareholders, customers, other companies;
- individuals: workers, workers' families.

Figure 4 - Poor working conditions inflicts costs on many parties (adapted from Krüger, 1997 and from Mossink, De Greef, 2002)



Source: De Greef and Van den Broek, 2004b

The total societal costs doesn't equal the sum of the costs of each of the groups

Costs fall on different parties but each of these parties has to bear other consequences. Table 1 provides an overview of these consequences indicating that some of these are not or very difficult to quantify. Moreover, none of these groups sees or experiences the full extent of the social and economic consequences of accidents at work or work-related ill-health. The nature of the consequences are such that it is rare all the costs are combined to provide an overall picture of the magnitude and complexity of outcomes (Adams et al., 2002).

Is there such a thing as the total cost of accidents at work and work-related ill-health? All the costs, regardless of who is to pay the bill. Dorman describes this as 'social cost'⁷ meaning that if it would be possible to add up all the costs of accidents at work and work-related ill-health to whomever they might accrue, this sum would be the full societal costs. Within this overall accounting, however, costs fall on different parties. The particular portion of the cost paid by any one individual or organisation is called the private cost by Dorman. This cost is relevant for decision-making on that level insofar as the decision maker is economically rational.

⁷ Social costs as defined by Dorman must be distinguished from the term social costs as used below (2.3.2). This is why we will refer to these costs as 'societal'.

This distinction between private and 'societal costs' (the total costs for society) reflects the different perspectives of groups that bear the costs of accidents at work and work-related ill-health. But it is not so that the total costs are the sum of all private costs. Although identified costs can be classified from the perspective of the company, the worker, the economy and society as a whole, these cost categories are not mutually exclusive and there may be a substantial overlap (Lahiri, 2005).

Some private costs do not necessarily enter into the societal cost, because they may be offset by benefits to other members of society. Dorman illustrates this by referring to a company that loses its market share due to a catastrophic industrial accident. For the company it presents an enormous private cost. But if the sales are taken up by other companies this is not a component of societal cost.

Also, not all societal costs appear as private costs. For instance, a significant portion of the medical cost of accidents at work and work-related ill-health in the industrialized countries is paid for by social insurance systems and it is not easy to establish who pays this cost and how. The cost may be so spread out as to be invisible at the private level (Dorman, 2000a).

Box 1 - The influence of the labour market

Who bears the cost? The availability of labour on the market can be a strong influencing factor

If a *company* can easily replace an employee that has fallen ill or injured, this means that the 'private' costs for the company are limited.

Costs are shifted onto *society*. But, does society suffer the full cost resulting from the loss of this individual's productive capacity, or does the availability of unemployed labour render this a private cost to the *worker* only, and not a true opportunity cost at the level of society?

Source: Dorman, 2000a

Table 1 - Consequences of accidents at work and work-related ill-health for different groups

	Non tangible	More or less tangible
Victim	Pain and suffering Moral and psychological suffering (especially in the case of a permanent disability) Lowered self-esteem, self confidence Strain on relationships Lifestyle changes	Loss of salary and premiums Reduction of professional capacity Medical costs Loss of time (medical treatments)
Family and friends	Moral and psychological suffering Medical and family burden Strain on relationships	Financial loss Extra costs
Colleagues	Psychological and physical distress Worry or panic (in case of serious or frequent accidents/cases of ill-health)	Loss of time and possibly also of premiums Increase of workload Training of temporary workers
Company	Presenteeism Company image Working relations and social climate	Internal audit Decrease of the production Damages to the equipment, material Quality losses Training of new staff Technical disturbances Organisational difficulties Increase of production costs Increase of the insurance premium or reduction of the discount Early retirement Administration costs Legal sanctions
Society	Reduction of the human labour potential Reduction of the quality of life	Loss of production Increase of social security costs Medical treatment and rehabilitation costs Early retirement Decrease of the standard of living

Source: De Greef and Van den Broek, 2004a

Different perspectives require different cost calculation methods

It remains highly difficult to capture all effects of accidents at work and work-related ill-health. Efforts to do so tend to look to evidence from one perspective. This means that the information collected is often limited and frequently underestimates the true range and depth of effects. The study population offers evidence from one perspective, and the cost information is usually restricted to one type of cost. Different areas view these outcomes from a range of perspectives, and it is rare that one area learns about or appreciates the experiences of another (Butcher, 2004). For instance, for employers only the costs that they bear themselves are relevant. The cost of lost output of workers that are injured or confronted with work-related ill-health - which is the denial of the full productivity of all remaining years in an otherwise normal working lifetime – is of little importance to them. But, in an estimate on societal level lost output is an important cost category (Leopold and Leonard, 1987). From the individual worker's perspective, costs are for instance associated with the impaired ability to work or to engage in leisure activities because of morbidity and costs to dependents. Each of these perspectives requires

another calculation (see also table 2) (Berger et al., 2001). The context of the cost analysis plays a determinant role and influences the results. A cost category can appear on different levels but in different forms. The cost of a short absence from work for instance is a cost for the insurance and also for the company. But, for the insurance the nature of the cost is a compensation payment and for the company the cost will present itself as a replacement cost or reduced productivity (Rower, 2010).

However, choosing a perspective and subsequent approach for making cost calculation studies may not pose a problem. In fact, it is essential because it is strongly linked with the purpose of cost studies. As Dorman pointed out private costs are the cost relevant for a group and these cost have an impact on decision-making (Dorman, 2000a). The perspective taken in cost studies heavily depends on the answers to questions such as What do cost studies measure? When choices are made about the allocation of resources, who is affected? On whose behalf are decisions made? For example, costs or losses to companies due to a work-related ill-health problem focus on the impact of absenteeism and lost productivity. Costs to society take a comprehensive approach to estimating direct and indirect health and other related costs associated with a work-related ill-health problem or injury (Rice, 2000).

And, since costs for one group only reflect one perspective, they must be considered as a poor guide for societal costs. Nevertheless, for the purpose of understanding why individuals and companies behave the way they do, the study of private costs is indispensable (Dorman, 2000a).

A company is a strictly economic entity that can only perceive economic benefits and costs. Non-economic benefits or disadvantages may appeal to the stakeholders of the enterprise, but they do not serve the enterprise and its goals. Therefore, only economic benefits and costs associated with health are meaningful for decision-making on company level (Targoutzidis, 2009).

The situation might be somewhat different in companies focussing on Corporate Social Responsibility (CSR). CSR is the integration of social and ecological concerns on a voluntary basis into business operations and into the interactions with stakeholders. CSR focuses at a systematic incorporation of economic, environmental and social considerations in the decision making process on company level. CSR links directly to company excellence via excellent performance delivered to customers, shareholders, employees and external stakeholders.

The social dimension of CSR impacts on the internal social responsibility with regard to employees such as health and safety, human resource management, working conditions and adaptation to change on the one hand side and the external social responsibility with regard to society such as the local communities, the suppliers and the consumers, the NGO's and the business partners on the other hand side.

Management concepts such as the balanced scorecard reflect this broader perspective. The balanced scorecard measures company performance not only in financial terms but other aspects such as the customer, internal business, innovation and learning factors are also taken into consideration. Company strategy is approached in a comprehensive way and looks how resources can be linked to the company goals (De Greef and Van den Broek, 2004b; Köper et al., 2009).

In conclusion, one might argue that making cost studies is not about looking for large sums that can be allocated to accidents at work or work-related ill-health, because they seldom offer a good incentive to act. Any attempt to argue that safety pays must specify for whom. Unless a relevant decision-maker can be identified for whom safety pays, the argument has no capacity to motivate action to reduce accidents at work and work-related ill-health (Hopkins, 1999).

Table 2 - Indirect cost of illness from the individual, societal and employer perspectives

	Individual Perspective	Societal Perspective	Employer Perspective
<i>Definition</i>			
	Value of a human life in terms of a person's income and value of leisure time	Value of a human life in terms of a person's potential income generation	Cost of the disease to the employer from illness and/or death
<i>Calculation</i>			
Mortality	The ultimate loss Effect on family	Present value of forgone future income	Cost of replacing workers (hiring and training)
Morbidity	Loss of income (e.g. unpaid sickleave days, decrement in income when on disability) and loss of leisure time	Lost income from missed work	Workloss, idle assets, and non-wage costs (e.g. benefits and fixed payroll costs)

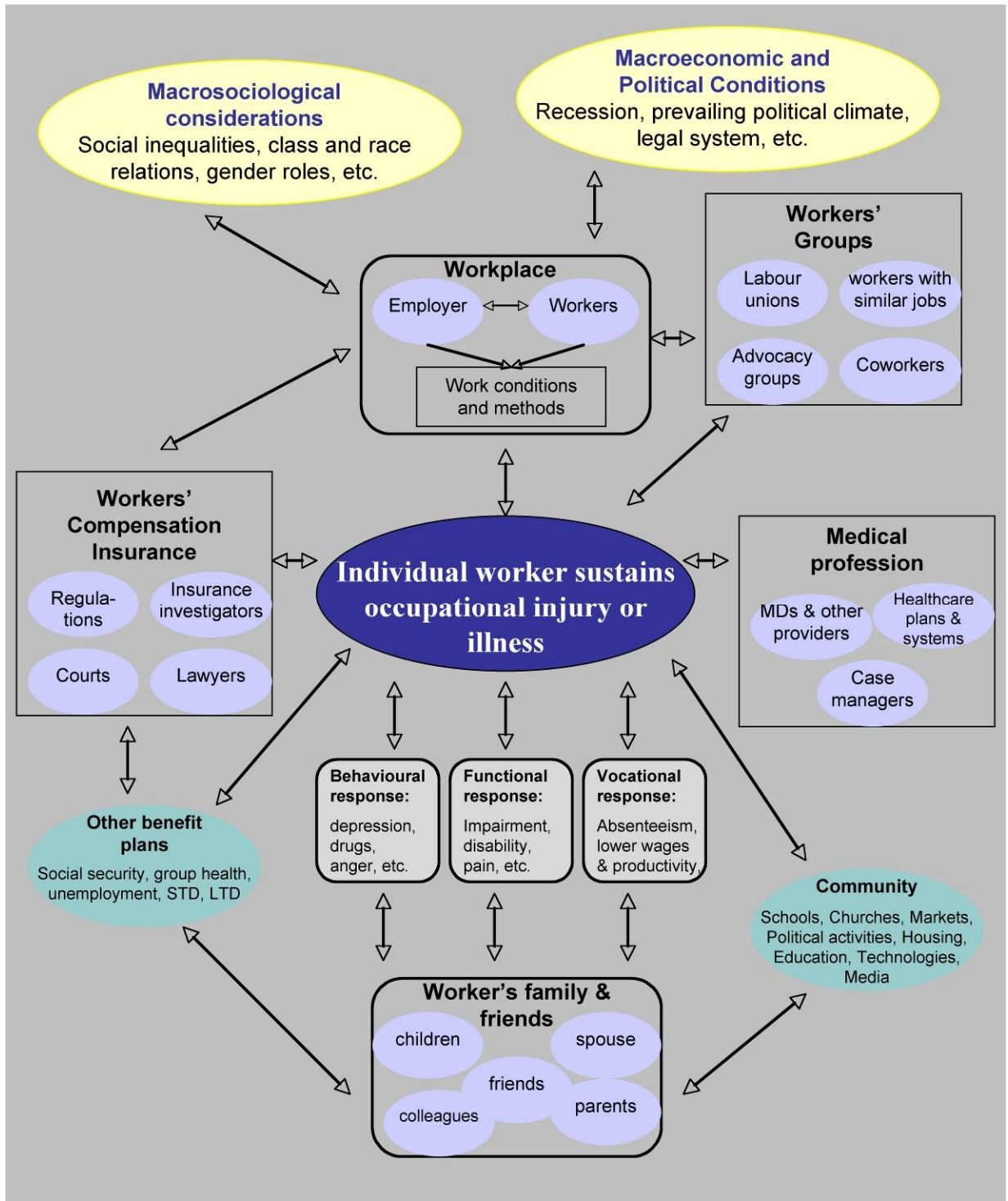
Source: Berger et al., 2001

2.3.2 The importance of the social consequences

2.3.2.1 A social ripple effect

Just as work affects many areas of our lives, the impacts of accidents at work and work-related ill-health reach all aspects of society, rippling out to affect personal, social and workplace relationships. According to Dembe (2001) this makes it difficult to isolate and measure the social consequences of an accident at work or a case of work-related ill-health. Although the injured worker is normally the person most directly affected, accidents at work also potentially impact on family members, co-workers, medical care providers, insurance administrators and other individuals and groups. The figure below (figure 5) illustrates Dembe's model depicting how an individual affected worker is embedded in a complicated web of reciprocal relationships with other individuals, groups, and social institutions. The social consequences lead to a 'ripple effect', where the repercussions of an accident at work or case of work-related ill-health touch the larger community. The social consequences tend to reinforce each other and can mutually influence each other. For example tensions from prolonged home care can lower the self-esteem of the affected employee, which in turn affects the work environment. This could lead to poor work performance when the employee returns to work (Adams et al., 2002).

Figure 5 - The affected worker and the relationships with other individuals, groups, social institutions



Source: Dembe, 2001

2.3.2.2 The economic value of social consequences

These complex interactions create significant difficulties for researchers attempting to study the social consequences of accidents at work and work-related ill-health. Any analysis is likely to be fragmentary because of the researchers inability to isolate social impacts precisely.

Analysis of social consequences is further hindered by the fact that these consequences vary according to the domestic, vocational and other societal roles of the individuals (Dembe, 2001). For instance, the family of a single mom will suffer greater consequences if she falls injured or ill. Characteristics such as the injured worker's age, gender, race, ethnicity, nationality, education, and socio-economic status have to be considered.

Studying and measuring economic and social consequences is also made more complex due to the complicated shared relationships between the victims and the community of family and friends, the impact of various modifying factors, and the effects of the injury or illness itself (Adams et al., 2002). Also the type of injury or illness determines the social consequences that arise. Permanently disabling injuries or chronic illnesses have major consequences. The case of chronic disease puts a heavy burden on society and is often aggravated by the fact that in some cases victims have difficulties to prove the link between the disease and work-related aspects making it more difficult to get any form of compensation (Adams et al., 2002). Many workers affected by chronic work-related diseases have to leave their job (see box 2) resulting in a permanent loss.

Many of these consequences cannot be expressed in monetary values. Dorman refers to this question by making a distinction between economic and non-economic costs. Economic costs are those costs that can be expressed in monetary units. They include the costs paid - or expected to be paid - by individuals and organisations acting within the economy, as well as the monetary values implicit in activities undertaken and foregone. Non-economic costs are no less real, but for one reason or another cannot be captured in monetary terms. In the case of accidents and ill-health, the non-economic costs are above all the subjective costs of pain, fear, and loss suffered by the victims, their families, and their immediate communities (Dorman, 2000a).

Thus, it requires an expanded use of qualitative research approaches including interviews, focus groups. (Dembe, 2001). More so since the social or non-economic costs of accidents at work and work-related ill-health tend to remain invisible, unknown and thus not calculated. The consequences are treated as if they did not exist (Boden et al., 1999; Dembe, 2001; Adams et al., 2002). Qualitative methods offer the possibility to get an insight in these costs. The Aftermath study (Adams et al., 2002) can serve as an example where based on qualitative interviews with several victims, the researchers tried to investigate the social consequences of accidents at work and work-related ill-health (see also below).

Box 2 - Socio-economic consequences for workers affected by occupational asthma

Occupational asthma often leads to serious health and socioeconomic consequences for the affected workers. In many countries, the choice for affected workers is either continued exposure, part-time work, or job loss; Leira et al. (2005) collected data in Norway from the notifications for respiratory disease for the period 1995–1999. A postal questionnaire inquiring into work, respiratory symptoms, smoking, and socioeconomic consequences of the disease was sent to 1,239 workers with a physician's diagnosis of obstructive respiratory disease. The results showed that, at the time of notification, more than half of the workers had left their original jobs. At the time of the study, 2–6 years later, approximately the same proportion of workers had experienced a reduction in income and had received financial compensation. 60 to 78% were still on antiasthmatic medication.

A study on the socio-economic status of 86 persons with a diagnosis of occupational asthma in Belgium found that 43 months after the diagnosis, 38% suffered permanent work disruption, 33% remained exposed, and 64% reported a reduction in income. The loss of earnings was offset by the disability indemnity in only 22%. The study cites similar findings for the UK, France and Canada. Regarding working status, 25 to 38% were not working due to unemployment, sick leave or early retirement. Of those that were still working, 26 to 31% had the same job, 15 to 31% relocated within the company, and 14 to 36% found a new job with a new employer (Vandenplas, 2002).

2.3.2.3 Cost factors of accidents at work and work-related ill-health on individual level

Individuals – the victims, their colleagues, family, friends – suffer financial losses as well as losses related to the quality of life. The latter category comprises social and clinical consequences, and as explained above, is difficult quantifiable.

The table below brings together the consequences from accidents at work and work-related ill-health for victims and the community of family and friends as they are described in the literature. The consequences are clustered along 3 categories: financial, social en clinical.

Table 3 - Consequences for victims and their family and friends (summary of the research findings)

	Victim	Family and friends
Financial	Loss of earnings Reduction of professional capacity Medical costs Unemployment	Financial loss Extra household help
Social	Strain on relationships Lowered self esteem, self-confidence Lifestyle changes Affected mental health	Time loss Lifestyle changes Strain on relationships
Clinical	Pain Disease, injury Limited physical capabilities Permanent disability	

A diminished quality of life

In defining social costs most authors (e.g. Boden et al., 2001; Butcher, 2004; Shalini, 2009) refer to Keller (2001). He summarises social costs as follows: Social costs are typically described in losses or limitations in a person's ability to engage in major social roles and activities. These include working, parenting, or sharing leisure activities with or caring for friends and family.

Impacts commonly discussed are the ability to perform tasks that are dictated by the work role (social consequences), as opposed to lost wages (economic consequences), or losing a range of motion (clinical consequences) (Keller, 2001).

The lack of occupational safety and health resulting in accidents at work and work-related ill-health has several effects on individuals and their quality of life. Physical and psychological functioning in everyday activity can be affected, self-esteem and self-confidence reduced and family relationships stressed. Labour relations in workplaces may be damaged (Boden et al., 2001).

Adams et al. 2002 held for their Aftermath study, interviews with victims in order to get a clear picture of the economic and social consequences of accidents at work and work-related ill-health.

The Aftermath study found a range of costs, some quantifiable, others not. Although some consequences were financial, the study did not try to establish an accurate calculation. The study revealed a number of hidden, 'indirect' costs of which a considerable proportion was borne by the injured or ill employee or their family. For example, the effects on their relationships were considerable. Loss of intimacy, increased distance between spouses or parents and children, employer to employee, between colleagues, were common in the participants to the study. Feeling isolated or self-imposed isolation put relationships under pressure. Some broke down while others emerged from the difficult period strengthened through shared experiences. Other costs involved loss of future earnings and medical costs.

For the family and friends of the injured or ill employee, one of the most considerable indirect costs observed was separation, both physical and emotional. This led to strain on relationships. In addition, there were major lifestyle changes for many of the families, with many participants changing their careers, beginning or stopping study and giving up hobbies to care for the family member. Friends of the individual were also affected, for instance by helping them through their illness and injury with support, often at their own cost. This may have meant less time with their own families, or financial cost (Adams et al., 2002).

In a summary article on the Aftermath study, Butcher describes the hidden costs, 'indirect' costs as comprising both social effects and non-compensated financial costs. The hidden costs have a ripple effect: not only are the full range of costs borne by the injured or ill employee and their family, but consequences extend out beyond the home to affect friends and the wider community. Eventually these consequences are borne by society itself in the form of insurances, taxes and loss of social capital. These costs amount to many times the direct, visible, compensated costs that typically appear on the accounting balance sheet. The hidden costs are significant, but have no monetary value assigned to them, and are therefore not usually part of economic calculations (Butcher, 2004).

Boden (2005) raises the question of the effects on the family of the victim. Accidents at work and work-related ill-health can provoke major crises for the families in which they occur. In addition to major financial burdens, they can impose substantial time demands on uninjured family members. The author states that 40% of injured workers reduce the time they spent on household work by 1 or more days, with 11% reporting that they could no longer do household work at all. The result being that the injured worker's family takes up the slack or that less household work gets done (or both). Moreover, a substantial number of injured workers require care during recovery, increasing time demands on other family members. Today when many families are operating with very little free time, family resources may be stretched to the breaking point (Boden, 2005).

However, looking at the social consequences of accidents at work and work-related ill-health, it is clear that they are not unique in this regard. In many ways, they have consequences that are similar to those of illnesses with nonwork origins. Also chronic health problems that are not work-related can impose a large strain on individuals and their families that goes beyond the mere financial consequences. So, one might even argue that people with occupational injuries or diseases are better off in one way than are those whose health problems originate outside work. Since, injured workers are eligible for workers' compensation benefits (Boden, 2005).

Considerable financial consequences

Accidents at work and work-related ill-health are likely to hamper the ability to work and workers' productivity following an incident. The working time lost during the recovery period may also have implications for their human capital and their subsequent earning capabilities. Boden and Galizzi (1999) estimated lost earnings and compared them with benefits for workers injured in Wisconsin. Using

conservative estimates they have shown that accidents at work and work-related ill-health often lead to substantial lost earnings. Workers with a temporary disability that last longer than 8 weeks have the largest losses. Also, earnings and employment after return could be affected. A substantial number of people in the longer temporary disability groups suffer losses that continue after their benefits have ceased. In general, the income of people with disability is substantially lower than average. Estimates put this 12% below national averages and as much as 20 to 30% in some countries (OECD, 2009).

Furthermore, individuals that experience accidents or ill-health related to work may face a higher probability of unemployment, experience early exit from the labour market or face increased difficulties to re-enter into a suitable job. Studies point to the fact that this provokes the effect that a significant portion of the European labour force remains idle following the occurrence of an accident or case of ill-health, as individuals do not feel capable of performing the work that they performed prior to the incident (Pouliakas and Theodossiou, 2010).

Lost wages during the period of absence and reduced wages after the return to work are the most important financial cost factor for individuals but also medical treatment can bring about costs (Dorman, 2000a). One can expect that most of these costs will be covered by the Workers' Compensation System, but this is not always true. Not all workers that suffer an accident at work or a work-related illness are compensated. This is due to exclusions in the Workers' Compensation System but also to that fact that workers don't always report their case. Especially the workers in precarious employment are not always in position to file for benefits (Biddle, 1998; Dorman, 2000a). Less severe cases or cases with no time off are also likely to be underreported (Shannon and Lowe, 2002). In a study on occupational diseases Leigh and Robbins even conclude that most of the costs of occupational disease are not covered by workers' compensation. Using epidemiological studies for estimating the deaths and costs for all occupational diseases and comparing these findings with the number of workers' compensation cases, the authors argue that, workers' compensation missed roughly 46,000 to 93,000 deaths and 8 billion US dollars to 23 billion US dollars in medical costs (in 1999). These deaths and costs represent substantial cost shifting from workers' compensation systems to individual workers, their families, private medical insurance, and taxpayers through the general welfare system (Leigh and Robbins, 2004).

2.3.3 Identifying macro-economic costs

All of the accidents at work and cases of work-related ill-health potentially impose costs on employers, workers and their families, and society at large. But how large are the costs and how does one go about measuring them? Providing estimates for the societal costs of work-related accidents and ill-health is not an easy task. Weil (2001) reviewed the methods for valuing the economic costs of accidents at work and work-related ill-health and found that most studies tended to underestimate the true economic costs from a social welfare perspective, particularly in how the studies accounted for occupational fatalities and losses arising from work disabilities. Many of the estimates of costs of accidents at work and work-related ill-health depend on a combination of methodological assumptions, extrapolation methods, and known and unknown biases (Weil, 2001; Schulte, 2005).

The estimates found in various macro-level studies tend to differ depending on the *data sources* that are used (2.3.3.2), the *cost categories* that are included (2.3.3.1) and the *measuring method* (2.3.3.3). In most cases these differences relate to the aims of the studies. Most of the macro studies serve different purposes, which in turn affect their data sources and methodologies. Clearly stating the purpose is already a first, but critical step towards ensuring the fact that the correct methodology will be used (Adams et al., 2002).

2.3.3.1 Framework and cost categories

The basis: Social insurance costs

The most obvious costs are the costs compensated by national social security bodies. Often estimates on societal level are based on these costs, and sometimes making extrapolations to other cost categories (e.g. den Butter et al., 1998; Tompa, 2002; Blandin and Kieffer, 2004; De Jongh et al., 2005; Brown, 2007). Extrapolations are deemed necessary since social insurance costs are not the only costs due to ill-health and poor working conditions borne by society. The costs of accidents at work and work-related ill-health on societal level should be considered from a broader perspective, as opportunity costs. An opportunity cost is the value to society of the goods or services (including leisure) it could otherwise have enjoyed had there been no diversion of resources resulting from accidents or illness at work. In general, the main sources of opportunity cost are lost output, costs of treatment and rehabilitation, and the cost of administering the various programmes to prevent, compensate, or remedy accidents at work and work-related ill-health. Of these, the last two are the most readily calculated, taking into account that they are normally reported by social insurance organisations or by other similar programmes (Dorman, 2000a).

Den Butter et al. argue that a difference has to be made between collective costs and societal costs. Collective costs are the costs linked to the social security systems that have to bear the financial consequences of work-related accidents and diseases. Societal costs comprise also lost output and lost productivity (den Butter et al., 1998).

Most authors argue that the opportunity costs exceed medical and insurance costs. An in-depth study of Leigh et al. into the costs of occupational injuries and illnesses in the US (1992) found that 55% of the total costs can be attributed to lost earnings compared to 17% medical costs and 10% insurance costs (Leigh et al., 1997, see also Dorman, 2000a and Indecon, 2006).

Tompa (2002) makes a distinction between direct and indirect costs for society. Direct costs refer to the costs to the Canadian social security system while indirect costs also reflect losses in productivity. These direct cost of work-related injuries and illnesses exceeded 5.7 billion \$ in 2000. This estimate includes indemnity payments, insurance administration expenses and medical services that are paid by employers through workers' compensation premiums. According to the author these direct costs substantially underestimate the true cost of productivity losses attributable to work-related injuries and illnesses. The indirect cost estimate for Canada is \$12 billion. This includes costs incurred by employers to accommodate injured workers who return to work, recruitment and training costs incurred for replacing injured workers, earnings lost by workers due to injury and the lost home production of workers (Tompa, 2002).

The actual expenditures of social security bodies such as medical costs, lost time at work, compensation payments are readily and apparent while other costs are more difficult to quantify. These costs comprise the loss of life, changes in the future work activity and earnings of the injured, impacts on households of injured or ill workers, diminishing quality of life, etc. In that way these actual expenditures on medical and administrative costs could provide a reasonable measure of social costs related to injuries and ill health. Costs arising from diminished labour force participation, earnings, or changes in household activity, in contrast, are more difficult to deal with partly because they are affected by the present and future behaviour of employers, households, and the decisions of the victims themselves (Weil, 2001).

Apart from the fact that social insurance costs don't cover all costs due to accidents at work and work-related ill-health, Mossink and De Greef state that compensations and pensions paid by social insurances are not adequate for making cost estimates at society level for the following reasons:

- transfer payments (payments that are not related to some kind of output) are not a part of the domestic 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.

Mossink and De Greef consider the total societal costs of work accidents to consist of two components:

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

This means that cost estimates of accidents at work and work-related ill-health should include health variables as well as variables with respect to economic performance of companies (see table 4).

Table 4 - Variables of costs at societal level

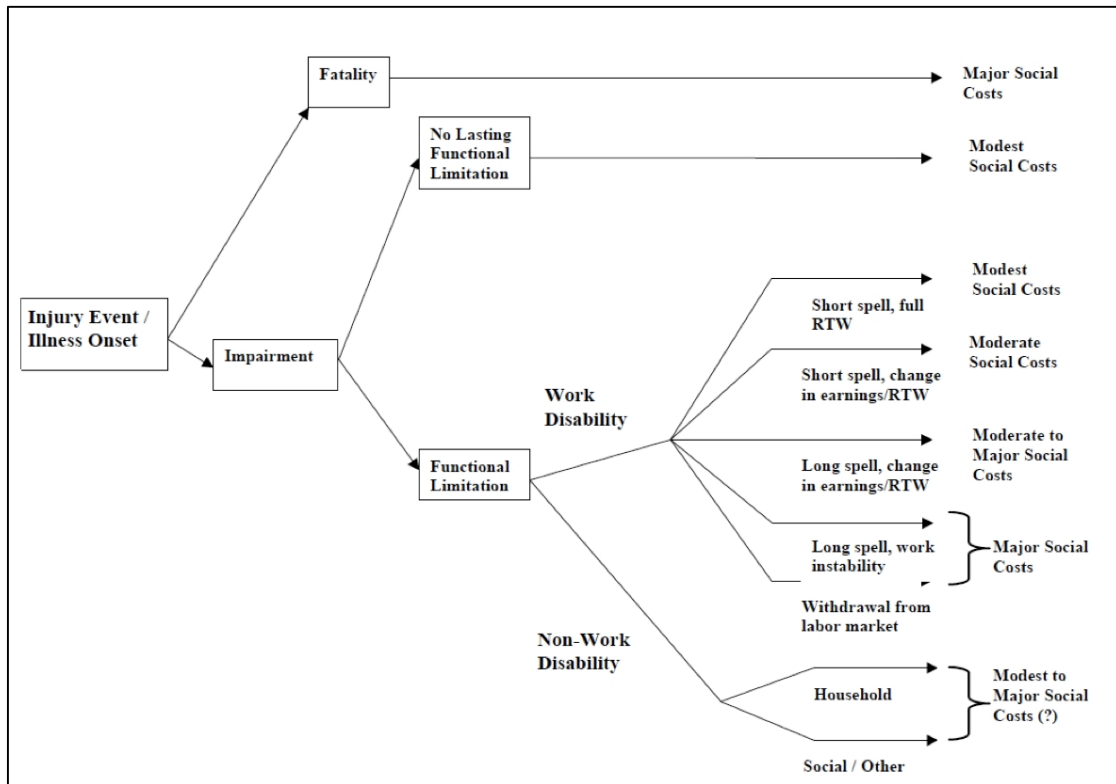
Variable	Description	How to obtain money value
Health-related costs		
Health	Hospitalisation (bed-days) Other medical care, such as non hospital treatment, medicines Permanent disability (numbers, age of patient) Non-medical (e.g. vocational) rehabilitation, house conversions	Actual expenditures on medical 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		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	Lost earnings during the whole period of permanent disability	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

Source: Mossink and De Greef, 2002

Looking for comprehensive approaches

Since cost categorisation based on social insurances expenditures could result in under-estimates, efforts have been made to develop frameworks that incorporate a more comprehensive approach. The calculations made by Koningsveld (2004) are based on a model picturing not only several cost categories but also how they relate to and influence one another (figure 6).

Figure 7 - Pathway framework

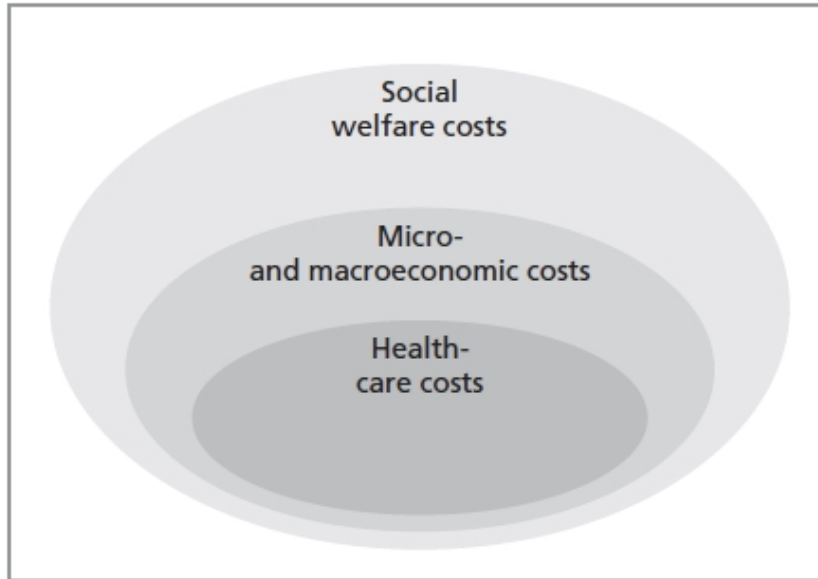


Source: Weil, 2001

The fact that incorporating a welfare perspective on costs related to accidents at work and work-related ill-health, is necessary to get a comprehensive picture of such costs, is made apparent by the framework used in a study on the economic costs of ill-health in the European Region (Suhrcke et al., 2008). The starting point of the study is that evidence on the economic costs of ill-health is essential to any assessment of the economic return on investing in health. But, in order to do so, one should understand what those costs mean and how they should be measured to ensure that such investments are made wisely. The study addresses three economic concepts:

- the broadest, most relevant concept is social welfare costs/benefits, which attempts to capture the value people place on better health. The welfare costs of ill-health are the most encompassing and measure the value individuals attribute to health. This includes the intrinsic value of health and far exceeds the earnings an individual would gain by living a longer, healthier, more productive life. Although people place high value on health, does not mean that this value is infinite. The value people attribute to health is difficult to measure since there is no market price. Such value can be inferred, however, from the decisions people make in situations that involve a trade-off between money and health. For instance in deciding to require greater compensation to perform dangerous jobs.
- the more limited but more tangible concept, micro and macroeconomic costs, looks at, for instance, the foregone earnings of individuals/households and the GDP losses countries incur, respectively, due to the ill health of a household member or the national population. Microeconomic and macroeconomic costs are more tangible but more limited measures of the costs of ill health.
- the most limited but nevertheless widely applied cost concept looks at the additional health-care expenditures that may be associated with ill-health.

Figure 8 - From healthcare to social welfare costs



Source: Suhrcke et al., 2008

Box 3 - Some findings from the study on ill-health in the European Region (Suhrcke et al., 2008)

Welfare costs

A calculation reveals that in many WHO European Region countries between 1970 and 2003, the welfare gains associated with improvements in life expectancy totalled 29–38% of gross domestic product (GDP). A value that substantially exceeds each country's national health expenditures.

Micro and macroeconomic costs

At the microeconomic level, there is substantial and growing evidence suggesting that ill health reduces individuals' labour productivity and labour supply. Health status even emerges as the main determinant of labour supply by older workers in several studies.

Findings are more mixed at the macroeconomic level. Considerable literature suggests that ill-health is bad for economic growth in developing countries, but recent research contradicts that view.

Health-care expenditures

"A healthier population means less spending on costly health care" sounds plausible, but the evidence is equivocal. Even if better health may, in some circumstances, lead to lower health spending, other cost drivers, in particular technological advances, will more than outweigh any savings from improved health. On the other hand, there is also not much support for the hypothesis that better health by itself would be a major cost driver.

2.3.3.2 Data sources

Estimates of economic costs of accidents at work and work-related ill-health on societal health are often based on various sources of administrative data that are available (e.g. Blandin and Kiefer, 2004). Using administrative data has several advantages when calculating the costs of accidents at work and work-related ill-health. The most obvious advantage is that the data are easily available since for instance, governments or insurance companies already collect them. Furthermore, the databases often

contain detailed, information on the number of cases, the duration of absence periods, on the victims (age, gender, profession, salary, etc.) and also on the cause of absence.

However, the limitations of using administrative data are extensive (Reville, 2001; Adams et al. (2002)). The data

- don't include information on accidents at work or cases of work-related ill-health that do not result in claims;
- comprise a limited amount of demographic information;
- only include limited outcome measures and go rarely beyond the benefits paid;
- do not register uncompensated time off work;
- do not capture lost productivity from time out of work, overtime, retraining, or other costs incurred by employers;
- ignore costs associated with pain and suffering as well as those of within-home care provided by family members;
- exclude the costs to innocent bystanders, (e.g. explosion);
- do not always allow for recurring injuries to be registered;
- tend to be less reliable as degree of injury or illness decreases, since many moderate to minor cases are self treated or treated by allied health professionals;
- don't consider the complexity of the events since losses may occur over many years or an entire lifetime.

Costs are made by both workers and employers: these costs may also change over time, and it may be difficult to differentiate them from costs that would have occurred even without the event of an accident or case of ill-health. Losses for similar accidents/cases of ill-health may differ by socio-economic and demographic characteristics of the worker or employer, and by the economic conditions at time of injury.

Added to these problems, comes the problem of comparing results between different countries. This poses especially a problem in the EU where these kinds of data are available from national social security bodies. Yet there are big differences in the amount of social insurance data routinely available in the Member States. In some countries comprehensive data are available while other countries dispose over little to no data. There are other factors as well, in terms of regulations applied by the respective social insurance systems which influence absence from work (and the data recording these absences) and the number of days people take off. These factors include length of qualifying period, income-related versus flat rate benefits, etc.

This of course raises the question of validity when making comparisons across countries (Kreis and Bödeker, 2004). The problem of making comparisons between countries is not only linked to the availability of data, also significant variations in wages and benefits are influencing factors and are bound to make generalisations difficult (Hoel et al., 2001). Brown et al. argue that the results they have found for the Canadian workforce are transferable to the US workforce given the few differences between the Canadian and the US system. However, the authors note that if social security systems provide lower wage replacement or lower social security benefits, the expected effect on injured workers would likely be greater than that observed in Canada (Brown et al., 2007).

Data sources often rely on systems counting cases of accidents at work and work-related ill-health. But, counting the cases is not always straightforward due to problems related to the definition of work-relatedness (is a case due to the work or not) and to reporting issues (Driscoll et al., 2005). Underreporting is often mentioned as a problem when dealing with data on accidents at work and work-related ill-health. Accidents or cases of ill-health are not reported because they are considered to be minor and self treated or because they occur to workers that don't enter the social security system. Especially workers in precarious positions such as temporary workers, contract workers, illegal workers are vulnerable (Dorman, 2000a; Adams et al., 2002).

For cases of work-related ill-health the problem of underreporting is even greater. Long latencies and multifactorial influences hinder the registration of cases of work-related ill-health. This is due to the fact that the relationship between work-related exposure and the disease process is very complex. In fact, most diseases have multi-factorial causes. Common diseases such as coronary heart disease, mental illness and musculoskeletal diseases may be initiated or accelerated by chronic adverse work experiences. The knowledge of the extent to which different diseases can be attributed to occupational causes is limited. Also workers' exposure is difficult to ascertain in a world in which the exposures associated with particular jobs are often not known, and in which workers frequently move from one job to another. Furthermore, work-related diseases present the challenge, that due to their long latency, it is often difficult to document the precise contribution of work-related factors to the onset and progress of such diseases (Dorman, 2000a; Schulte, 2005; Mustard, 2008). For work-related problems such as stress and workplace bullying this might even be more complicated. The relationship between stressors and negative outcomes for health are seldom linear and deterministic (Hoel et al., 2001).

2.3.3.3 Methodology

Cost estimations use different methodologies. In determining the method, the first step is to decide the time period for which the costs apply. Roughly two different principles can be used: the incidence method and the prevalence method (Mossink and De Greef, 2002; Adams et al. 2002; Sun 2005).

Incidence-based methods measure the lifetime costs from accidents and ill-health, based on all cases with onset of the case in a given base year and for each and every subsequent year over the natural course of the case. This method is used for decisions about treatment and research strategies. Results provide the basis for predictions about likely savings that reduce incidence and improve outcomes and is the preferred method for the evaluation of prevention programmes. The incidence method provides a baseline against which new interventions can be assessed.

Prevalence-based methods measure costs that occur as a result of the prevalence of the injury or disease; and estimate the economic burden (value of resources lost/used) to society incurred during base period (for example, one year) and are used for cost control. For example, results identify the main parts of costs and resources used and areas for cost-cutting. All accidents and ill-health events that occur in that year are measured, regardless of when the onset of the event occurred.

Although the incidence method is preferred (see also Sun, 2005; Paez et al. 2006), the prevalence method is far more common because the method requires less data and fewer assumptions than incidence based-studies. Data only need to be collected from one year and nothing has to be known or assumed about the course of the injury or illness (Mossink and De Greef, 2002; Adams et al., 2002; Segel, 2006).

Once the time period has been decided, two cost estimation methods can be used: the willingness to pay method and the human capital method. The two methods are based on different theoretical grounds.

The Human Capital approach is an approach to valuing life in which productivity is based on market earnings and an imputed value for housekeeping services. In the human capital approach, a person is seen as producing a stream of output that is valued at market earnings and the value of life is the discounted future earnings stream. Morbidity and mortality destroy labour, a valuable economic resource, by causing persons to lose time and effectiveness from work and other productive activities, forcing them out of the labour force completely, or bringing about premature death (Rice, 2000).

The Willingness To Pay approach measures the amount an individual would pay to reduce the probability of illness or mortality. There are various methods of determining an individual's willingness to pay, including surveys, examining the additional wages for jobs with high risks, examining the demand for products that lead to greater health or safety (e.g. seatbelts), and other related methods (Segel, 2006).

The Human Capital method has been criticised on various grounds because it tends to underestimate costs by ignoring costs for non-wage earning persons and underestimating the costs to women and minorities given their wages tend to be low due to discrimination. In addition, psychosocial costs, such as pain and suffering, are components that are omitted from the human capital computation of costs. Hence the Willingness To Pay approach is preferred given it is more comprehensive but since the method requires a lot of data, it is often more difficult to put the approach in practice (Rice, 2000, Suhrcke et al., 2008; Shalini, 2009).

2.3.4 Distribution of costs between individuals, companies and society

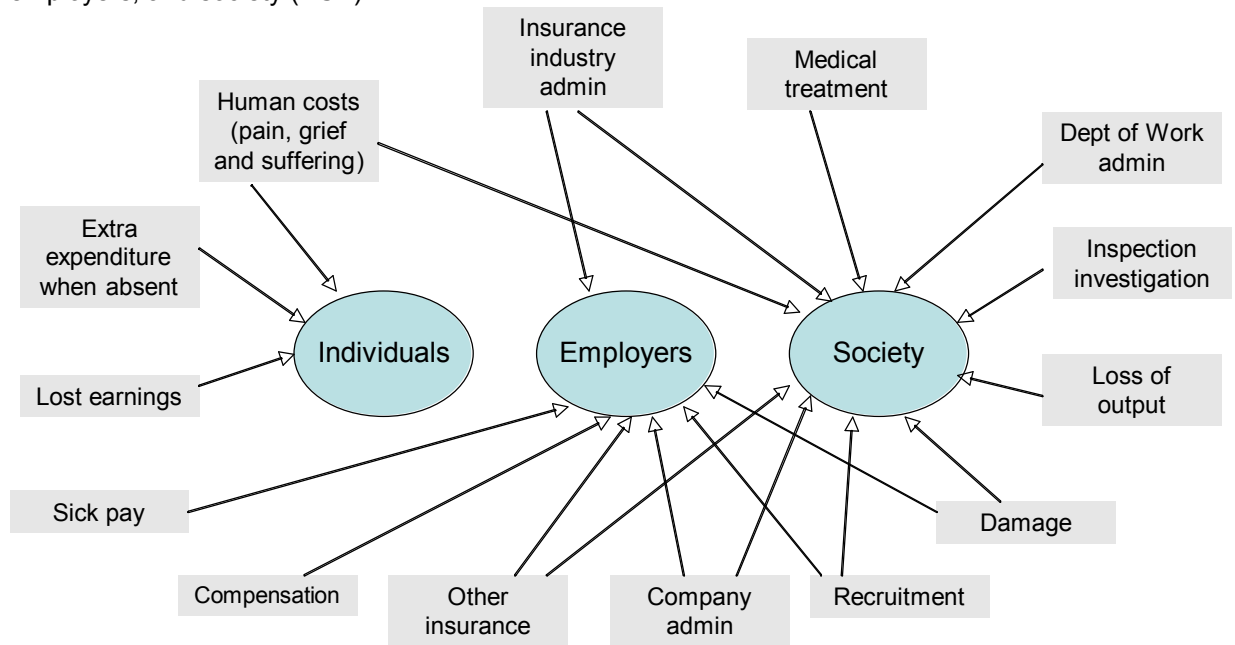
Who is the most burdened?

The consequences of accidents at work and work-related ill-health affect victims, and their family, the company and society at large. The distribution of the costs related to these consequences is unevenly proportioned. According to Boden et al. (2001) the economic burden falls heavily on workers (Boden et al., 2001). Other studies are less equivocal and make a distinction in the severity of cases.

According to some studies, 76% of the average cost of an accident at work is incurred by society, 13% by the victim and his or her family and 11% by the employer (CIOP cited in European Commission, 2007). The Australian Industry Commission (1994) divided the costs more equally between the different stakeholders stating that around 30% of the total cost has to be borne by injured workers and their families. Employers have to bear about 40% in workers' compensation costs, lost productivity and extra overtime. Society pays approximately 30%, mostly in social security benefits and health subsidies (Industry Commission, 1994). However, the authors stipulate that the community's share increases with the severity of the consequences. In case of a permanent disability the share rises up to 40% compared to 10% for minor accidents. Most costs of minor accidents are borne by the company. Also Larsson and Betts (1996) conclude that for severe cases more costs are picked up by social security. For severe accidents, the compensation system pays 70% of the costs. The victim and the company pay an equal portion of 15%.

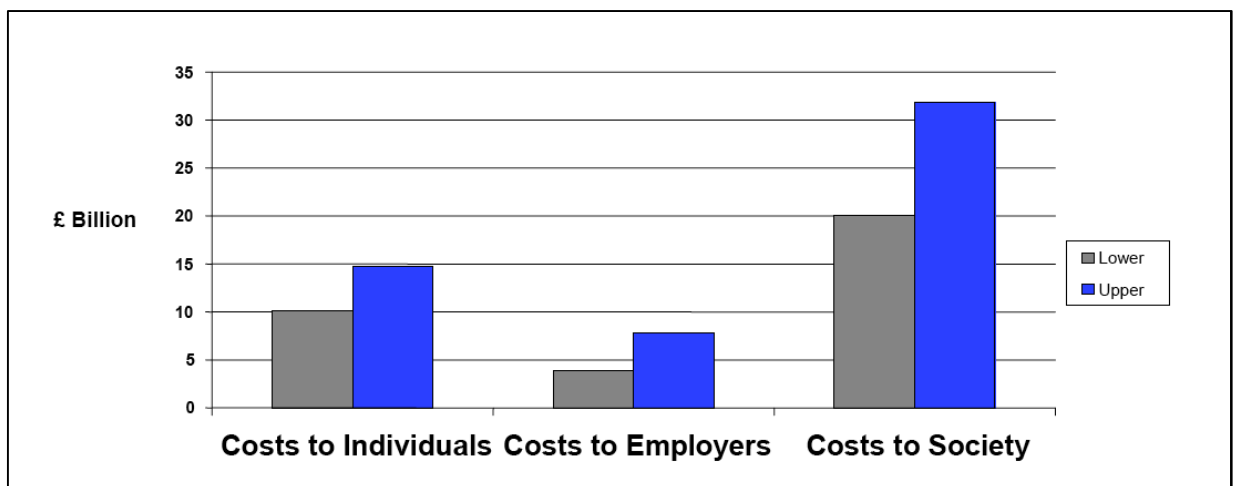
When analysing the total costs of accidents at work and work-related ill-health, Health and Safety Executive (UK) distinguishes three cost categories: costs to individuals, costs to employers and costs to society (figure 9). The data of their analyses are referring to 1990 (Davies and Teasdale, 1994), to 1995/96 (HSE, 1999), 2001/02 (HSE, 2004) and to 2005/06 (Pathak, 2008).

Figure 9 - Distribution of cost categories of accidents at work and work-related ill-health to individuals, employers, and society (HSE)



The data show that society bears the largest part of the costs created by accidents at work and ill-health, followed by individuals. Employers bear the smallest part of these costs (figure 10) (Pathak, 2008). Rauner et al. (2005) came to similar conclusions comparing costs for companies, the national social security body and the economy. Society bears the greatest part of the costs (Rauner et al., 2005). This means that employers will continue to have weaker than optimal incentives to reduce occupational safety and health risks (see also 2.4.2.1).

Figure 10 - Costs to Britain of workplace accidents and work-related ill-health (2001/02)



Source: Pathak, 2008

Who pays? The influence of workers' compensation systems

Who pays what and how much depends in some extent of the Workers' compensation system that is in place. Workers' compensation (insurance) systems can be defined as the social insurance arrangements providing compensation for occupational accidents and occupational diseases. Workers' compensation systems are the result of complex social, political and economical conditions in each country. This is why that, although the systems are based on common principles, they tend to differ from country to country. A trend towards standardisation can be noticed due to harmonisation of trade rules and because working costs are considered an important competition factor. In order to avoid social dumping, national regulations in the field of social security should be standardised between countries. This standardisation finds support in the European legislation on safety and health at work and in ILO Conventions⁸ (European Agency and TC-OSH Work Environment, 2010; Munich Re, 2000).

The report prepared by TC-OSH Work Environment for the European Agency Safety and Health at Work in 2009 on Economic Incentives (see also Elsler and Eeckelaert, 2010) viewed the workers' compensation systems from a general welfare typology. The typology is categorised in two main types: 'Beveridgian' and 'Bismarckian' based on the way that the systems are financed. Whereas the Beveridge model is tax financed, the Bismarckian model is funded by social insurance (contributions). The majority of social security systems in the EU are primarily contributions-based, although there has never been a 'pure' system of either type. Nevertheless, the United Kingdom and the Scandinavian countries have been closer to the Beveridge model, where continental Northern Europe has been closer to the Bismarckian model. The systems in Ireland, Spain, Portugal, Italy, Greece have been moving from insurance-based to predominantly tax-based financed systems. The Baltic and Eastern European countries have introduced adapted Bismarckian models since they regained control over national policy making in the 1990s.

Within this global typology the workers' compensation systems can be distinguished as public or private on the one hand and monopolistic or competitive on the other hand.

- public system: workers' compensation is integrated into a social security administration or organised into a separate unit (e.g. a special fund);
- private system: private insurance companies act as main players in a privatised market with compulsory insurance, covering the risks and offering the benefits prescribed by law; the State may act as a competitor in the free market (e.g. via a state-owned company) or withdraw totally and restrict its role to legislative, controlling and supervising activities.

Furthermore, a distinction can be drawn between state monopolies on the one hand, and private, free markets for workers' compensation insurance on the other. In the latter case, there may be restrictions to the free market, e.g. with regard to the insurance of occupational diseases.

Based on the classification it becomes clear that most countries have a public (state-run) insurance system, only six have a private system with a competitive market. Spain is the only Member State with a state-run, competitive insurance system. Four countries (Belgium, Spain, Portugal, Denmark) have a separate system for occupational accidents and diseases, instead of an insurance of occupational accidents and diseases that is done by one, overall system. Table 5 provides an overview of the social insurance systems and workers' compensation in the European Union.

⁸ E.g. ILO Convention on Minimum Standards of Social Security n° 102

Table 5 - Classification of EU Member States and the characteristics of their workers' compensation schemes (based on the report prepared by TC OSH Work Environment for the European Agency, 2010)

Country	Social insurance system		Workers' Compensation System				
	Predominantly Beveridge	Predominantly Bismarckian	State-run	Private	Monopolistic	Competitive	Separate system Occ. accidents/ diseases
Austria		x	x		x		
Belgium		x		x		x	x
Bulgaria		x	x		x		
Cyprus	x		x		x		
Czech Republic		x	x		x		
Denmark	x			x		x	x
Estonia		x	x		x		
Finland	x			x		x	
France		x	x		x		
Germany		x	x		x		
Greece	x		x		x		
Hungary		x	x		x		
Italy	x		x		x		
Ireland	x		x		x		
Latvia		x	x		x		
Lithuania		x	x		x		
Luxembourg		x	x		x		
Malta	x		x		x		
Poland		x	x		x		
Portugal	x			x		x	x
Romania		x	x		x		
Slovenia		x	x		x		
Slovak Republic		x	x		x		
Spain	x		x			x	x
Sweden	x		x		x		
The Netherlands		x		x		x	
United Kingdom	x			x		x	

The Munich Re report (2000) compares the Workers' Compensation systems on several characteristics: risk, coverage, benefits, claims handling, admission and control of insurance carriers, financial aspects and taxation aspects. Especially the first three items are of influence on the cost distribution of accidents at work and work-related ill-health between the victims, the companies and society at large. Regarding the risk covered by the workers' compensation system, the differences are relatively small. All systems make a distinction between accidents and diseases. The basic definition of an occupational accident (see box 4) is the same but some systems have a broader interpretation than others. Not all systems cover for instance commuting accidents meaning that victims of these types of accidents will not be covered by the Workers' compensation system and in general will have to bear more costs by themselves.

Regarding the recognition of an occupational disease by the system most European systems are based on a mixed model combining 'lists' and 'general clauses'. A victim has two options either to refer to the list or to prove that a disease that is not on the list is work-related. In contrast, the US system is based on general clauses but further developed by case law. In practice this means that in most European countries victims of conditions such as mental health problems, or musculo-skeletal disorders face huge problems to prove that these conditions are work-related. While in many US jurisdictions these conditions are included in the compensation systems through case law.

Box 4 - Definition of an occupational accident (Workers' Compensation Systems)

The standard definition of occupational accident contains the following elements:

- (1) fortuitous, sudden, or unexpected external event
- (2) during working hours/on the way to or back from the workplace
- (3) arising out of work performed in the course and the scope of employment
- (4) bodily harm
- (5) causal link between the event and the harm

Remark: these elements refer to the definition used in Workers' compensation systems and are important to determine whether or not a victim can be compensated.

Source: Munich Re, 2000

The coverage of the Workers' compensation system includes all dependent workers but the situation is not always the same for workers that don't clearly fit this definition such as contract workers. In most countries it is left to jurisdiction to deal with problems related to this issue.

Regarding benefits, systems tend to differ and of course, especially this element can have an impact on the cost distribution of accidents at work and work-related ill-health. Table 6 for instance gives the example of the compensation payments in case of temporary disability. The examples show that not only there is a difference in the amounts paid (in % of salary) but also in the duration of the payments. Furthermore, in some countries the employer has to cover the first month of the disability, while in other countries the payments are shifted almost immediately to the insurer. Similar differences exist for permanent disability cases

Most European Workers' Compensation systems don't cover 'non-economic' losses such as pain or suffering while the US has a long tradition in compensating moral damages. Often this compensation exceeds by far the compensation for economic losses (Munich Re, 2000).

Table 6 - Compensation in case of temporary disability

Country	Payment by the employer		Payment by the insurer	
	Percentage of the salary	Duration of payment	Percentage of the salary	Duration of payment
Italy	60% of the daily earnings	3 days	60%	From the 4th up to the 90th day
			75%	After the 90th day up to reconstitution of health or recognition of disability
Belgium (*)	100% of the salary	1 month	90% of average daily salary	After the 30 th day and until recovery
New Zealand	100% of weekly earnings	1 week	80% of the weekly earnings	Until recovery or permanent disablement
France	Complementary payments, so that the victim receives 90% of the gross income	28 days	60% of the daily net income	Until recovery or permanent disablement
	Complementary payments, so that the victim receives 2/3 of the gross income	Up to the final statement of invalidity or to recovery		
Germany	100% of the salary resp. wages	6 weeks	80% of the regularly paid gross salary/wages; must not exceed the net salary/wages	Until recovery or permanent disablement

Based on Munich Re (2000), information added for Belgium and Germany

(*) The regime is different for white and blue collar workers; there is also a difference between compensation in case of an occupational accident and an (occupational) disease. In this table data are referring to the compensation of a white collar worker in case of an occupational accident.

Who pays? An incentive with constraints

The economic impact of accidents at work and work-related ill-health illustrates that these costs would not be created if these accidents and cases of ill-health could be prevented. Thus preventing occupational accidents and diseases should make good economic sense for society as well as being good business practice to companies (Dorman, 2000a; Rikhardsson, 2003).

The problem remains that this is not automatically the case. This is due to the nature of costs and benefits. A report for Norwich Union (insurer and provider of healthcare services in the UK) looks into the costs of workplace absence (Nera, 2006). According to the report, stakeholders do not automatically invest in prevention or promotion programmes due to the fact that no one stakeholder has an overriding incentive because of the nature of how the costs and benefits accrue: the costs of illness are spread across many different stakeholders (e.g. employers, the National Health Service, the social

security budget and individuals) and there is uncertainty over when and how the benefits from early intervention will accrue.

This unevenness between the stakeholder(s) bearing the costs and the one(s) that can profit from the benefits is of lesser importance if the costs can be considered relatively small and the benefits as high. However, if both the costs and benefits are of a similar magnitude, this phenomenon is important and impacts behaviour (Giuffrida et al., 2002).

Tompa refers in this regard to the concept of health capital and firm-specific human capital of the workers. Since health capital complements firm-specific human capital (it increases the returns to firm-specific skills and knowledge), one might expect that employers would be willing to bear the cost of investing in the health of workers in order to reap the benefits of productivity gains. The problem however is that health capital is generic rather than company-specific since workers can take it with them from job to job. This might explain why companies might be unwilling to bear these costs, even if health capital increases worker productivity. But health capital has some degree of complementarity and some generic aspects. This is why companies may voluntarily invest in the health of workers but not necessarily to a socially optimal level (Tompa, 2002).

It is not always clear who benefits from the investment and the benefits might only be visible in the long run. The benefits for instance to national security bodies of reducing the future flow of incapacity benefit claims, is a long-term gain rather than an immediate win. Furthermore from society's perspective, no stakeholder has an incentive to invest in programmes in a socially optimal perspective because each stakeholder considers the private costs and benefits rather than the societal costs and benefits. The consequence of this distinction is that when employers set up workplace health interventions, they will under-invest from society's perspective because they focus on the private benefits rather than the social benefits. Incentives are tools that can be used to correct these kinds of market failures (Nera, 2006).

2.3.5 Conclusions

The costs of accidents at work and work-related ill-health impact several groups on three different levels: the society, the company and the victim. These three groups are affected by the consequences of poor working conditions and bear the costs. The costs are not equally distributed between the three groups. Furthermore, the costs are not perceived in the same way. What might be a cost for society might be of no (or of minor) consequence for a company. The interests of each group are not the same, as are their capacities to influence the working conditions.

Just as work affects many areas of our lives, the impacts of accidents at work and work-related ill-health reach all aspects of society, rippling out to affect personal, social and workplace relationships. Many of these consequences cannot be expressed in monetary values. Researchers have tried to capture these consequences by using qualitative techniques. Especially victims confronted with disabling conditions are faced with major consequences that impact their finances and social role.

On societal level, efforts have been made to come with reliable estimates but the results heavily depend on the chosen methods, the cost categories and the data that are used. It's an even bigger challenge, if one tries to account for differences that emerge from recording practices and benefits that arise from the various social security schemes. These social security schemes will almost certainly have an impact on the distribution of costs from accidents at work and work-related ill-health between individuals, society and companies. Although there are similarities between the social security schemes, differences can be noticed in coverage and benefits. Further research is needed to gain a better insight into the extent it impacts on the distribution of costs among the different groups.

The difference in perspective on costs of accidents at work and work-related ill-health has several consequences. First, it means that other assessment methods must be used on all three levels to make

realistic cost estimates. Moreover, when using economic arguments based on these costs, one has to take into account this difference in perspective. The decision-making process of a government is totally different from a decision-making process of a company. This means that other cost arguments will have to be developed.

The data show that the costs that arise from poor working conditions are distributed among the companies, society and individuals. Depending on the severity of the cases, society even bears the largest part of these costs. This means that employers will continue to have weaker than optimal incentives to reduce work-related risks for health and safety. Since a lot of the costs are borne by society the motivation for intervention should also be attractive to policy makers. An increased insight into the costs on societal level could have an impact on priorities and willingness to intervene, for example by making funds available for initiatives in this field or by implementing financial incentives to change business behaviour.

2.4 Costs of accidents at work and work-related ill-health on company level: general framework

Economic consequences of accidents at work and work-related ill-health are put forward as convincing arguments to make the case of occupational safety and health. Researchers have made estimates of these costs by various methods and research designs. An overview shows that different concepts (2.4.1) and theories on cost categories (2.4.2) underlie these studies.

2.4.1 Basic concepts

In describing the concept of costs of accidents at work and work-related ill-health, several definitions have been formulated (2.4.1.1) but most agree that it comes down to estimating the costs of the harmful effects of accidents at work and work-related ill-health (2.4.1.2).

2.4.1.1 Definitions

Cost is not an easy concept to define. From a strictly financial viewpoint, a cost must be considered as *the value that must be given up to acquire a good or service*⁹. It's clear that this definition cannot immediately be applied to costs of accidents at work and work-related ill-health. Krüger and Meis (1991) refer to this problem indicating that "accident costs" is not a correct concept. In the context of a company, costs can be related to production factors (personnel costs, costs of goods, etc.), or to their accountability (fixed costs, variable costs), etc. Costs for accidents at work or work-related ill-health don't fit this profile.

However, one has to take a broader perspective on the matter. Dorman (2000a) defines economic costs as costs that can be expressed in monetary units. They include the costs paid - or expected to be paid - by individuals and organisations acting within the economy, as well as the monetary values implicit in activities undertaken and foregone. It is clear that not all such costs involve financial payments. Some can be attributed through careful analysis, such as the impact of an accident on the depreciation of equipment or the loss of raw material. Ultimately, these come down to a set of payments, but it may take a careful study to determine what portion of the payment is attributable to accidents at work and work-related ill-health. Other costs should be placed under the heading 'opportunity costs', referring to the value of the opportunities lost to the company due to worker absences or other forms of disruption due to ill-health. If a company loses market share, for instance,

⁹ Definition taken from <http://economics.about.com/library/glossary/bldef-cost.htm>

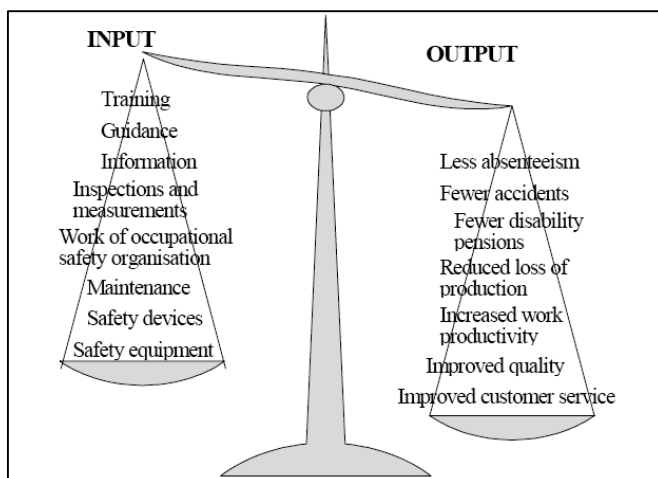
this is really the cost of not enjoying the benefits of the higher market share that would otherwise have been possible.

Some authors have placed the concept of costs of accidents at work and work-related ill-health in a more general context considering both prevention and accidents/ill-health. According to Brody occupational safety and health costs must be seen in the light of financial management of risks:

- part of the risk is eliminated by prevention measures;
 - another part of the risk is covered by insurance; and
 - the residual part of the risk is considered as part of the hazards associated with managing a company.
- Occupational safety and health costs are the sum of these components but only the last two are determined by the level of accidents at work and constitute accident costs. Prevention costs are by nature "ex ante" and Accident costs "ex post". (Andreoni, 1986; Brody, 1990b).

The Tyta model takes a similar view on these matters considering costs from an input-output perspective of the working environment. Input being all the efforts that are made to protect and promote the well-being of the workers and the work environment. The output consists of the negative outcomes such as accidents and absenteeism and the positive outcomes such as increased work productivity (figure 11). Working environment costs have to consider both the input and output.

Figure 11 - Input and output of the working environment



Source: Ministry of social affairs and health, 1999

Even though formulating a definition for costs of accidents at work and work-related ill-health brings about some difficulties, most authors consider these costs to be the costs that can be attributed to the effects of accidents at work and work-related ill-health (e.g. Kunz, 1984; Andreoni, 1986; Pawlowska, Rzepecki, 1997; Dorman, 2000a; Hoel et al. 2001).

In this context, the following definition (see also box 5) could be proposed:

Cost of an accident at work/case of work-related ill-health = the effects on the costs and the revenue of an organisation (company) that would not have emerged if the accident/case of work-related ill-health would not have taken place.

(De Greef and Van den Broek, 2009)

In this regard it is obvious that the costs to a company due to accidents at work and work-related ill-health are by their very nature non-value added and should be avoided. They have a negative impact on the corporate value creation. The identification of the costs of occupational accidents illustrates the benefit of the corporate occupational health and safety effort in terms of costs that could be avoided if accidents are prevented (Rikhardsson, 2003).

2.4.1.2 Consequences

The consequences of accidents at work and work-related ill-health increase on the one hand the costs of a company and on the other hand diminish the revenue (see also table 7).

The increase of costs is mainly due to non-productive time. This is time lost due to the accident or case of ill-health. It is not just about the days of absence of the victim, whose salary is also partially reimbursed by the insurance system, but also the time spent on the immediate response to the accident/case, taking measures for reorganising the work and the replacement. This non-productive time affects in a negative way the cost of a company.

Problem is that this non-productive time often remains hidden and is not assigned to the phenomenon that causes the costs: the accident or case of ill-health. This poses difficulties for making adequate cost estimates (see also 2.5.3.3) due to the fact that most companies dispose of a spare capacity. This spare capacity (in labour force, stock) is used to bridge gaps because of interruptions in the production process due to absenteeism, mechanical failures, accidents, delivery failures, etc. Losses of human resources have an impact on a company's financial results if planned production can no longer be achieved by appropriate substitute measures. Built-in flexibility, reserve capital or planned and unplanned production buffers are in most cases able to absorb lost production time (Rundmo and Söderqvist, 1994; Larsson and Betts, 1996; Lehmann and Thiehoff, 1997). Although most companies maintain a certain level of slack in order to meet unexpected demands on their resources, they are aware of the fact that maintaining an overhead of excess capacity is costly. Especially companies that adhere 'lean production' principles are forced to control and reduce any overhead or spare capacity as much as possible (Dorman, 2000a).

In case of an accident at work, some consequences can also lead to specific expenditures. These expenses are in principle clearly identifiable in the accounts of the organization. For example, repair costs for damaged equipment.

Several effects such as a bad company image, a decrease in job satisfaction, production losses, etc. mainly cause the reduction of the revenue.

Box 5 - Definitions

Cost of an accident at work/case of work-related ill-health = the effects on the costs and the revenue of an organisation (company) that would not have emerged if the accident/case of work-related ill-health would not have taken place.

Impact on the profitability of a company = difference between the profits of the situation with and without accidents at work/cases of work-related ill-health

Profit (P) = Revenue (R) – Costs (C)

$\Delta P = \Delta R - \Delta C$

Short-term scenario: increase of the costs

Long-term scenario: decrease of revenue

	ΔR	ΔC	ΔP
Short-term	=	↗	↘
Long-term	↘	↗	↘

Source: De Greef and Van den Broek, 2009

Table 7 - Overview of the effects on the costs and revenue of a company due to accidents at work or work-related ill-health

	Effects on costs	Effects on revenue
absence of the victim	+	
interruptions in the production process	+	
reorganisation of the work	+	
first aid	+	
accident/case analysis	+	
administrative follow-up	+	
recruitment and additional pay for temporary worker	+	
training of replacement worker	+	
repair and/or clean-up (accident)	+	
replacement of damaged equipment/goods (accident)	+	
fines, increase of insurance premiums	+	
production losses		-
loss of orders/clients		-
company image		-
job satisfaction		-

Source: De Greef and Van den Broek, 2009

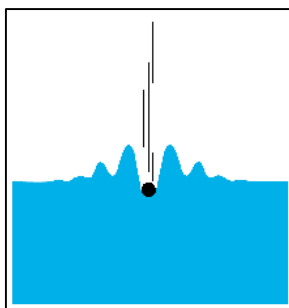
However, the effects or consequences of accidents at work and work-related ill-health are not always straightforward and easy to identify. This has to do with the fact that

- the effects can occur a long time after the event (*effects in time*); and
- the effects can occur in different locations (*effects in place*); and
- the causal link between the effect and the event is not always clear (*causality*).

The metaphor of a stone thrown in a pond illustrates this (figure 12). When a stone is thrown in the water, it causes ripples on the water surface. However, the farther away from the point where the stone fell in the water, the less obvious it will be that a wrinkle is caused by the falling stone (*causality*) (De Greef, 2003). The causal link is especially difficult to establish for work-related health problems. Ill-health cases such as musculo-skeletal problems and mental health problems are not always linked to working conditions nor to the consequences on costs of these problems. Many diseases have multiple potential causes, including lifestyle factors and a long latency period. This makes it difficult to establish whether the disease is work-related. Moreover many primary care providers are not trained in occupational medicine and may not recognize a disease as being work-related. (Mossink, 1998; Schulte 2005).

The pond model also illustrates the *effects in time and place*. Ripples of a stone falling in the water can be noticed after the event took place or at a long distance from where the event took place. The fact that the consequences of accidents can occur in different time periods and in different locations makes it a difficult task to identify and subsequently measure the costs (Laufer, 1987; Aaltonen et al., 1996).

Figure 12 - The Pond Model



Source De Greef, 2003

Even if it remains difficult, identifying the consequences of an accident or a case of work-related ill-health remains at the heart of cost calculations. Aaltonen et al. suggest that accident theories are mainly aimed to understand the nature of accident phenomena. The attention is given to the accident process before the injury phase. However, a more comprehensive view is needed to also consider the consequences. Cost calculations of accidents at work and work-related ill-health require that more accurate data on the consequences of these cases are made available (Aaltonen et al., 1996).

2.4.2 Theories on cost categories

Theories on cost categories can be found throughout the literature, especially in the literature concerning the costs of accidents at work. The aim of dividing the costs into these categories was mainly to provide an insight in the impact of these costs on business. Dividing the costs into external and internal costs shows that not all costs are borne by the one who is responsible for the costs (2.4.2.1). A distinction between direct and indirect costs (or insured and uninsured costs) points to the fact that not all costs are visible (2.4.2.2). Fixed and variable costs emphasize the fact that a lot of costs vary with the incidence of cases of accidents at work and work-related ill-health (2.4.2.3). The distinction between tangible and intangible costs refers to the fact that some consequences cannot be expressed in monetary values (2.4.2.4). Making distinctions between cost categories serves as an argument for supporting the case of OSH on company level (2.4.2.5).

2.4.2.1 Internal versus external costs

A distinction between costs can be made based on the group that bears the cost. Does the cost of accidents at work and work-related ill-health fall on the enterprise or not. Although the distinction might be considered similar to the distinction between societal and company costs, the focus is somewhat different. Dorman defines internal and external costs as follows: an internal cost to the firm is a cost which it must pay; an external cost is one which is attributable to the activities of the firm but is paid by others external to it (Dorman, 2000a). The example in box 6 clarifies this.

Box 6 - Internal versus external costs, an example

"Suppose, for instance, a company experiences a certain number of occupational illnesses each year due to a compound it uses in painting, and that the potential remedy consists in buying another safer but more expensive compound. Upon examination, managers see that they pay an extra \$1 million in medical and indemnity costs—costs they could avoid by switching paint formulas. This might provide enough incentive to make the change, or it might not. If the firm cares only about profits (and therefore economic costs), its decision will depend on whether the extra cost of the new paint is more or less than \$1 million. Let us say that it costs \$2 million to switch paints. In that case it is not in the company's immediate financial interest to solve their exposure problem. Yet, as we have seen, a large portion of the economic costs of injuries and illnesses do not fall on employers; they are paid by workers, their families, and their communities—this in addition to the noneconomic costs which, by definition, cannot show up on the firms' books. Let us suppose that these extra costs amount to another \$2 million, effectively tripling the total social cost. A \$2 million investment to save \$3 million is a good bargain for society, but not for the firm, since it stands to lose. In this example, the internal cost is \$1 million, the external cost is \$2 million, and the total social cost is \$3 million."

Source: Dorman, 2000a

The fact that costs are internal or external highly depends on the national social security system and more in particular on the workers' compensation system (see also 2.3.4). The extent to which these costs are borne by those who caused the accidents at work and cases of work-related ill-health differs from country to country. Box 7 gives some examples of costs that are externalised (cost shifting).

Box 7 - Typical components of the external cost of occupational accidents and diseases

- Victim's lost wages, concurrent and future, not replaced through workers' compensation
- Victim's medical expenses not compensated through workers' compensation or other employer-paid insurance
- Time and resources expended by the victim's household in nursing and recuperation
- Lost household production by the victim
- Public medical subsidies applied to health services received by the victim
- Public subsidies, such as tax exemption, to the workers' compensation system
- Environmental contamination in the vicinity of the enterprise
- Productivity no longer available to society due to premature death (if not captured by lost wages)

Source: Dorman, 2000a

Cost-shifting can be seen in every economy. However, some characteristics increase the extent to which it is society and not the employer who pays. These characteristics are:

- the degree of market competition: in highly competitive markets individual companies are more likely to try to avoid bearing safety and health costs;
- the unemployment rate: when unemployment rates are high, companies are more able to shed costs on their workers;
- the transfer and social insurance programmes: countries with highly developed public welfare programs are more vulnerable to cost externalization (equalizing risks to all companies or transferring the costs to taxpayers).

Dorman, 2000a

This cost shifting mechanism is generally considered to be an obstacle for companies to invest in occupational safety and health programmes. Because, why invest in OSH if the company is not able to benefit from it. A study for Norwich Union on the costs of workplace absence confirmed that costs and benefits are not always borne by the same stakeholder: the costs of illness are spread across many different stakeholders and there is uncertainty over when and how the benefits from early intervention accrue. As an example, employees are mobile, so investment in workforce health and safety will not always generate a return to the investing employer. Benefits will also accrue over time - the payback from investment may be five or ten years down the line – which increases both the uncertainty about the scale of benefits and about to whom they will accrue (Nera, 2006).

In many countries systems exist that bring the costs back to the company or the person who inflicted the costs (cost internalisation). Methods for cost internalisation are e.g. liabilities, legal sanctions, differentiation in premiums, etc. (table 8) (Mossink J., De Greef M., 2002).

Table 8 - Overview of instruments that can be used to internalise the costs of accidents at work and work-related ill-health

Variable	Description
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.

Source: Mossink and De Greef, 2002

Some of these methods can be used by governments and by national social security organisations as an incentive to stimulate companies to implement occupational safety and health programmes. A report prepared by TC OSH Work Environment for the European Agency of Safety and Health at Work provides an overview of the incentives in the member states and presents several case studies.

Shifting the costs of accidents at work and work-related ill-health to the employers might have positive effects on investments in occupational safety and health and ultimately on the number of cases of accidents at work and work-related ill-health (see also Van den Broek and Krüger, 2010). Employers do seem to be motivated by incentives based on cost internalisation principles. Wright and Marsden found in a study that UK employers would be motivated to improve occupational safety and health and rehabilitation if the insurance cost increased and they believed there was a link between their performance and the cost of insurance. They found that it would be sufficient to integrate 'tangible' costs of ill-health and injury for the cost to be a motivator (1% of the payroll). The same study revealed that it might be impossible to bring all costs back to the company. If the insurance costs would increase too much to include also costs for pain and suffering they might have an opposite effect. Employers perceived these premiums as unrealistic which leads to negative reactions (Wright and Marsden, 2002).

This shows that cost internalisation has its limits. Dorman comes to the same conclusion arguing that cost internalisation is neither feasible nor desirable. Not all societal costs can be adequately calculated and attributed, which makes it impossible to assign them properly to companies (Dorman, 1997).

2.4.2.2 Direct versus indirect costs

The distinction between direct and indirect costs is widespread in literature on costs of accidents at work and work-related ill-health, although sometimes slightly different terms might be used such as insured and uninsured costs.

Direct and indirect costs of accidents at work

Traditionally, the costs of accidents at work have been expressed in terms of direct and indirect costs. This has much to do with the work of Heinrich, as early as the 1930s. In his study *Industrial Accident*

Prevention he distinguishes these 2 categories (Heinrich, 1959). Table 6 shows the cost items in each category according to Heinrich.

Table 9 - Direct and indirect costs according to Heinrich

Direct costs	Indirect or hidden costs
Compensation payments	Cost of lost time of injured employee
First aid and medical expenses	Cost of time lost by other employees who stop work
	Cost of time lost by foremen, supervisors, or other executives
	Cost of time spent on the case by first-aid attendant and hospital department staff when not paid for by the insurance carrier
	Cost due to damage to the machine, tools, or other property or to the spoilage of material
	Incidental cost due to interference with production, failure to fill orders on time, loss of bonuses, payment of forfeits, and other similar causes
	Cost to employer under employee welfare and benefit systems
	Cost to employer in continuing the wages of the injured employee in full, after his return
	Cost due to the loss of profit on the injured employee's productivity and on idle machines
	Cost that occurs in consequence of the excitement or weakened morale due to the accident
	Overhead cost per injured employee

Source: Heinrich, 1959

The study and the conclusions of Heinrich have proven to be very successful throughout the years. This is largely due to the fact that he pointed out that indirect costs are in fact hidden costs. Based on his study he also established a ratio between direct and indirect costs of 1:4. This general ratio is very appealing because it is an easy to understand indicator. For every euro of direct costs that is spent (and these direct costs can easily be calculated), a company also spends 4 euros that it doesn't know of.

The distinction between direct and indirect costs is very common. Many authors use the categories to determine the economic impact of accidents at work. Examples can be found in the Tyta Model (Ministry of social affairs, 1999, see also table 10; Labelle, 2000; Leopold and Leonard, 1987; Klen, 1989; Reville et al., 2001; Liu et al., 2009)

Table 10 - Direct and Indirect costs of the Tyta model

Direct costs	Indirect costs
payroll costs of time of absence due to accident	compensation of absence
	loss of working hours concerning individuals other than those injured
	loss of property
	loss of output
	other direct costs
	additions to accident insurance premium

Source: Ministry of Social affairs, 1999

The cost items that all of these authors allocate to the two categories might be somewhat different but basically they define the categories as follows:

- Direct costs: costs that can be directly allocated to the accident such as wages of the victim, medical expenses, material damages, etc.
- Indirect costs: these are costs that have incurred due to the accident but that cannot be related immediately to the accident such as lost production time, damage to the corporate image, production losses.

In the literature many different definitions of direct and indirect costs can be found. Labelle for instance defines direct and indirect incident costs as follows: direct costs represent all cash outlays attributable to the incident; such outlays would not have been necessary had the incident not occurred. Indirect incident costs represent costs in terms of time and resources (other than cash) incurred as a result of the incident. Direct costs are easy to determine, since they represent real expenses, and indirect costs are difficult to determine (Labelle, 2000). Reville et al. (2001) add to this distinction, the fact that some costs are paid before (ex ante) and after (ex post) the occurrence of the injury. Thus allowing for global estimates of the employers costs to be based on the premiums paid (ex ante) or on the benefits (ex post) (table 11). Liu et al. (2009) who investigated the costs of losses due to human errors add to the distinction between direct and indirect, the notion of primary and secondary. Primary costs are more important than secondary costs. Primary direct costs are for instance medical costs while secondary direct costs comprise cost categories such as overhead of processing wages.

Table 11 - Direct and Indirect costs, ex ante and ex post according to Reville et al.

	Direct costs	Indirect costs
Ex ante costs	Workers' compensation insurance premiums Injury-prevention programs Costs of compliance	Compensating higher wages to workers for job risks Redundant hiring to insure against workplace injury
Ex post costs	Payment of indemnity benefits (workers' compensation and other benefits) Medical benefits for the injured worker (workers' compensation and other health benefits) Return-to-work programmes Costs of job accommodations	Lost worker productivity Training other workers to replace the injured worker Decreased company morale Overtime costs paid to other workers covering for the injured worker

Source: Reville et al., 2001

Dorman points to the inconsistencies of the division between direct and indirect costs. According to him this is due to the fact that most approaches simply list the costs that will qualify as direct, and assign all the rest to indirect. Since each industry is unique in terms of the kinds of costs it generates and the channels through which they are paid, it is not surprising that no two lists are the same. He proposes an alternative that is more aligned with the decision-making process in a company. A direct cost would be a cost of which the amount and the cause automatically show up in the company's routine accounting system. All other costs are indirect. Examples of such indirect costs are provided in box 8 (Dorman, 2000a). A British study confirms the fact that the distinction between direct and indirect costs, although it is very common in the literature, is somewhat arbitrary. The distinction is made for methodological reasons rather than theoretical concerns. The distinction doesn't explain why health and safety failures bring about costs nor do they provide an indication for who has to pay for them (CSES, 2009).

Box 8 - Potential Indirect Costs of Occupational Accidents at the Company Level according to Dorman

Interruption in production immediately following the accident
Morale effects on coworkers
Personnel allocated to investigating and writing up the accident
Recruitment and training costs for replacement workers
Reduced quality of recruitment pool
Damage to equipment and materials (if not identified an allocated through routine accounting procedures)
Reduction in product quality following the accident
Reduced productivity of injured workers on light duty
Overhead cost of spare capacity maintained in order to absorb the cost of accidents

Source: Dorman, 2000a

One of the first studies to criticize the distinction between direct and indirect costs came from Simonds and Grimaldi (1956). They introduced the terms insured versus uninsured costs since they believed that the terms suit better the aim of calculating the costs of an accident to convince management. Uninsured costs reflect better the fact that these costs are very real instead of 'indirect' (Laufer, 1987). The cost items they identified are similar then those of Heinrich. This does not imply that the terms are interchangeable. In theory indirect costs may not take into consideration certain aspects of an accident such as the overhead cost of insurance. The terms direct and indirect refer to the causal relationship between the cost of accidents and the accident itself while the insured and uninsured classification seeks to identify cash flows associated with the accident (Sun, 2005).

After the introduction by Simonds and Grimaldi the terminology of insured and uninsured costs can be found in several studies (e.g. Monnery, 1999; Paez et al., 2006) but the distinction between the categories is very similar to the distinction between direct and indirect costs. The basic definition of insured and uninsured costs is the following:

- the insured costs: costs paid by insurance
- the uninsured costs: costs that are not covered by insurance

In his study Laufer first analyses the costs of accidents in Israeli construction firms by using the classification of Simonds and Grimaldi of insured and uninsured costs. He concludes by proposing a new classification of controllable and uncontrollable costs. By this classification he refers to controllable costs as the portion of the costs that is affected by the safety performance of the company and thus 'controllable' by management (Laufer, 1987).

Direct and indirect costs of work-related ill-health

The use of the cost categories direct and indirect is also very common for classifying the costs of (work-related) ill-health (e.g. Nera, 2006). In a joint publication by the ILO and the Finnish Ministry of Social affairs and Health it can be found that, aside the measurable costs of absenteeism (e.g. wages), a lot of indirect costs occur. Examples of these indirect costs are recruitment of replacements, overtime or maintenance of over-capacity, sales and production losses. These costs are influenced by the production capacity's degree of use and the way the production is organised in the company (ILO, 2002).

According to Sümelahti et al. the direct costs of sick leave are sick pay. Indirect costs can be divided into

- additional payroll costs such as overtime, replacements
- administrative costs and work reorganisation
- additional production costs such as potential loss of quality and potential loss of production. These indirect costs can be very different from company to company or from sector to sector (Sümelahti et al., 1997).

Berger et al. (2001) point to the fact that indirect costs represent over half of the total disease cost. For depression and other chronic diseases, the proportion is even higher. Important components of the direct costs are work loss and reduced productivity. Table 12 provides a more detailed overview.

Table 12 - Components of indirect costs of employee illness

Component	Costs
Mortality	Employee replacement Effect on family and friends Value of lost income
Morbidity	Lost wages - paid sick leave - unpaid sick-leave days - payroll and benefit costs for absent employee Loss of vacation and personal leave Disability Most leisure time Idle employee assets
Reduced productivity	Return-to-work productivity Employee's health capital investment On-the-job training New hiring administration and training Motivation and uptake of training Teamwork and communication Institutional effect among coworkers Effect on family members

Source: Berger et al., 2001

In a report from the European Foundation for the Improvement of Living and Working Conditions costs from absence at work in the member states can be found. The data include how these costs are attributed to the employer, the nation and to specific social security budgets. However, many countries don't have recording systems that make such analyses possible. Costs are most commonly divided into direct and indirect. Direct costs include the salary costs of the absent employee (or statutory sick pay), the replacement costs and the overtime costs. The direct costs can, in principle, be measured fairly clearly, though countries differ as to what is included. In the UK, for example, the social security system bears less of these costs than in other countries, and cost estimates from the UK should not be compared directly with those elsewhere. The indirect costs may include the effects on productivity, administration, quality of service, social security contributions and the hiring of replacement workers. The results are mixed for the company level as well as for society and social security systems making it difficult to make comparisons (Edwards and Greasley, 2010).

The impact of indirect costs

In distinguishing between direct and indirect (or insured and uninsured) most authors focus on estimating the indirect costs. Since these costs are hidden, revealing them would have the most impact on decision makers.

Some authors found the hidden costs to be relatively small, too small to constitute a motivating factor. Tore and Larsson performed a study in Australian companies (1996), Leopold and Leonard in construction companies in the UK (1987) and Laufer in construction companies in Israel (1987). They conclude that substantial consequences to the production system due to occupational accidents are

rare. These consequences are related to the medical severity of the case, the special requirements of some types of production processes and to the unplanned absence of certain key operatives in such processes. The assumption that uninsured accident costs are high was not proven.

Hämäläinen et al. point to the fact that most of the studies have been conducted in industrialised countries with established social security and Workers' compensation systems. Often in developing countries an accident that occurs in the workplace does not cause direct costs. All costs should be considered as "indirect" (Hämäläinen et al., 2006).

Also Brody states that these studies have to be regarded with caution in view of differences in definitions and methodologies as well as differences in national and international contexts (Brody, 1990b). In a study that he conducted in Canada (311 cases, 151 companies) he was able to determine an average amount of indirect cost of 1,150 CAN (Brody, 1990c). According to him direct costs are insurance costs. Insurance costs have a fixed and a variable component. The fixed insurance costs are largely independent of the number and severity of accidents of the company. The variable insurance costs are equal to the part of the firm's premium established and adjusted according to its own accident level (experience rating). The company can control only the variable part of these costs. The indirect costs are all other costs such as:

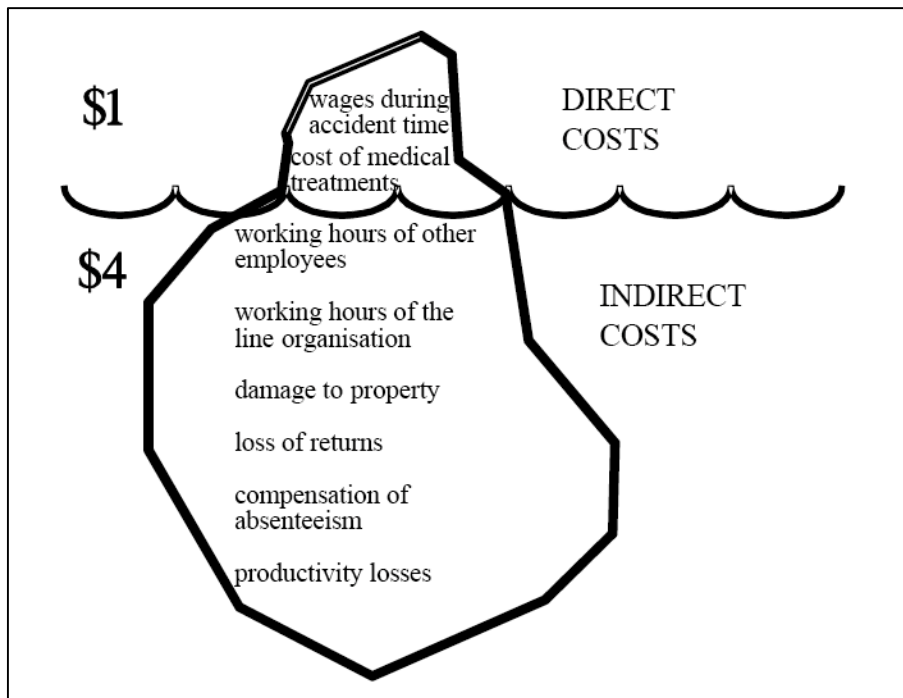
- salary costs;
- costs of material damage;
- cost of administrators time;
- costs due to production losses;
- other costs;
- intangible costs.

(Brody, 1990b)

A ratio between cost categories

The ratio that Heinrich proposed in his study between direct and indirect costs, led to the overall use of the iceberg metaphor (figure 13). Only the top of the iceberg, being the direct costs, is visible. All the rest, the indirect costs are hidden beneath the surface.

Figure 13 - Iceberg theory



Source: Ministry of Social Affairs and health 1999

In the tradition of Heinrich, several authors have conducted studies to determine the ratio between direct and indirect costs. Numerous ratios have been found and most of them didn't corroborate Heinrich's findings of 1:4. The relationship between direct/insured and indirect/uninsured costs has been shown to vary considerably. Brody found a ratio of 1:0.83 between insured and uninsured costs (Brody, 1990c). Factors influencing this ratio seem to be the industry studied, the characteristics of the firm, the characteristics of the victim, the severity of injury consequence, the definitions of cost and the research methods used and the structure of the prevailing system of workers' compensation of health insurance (Brody, 1990c; Larsson, Betts, 1996). Heinrich himself already indicated that the ratio of 1:4 does not hold true for every industrial accident or every individual plant (Heinrich, 1959).

Paez et al. argue that the linear ratios, as introduced by Heinrich, cannot be maintained due to the low correlation between the incidence rate of accidents and the cumulative accident costs. Insured costs are determined by the cost of medical treatment and the extent of the employee's absence. Uninsured costs are determined by the impact that personnel absences have on the rest of the organisation. Instead the authors propose a logarithmic relationship between uninsured and insured costs (Paez et al., 2006).

In Annex 2 an overview can be found with results from some empirical studies based on the distinction direct, insured/indirect, uninsured costs.

Simonds and Grimaldi abandoned the idea of using one ratio. They divided the accidents at work into four groups depending on the consequences of the occupational accidents:

- lost time injuries;
- doctor injuries (requiring treatment of a medical doctor);
- first aid injuries;
- material damage.

For each group the authors determined the average uninsured costs, thus calculating the average cost (insured + uninsured cost) of each type of accident. In order to calculate the total costs, it suffices to multiply the number of accidents of each group with the average cost. Their objective was not so much

to determine a ratio between insured and uninsured costs but to come up with average costs. The study did confirm that uninsured costs are much higher than insured costs and this was particularly so for minor accidents (non-injury accidents) (Gosselin, 2004).

Bird and Germain (1966) confirmed the importance of non-injury accidents. They emphasised the necessity to include material damage into the costs of accidents. Managing all incidents is at the basis of a prevention system (loss control). However, the importance of these non-injury accidents seems highly sector related. Monnery for instance found in his study of a cheque-clearing department no important amounts of non-injury accidents and concludes that the loss control argument is difficult to maintain in the financial sector (Monnery, 1999).

The problem in estimating the costs of these non-injury accidents often lies in the fact that non-injury accidents are seldom exactly recorded. HSE for instance estimated the portion of the costs of these accidents by using ratios per sector. These ratios were determined on the basis of case studies (ratio injury to non injury accidents):

- Construction 1:64
- Health and social work 1:18
- Transport 1:20
- Finance 1:0.6
- All other industries 1:20

(Davies et al., 1999)

A recent scoping study in the UK could not confirm these ratios based on the lack of available data within companies. The authors cautioned against the use of these ratios to extrapolate costs of accidents (Binch and Bell, 2007).

2.4.2.3 Fixed versus variable costs

Another classification of costs relies on the fixed or variable characteristic of costs related to accidents at work and work-related ill-health:

- Fixed costs: costs that are essentially constant whatever the incidence rate of the injury or the disease;
- Variable costs: costs that vary with the incidence rate.

An example of a fixed cost is a fixed premium for workers compensation. A variable cost is for instance the first aid cost. Every accident that occurs increases this cost. According to Dorman the general principle is that only variable costs generate economic incentives (Dorman 2000a).

Compes uses a similar classification as fixed and variable subdividing accident costs into Specific and Common costs. Specific costs are the costs that can be attributed to a specific accident. Common costs can not be attributed to an accident. Common costs occur regardless of the number and the severity of the accidents (Compes, 1956).

Andreoni proposes a cost analysis method based on fixed and variable costs (table 13).

Table 13 - Fixed and variable costs

Category	Costs
Fixed costs	
Fixed prevention costs	expenditures essential to the operation of the safety and health organisation in the enterprise expenditures for participation by the workers and their representatives expenditures related to control of the state of health of workers etc.
Fixed OSH insurance costs	insurance premiums
Variable costs	
Variable prevention costs	costs of occasional operations of OSH services (depending on the extent of accidents at work and diseases e.g. additional information)
Variable OSH insurance costs	insurance arrangements
Variable cost on accidents and diseases	costs of treatment costs related to wages paid without any counterpart in productive work
Variable expenditure arising from material damage	
Exceptional cost on prevention	additional costs falling outside fixed routine prevention cost (can be very substantial, can be amortised)

Source: Andreoni, 1986

As stated below, only variable cost provides motives to the enterprise to reduce its occupational risk (see 2.4.2.5). For example, if an enterprise pays a fixed insurance premium that is not related to the number of cases of accidents at work or work-related ill-health, this fixed cost does not provide a financial motive to set-up preventive actions. The problem however is that many costs that are actually variable appear to be fixed. This is due to accounting problems. Most accounting systems in companies do not show resource allocation for support activities such as occupational safety and health. These costs are mostly comprised in large and undifferentiated overhead cost pools (Rikhardsson and Impgaard, 2004).

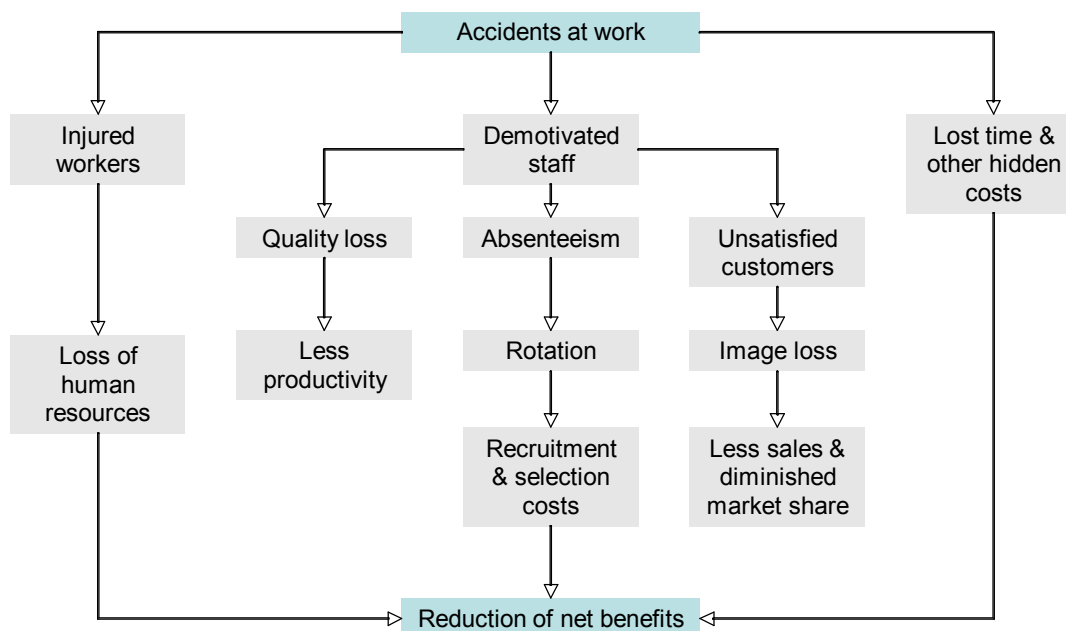
2.4.2.4 Tangible versus intangible costs

The distinction between tangible and intangible costs is mostly used to indicate that in some cases it is difficult to attribute a monetary value to specific consequences of accidents at work and work-related ill-health. Some authors consider this distinction to be similar to direct and indirect. Butcher for instance considers the distinction between tangible and intangible costs to be the same as between direct and indirect costs. Tangible costs are visible and direct. These are the costs that appear on the accounting balance sheet and are compensated and identifiable. Intangible costs are invisible, indirect. They are real but they have no monetary value assigned to them and are incalculable and subjective (Butcher, 2004).

Others consider intangible costs to be a part of indirect costs. Shalini describes indirect (hidden) costs as costs for overtime, retraining employees and for intangible factors comprising loss of company prestige and deteriorating industrial relations (Shalini, 2009).

Bestraten et al. refer in a technical note of the Spanish OSH institute on the costs of accidents at work to the importance of intangible costs. Examples of intangible costs are for instance costs due to a decline in employee morale, poor company image, loss of market share, ... These costs may not only be important, but even irreparable. Another technical note elaborates this issue of intangible values (Pujol and Maroto). Tangible and intangible values are distinguished. The first category is easy to quantify and can be calculated in an objective manner. Examples are costs associated with failures, and that basically translate into labour costs, raw material costs and costs of repairs or replacements. Intangible costs are difficult to identify, they do not have a book value or their value is governed by essentially subjective criteria. However, intangible aspects such as motivated staff, loyal customers, prestige and image of business, innovation, etc. are important and the viability of business depends on it. Figure 14 depicts how intangible consequences of accidents at work ultimately lead to reduced business benefits (Pujol and Maroto).

Figure 14 - From accidents at work via intangible outcomes to reduced benefits



Source: Pujol and Maroto

2.4.2.5 Cost categories and business arguments

Substantial efforts have been made to make distinctions in the costs that can be attributed to the consequences of accidents at work and work-related ill-health. These distinctions have been made for purpose of calculation but first and foremost in support of convincing arguments for companies. By clarifying costs companies could have economic reasons to invest in the improvement of working conditions. Dorman points out that costs can only serve as arguments for the improvement of safety and health conditions, if they are internal, routinely visible ('direct'), variable, and economic ('tangible') (Dorman, 2000a). Table 14 provides an overview of the cost categories and the significance for decision-makers.

Table 14 - Cost categories and their significance as incentives

Distinction	Criteria	Significance
internal/external	whether the cost is paid by the economic unit that generates it	determines the gap between the economic incentive to the individual decision-maker and the corresponding incentive to society
direct/indirect or visible/invisible	whether the cost is measured and allocated through routine accounting methods	determines whether the decisionmaker will perceive the economic incentives that actually exist
fixed/variable	whether the cost remains constant despite changes in the incidence and severity of injuries and illnesses	determines the economic incentive for an individual decision-maker to take measures to reduce incidence or severity rates
economic/noneconomic	whether the cost takes the form of damage to goods or services that have or can be given prices	determines the economic case for intervention, apart from the ethical and public health case

Source: *Dorman, 2000a*

2.4.3 Conclusions

In describing the concept of costs of accidents at work and work-related ill-health, several definitions have been formulated but most agree that it comes down to estimating the costs of the harmful effects of accidents at work and work-related ill-health. However, the effects or consequences of accidents at work and work-related ill-health are not always straightforward and easy to identify. This has to do with the fact that the causal link between the accident/case of ill-health and the effect is not always clear. The effects do not all occur at the same time or in the same place. Since estimating the costs of effects is the main issue of calculating costs, the methods and tools should focus on these effects. Identifying the effects of accidents at work and work-related ill-health should be an integral part of methods and tools that are made available to companies.

Theories on cost categories can be found throughout the literature, especially in the literature concerning the costs of accidents at work. The aim of dividing the costs into these categories was mainly to provide insight in the impact of these costs on business. Dividing the costs into external and internal costs shows that not all costs are borne by whoever is responsible for the costs. Companies externalise part of their costs onto society. Techniques exist to shift some of these costs back to the companies. Policy makers can make use of these techniques as an economic incentive. An example of such a cost shifting technique is the differentiation of insurance premiums. And although cost shifting and economic incentives can contribute to the awareness raising of companies and the implementation of prevention measures, the technique has its limits. It is not possible to bring all costs back to the companies.

A distinction between direct and indirect costs (or insured/uninsured costs) points to the fact that not all costs are visible. Some of the costs are obvious and can be directly linked to the accident or the case of work-related ill-health. Others however are hidden. Often uninsured costs are the ones that are hidden from company management. This is why the cost categories direct versus indirect and insured versus uninsured are based on a similar concept. The underlying idea of this concept emphasizes the importance of making the hidden costs visible for company decision-making. Ratios between direct and indirect costs are easy to understand and to put into practice. Nevertheless it became clear that it is

impossible to define single ratios. The Heinrich ratio of 1:4 for instance cannot be applied to all accidents or in all sectors. This lack of credibility undermines the power of the economic argument.

Fixed and variable costs emphasise the fact that a lot of costs vary with the incidence of cases of accidents at work and work-related ill-health. Only variable costs can serve as an incentive. In practice, costs related to accidents at work and work-related ill-health do not appear in variable costs but are hidden among overhead cost and are thus included in the fixed costs.

Tangible and intangible costs refer to the fact that some consequences of accidents at work and work-related ill-health cannot be valued in monetary units. Often they refer to qualitative aspects such as staff morale, corporate image and customer relations.

The theoretical background of studies on costs show that the basic definitions clearly identify the concept of costs of accidents at work and work-related ill-health. It is about identifying and valuing the harmful effects of accidents at work and work-related ill-health and the identification of these costs at company level. The splitting of costs into categories in order to get an easily understandable argument to promote occupational safety and health did not lead to the desired result. The efforts of researchers in this respect led to discussions on what costs belong in which category. Furthermore, it resulted into a search for a universal ratio between the different categories. Thus, the essence was ignored. It is important to identify the costs at company level and present them in a way that they can be related to the company's bottom line. This can only be achieved by applying methods and techniques that are familiar to management and situated in the business context.

2.5 Calculating costs of accidents at work and work-related ill-health on company level

The goal of calculating the costs of accidents at work and work-related ill-health is to show that investing in occupational safety and health makes good business sense. Therefore, it must be looked upon as a management issue with an added value on company management practices (2.5.1). However the available methods are not always developed on management level (2.5.3) and the calculation of these costs presents several difficulties and problems (2.5.2).

2.5.1 The added value of calculating costs

The studies and theories on costs of accidents at work and work-related ill-health seem rather unanimous about the ultimate goal: increase awareness at management level in order to stimulate preventive actions and decrease accidents and diseases. Accident costs will motivate accident prevention (Aaltonen et al., 1996).

Using the language of costs is an attempt to speak the language of management and make the safety and health message appealing. According to Labelle the safety and health department of a company has to align its goals with the goals of business. This means that since companies are in business to maximise profit one way to support profit maximization is loss minimisation. To best align its goals the safety department must determine how much its profits return to the company and how much losses cost the organisation (Labelle, 2000). Williams states that only what can be measured, can be controlled. Accident costing is a useful means of measuring and therefore, controlling and ultimately improving health and safety (Williams, 1998).

Bird already pointed to the fact that it is essential not only to reveal the costs of injuries but also of material losses that can be attributed to industrial accidents. It is important to link all of these costs to

the departments responsible as well as to the ledgers in the accounting system as to determine how much money can be saved by prevention (Bird and Germain, 1966).

The question however remains if an insight in the costs of accidents at work and work-related ill-health would make a motivating factor to encourage investments in health and safety at work. According to a study from the Health and Safety Executive (UK) the information on costs and benefits of health and safety at work is not the main motivating factor. Other factors such as the fear of loss of corporate credibility and a belief that it is necessary and morally correct to comply with health and safety regulations seem more important. Furthermore, the researchers state that the perception that health and safety improvements are a cost rather than an investment is a significant demotivating factor among management. Based on this finding, the researchers concluded that there is a need to demonstrate the commercial benefits of health and safety improvements in order to, at least, neutralise cost concerns (HSE, 1998).

A 2005 study partially confirms these findings stating that the avoidance or reduction of accident and work-related ill-health costs per se does not appear to be the primary motivating factor for effective health and safety management. The motivation relies more on a combination of interlinking factors that might ultimately have an impact on the financial performance. The authors did however find that demonstrating the financial impact of health and safety failures could form a lever for change. At the same time the problem seems to be that companies have very limited knowledge about the costs of accidents at work and work-related ill-health. Providing organisations with guidance on how to collect meaningful cost data would be beneficial (Haefeli et al., 2005).

2.5.2 Difficulties and methodological problems

Calculating the costs of accidents at work and work-related ill-health presents difficulties and methodological problems. The main difficulty is the fact that although calculating the costs of accidents at work and work-related ill-health brings added value for businesses, most managers don't make these kind of assessments. The barriers to put calculation into practice are manifold (2.5.2.1). Since the methods try to put cost estimates to the consequences of accidents at work and work-related ill-health, the main difficulty lies in identifying these consequences (2.5.2.2). Also the fact that the costs refer to human resources and quality (of life) aspects brings about specific accountancy problems (2.5.2.3 and 2.5.2.4).

2.5.2.1 The barriers to calculate costs

Although information on costs contributes to an improved health and safety management, most organisations have a limited notion of these costs. They simply don't calculate. Limited time and resources, perceived complexity and lack of expertise are the most cited barriers to conducting accidents at work and work-related ill-health cost assessments (Haefeli et al., 2005).

Dorman quotes five main reasons for the fact that companies refrain from calculating costs of accidents:

- measurement problems: measuring these costs can be difficult and expensive because it takes time to sort out the ripple effects, assign prices to them, etc. and the firm may not have the trained staff this task requires;
- management overload: the attention of managers is often fully taken up by existing proposals and reports, leaving little surplus attention to devote to the complex issue of safety and health costs;
- biases in accounting methods: standard accounting procedures are less able to accommodate human resources than traditional assets;
- low status for (or nonexistence of) OSH departments: too often OSH has a low status with little claim on resources or input into the strategic level of management;

- “don’t ask, don’t tell”: in some firms there is a conspiracy of silence surrounding working conditions.

Managers may fear that simply recording the true financial impact of injuries and illnesses may stir up the workforce and lead to more demands from unions or similar groups. (Dorman, 2000a).

Another problem is linked to the fact that it is not always possible to separate health and safety costs from production and personnel costs. An attempt to give accurate information to management about the underlying costs of a poor work environment might only lead to either a lack of information or to a huge flow (Ministry of social affairs and health, 1999). Few companies tend to monitor their costs relating to accidents at work and work-related ill-health which leads to the fact that the economic importance of working conditions is usually underestimated (Bjurström, 2009).

2.5.2.2 Consequences of accidents and work-related ill-health

Identifying costs of accidents at work and work-related ill-health is closely related to identifying consequences of these accidents at work and work-related ill-health. It aims to identify various harmful effects that cause suffering and costs (Aaltonen et al., 1996). The process of identifying the consequences is important because it influences the reliability of the results. If consequences have been identified wrongly, the costs of accidents are easily underestimated (Brody et al., 1990b; Aaltonen et al., 1996).

The same is true for the problem of not identifying all consequences. A lot of studies seem to only consider a subset of costs and consequences (Tompa et al., 2007). The identification of consequences of accidents at work and work-related ill-health remains very difficult since the causal relationship is not always clear and not all consequences incur at the same time or place (see also the pond model, 2.4.1.2). According to Laufer this causes important difficulties when collecting cost data. Accident costs are incurred in different time periods (e.g. immediately following the accident, later, when a replacement worker takes over, and on return of the injured worker after recovery); at different locations (e.g. at the site, in the field and in the office, at company head-office, in hospitals, in garages); and are handled by different organisations (e.g. the company, social security, and private insurance companies) (Laufer, 1987).

Researchers do not always agree on which consequence/cost must be linked to the harmful event. In some studies material damage is included while in others not. The SACA method for instance does not include these costs. This means that if e.g. a machine malfunctions and causes an accident then the replacement or repair costs of that machine are not included. The underlying view is that these costs do not arise because of the accident itself but are related to machine or plant maintenance (Rikhardsson, 2003).

The need of making a thorough consequence analysis in order to obtain reliable results, sometimes leads to the fact that methods use long checklists in which all possible consequences of an accident are taken into account. However, from the companies’ point of view it is more important to concentrate on consequences that are more significant and easier to assess, than trying to calculate an accident cost as exact as possible (as high a possible) (ILO, 2002).

2.5.2.3 The nature of costs of accidents at work and work-related ill-health

The difficulty to determine the harmful consequences of accidents at work and work-related ill-health is not the only problem. Other difficulties are linked to the questions

- if a consequence occurs, does it really bring about a cost?
- and if so, how can the cost be calculated?

An example to illustrate the first question – does the harmful effect really lead to a cost – is the problem that some authors have whether or not to calculate administration time. It is clear that if an accident at work or a case of work-related ill-health occurs, administrative personnel will have to deal with the consequences. They will be involved in the administrative follow-up of an accident or the period of absenteeism. Some authors (Simonds and Grimaldi, 1963; Leopold and Leonard, 1987) consider administrative time costs to be annual charges, incurred irrespective of the number of accidents and therefore a fixed direct cost not to be attributed as a variable to any specific accident.

Brody et al. argue that this viewpoint is untenable since it assumes that the time use, opportunity cost of such professionals is zero. According to him it is more accurate to recognize that they normally carry out productive work and that the time spent on a particular case (during or after the event) is an additional cost to the firm equivalent to the value of the unexecuted duties (Brody et al., 1990b).

The difficulty brought about by the second question – how to calculate – has a lot of different aspects but the main difficulty can be traced back to the problems with human resources accounting: accounting systems are weak in most aspects of human resources. For instance, the cost of training a worker will be accounted for but the added value of a trained worker will not appear in the books of the company. According to Dorman, this is due to the fact that labour is not fully a commodity. Machines can be owned, rented and sold. Improvements or deterioration are capitalized into their market value. This is not the case for workers. The worker is not an asset. Accounting systems simply cannot allocate all costs related to it (Dorman, 2000b).

Labour cost is also highly depending on the circumstances and factors such as the labour market and the production system. The labour cost of a worker working in a team might be different from the labour cost of the worker in a more traditional production system. For instance, in the traditional system a worker being absent costs the enterprise the value of his or her wage plus the extra costs for this idle workstation. If the same work is being done in a team, if one worker is unexpectedly absent, it interferes with the productivity of every other worker in the team. To calculate costs in this situation, in addition to the cost of the absent worker's wage, also the lost production of everyone else has to be taken into account (ILO, 2002).

Berger et al. also point out the fact that specific characteristics of firms and markets determine whether the costs of work loss will be large or small and how these costs will be distributed between the employer and employee. For a firm that has a production unit based on team performance the impact on output of a worker's absence on the output will be quite different between a firm with a production unit based on individual performance. The same holds true if there is a large dependence on firm-specific human capital (e.g. knowledge workers) versus a small dependence. Another important characteristic is whether the job function is labour intensive or capital intensive or a combination. Valuation of work loss also depends on how work loss affects the flow of output. In a company that has small inventory costs or small costs associated with variations of output, valuation of work loss will be different than in a company having large inventory costs or incurring large costs when output falls short of the expected or desired level (Berger et al., 2001). Figure 15 shows examples of firms along these characteristics.

Figure 15 - Dimensions of a firm's characteristics that affect the valuation of costs

		Small inventory costs or small costs associated with variations in output		Large inventory costs or large costs associated with variations in output	
		Labour Intensive	Capital Intensive	Labour Intensive	Capital Intensive
<i>Individual production & little firm specific human capital</i>		<ul style="list-style-type: none"> ▪ claims processing ▪ telemarket 	<ul style="list-style-type: none"> ▪ telephone & cable installation and repair 	<ul style="list-style-type: none"> ▪ reservation agents ▪ stock brokers ▪ retail sales people 	<ul style="list-style-type: none"> ▪ truck drivers
	<i>Team production &/or firm specific human capital</i>	<ul style="list-style-type: none"> ▪ R & D of new products ▪ sales people (scheduled calls) 	<ul style="list-style-type: none"> ▪ manufacturing of durable goods e.g. airplanes 	<ul style="list-style-type: none"> ▪ law, consulting ▪ patient care ▪ hotels ▪ customer supprt 	<ul style="list-style-type: none"> ▪ airlines ▪ construction ▪ overnight delivery ▪ hospital surgery

Source: Berger et al., 2001

Labour market aspects but also the way a company organises its human resources influence costs. Companies tend to have spare capacity to deal with disruptions in production due to absenteeism. This obviously means that an absent worker does not necessarily lead to higher costs. Some researchers have attempted to overcome this methodological problem by proposing other methods that focus on labour capacity. Koopmanschap et al. describe four different situations that can be identified when a worker gets ill and is absent from work (see box 9).

Box 9 - Possible outcomes for a firm's production and costs (assuming some form of social insurance for absence)

<p>(1) Both the level of production and costs are unaffected. This situation may occur if work can be made up for the sick employee on his return to work or if internal labour reserves exist, allowing work to be taken over by colleagues without extra costs. The opportunity costs of internal labour reserves depend on the probability for the internal labour reserve to be gainfully employed elsewhere. If unemployment is well above the level of frictional unemployment, these costs are very low. However, the existence of permanent internal labour reserves raises labour costs, which may have medium-term macro-economic implications.</p> <p>(2) Production remains unchanged, but at higher costs, due to colleagues working overtime or hiring temporary workers, from a firm's own pool or from temporary agencies. In both cases the extra costs of maintaining production tend to be somewhat higher than average labour costs, as a result of higher wages paid for working overtime (reflecting the opportunity costs of leisure time) or the extra costs of using temporary agencies.</p> <p>(3) Production falls, while costs remain unchanged. The value of production lost is the relevant outcome.</p> <p>(4) Production falls, despite higher costs. The consequences are a mix of production loss and extra costs of permanent or temporary employees, which may be higher (or lower, although this is not to be expected) than the value of production of the sick employee.</p> <p>In case of Situation 1, zero costs are incurred in the short run, whereas the medium-term consequences need to be analyzed, see below. Concerning the other three possible situations, the sum of production loss and extra costs varies from case to case, but on average it may well be approximated by the productive value of the sick employee during the period of absenteeism.</p>
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Source: Koopmanschap et al., 1995

2.5.2.4 Valuing the consequences of accidents and ill-health

Valuing the consequences of accidents at work and work-related ill-health proves to be very difficult. Most authors cite this problem and make a distinction between costs that are readily apparent and others that are more difficult to quantify. However, to make costs assessments it remains important to put monetary values to cost variables. For some variables market prices are available or can be derived. For other variables techniques exist to put a price on the variable. But, for some variables no

pricing techniques exist and they only can be considered as non-monetary values. An example of such a variable is the reduction of job satisfaction due do accidents at work or work-related ill-health (Mossink and De Greef, 2002; Zangemeister, 2000). Table 15 gives an overview of cost variables and how a monetary value can be obtained.

Table 15 - Cost variables and how to obtain monetary value

Variable	Description	How to obtain monetary 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
Non-health related costs and damages		
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)	Total production value
Opportunity costs	Orders lost or gained	Estimated production value, representing lost income for the company
Lack of return on investment	Non-realised profit because of accident costs	Interests of the expenditure amount, invested during x years, with an interest rate of y %

Source: Mossink and De Greef, 2002

2.5.3 Methods and approaches to calculate costs

According to Rikhardsson studies that assess the costs of accidents at work and work-related ill-health should be considered as consequence studies. They evaluate the consequences of negative health and safety effects such as occupational accidents. Rikhardsson classifies consequence studies into two different approaches. The first approach is the insurance-based approach and the second is the activity based approach (Rikhardsson, 2005).

For the overview of the methods below, these two approaches serve as a broad classification, adding to it a third category: labour capacity based approach.

2.5.3.1 Insurance based approach

Methods that are based on this approach make a distinction between hidden and visible health and safety costs and usually apply insurance criteria to do so (Rikhardsson, 2005). Oxenburgh and Marlow state that since insurance costing models are based on easily obtained workers compensation insurance information they have the advantage of simplicity. They are however limited (Oxenburgh and Marlow, 2005). Costs are analysed in an insurance perspective and there is a lot of weight on what costs are refunded and what costs are not. Often the methods use predefined cost categories that require some knowledge about insurance issues (Rikhardsson, 2005).

Most of the studies that try to establish a ratio between direct and indirect costs or between insured and uninsured costs in Heinrichs tradition belong to this category. As explained earlier (see 2.4.2.2) these studies did not result in a consistent ratio that can be applied to all cases due to differences in definitions and cost categories but also in industry and social security system.

These studies are not focussed on providing a practical method for companies. The aim is to give an insight in costs of accidents at work and work-related ill-health by calculating a ratio. This ratio could than be applied by businesses to get an idea of costs. The method used to determine this ratio is therefore neither usable nor practical in companies. Often a predefined categorisation of costs or secondary evidence - such as insurance statistics - are used. This leads to the potential risk of cost categories being overlooked if they are not explicitly registered in the accounting systems (Rikhardsson, 2003).

2.5.3.2 Activity based approach

An even greater difficulty with the insurance-based methods is the fact that the results have a limited value for managers (Rikhardsson, 2005). Laufer for instance used a method based on insured/uninsured costs but concluded that it would be better to distinguish controllable and uncontrollable costs. This distinction is easier to understand by management and more action oriented (Laufer, 1987).

This is why the activity based approach has its focus on management and on how management can use measurements of health and safety costs in their decision making to help to ultimately avoid these costs. The focus lies on tools and techniques that can be applied by management. The cost analysis is based upon documenting all the activities that the event in question has led to and then evaluating the costs of these activities (Rikhardsson, 2005). Activity-based costing can enhance the visibility of the costs related to health and safety and thus increase the insight for decision-makers (Grant et al., 2003).

Examples of this activity-based approach are:

- Calculating the cost of occupational accidents
- The Accident Consequence Tree Method (ACT)

- The Systematic Accident Cost Analysis Methodology (SACA)
- The Matrix

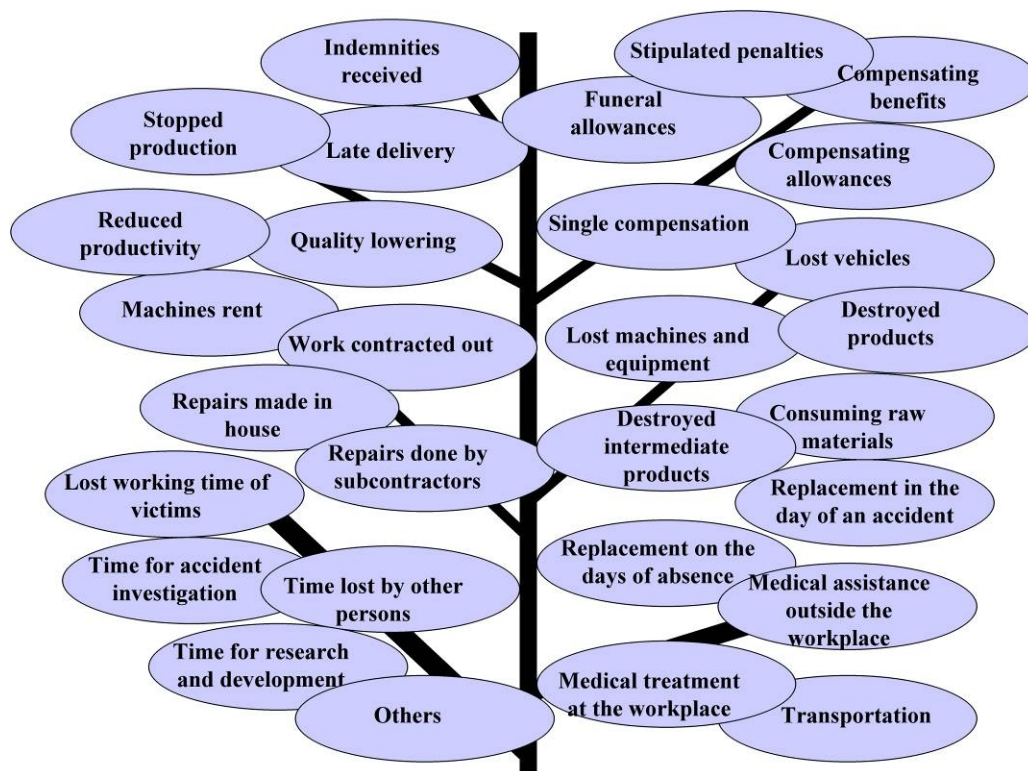
Calculating the cost of occupational accidents

The method proposed by Pawlowska and Rzepecki is based on the assumption that costs can be grouped into those that are controlled and those that are not controlled by the company (cfr. the distinction made by Laufer, 1987). The controlled costs include all of the costs items that the company is able to control. An insight in controlled costs is valuable for management. Since these costs can be controlled and thus also limited by implementing preventive measures, they can provide incentives to effectively manage the issues related to occupational safety and health.

The main cost items used in the method are:

- Lost working time;
- Current liabilities;
- Lost fixed and current assets;
- Lost revenues;
- Income for e.g. the compensation or indemnity payments.

Figure 16 - Cost items



Source: Pawlowska and Rzepecki, 1997

Based on a study in 25 companies with different production profiles, 48 cost items that could be grouped into these main cost items were defined (see figure 16). To provide a practical tool for companies to collect and register the cost data in a structured way a form was developed. The form was then tested in several companies from different branches. The results showed that although the actual cost data might differ from company to company or even from branch to branch, the method is useful in offering companies the possibility to obtain an insight in the costs of accidents at work (Pawlowska and Rzepecki, 1997).

The Accident Consequence Tree method

The Accident Consequence Tree method (ACT) was developed in Finland on company level and later also on the level of the national economy and on the individual level (Aaltonen et al., 1996). The principle of the ACT is based on the fault tree method. The fault tree method (e.g. MORT) is used to describe the cause and effect relationships involved in faults and mistakes. The ACT method uses the same principles by applying them to the map of the consequences of accidents that already happened.

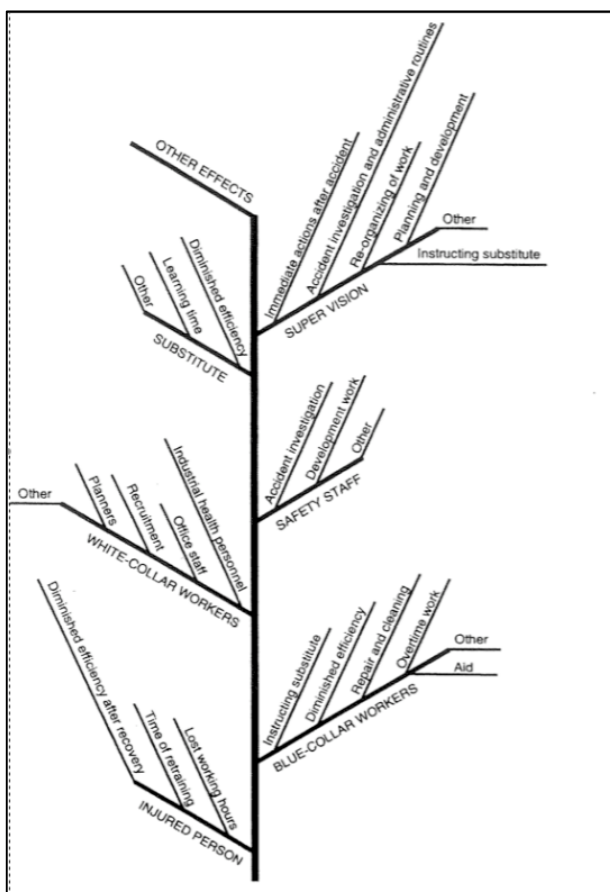
The classification of consequences in the tree has been chosen so that it supports the calculation of accident costs in particular and that it is based on the normal accounting of companies. The main branches of the ACT are equal to the main cost items and they are divided hierarchically into more detailed branches as far as feasible. The branches are not in chronological order since consequences occur in various situations, sometimes even at the same time (Aaltonen et al., 1996).

There are 6 main categories used in the ACT method to classify consequences of e.g. occupational accidents. These are:

1. Lost working time that includes e.g. sick pay to the injured worked for which the company gets no work value in return, lost working time due to production disturbances etc.
2. Loss of short-term assets: loss of e.g. raw materials and products because of the event
3. Loss of long-term assets: includes loss of e.g. machines or tools because of the event
4. Diverse short-term costs such as costs of transport, consultants and fines
5. Lost income such as lost contracts or price reductions
6. Income such as reimbursements from insurance companies
7. Other costs such as changes in insurance premiums

Figure 17 shows an example of an ACT for lost working time.

Figure 17 - Accident Consequence Tree: example for lost working time



Source: Aaltonen et al., 1996

The ACT method occurs in real time: the registrations and costs are made immediately after the accident occurs. The ACT method was applied in 18 Finnish furniture factories of different sizes and production types. The foremen registered the data. The researchers interviewed the foremen and injured workers. On the average 20 consequences per accident could be identified (Aaltonen et al., 1996).

Systematic accident costs analysis

The Systematic Accident Costs Analysis (SACA) is a method developed by the Aarhus School of Business and consultants from PricewaterhouseCoopers (Denmark). The SACA process comprises three main phases. In the first phase the activities following the accident are identified. This includes activities directly related to the accident e.g. first aid as well as more indirectly related activities such as production disturbances to other departments. In the second phase the costs of these activities are identified. The calculation of costs includes identifying man-hours and average wages as well as calculation of lost production capacity. In the third phase the feasibility of possible integration of accident cost calculations in the accounting information system of the company is explored.

The basis for the SACA method is activity mapping: company costs are considered as being caused by the activities of employees and managers. The cost categories of the SACA method are

- time: hours used by employees and management
- materials and components: costs of any materials and components acquired or lost due to the accident
- external services: costs of external services obtained due to the accident (e.g. temporary replacement)
- other costs

Box 10 - The Systematic Accident Costs Analysis (SACA) – A study summary

Within the SACA project a study was carried out involving 9 Danish companies. In each company 3 different types of accidents were chosen and analysed in depth. The accidents were chosen as representative of either serious accidents, less serious accidents or company typical accidents. The basic cost categories used in the SACA project include the costs of employee and management time, acquisitions of materials and components, purchases of external services and other costs such as fines. With regard to employee and management time this includes both time used to do the activities arising because of an accident as well as possible loss of working hours due to reduced efficiency for example.

The analysis of the 27 occupational accidents resulted in the identification of 30 activity types which can be categorised as 6 activity groups. The 6 activity groups are listed below along with the average distribution of the total accident costs. These percentages illustrate the average distribution of costs for an average occupational accident within these companies.

1. Absence of the injured party (on average 65% of total cost of an occupational accident)
2. Communication of information (on average 4% of total cost of an occupational accident)
3. Administration and follow up (on average 13% of total cost of an occupational accident)
4. Prevention measures (on average 3% of total cost of an occupational accident)
5. Production loss (on average 14% of total cost of an occupational accident)
6. Others (on average 1% of total costs of an occupational accident).

Source: Rikhardsson et al., 2002

Matrix

This method has been developed by Prevent in collaboration with the occupational accidents insurance organisations in Belgium (De Greef and Van den Broek, 2006). The method is based on field research. It has been tested in several cases on company level.

This technique uses on the one hand elements that are commonly used in the field of OSH and on the other hand elements from the accountancy practice. This offers the advantage of a technique that is familiar to OSH practitioners but offers results that can be related to management practice (accountancy). The Matrix distinguishes cost categories and cost centres. For the cost centres a categorisation is used based on HEEPO. HEEPO stands for Human factor, Equipment, Environment, Product, Organisation. This categorisation allows inventorying costs related to the impact of the accident/case of ill health. In fact, every accident/case of ill health has an impact on the human factor (e.g. absence of the victim), the organisation (e.g. re-organisation of the work) and might also have an impact on the environment (e.g. spills), on the product (e.g. damaged goods) and on the equipment (e.g. damaged equipment). Clustered into cost categories and cost centres, the costs can be presented in a matrix (table 16).

Table 16 - The Matrix

		cost categories				
		1 goods	2 services	3 staff	4 depreciation	
cost centres	A human factor	X_{A1}	X_{A2}	X_{A3}	X_{A4}	$\sum_{i=1}^{i=4} X_{Ai}$
	B equipment	X_{B1}	X_{B2}	X_{B3}	X_{B4}	$\sum_{i=1}^{i=4} X_{Bi}$
	C organisation	X_{C1}	X_{C2}	X_{C3}	X_{C4}	$\sum_{i=1}^{i=4} X_{Ci}$
	D product	X_{D1}	X_{D2}	X_{D3}	X_{D4}	$\sum_{j=1}^{j=4} X_{Dj}$
	E environment	X_{E1}	X_{E2}	X_{E3}	X_{E4}	$\sum_{j=1}^{j=4} X_{Ej}$
		$\sum_{j=A}^{j=E} X_{1j}$	$\sum_{j=A}^{j=E} X_{2j}$	$\sum_{j=A}^{j=E} X_{4j}$	$\sum_{j=A}^{j=E} X_{4j}$	$\sum_{j=A}^{j=E} \sum_{i=1}^{i=4} X_{ij}$

Source: De Greef and Van den Broek, 2006

The categorisation of the cost categories is based on the principles of cost accounting (accountancy). The costs are related to two main categories: operating costs (goods, services, staff) and depreciation. By relating every cost to a cost centre and a cost category a matrix can be build up (table 16). The total sum is the sum of all costs.

The Matrix uses a checklist to facilitate the practical use and to get an overview of the costs (see also 4.1).

2.5.3.3 Labour capacity based approach

Labour capacity based approaches have in common that they recognize the fact that absenteeism and lost production time do not immediately lead to production losses or higher costs. This is due to production buffers (both in human resources as in stocks) that are present in most companies. However, it is important to use methods that, in spite of these production buffers, reveal the impact of absenteeism and lost production time.

Examples of this approach are:

- The spare capacity method
- The friction method
- The uninterrupted working hours

The spare capacity method

Rundmo and Söderqvist developed the spare capacity method. They studied 39 furniture-manufacturing firms in Norway and Sweden. The authors compared a market pricing method with the spare-capacity method. A market-pricing method uses price estimates to assess costs. Such price estimates are for instance hourly wages for lost working time, costs of damaged machinery, etc. This method can be a good approximation only when there is no unemployment in the industry and when the market is not dominated by monopoly pricing (Rundmo and Söderqvist, 1994).

The spare capacity method is based on the fact that the capacity of the labour force is not fully utilized. This creates a buffer to deal with unexpected disruptions. According to the spare-capacity method the inclusion of redundant workers to guard against losses of production and revenues should be considered as a cost of loss prevention. Therefore, the method estimates the costs of such redundancy in the labour force. The study showed that the spare-capacity model is more suited to reveal the costs. Larsson and Betts argue that although the spare-capacity method deals with some difficulties of other methods, it is not an easy solution. The researchers investigated cases in 14 small and large Australian companies. The spare-capacity method presupposes a fairly rigid labour market structure that makes it difficult to apply to a range of company sizes and types. Small companies might for instance look to flexible, slim, low-cost, and sometimes even unofficial solutions when dealing with unplanned absences (Larsson and Betts, 1996).

Friction method

Koopmanschap et al. (see also 2.5.2.2) developed the friction method. The basic idea of the method is that the amount of production losses due to disease depends on the time-span organisations need to restore the initial production level. The method assumes that if unemployment, registered and hidden, is beyond the level of frictional unemployment, sick employees can be replaced, after a period necessary for adaptation. Frictional unemployment is an inevitable part of unemployment, since filling vacancies takes time and some qualitative discrepancies between labour demand and supply always prevail. Production losses are assumed to be confined to the period needed to replace a sick worker: the friction period. The length of the "friction period" - how soon the new employee is at work - varies according to the labour market situation (unemployment) and the education needed for the job. The general rule is that the higher the qualifications, the longer the friction period.

The friction period method was criticised by Johanneson and Karlsson (1997). They stated that the method does not provide correct estimates of costs of absence. The costs are reduced to the period that it takes to replace a worker (Johanneson and Karlsson, 1997).

Costs per uninterrupted working hour

The method of calculating costs per uninterrupted working hour goes beyond the concept of calculating the costs of accidents at work and work-related ill-health. It broadens the perspective to company performance. The method is based on the idea that uninterrupted business operations form the basis of successful management. The cost of a corporate health and safety system can be seen in the light of the number of uninterrupted working hours. The economic advantage of health and safety measures lies in the high availability of the production process. This advantage can be measured indirectly by means of the number of uninterrupted working hours. By dividing the costs of the occupational safety and health system by the number of uninterrupted working hours, an efficiency indicator can be calculated (Lehmann and Thiehoff, 1997).

Health and safety costs per un-interrupted working hour	=	$\frac{\text{Costs of the health and safety system}}{\text{Number of uninterrupted working hours}}$
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The method also allows a company to improve itself (comparison between periods) or to compare itself with other companies (e.g. in the same sector). It is also possible to compare several sectors (box 11).

Box 11 - Costs of uninterrupted working hours in Germany

The costs per uninterrupted working hour depend on the type of production. In Germany, the costs per uninterrupted working hour are on average, €0.20 per hour. This is approximately 1% of the average labour costs in Germany. This means that German employers pay on average 1% of their labour costs for health and safety at work measures.

Source: Krüger and Meis, 1991

2.5.4 Conclusions

The goal of calculating the costs of accidents at work and work-related ill-health is to show that investing in occupational safety and health makes good business sense. Therefore, calculating the costs of accidents at work and work-related ill-health can bring added value to the decision making process on company level. A company is an economic entity aimed at creating a - sustainable - profit. Linking occupational safety and health to an economic perspective should therefore be appealing for company management. In practice, companies rarely make cost assessments due to barriers such as limited resources and a lack of expertise.

There are several methodological problems linked to calculating the costs of accidents at work and work-related ill-health. Lack of data, inadequate human resources, accountancy methods and insufficient pricing techniques are examples of these problems.

Several methods exist to calculate the costs of accidents at work and work-related ill-health at company level. Insurance-based methods analyse costs from an insurance perspective and focus on what costs are refunded and what costs are not.

Activity based methods emphasize tools and techniques that can be applied by management. The cost analysis is based upon documenting all the activities caused by the accident or case of work-related ill-health and upon evaluating the costs of these activities. Examples of this activity-based approach are:

- Calculating the cost of occupational accidents
- the Accident Consequence Tree Method (ACT)

- the Systematic Accident Cost Analysis Methodology (SACA)
- the Matrix.

Labour capacity approaches have in common that they recognize the fact that absenteeism and lost production time do not immediately lead to production losses or higher costs. This is due to production buffers (both in human resources as in stocks) that are present in most companies. However, it is important to use methods that, in spite of these production buffers, reveal the impact of absenteeism and lost production time. Examples of this approach are the spare capacity method, the friction method and the uninterrupted working hours method.

2.6 From costs to benefits

Calculating the costs of accidents at work and cases of work-related ill-health may give an indication of their impact on company performance. However, it is much more interesting to know how we can effectively prevent the causes of such accidents and cases of ill-health and how much we can benefit from this prevention in monetary terms (Verbeek, 2009). This could provide a basis for putting forward a strong business case for occupational safety and health (2.6.1). Calculating the benefits from preventive measures requires adequate assessment methods such as cost-benefit analysis and although these methods are useful in assessing the economic impact of interventions, they do present methodological limitations (2.6.2).

2.6.1 The business case as a driver for OSH

2.6.1.1 OSH benefits and business arguments

Studies show that legal compliance is the most important driver for OSH on corporate level. Also ethical arguments (right thing to do) play an important role as well as some financial considerations. Labour is one of the key factors of production and so employee health is an indirect component of any organisation's production function. But, higher-level activities and resources do require a business case (Miller and Haslam, 2009). Moving beyond legal compliance requires a sound strategy on occupational safety and health tying its outcomes to the overall business outcomes. Economic analysis can help to build business cases that show how strategic investments in innovative OSH practices offer financial opportunities (Linhard, 2005; Veltri, Ramsay, 2009). A better understanding of positive effects of a good working environment can support the implementation of an effective health and safety policy at company level. Companies need to be convinced that it is worthwhile to develop their own OSH objectives and to integrate these objectives into the overall company objectives (De Greef and Van den Broek, 2004a).

A company has to be considered as an economic entity that is strongly focussed on economic benefits and costs. This means that a company will view occupational health and safety issues from this perspective (Targoutzidis, 2009). Information and perceptions about future effects of decisions concerning occupational safety and health measures, 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 (Mossink, 2002). This economic appraisal is best done on company level since it is important to measure the costs that matter for employers because that will influence their decision-making more than the total societal cost (Verbeek et al., 2009).

Research has supported the concept that there is a positive association between top management support and improved workplace safety and health outcomes. It was found that top management commitment to occupational safety and health was associated with reduced lost-time injuries and a better safety performance in general. Since financial decision makers usually focus on the financial impact of decisions providing actual financial evidence of the impact of OSH investments on company level can support safety and health professionals in their efforts to improve top-level managers' perceptions of the importance of workplace safety (Huang et al., 2009).

Although a strong business case is important for convincing management, one must not overestimate the importance of economic arguments. Frick (1997) for instance argued that the applicability of the economic arguments may be considerably less than what is often claimed. Applying economic models to a complex reality requires a cautious interpretation. Many internal stakeholders in a company are sceptical about the financial arguments that come out of economic OSH analyses (Veltri and Ramsay, 2009).

However, employers and employees are not strictly rational and economic thinking persons. Improving OSH is a social process and the use of economic arguments influences this process. It should be noted that OSH and profits remain separate goals but economic theory can give indications when improvements serve both OSH and profits (Mossink, 1997). Myers et al. argue that economics can influence decision makers, it should however be noted that the economic approach is often difficult to defend in front of an audience reluctant to accept safety messages. In that case a narrative approach integrating economic arguments works better (Myers et al., 2008).

This leads to the conclusion that the economic approach to occupational safety and health must be viewed from a broader perspective and not only focus on mere economic costs and benefits. It is important to define the business case as the (potential) value of OSH as seen from a business perspective. The objective of a business case is hence to obtain management commitment and approval for investment in business change by providing a rationale for the investment. Thus, a business case should provide argumentation to convince management to increase the use of occupational safety and health interventions at the corporate level. Thus, the OSH business case plays an important role in reporting the contribution of occupational safety and health to the organisation's strategic objectives. The link with business core activities is essential to obtain commitment and to integrate occupational safety and health into business processes (De Greef and Van den Broek, 2004b; Zwetsloot and van Scheppingen, 2007; Köper et al., 2009; Verbeek et al., 2009; Zwetsloot, 2009).

2.6.1.2 Evidence for OSH benefits

The theoretical framework (see figure 1, p. 19) offers an insight into the relationship between occupational safety and health prevention measures and programmes, the process and the outcomes. Occupational safety and health programmes generate effects and outcomes that influence company performance positively and which contribute to the company goals. Outcomes are noticeable on both organisational (less costs, improved company image, less job turnover and higher productivity) and individual level (healthier lifestyle, improved motivation and commitment).

The business arguments that can be derived from this theoretical framework are underpinned by many studies (e.g. Kuusela, 1997; Aldana, 2001; Barling et al., 2003; De Greef and Van den Broek, 2004, Ervasti and Elo, 2006; Sockoll et al., 2009; Pot and Koningsveld, 2009b) demonstrating the positive effects of investing in health and safety at work. Such investments result in business benefits as:

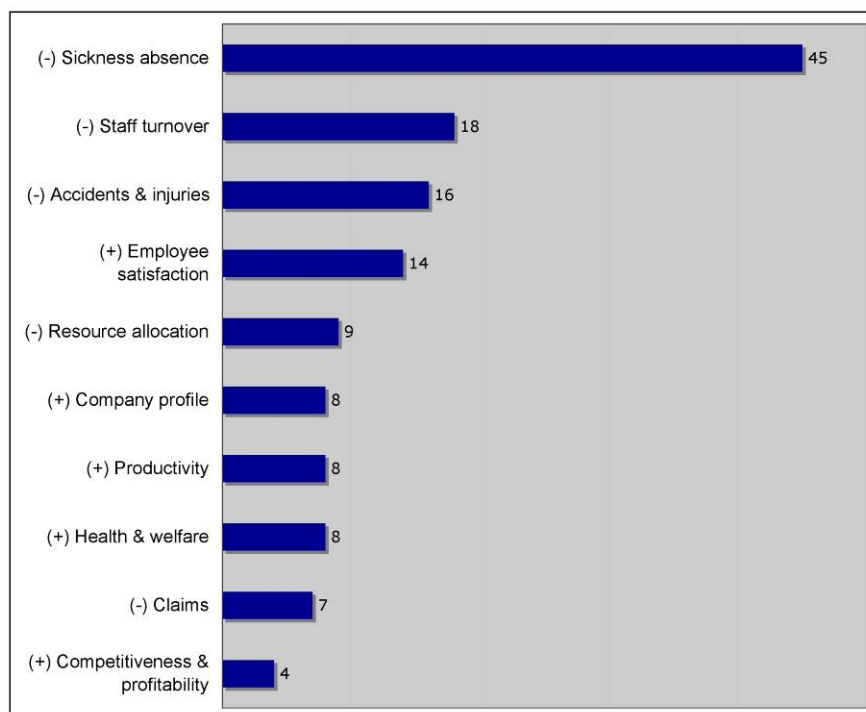
- a reduction in sickness and absenteeism rates;
- a reduction in staff turnover;
- an increase in productivity;
- an improvement in the image presented to the customers;
- keeping qualified personnel in the long term.

The IGA-report (Sockoll et al., 2009) presents the results of a comprehensive search of literature into the effectiveness and economic benefits of workplace health promotion and prevention. The study found that in the field of preventive interventions aiming at the individual, there is strong evidence that exercise programs may increase the physical activity of employees and prevent musculoskeletal disorders. For organisational and environmental interventions the evidence-base is much weaker than for individual-focused prevention approaches but this is mostly due to the lack of reliable studies (Sockoll et al., 2009).

In a recent study (Fernández-Muñiz et al., 2009) found empirical evidence of the economic advantages of adopting an adequate safety management system. The results of their study show that the more developed the system is, the better not only the safety performance, but also the competitiveness and the economic-financial performance enhances. The safety performance was related to outcomes such as injuries, material damage, absenteeism. Competitiveness performance links with elements such as the quality of products and services, customer satisfaction, reputation and image. Also, the more advanced the OSH management system, the more satisfied these organisations are with their economic and financial indicators.

Often studies focus on intermediate benefits such as absenteeism but it is clear that these benefits are linked with quantifiable financial outcomes that directly affect the bottom line. A reduction in absenteeism rates will lower personnel costs. Health and safety as well as economic efficiency thus go hand in hand. Demonstrating such intermediate business benefits such as lower accident and absenteeism rates is essential to show the impact on quantifiable financial outcomes and link occupational safety and health to economic performance. Evidence from 55 UK case studies (PriceWaterhouseCoopers, 2008) show that occupational safety and health programmes result in financial benefits, either through cost savings or additional revenue generation, as a consequence of the improvement in a wide range of intermediate business measures (figure 18).

Figure 18 - Benefits attributed to workplace health promotion programmes in the UK (scale: number of case studies, n=55)



Source: PriceWaterhouseCoopers, 2008

There is less evidence available from studies investigating the business benefits based on thorough economic assessment methods. Verbeek et al. (2009) reviewed 26 studies on occupational safety and health interventions to assess if health and productivity arguments make a good business case. Most of the studies were ex-post cases. In seven studies the profitability of the intervention was negative but for the other studies the payback period of the intervention was less than half a year.

The most promising results can be obtained if enhancing business performance forms an integral part of setting up OSH interventions. This is demonstrated by a review of eighteen cases by Koningsveld. The cases come from TNO projects (TNO Work and Employment, NL) aimed at improving prevention as well as performance. The evaluation of the qualitative effects and of the financial effects as well as is part of the projects. The reviewed cases are diverse, ranging from ergonomically designed hand tools, via assembly work, and an integral health program, to job enrichment. Seven of the eighteen cases show a return on investment in less than 1 year, while two other have a return on investment of a little more than one year (Pot and Koningsveld, 2009a).

2.6.2 Economic assessments

2.6.2.1 Overview of economic assessment methods

Economic evaluations are systematic appraisals of both the costs and consequences of an action implemented at the workplace. The objective is to make economic information available for decision-makers. Each method involves costs to be measured in monetary terms but the key difference between them lies in how health and other consequences or outcomes are measured (Hoch and Dewa, 2008).

A full economic evaluation compares the costs and consequences of two or more actions. A full economic evaluation is required to gain valid information on efficiency, how to make the best use of the available resources. The methods to conduct a full economic evaluation include cost-benefit analysis, cost-utility analysis, cost-effectiveness analysis or cost-minimization analysis. Cost-benefit analysis is the most commonly used method from an employer perspective. This method expresses all costs and consequences in the same unit, which is usually money (see 2.6.2.3).

Cost-effectiveness analysis expresses the costs and consequences in different units, for example, cost per health outcome. 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.

Cost utility analysis is similar to cost-effectiveness analysis but it introduces the notion of utility, it is the value assigned to the outcome, thus attempting to incorporate all these aspects in one dimension. This dimension (value) is usually measured in Quality Adjusted Life Years (QUALY) or Disability Adjusted Life Years (DALY) and estimated either by weighting scales or by questionnaire methodologies to a proper sample of respondents (Drummond et al. cited in Targoutzidis, 2009).

In Cost-minimization analysis the only measure of interest is the difference in cost. A cost-minimization analysis assesses which choice is cheapest (Hoch and Dewa, 2008). An overview of the methods is presented in the table below (table 17).

Table 17 - Different types of economic evaluations and their characteristics

Kind of economic evaluation	Sample result (study example)	Decision rule for selecting the programme	Advantages	Limitations
Cost-benefit analysis	Extra benefits are ΔB and extra costs are ΔC	If $\Delta B > \Delta C$	Both benefits and costs are valued in monetary units	May be difficult to obtain objective monetary values for non-monetary consequences
Cost-effectiveness analysis	Extra cost per depression free day is \$22	If there is money in the budget and if a depression free day is felt to be worth at least \$22	Outcomes are measured in natural units to facilitate understanding of health effects	Different outcomes from different programmes are not easily comparable
Cost-utility analysis	Extra cost per QALY is \$57000	If there is money in the budget and if a QALY is felt to be worth at least \$57000	QALY's make all health programmes comparable	There are many ways to estimate a QALY and different ways can yield different answers
Cost-minimization analysis	The extra cost was less than that of an alternative programme	Since ΔB is assumed = 0, select the programme if $\Delta C < 0$	Focus only on costs	Benefits must be equivalent (i.e. $\Delta B = 0$)

Source: Hoch and Dewa, 2008

2.6.2.2 Methodological issues

Assessments of occupational safety and health interventions are facing various methodological problems. The problem with evaluating the economic return of OSH programmes is that small changes in the analytical procedure, the choice of variables, and the timeframe of the analysis are some of the factors that can markedly change the results of economic evaluations (De Greef and Van den Broek, 2004b).

Tompa et al. (2008a) have reviewed the literature on economic evaluations of workplace-based interventions for occupational health and safety and have identified the methodological issues. One of the problems is that it is very difficult to establish the cause-effect relation (see also box 12). Often several measures and programmes are initiated at the same time (not only occupational safety and health initiatives but also other human resources actions), which makes it difficult to link a specific outcome to a specific measure. Tompa et al. (2008a) give examples of published studies that credit all productivity increases to the intervention, even though a new incentive payment scheme was being introduced in the organisation at the same time.

Tompa et al. (2008a) also point to the fact that most studies use a short time frame. The problem is that the observed change in OSH indicators, even if it is properly measured, may be a one-time, short-lived effect rather than a sustainable change.

Several studies, reviewed by the authors, did not consider all costs and consequences. In several cases, not all intervention costs were calculated. Even more difficult appears to be the accurate valuation of the costs and consequences. Monetary values should reflect the value of the resources used. In a research study from the German Workplace Accident Insurers, it readily appears that it often poses difficulties to put monetary values on benefits from prevention. The study examines the question whether the investments in prevention outweigh the benefits. Benefits from prevention are often qualitative aspects requiring specific pricing techniques to put them into monetary values (Kohstall, 2008).

Economic assessments such as cost-benefit analysis require a methodological approach. Tompa et al. (2008a) found in their review that OSH economic studies do not always take these into account.

- Analytical time-frame and future costs and consequences: substantial costs and consequences may occur after the measurement time period; the projection of costs and consequences beyond the period of measurement is difficult; a sensitivity analysis should be undertaken;
- Adjustment for inflation and time preference: discounting is required for both costs and consequences; for discounting, one should separate inflation from the time preference component;
- Use of assumptions and treatment of uncertainty: the assumptions should be well reasoned, their justification should be transparent, and their implications should be studied with a sensitivity analysis.

Box 12 - Advantages and limitations of Economic Analysis

Advantages

- Clarifies choices among alternatives by evaluating consequences systematically and rationally
- Makes explicit the estimates of costs and benefits and the assumptions on which they are based
- Permits the expressions of gains and losses in common monetary metric

Limitations

- Uses methods and terminology that are inappropriate or inaccurate for some type of effects
- Contains shortcomings consistent with market imperfections (e.g. imperfect information, externalities, imperfect competition, transmitted injustices or inequities)
- Omits possible uncertainty such as the fact that the relationship between exposure and disease/injury may be unknown

Source: Myers et al., 2008

2.6.2.3 Cost-benefit analysis

Cost-benefit analysis is the most common method and can be found in several case studies (e.g. Lanoie and Trottier, 1998). However, the method has also been contested. Some of the critique has to do with the fact that the method is not suited for assigning monetary values to health effects or to human life (Tudor, 1999). But it has been argued that this is only important on the level of society or on the level of individuals where loss of life enters into account. At company level however, it is not necessary to attribute a monetary value to human life, even if it sounds immoral. If a company is seen as a strictly economic entity, the monetary value of human life does not have to be considered (Rower, 2010).

More in general, the critique states that by focusing on benefits that can be found in reducing costs (e.g. lowering accidents or absenteeism rates) the qualitative aspects of occupational safety and health are highly ignored. The full OSH economic picture is more than reducing costs related to sick leave and effects on productivity are often not considered (Frick, 1999). Cost-benefit analysis can also lead to decisions opting for the interventions at the lowest costs and not so much for the most optimal investments. Low cost interventions are appealing for decision-makers (Frick, 1997). However, since the method leads to results that are straightforward and that can be directly linked to company-decision-making it can be useful. The condition being that the technique is correctly used and combined with professional OSH expertise (Frick, 1999).

2.6.3 Conclusions

Most decisions about investments in healthier and safer workplaces are taken at company level. The question arises how decision-makers in companies can be provided with the best information on the cost-effectiveness of occupational safety and health interventions (Verbeek, 2009). While presenting convincing arguments for investments in occupational safety and health (business case), there is a need to make the link with business strategy and the company's bottom line. The link with business core activities is essential to obtain commitment and to integrate occupational safety and health into business processes. The available evidence on the links between occupational safety and health and company performance is promising and in some cases even convincing, but there is still work to be done to bring research results into companies.

This emphasises the need to set-up economic assessments of occupational safety and health interventions on company level as part and in support of strategic business cases. Cost-benefit analysis is a useful assessment method since it compares benefits and costs of OSH interventions in monetary values. Obviously this method faces various methodological issues such as defining the study design, using a correct time-frame, the underlying assumptions, the discount techniques, ... These comments should not lead to the conclusion that cost-benefit analyses doesn't offer an interesting evaluation instrument. On the contrary, the challenge lies in developing a reliable approach.

3 The scoping study

The scoping study was conducted to provide selections of accidents/occupational illnesses/ill health types in relation to sectors, company sizes and appropriate prevention measures, thereby encompassing a relevant sample. It resulted in a respective list, which was used to approach related companies for the field study.

3.1 Methodology

The aim of the scoping study has been to define a framework for selecting the case studies. The challenge lay in defining a scope of case studies that are representative for a large number of companies by choosing the economic sectors and determining the risks to consider in these sectors.

The research set focus on the EU and selected member states. It has excluded commuting accidents of employees going to work or back home. However we included - besides the usual fatal accidents and accidents leading to more than three days absence - also accidents with three or less days absence, otherwise a large portion of accidents would be left out and it would have been difficult to find enough cases in a specific company.

We excluded noise because it is very difficult to differentiate between work induced and non-work induced hearing problems. In addition as disadvantages for the company may occur only very late in working life a realistic balance may be very difficult to establish. We have tried to identify a case at a later stage and discuss, as to whether it should be included in the project, but decided against it¹⁰. We also excluded health problems which can be attributed mainly to environmental causes e.g. to maintenance problems of air conditioning.

We have not considered high incidence rates in the fishing and mining and quarrying sectors (European Commission, 2009) for our selections, because the overall workforce is very small in these sectors.

We established a matrix combining the following information:

1. Relevant sectors regarding turnover and numbers of employees
2. Relevant company sizes regarding number of employees (turnover)
3. Relevant accidents (fatal, non-fatal- 3 days absence, general)
4. Relevant occupational sicknesses (acute and chronic)
5. Relevant occupational ill health
6. Related relevant hazards and risks
7. Related prevention measures
8. Related companies and cases

The study has been mainly based on the following material:

Eurostat material, e.g.

- Health and safety at work in Europe (1999-2007) – A statistical portrait, Eurostat, Inna Šteinbuka, Anne Clemenceau, Bart De Norre, August 2010.

Data from different European surveys are presented in this report, including the Labour Force Survey (LFS) (more specifically the ad hoc modules on safety and health at work), European Statistics on Accidents at Work (ESAW), European Occupational Diseases Statistics (EODS), The European Survey

¹⁰ Discussions in companies showed that costs clearly related to hearing problems can hardly be established. Often hearing problems lead to early retirements. On the other hand companies often invest higher amounts in noise prevention.

on Working Conditions (EWCS), and the European Survey of Enterprises on New and Emerging Risks (ESENER).

- Work and health in the European Union - A statistical portrait based on statistical data collected by Eurostat over the period 1994-2002.
- Eurostat's data are complemented with data from other sources, especially by data from the European Foundation for the Improvement of Living and Working conditions. The data mainly cover the 15 Member States of the EU, but some preliminary data are available for trends in the incidence of accidents at work in the acceding and candidate countries.
- Statistical analysis of socio-economic costs of accidents at work in the European Union, 2004. This study looks at accidents only but gives an estimate on work related health problems. It covers the 15 Members States of the EU before accession.
- Eurostat regional yearbook 2008

Material from the European Commission, Directorate-General for Employment, Social Affairs and Equal Opportunities:

- Causes and circumstances of accidents at work in the EU, manuscript completed in November 2008.

After the implementation of three different phases of the European Statistics on Accidents at Work, ESAW methodology, this report presents the first detailed analysis of causes and circumstances of accidents at work in the European Union. The publication consists of two parts: "Statistical analysis of ESAW Phase III data" and "Implications on preventive measures".

European Agency for Safety and Health at Work material, e.g.

- Issue 401: Monitoring the State of Occupational Safety and Health in the European Union, Agency 2000 – Pilot Study

Aims at providing decision-makers at Member State and European level with an overview of the current safety and health situation in the European Union and in this way supporting the identification of common challenges and priority areas for preventive actions. Identifies for physical exposures, postures and movement exposures, handling chemicals, psycho-social working conditions and occupational safety and health outcome for example sectors/occupations most identified to be at risk. Further, the Focal Points and their national networks provided information on trends and needs.

Member states OSH strategies, e.g.

- German GDA

Material from health and accident insurers

Discussions with experts

Wherever possible the study relied on the latest data. However where new data were not available also less recent studies were used in order to arrive at detailed suggestions. These data especially were then also discussed with specialists in order to back up findings.

3.2 Relevant sectors and company sizes

3.2.1 Relevant sectors regarding turnover and numbers of employees

In the Eurostat regional yearbook of 2008 we find sectors listed according to their shares of total employment as well as of total GVA (gross value added). Above 10% (in both aspects) we find the most important sectors for the EU-27:

1. Manufacturing
2. wholesale and retail, repair-of-vehicles-and-personal-goods
3. real-estate, renting and business-activities

Roughly between 10 and 5% we have:

1. health and social work
2. construction
3. public administration-and-defence, compulsory-social-security
4. education
5. agriculture, hunting and forestry
6. transport, storage and communication
7. other community, social-and-personal service activities
8. hotels and restaurants
9. Financial intermediation

And below 5% remain:

1. Activities of households
2. Electricity, gas and water supply
3. Mining and quarrying
4. Fishing

3.2.2 Relevant company sizes regarding turnover and numbers of employees

Micro, small and medium-sized enterprises represent 99% of all enterprises in the EU and provide around 65 million jobs¹¹ out of a total number of employees (EU-25, 2005) of 180 million.

3.2.3 Conclusions

For the resulting proposal list this study does not consider those sectors that employ less than 5% of the workforce or have less than 5% of total GVA and it only considers large industry in special cases.

¹¹ See European Commission, http://ec.europa.eu/enterprise/enterprise_policy/sme_definition/index_en.htm (retrieved 11 5 2009)

3.3 Accidents at work and work-related ill-health

In this part of the study the accidents at work and work-related ill-health are related to their numbers and their effects like sick days and severity. They are listed in descending order and related to the identified sectors and company sizes. In the last step they are related to the causes and risks leading to these accidents or diseases.

3.3.1 Fatal accidents

A fatal accident is defined as an accident that leads to the death of the victim within one year (Eurostat, 2010).

According to ESAW (European Statistics on Accidents at Work), 5580 workers in the EU27 died in a fatal accident at work in 2007 (Eurostat, 2010). Eurostat reported in 2000 that fatal accidents at work fell from 6,423 in 1994 to 5,549 in 1996 (European Agency, 2000). From 1999 to 2007 the number of fatal accidents in the EU-15 declined from 5,275 to 3,780 (Eurostat, 2010).

In 2001 there were about 4,900 fatal accidents at work (Eurostat, 2004). Most affected were:

1. Agriculture, hunting and forestry
2. Construction
3. Transport and communications
4. Electricity, gas and water supply
5. Manufacturing

This picture is quite the same regarding the 2005 data according to the DG Employment, Social Affairs and Equal Opportunities study "With more than 73% at EU-15 level, fatal accidents at work were largely concentrated in the sectors of 'agriculture', 'manufacturing', 'construction' and 'transport' [...]. Overall, 95% of fatal accidents at work occurred among men. This reflects the relatively low proportion of women in the sectors affected by the highest numbers of fatal accidents at work" (European Commission, 2009, p. 24)

Sector categories (NACE code) most at risk as identified by the European Agency for Safety and Health at Work (Agency) by a survey at their national focal points in 2000 (Agency, 2000):

- 45 Construction
- 01 Agriculture, hunting and related service activities
- 60 Land transport; transport via pipelines
- 05 Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing
- 14 Other mining and quarrying
- 28 Manufacture of fabricated metal products, except machinery and equipment
- 02 Forestry, logging and related service activities

Occupation categories (ISCO code), as above:

- 93 Labourers in mining, construction, manufacturing and transport
- 83 Drivers and mobile plant operators
- 71 Extraction and building trades workers
- 92 Agricultural, fishery and related labourers
- 72 Metal, machinery and related trades workers.

Regarding the sizes of companies, most fatal accidents occur in companies having 1-9 employees, followed by 10-49, 50-249, and 250 or more employees

Regarding age groups fatal accidents affect first of all the group of the oldest employees (55-64 years) and the other groups to a lesser extent (European Commission, 2009).

Consequences

The study from the European Commission has established the following list of injury types also in descending order (DG EMPL, 2008):

- Multiple injuries
- Bone fractures
- Other (sum of categories Amputations, Shocks, Temperature, Sound and Other specified injuries not included in others sections)
- Concussions and internal injuries
- Wounds and superficial injuries
- Drowning and asphyxiation
- Poisoning and infections
- Burns, scalds and frostbites
- Dislocations, sprains and strains

Eurostat published an analysis of costs due to accidents in 2004 and stated: “The costs of lost working time (labour cost) due to fatal accidents at work were estimated assuming a retirement age of 65 years. The 5237 fatal accidents at work were estimated to result in a cost of 3.8 billion euros (...). The number of fatal accidents at work increases importantly with age, but the total number of working years lost and therefore also the highest costs were due to fatal accidents at work among those aged 25-34 years and those aged 35-44 years. The detailed distribution of costs due to fatal accidents at work is given in tables 24 and 25 of Annex 8” (Eurostat, 2004b).

Extract:

■ F: Construction,	971 666,000 Euro
■ D: Manufacturing,	750 504,000 Euro
■ I: Transport, storage and communication	584 598,000 Euro
■ A: Agriculture, hunting and forestry	387 436,000 Euro
■ G: Wholesale and retail trade, repair...	360 331,000 Euro
■ K: Real estate, renting and business	246 621,000 Euro

Causes, risks

As type of injury the Eurostat study lists in descending order (Eurostat, 2010):

- Struck by object in motion, collision with
- Horizontal/vertical impact with/against stationary object (victim in motion)
- Trapped, crushed, etc.
- Contact with electrical voltage, temperature, hazardous substances
- Contact with sharp, pointed, rough, coarse Material Agent
- Drowned, buried, enveloped
- Physical or mental stress
- Bite, kick, etc. (animal or human)

In comparison the agency study from 2000 has established the following list also in descending order (European Agency, 2000):

- Accidents with vehicles.
- Falling/leaping from platform.
- Falling/collapsing objects.
- Slips, trips and falls.
- Traffic routes.
- Dangerous machinery.
- Entanglement/entrapment.
- Contact with Electricity.

The study also states: Accidents at work occurring at night are more often fatal than those occurring during the daytime. Handling or touching dangerous substances poses a direct risk of having accidents at work. Equipment likely to come under close scrutiny by one focal point included: cranes, elevators and forklift trucks. Consequently could be considered specifically: Work at night and handling of dangerous substances.

The German accident insurer BG ETEM (for the sectors precision engineering, electricity, electronics and media) reports on accidents among their insured companies with electricity in 2004 a number of 491 related accidents out of which 1.22% were fatal ones. The insurer regards this percentage as much too high especially when compared with usual work accidents (Jühling, 2005).

Conclusions

Summarising information of the above was entered into the summary table of chapter 3 Scoping study (Annex 3) in order to allow a better overview and comparison. Selected for the field study was the construction sector and fatal accidents through electric shock because in relation to other types of accidents the number of fatal accidents is very high. Suitable as preventive measures are: Training and instructions, Residual Current Protective Device, and SPE-PRCD, Switched Protective Earth - Portable Residual Current Device. The measures were discussed in more detail during the field study with experts.

3.3.2 Non-fatal accidents

An accident at work is defined as “a discrete occurrence in the course of work which leads to physical or mental harm”. This includes cases of acute poisoning and wilful acts of other persons, as well as accidents occurring during work but off the company’s premises, even those caused by third parties. It excludes deliberate self-inflicted injuries, accidents on the way to and from work (commuting accidents), accidents having only a medical origin and occupational diseases. The phrase “in the course of work” means whilst engaged in an occupational activity or during the time spent at work. This includes cases of road traffic accidents in the course of work (Eurostat, 2010).

According to the LFS (Labour Force Survey) ad hoc module 2007 3.2% of the persons in the EU27 of 15-64 years that worked or had worked during the past year had one or more accidents at work in the past 12 months. This percentage corresponds to 6.9 million persons in the EU27. Data from the ESAW showed that 2.9% of the workers had an accident at work with more than three days of sickness absence in 2007 and that the occurrence of non-fatal accidents with more than three days of sick leave decreased from 3.4% in 1999 to 2.5% in 2007 (Eurostat, 2010). It has to be noted that LFS considers all accidents irrespective of resulting absence from work, whereas ESAW considers only accidents with more than three days absence from work (and fatal accidents).

In a survey by the European Agency for Safety and Health at Work a number of the member states' focal points recognised that reporting of accidents at work is subject to a degree of under reporting. However, primarily accidents with a less serious consequence tend not to be reported (European Agency, 2000).

Sectors most affected in descending order were according to the LFS adhoc module 2007 (Eurostat, 2010):

- Hotels and restaurants
- Agriculture, hunting and forestry
- Health and social work
- Manufacturing
- Transport, storage and communication
- Construction
- Public administration and defense, compulsory social security
- Wholesale retail trade, repair

A comparable pattern was found in the ESAW 2007 data (EU 15 without Greece). Accidents at work with more than three days of absence occurred most often in the sectors (Eurostat, 2010):

- mining and quarrying (10.0%),
- construction (51%),
- fishing (4.1%) and
- agriculture (3.9%).

The lowest occurrence was found in

- financial intermediation (<1%),
- real estate, renting and business activities, and
- electricity, gas and water supply (both 1.7%).

Comparing the data from LFS ad hoc module 2007 and from ESAW 2009 the sectors having the highest rates of accidents with three or less days absent from work are hotels and restaurants, transport, storage and communication, and public administration and defense; compulsory social security.

In the 2005 data according to the DG Employment, Social Affairs and Equal Opportunities study (European Commission, 2009) the following sectors were identified:

"For non-fatal accidents at work, the distribution by sector was less concentrated [as opposed to fatal accidents]. The sectors of 'manufacturing', 'construction', 'trade' and 'health and social work' accounted for 66% of all accidents. Around 24% of all non-fatal accidents occurred among women. In sectors comprising a high proportion of female workers, just over half of non-fatal accidents occurred among women, as in 'health and social work' (56%).

Most accidents occur in smaller companies (10-49 employees). Workers who usually or sometimes do shift work and workers who usually or sometimes do night work have a 50-70% higher incidence of accidents at work than those who never do such work. Handling or touching dangerous substances poses a direct risk of having accidents at work. (Eurostat, 2004a)

Occupation categories (ISCO code) most at risk as identified by the European Agency for Safety and Health at Work by a survey at their national focal points in 2000 (European Agency, 2000):

- Machine operators and assemblers
- Metal, machinery and related trades workers
- Extraction and building trades workers
- Labourers in mining, construction, manufacturing and transport
- Stationary-plant and related operators

Consequences

ESAW listed in 2007 the different types of injuries suffered by the victims of occupational accidents resulting in more than three days absence from work (Eurostat, 2010):

- Wounds and superficial injuries
- Dislocations [!], sprains and strains
- Concussion and internal injuries
- Bone fractures
- Other specified injuries not included under other headings
- Burns, scalds and frostbites
- Multiple injuries
- Poisonings and infections
- Traumatic amputations (Loss of body parts)
- Shock
- Effects of sound, vibration and pressure

Eurostat published an analysis of costs due to accidents in 2004 and stated: “Accidents at work were estimated to have caused costs of 55 billion Euros in EU15 in 2000. Most of these costs (88%) were due to lost working time (labour cost). However, one must bear in mind that for accidents with permanent incapacity to work and fatal accidents at work, the questionnaire information did not allow to estimate costs other than those resulting from lost working time. From all economic activities, most costs were caused in manufacturing and construction, which also accounted for the largest number of accidents at work.” The detailed distribution of costs due to accidents at work is given in tables 20 - 23 of Annex 8 (Eurostat, 2004b).

Table 18 - Extract from table 5 of the Eurostat study ordered by costs: Number of accidents at work, costs due to lost working time (labour cost) and other costs in 2000. EU15 level results by economic activity and severity of accident (costs in 1000 Euros)

Sector		Temporary incapacity to work (< 1 year)	Permanent 100%	Permanent 15%	Fatal
D: Manufacturing	Number	2 088,472	4,177	30,077	976
	Labour costs total	3 875,844	3 667,145	3 865,855	750,504
	Other costs	1 751,342			
	Total costs	5 627,186	3 667,145	3 865,855	750,504
F: Construction	Number	1 329,307	2,659	24,797	1,279
	Labour costs total	2 830,676	2 400,200	3 243,898	971,666
	Other costs	1 131,773			
	Total costs	3 962,449	2 400,200	3 243,898	971,666
G: Wholesale and retail trade, repair...	Number	852,066	1,704	12,651	461
	Labour costs total	1 678,946	1 643,581	1 715,082	360,331
	Other costs	739,211			
	Total costs	2 418,157	1 643,581	1 715,082	360,331
I: Transport, storage and communication	Number	706,411	1,413	13,658	885
	Labour costs total	1 685,901	1 023,198	1 404,415	20,910
	Other costs	669,092			
	Total costs	2 354,994	1 023,198	1 404,415	20,910
A: Agriculture, hunting and forestry	Number	536,584	1,073	11,658	651
	Labour costs total	1 346,629	727,309	1 114,719	387,436
	Other costs	526,010			
	Total costs	1 872,639	727,309	1 114,719	387,436
K: Real estate, renting and business	Number	491,953	984	8,635	248
	Labour costs total	1 133,377	1 144,136	1 587,991	246,621
	Other costs	479,001			
	Total costs	1 612,378	1 144,136	1 587,991	246,621
O: Other community, social and personal	Number	290,778	582	4,763	147
	Labour costs total	656,119	397,179	477,149	90,060
	Other costs	274,143			
	Total costs	930,261	397,179	477,149	90,060

Source: Eurostat, 2004b

Table 19 - Extract from table 6 of the Eurostat study

Number of accidents, costs due to lost working time (labour cost) and other costs of accidents at work resulting in temporary incapacity to work. EU15 level results by duration of incapacity to work (in 1000 euros)	0-3 days	>3 days
% of acc. With other costs (Ratio1) 17.78%		
Other costs/labour costs (Ratio2) 581.59%		
Number of accidents	2 752,537	4 815,616
Labour costs total	373 663,000 €	15 335 141,000 €
Other costs	386 392,000 €	6 219 406,000 €
Total costs	760 055,000 €	21 554 547,000 €

Source: Eurostat, 2004b

Causes and circumstances

As modes of injury the Eurostat study lists in descending order (Eurostat, 2010):

- Horizontal/vertical impact with/against stationary object (victim in motion)
- Physical or mental stress
- Contact with sharp, pointed, rough, coarse Material Agent
- Struck by object in motion, collision with
- Trapped, crushed, etc.
- Contact with electrical voltage, temperature, hazardous substances
- Bite, kick, etc. (animal or human)

In comparison the agency study from 2000 has established the following list also in descending order (European Agency, 2000):

- Accidents with vehicles
- Falling/leaping from platform
- Falling/collapsing objects
- Slips, trips and falls
- Traffic routes
- Dangerous machinery
- Entanglement/entrapment
- Contact with Electricity

As causes were identified in the same study (European Agency, 2000):

- Slips, trips and falls (clearly the main cause)
- Manual handling
- Struck by moving objects
- Solid objects and articles
- Tools
- Transportation within the company
- Struck by falling objects
- Work environment and structure
- Machinery

Outsourcing of labour was said to increase the risk of accidents for two reasons. Firstly, subcontractors are not always under their employer's direct supervision. Secondly, subcontractors often service several contracts at the same time. These jobs are often of a short duration leaving little time for an individual to become familiar with the work surroundings. Such unfamiliarity can increase the chance of mistakes as well as increasing the level of mental stress (European Agency, 2000).

Conclusions

In selecting cases outsourcing, shift work and work at night should be considered; also the fact that most accidents occur in smaller companies (10-49 employees) and are connected with the handling of chemicals.

Summarising information of the above was entered into the summary table of chapter 3 Scoping study (Annex 3) in order to allow a better overview and comparison. Selected for the field study were the following sectors: manufacturing, construction, transport and health. The types of accidents (falls, slips and trips, moving objects, machinery) were selected according to the sectors. As suitable preventive measures have been suggested things like harnesses, guard rails, safety ladders, technical devices, "dry" or damp cleaning; often in combination with instruction, training and motivation. The measures were discussed in more detail during the field study with experts.

3.3.3 Occupational diseases

In a strict sense the concept of an occupational disease refers to cases for which the occupational origin has been approved by the national compensation authorities. This concept is obviously dependent on the national legislation and compensation practice, which typically restrict the compensation to cases for which the occupational factor is the only or the most important cause.

The highest proportion of occupational diseases was found in the sectors

- manufacturing (38%),
- construction (13%),
- wholesale retail trade, repair (7%), and
- health and social work (5%)

For men occupational diseases were most often found in the sectors 'manufacturing' and 'construction', whereas for women occupational diseases most often occurred in the sectors 'wholesale retail trade, repair', and 'health and social work'. The ranking in the occurrence of occupational diseases across sectors was stable over the years. However, the number of occupational diseases in the sector 'manufacturing' appeared to decrease with time, whereas the number of diseases in the other three sectors appeared to increase (Eurostat, 2010).

More than 80% of the occupational diseases occurred in workers with the following professions:

- workers in craft and related trades (41%),
- plant, machine operators, assemblers (21%), and
- workers with elementary occupations (19%).

This ranking of professions appeared to be stable between 2001 and 2007 (Eurostat, 2010).

Occupation categories (ISCO code), as identified by the Agency by a survey at their national focal points in 2000 (European Agency, 2000):

- Metal, machinery and related trades workers
- Labourers in mining, construction, manufacturing and transport
- Machine operators and assemblers
- Extraction and building trades workers
- Drivers and mobile plant operators
- Personal and protective services workers
- Other craft and related trades workers

The European Occupational Diseases Statistics (EODS) recorded the highest occurrence of recognized and newly recorded occupational diseases for the following diagnostic groups: musculoskeletal diseases, neurologic diseases, lung diseases, diseases of the sensory organs, and skin diseases (Eurostat, 2010).

Relevance, costs, severity

About 25% of recognized occupational diseases lead to permanent incapacity to work (Eurostat, 2010).

The Eurostat study (Eurostat, 2004b) did not cover non-accidental health problems. However the authors stated: "Such problems quite probably cause even more losses of working time or costs of health care. Depending on the survey such problems are estimated to cause 1.6 to 2.2 times more days of temporary incapacity to work than do accidents at work, while there are 2.4 times more people reporting long-standing health problems or disability due to work-related diseases than due to accidents at work. This indicates that work-related non-accidental health problems may cause at least two times more temporary and permanent incapacity as compared to accidents at work." This statement does not only cover recognised occupational diseases but all work related health problems.

Conclusions

Summarising information of the above was entered into the summary table of chapter 3 Scoping study (Annex 3) in order to allow a better overview and comparison. However the selections for the field study were made considering the combined recognised diseases and the work related health problems.

3.3.4 Work-related ill-health

3.3.4.1 A general overview

According to a Eurostat publication the concept of a work-related disease includes all cases of disease in the causation of which an occupational factor played some role. The concept of a work-aggravated disease includes all cases of disease which are made worse by work, whatever the original cause of the disease (Eurostat, 2004a).

In the LFS ad hoc module 2007, persons aged 15 to 64 years that work or worked previously were asked whether they suffered from one or more health problems caused or made worse by work in the past 12 months. In total, 8.6% of the respondents in the EU27 had a work-related health problem. This corresponds to approximately 23 million persons in the EU27 (Eurostat, 2010).

Whereas the accident statistics show a downward trend, the proportion of persons with a work-related health problem increased from 4.7% in 1999 to 7.1% in 2007 according to the LFS ad hoc modules (Eurostat, 2010).

Regarding the type of work related health problems, the EU LFS ad hoc module 2007 gives the following break down of the respondents regarding their most serious work related health problems (Eurostat, 2010):

- Musculoskeletal disorders ca. 60.4%
- Stress, depression or anxiety ca. 14%
- Breathing or lung problems ca. 5%
- Heart disease or attack, or other problems in the circulatory system ca. 4.9%
- Headache and/or eyestrain ca. 4.7%
- Infectious disease ca. 2.8%
- Hearing problem ca. 1.4%
- Skin problem ca. 1.4%
- Other types ca. 5.5%

Mainly affected were the following sectors (Eurostat, 2010):

- Agriculture, hunting and forestry
- Mining and quarrying
- Health and social work
- Construction
- Manufacturing
- Education
- Transport, storage and communication
- Public administration and defense; compulsory social security
- Electricity, gas and water supply
- Wholesale retail trade, repair
- Hotels and restaurants

The European Agency for Safety and Health at Work states in a survey at their national focal points in 2000 (European Agency, 2000), that 23% of all workers interviewed reported being absent from work due to occupational sickness. The occupation categories (ISCO code), were given as:

- Labourers in mining, construction, manufacturing and transport;
- Agricultural, fishery and related labourers;
- Drivers and mobile plant operators;
- Precision, handicraft, craft printing and related trades workers;
- Extraction and building trades workers;
- Personal and protective services workers;
- Teaching professionals;
- Life science and health professionals.

Small companies were commented as being more at risk because they have fewer resources available for both monitoring and implementing suitable control measures to combat occupational diseases at work.

Consequences

An estimated 350 million working days were lost during the year in the EU due to such problems. Based on the results of the EWCS a very similar estimate, 340 million days lost, was calculated for self-reported sickness absence due to non-accidental health problems caused by work in 2000. (Eurostat, 2004a)

As already mentioned above, the Eurostat study, Statistical analysis of socio-economic costs of accidents at work in the European Union (Eurostat, 2004b) did not cover non-accidental health problems. However the authors stated: "Such problems quite probably cause even more losses of working time or costs of health care. Depending on the survey such problems are estimated to cause 1.6 to 2.2 times more days of temporary incapacity to work than do accidents at work, while there are 2.4 times more people reporting long-standing health problems or disability due to work-related diseases than due to accidents at work. This indicates that work-related non-accidental health problems may cause at least two times more temporary and permanent incapacity as compared to accidents at work."

Conclusions

The following health problems will be considered for the field study: Musculoskeletal disorders, stress, depression or anxiety, breathing or lung problems, skin problems, infectious disease. The suggested sectors and diagnoses are established in the following chapters.

3.3.4.2 Musculoskeletal problems

The term musculoskeletal disorder denotes health problems of the locomotor apparatus, i.e. muscles, tendons, skeleton, cartilage, the vascular system, ligaments and nerves. Work-related musculoskeletal disorders (MSDs) include all musculoskeletal disorders that are induced or aggravated by work and the circumstances of its performance (European Agency, 2010).

The LFS ad hoc module 2007 showed that 8.6% of the respondents had a work related health problem corresponding to approximately 23 million persons in the EU 27. Out of these 61% stated that musculoskeletal problems (bone, joint or muscle) were the main work-related health problem.

In the LFS ad hoc module 2007, most workers (17%) reported exposure to difficult work postures, work movements or handling of heavy loads as the main risk factor affecting physical health, followed by exposure to the risk of an accident (10%), exposure to chemicals, dusts, fumes, smoke, or gases (8%), and exposure to noise or vibration (5%) (Eurostat, 2010).

The proportion of musculoskeletal problems related to sectors according to the LFS ad hoc module 2007 (EU 27) shows in descending order (Eurostat, 2010):

- Construction
- Wholesale retail trade, repair
- Hotels and restaurants
- Other community, social and personal service activities
- Transport, storage and communication
- Manufacturing
- Health and social work
- Real estate, renting and business activities
- Public administration and defense; compulsory social security
- Financial intermediation
- Education

When comparing data from 1999 and 2007 (9 countries) it was found that in all sectors the proportion of musculoskeletal problems had increased (Eurostat, 2010). The positive technological development, which has reduced the lifting of heavy loads, has not had the expected decrease in the number of back disorders incidents amongst workers in the highest risk groups nor for the general working population as a whole, according to the comments made in one national report. Repetition and monotony combined with working conditions such as low individual control of the work and high work-pace can also lead to an increase in the risk of musculoskeletal disorders (European Agency, 2000).

Occupation categories (ISCO code), as identified by the European Agency for Safety and Health at Work in a survey at their national focal points in 2000 (European Agency, 2000):

- Labourers in mining, construction, manufacturing and transport
- Extraction and building trades workers
- Sales and services elementary occupations
- Metal, machinery and related trades workers
- Agricultural, fishery and related labourers
- Skilled agricultural and fishery workers

In both small (< 10 persons) and larger firms, musculoskeletal health problems contributed importantly to work related health problems. Musculoskeletal health problems occurred slightly more often in small firms according to both the LFS ad hoc module 2007 and the EWCS 2005 (Eurostat, 2010).

Consequences

Besides the serious individual consequences (about one in five persons with musculoskeletal problems as the main work-related health problem faced considerable limitations) about 60% of all short term (< 1 month) and long term (at least 1 month) sickness absence in the EU27 can be attributed to musculoskeletal problems (Eurostat, 2010).

As stated in a previous Agency report¹², the true extent of MSDs costs within the workplace across Member States is difficult to assess and compare. This can be due to the different organisation of insurance systems, the lack of standardised assessment criteria and the fact that little is known of the validity of reported data. The report mentions nevertheless that certain studies have estimated the cost of work-related upper-limb musculoskeletal disorders (WRULD) at between 0.5% and 2% of the Gross National Product (GNP). More recent figures, for example from Austria, Germany or France, demonstrate an increasing impact of musculoskeletal disorders on costs. In France, for example, in 2006, MSDs have led to seven million workdays lost, about 710 million EUR of enterprises' contributions (European Agency, 2010).

Causes

There are numerous established work-related risk factors for the various types of musculoskeletal disorders. These include physical, ergonomic and psychosocial factors. According to the ESWC (Eurostat, 2004):

- 17% of European workers report being exposed to vibrations from hand tools or machinery for at least half of their working time,
- 33% are exposed to painful or tiring positions for at least half of their working time,
- 23% to carrying or moving heavy loads,
- 46% to repeated hand or arm movements and
- 31% are working with a computer at least half of their working time.

However as was mentioned above, the positive technological development, which has reduced the lifting of heavy loads, has not had the expected decrease in the number of back disorder incidents. This indicates as Hartmann and Spallek argue in an article published in 2009¹³, that physical work can have a clear positive effect on the physical health. They recommend that both too high and too low demands be avoided and that an individual optimum should be aimed for. This means that general preventive measures are not enough but individual workplace matching measures are needed.

Sector and occupation categories as identified by the European Agency for Safety and Health at Work by a survey at their national focal points in 2000 (European Agency, 2000):

Lifting/moving heavy loads, sectors most at risk:

- Construction
- Agriculture, hunting and related service activities
- Health and social work
- Manufacture of fabricated metal products, except machinery and equipment
- Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- Other mining and quarrying.

Occupation categories (ISCO code):

- Labourers in mining, construction, manufacturing and transport
- Metal, machinery and related trades workers
- Life science and health associate professionals
- Extraction and building trades workers
- Sales and services elementary occupations
- Machine operators and assemblers

¹² Work-related musculoskeletal disorders: Back to work, European Agency for Safety and Health at Work, EU-OSHA, Bilbao, 2007. Available at: <http://osha.europa.eu/en/publications/reports/7807300>

¹³ B. Hartmann, M. Spallek, Arbeitsbezogene Muskel-Skelett-Erkrankungen – Eine Gegenstandsbestimmung, in: Arbeitsmedizin Sozialmedizin Umwelt, Organ der wissenschaftlichen Gesellschaften für Arbeitsmedizin in Deutschland, Österreich und der Schweiz sowie des Verbandes Deutscher Betriebs- und Werksärzte und der Akademien für Arbeits- und Sozialmedizin, Alfons W. Gentner Verlag GmbH & Co. KG, Stuttgart, 44, 8, 2009, S. 429

Repetitive movements, sectors most at risk:

- Manufacture of food products and beverages
- Manufacture of wearing apparel; dressing and dyeing of fur
- Manufacture of textiles
- Land transport; transport via pipelines
- Manufacture of fabricated metal products, except machinery and equipment
- Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear.

Occupation categories (ISCO code):

- Machine operators and assemblers
- Labourers in mining, construction, manufacturing and transport
- Customer services clerks
- Sales and services elementary occupations
- Other craft and related trades workers

Strenuous working postures, sectors most at risk:

- Construction
- Agriculture, hunting and related service activities
- Health and social work
- Other service activities
- Manufacture of textiles
- Manufacture of food products and beverages

Occupation categories (ISCO code):

- Labourers in mining, construction, manufacturing and transport
- Renting of machinery and equipment without operator and of personal and household goods
- Metal, machinery and related trades workers
- Agricultural, fishery and related labourers
- Other craft and related trades workers
- Water transport

Vibrations, sectors most at risk:

- Construction
- Manufacture of fabricated metal products, except machinery and equipment
- Other mining and quarrying
- Land transport; transport via pipelines
- Agriculture, Hunting and related service activities
- Forestry, logging and related service activities

Occupation categories (ISCO code):

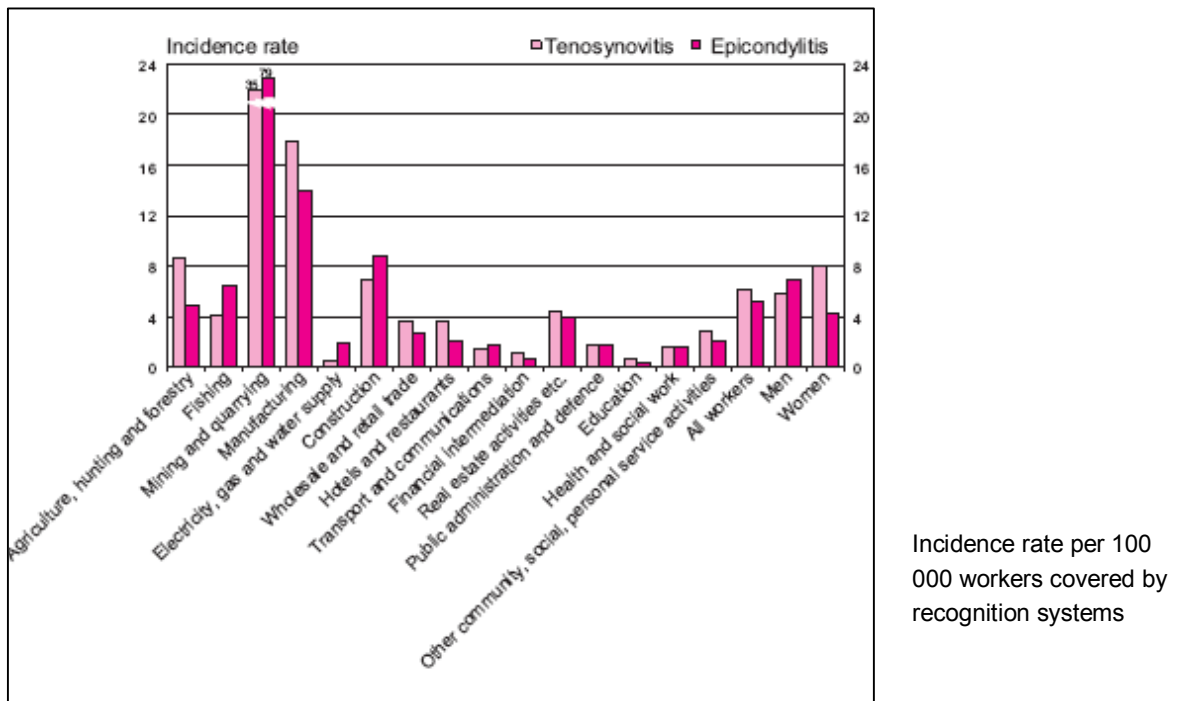
- Labourers in mining, construction, manufacturing and transport
- Extraction and building trades workers
- Drivers and mobile plant operators
- Metal, machinery and related trades workers
- Agricultural, fishery and related labourers
- Machine operators and assemblers

Recognized occupational musculoskeletal diseases

With regard to musculoskeletal diseases, the European Schedule of Occupational Diseases includes specific conditions linked to vibration, local pressure and overuse of tendons, peritendonous tissues and of tendon insertions. Whereas for example disorders of the lower back and neck and shoulder region are accepted as occupational diseases by only a few Member States and only for specific forms of disease. It is therefore difficult to collect comprehensive European level data on recognised occupational musculoskeletal disorders. According to the 2001 EODS data collection with 12 Member

States providing data on recognised cases of occupational diseases, the most common musculo-skeletal occupational diseases were tenosynovitis of the hand or wrist (5,379 cases) and epicondylitis of the elbow (4,585 cases). In addition there were 2,483 cases of carpal tunnel syndrome, a neurological disease of the wrist. If extrapolated to EU-15 in the ratio of the workforce of EU-15 and the participating countries there would be around 8 900 cases of tenosynovitis, 7 600 cases of epicondylitis and 4,100 cases of carpal tunnel syndrome recognised in EU-15 (figure 18) (Eurostat, 2004a).

Figure 19 - Incidence rate of recognised occupational hand or wrist tenosynovitis and epicondylitis of the elbow, EU-12, 2001



Source Eurostat, 2004a

Conclusions

Summarising information of the above was entered into the summary table of chapter 3 Scoping study (Annex 3) in order to allow a better overview and comparison. Selected for the field study were the following sectors: manufacturing, construction, health and mines or quarries. As suitable preventive measures were suggested things like technical aids, improved work organisation in combination with individual and workplace matching training especially of the movements. The measures were discussed in more detail during the field study with experts.

3.3.4.3 Psychosocial health problems

In total 14% of the persons with a work-related health problem experienced stress, depression or anxiety as the main health problem in the LFS ad hoc module 2007. Therefore, after musculoskeletal health problems, this health problem constituted the second most frequently reported main work-related health problem (Eurostat, 2010).

In the LFS ad hoc module 2007 the proportion of stress, depression or anxiety was highest in the sectors

- education (27%),
- financial intermediation (25%),

- public administration and defense (24%), and
- real estate, renting and business activities (22%).

In the EWCS 2005, the occurrence of stress and anxiety was also high in the sectors 'education' and 'health and social work' (Eurostat, 2010).

Sector categories (ISCO code) most suffering from stress as identified by the European Agency for Safety and Health at Work by a survey at their national focal points in 2000 (European Agency, 2000):

- Life science and health professionals;
- Teaching professionals;
- Corporate managers;
- Labourers in mining, construction, manufacturing and transport;
- Managers of small enterprises.

About 28% of workers consider their work affects their health in the form of stress, about 10% in the form of irritability and about 7% in the form of anxiety (Eurostat, 2004).

Sectors affected by stress:

1. Health and social work
2. Education
3. Transport and communications
4. Real estate activities
5. Hotels and restaurants
6. Financial intermediation
7. Public administration and defence
8. Electricity, gas and water supply

Sectors affected by irritability:

1. Education
2. Transport and communications
3. Mining and quarrying
4. Health and social work
5. Public administration and defence
6. Hotels and restaurants

Sectors affected by anxiety:

1. Education
2. Health and social work
3. Transport and communications
4. Mining and quarrying
5. Public administration and defence
6. Hotels and restaurants

According to the LFS ad hoc module 2007, stress, depression or anxiety was slightly more often experienced as the main work-related health problem by persons working in firms larger than 10 persons compared to firms of 10 persons or less. The EWCS 2005 also showed that stress and anxiety were more often found in workers employed in larger firms. This might be related to the fact that the size of firms in sectors in which stress, depression or anxiety frequently occurs are in general large, i.e. sector 'education', and 'public administration and defence' (Eurostat, 2010).

Consequences

The European Agency survey lists as potential health effects by excessive stress: "fatigue, anxiety, sweating panic attacks and tremors. Leads to difficulty in relaxing, loss of concentration, impaired appetite and disrupted sleep patterns. Some people become depressed or aggressive and stress increases susceptibility to ulcers, mental ill health, heart disease and some skin disorders." (European Agency, 2000)

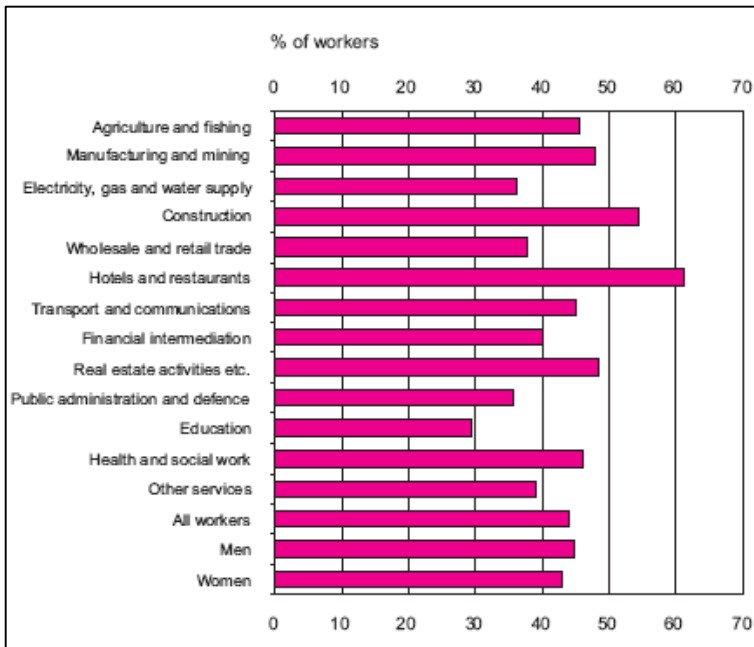
Among persons with this health problem as the main work-related health problem, 44% reported some limitations and 24% considerable limitations. Sick leave due to stress, depression or anxiety as the main work-related health problem occurred in 59% of the persons in the LFS ad hoc module 2007. Remarkably, long term sick leave (at least one month) occurred more often than short term sick leave (< 1 month) (32% versus 27%)¹⁴. Persons with stress, depression or anxiety as the main work-related health problem were more likely to experience long term sick leave than persons with musculoskeletal problems (32% versus 26%) (Eurostat, 2010).

Causes, risk factors

According to the LFS ad hoc module 2007, in the EU27, 27.9% of the workers reported exposure affecting mental well-being, this corresponded to about 55.6 million workers. Exposure to time pressure or overload of work was most often selected as the main risk factor (23%), followed by harassment or bullying (2.7%), and violence or threat of violence (2.2%) (Eurostat, 2010).

Less recent studies state that the problems are linked less to exposure to a specific risk than to a whole set of factors. Some key figures for four indicators are given by Eurostat (Eurostat, 2004a): work with a very high speed, occurrence of unforeseen interruptions at work, lack of ability to choose the working methods and match between skills and work demands.

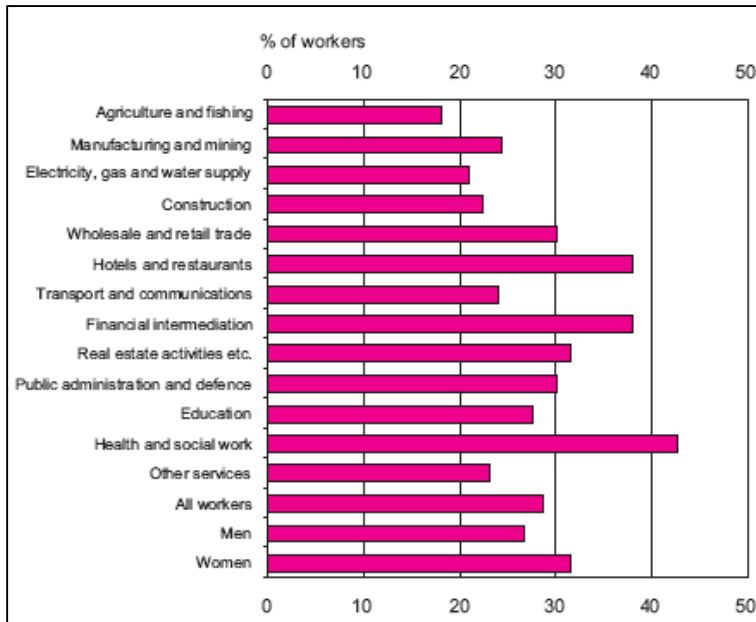
Figure 20 - Percentage of workers working at very high speed half of the time or more, EU-15, 2000



Source: EWCS, 2000

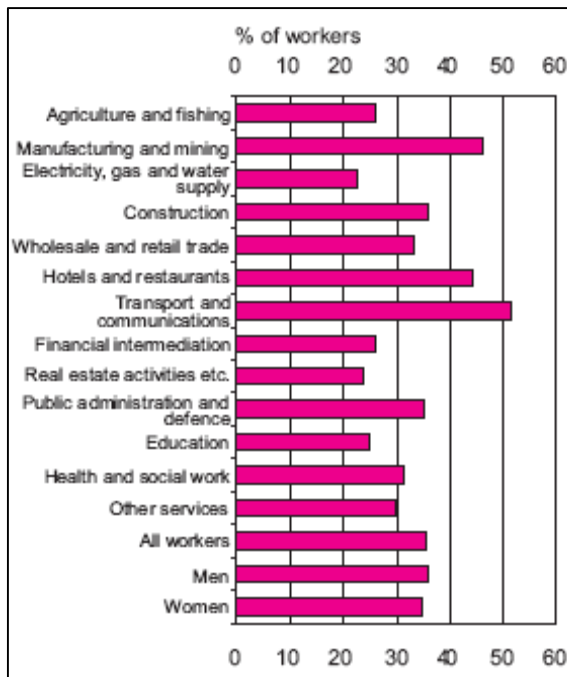
¹⁴ According to an expert this can be attributed to the fact, that it is more difficult to find short than long term therapy facilities.

Figure 21 - Percentage of workers having to interrupt their work several times a day due to an unforeseen task, EU-15, 2000



Source: EWCS, 2000

Figure 22 - Percentage of workers having no ability to choose or change the order of their tasks, EU-15, 2000



Source: EWCS, 2000

Sector and occupation categories as identified by the European Agency for Safety and Health at Work by a survey at their national focal points in 2000 (European Agency, 2000, pp. 42-44):

High speed work, sectors most at risk:

- Hotels and restaurants
- Post and telecommunications
- Land transport; transport via pipelines
- Construction
- Financial Intermediation, except insurance and pension funding
- Manufacture of wearing apparel; dressing and dyeing of fur
- Manufacture of food products and beverages
- Manufacture of motor vehicles, trailers and semi-trailers
- Manufacture of office, accounting and computing machinery
- Publishing, printing and reproduction of recorded media

Occupation categories (ISCO code):

- Corporate managers
- Customer services clerks
- Drivers and mobile plant operators
- Metal, machinery and related trades workers

Work-pace dictated by social demand, sectors most at risk:

- Hotels and restaurants
- Health and social work
- Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods
- Public administration and defence; compulsory social security
- Other service activities

Occupation categories (ISCO code):

- Customer services clerks
- Personal and protective services workers
- Life science and health associate professionals
- Life science and health professionals
- Models, salespersons and demonstrators

Machine dictated work pace, sectors most at risk:

- Manufacture of textiles
- Manufacture of food products and beverages
- Manufacture of fabricated metal products, except machinery and equipment
- Manufacture of basic metals
- Manufacture of rubber and plastic products
- Manufacture of wearing apparel; dressing and dyeing of fur

Occupation categories (ISCO code):

- Machine operators and assemblers
- Labourers in mining, construction, manufacturing and transport
- Drivers and mobile plant operators
- Stationary-plant and related operators

Recognised occupational psychosocial health problems

Because of a lack of knowledge on the mechanisms of work-related psychosocial disorders, very few if any such disorders are included in the national systems of reporting or compensating occupational

diseases. In 2000 a methodological survey was made in the 15 EU Member States to collect metadata and to plan a statistical data collection on occupational diseases. At that time all Member States reported they had not included any such disorders in their national list of occupational diseases. In some countries posttraumatic stress disorder and burnout are included in the reporting system and post traumatic stress disorder may in some instances be accepted under the system of compensating accidents at work (e.g. victims of assaults during work) (Eurostat, 2004a).

Conclusions

Summarising information of the above was entered into the summary table of chapter 3 Scoping study (Annex 3) in order to allow a better overview and comparison. Selected for the field study was the sector hotels and restaurants, because it is mentioned more often than other sectors. As suitable preventive measures were suggested instructions and improved work organisation. The measures were discussed in more detail during the field study with experts.

3.3.4.4 Respiratory, skin problems and infectious diseases

In the LFS ad hoc module 2007, 5.2% of the persons with a work-related health problem that work or worked previously reported breathing or lung problems as the main work-related health problem. The EWCS 2005 showed that 4.7% of the persons that reported their work affect their health experienced breathing difficulties (Eurostat, 2010).

The same source notes that skin problems were reported as the main work-related health problem in 1.3% of the persons with a work-related health problem. This was supported by the EWCS 2005, which found that overall, 6.6% of the workers experience skin problems (Eurostat, 2010).

In the LFS ad hoc module 2007, most workers (17%) reported exposure to difficult work postures, work movements or handling of heavy loads as the main risk factor affecting physical health, followed by exposure to the risk of an accident (10%), exposure to chemicals, dusts, fumes, smoke, or gases (8%), and exposure to noise or vibration (5%) (Eurostat, 2010).

Less recent sources do not show much of a difference: About 6% of workers consider their work affects their health in the form of skin problems, about 4% in the form of respiratory difficulties and about 4% in the form of allergy (Eurostat, 2004a).

For all these health risks the prevalence is the highest in agriculture, construction, manufacturing and health and social work and the lowest in financial intermediation and education. The difference between the highest and the lowest prevalence by sector is typically nearly 10-fold (Eurostat, 2004a).

Regarding the different sectors this is distributed as follows (in descending order):

Skin problems (Eurostat, 2010):

- Mining and quarrying
- Manufacturing
- Construction
- Health and social work

Skin problems (Eurostat, 2004a):

1. Agriculture and fishing
2. Health and social work
3. Construction
4. Manufacturing and mining

Respiratory difficulties (Eurostat, 2004a):

1. Construction
2. Manufacturing and mining
3. Electricity, gas and water supply
4. Agriculture and fishing

Allergies (Eurostat, 2004a):

1. Agriculture and fishing
2. Health and social work
3. Other services
4. Construction
5. Manufacturing and mining

Consequences

Reinhold Rühl from the German statutory accident insurance association for the construction sector (BG BAU) estimates the costs for occupational epoxy resin diseases at minimum 40 million Euro in 2008 in the EU (including costs for the accident insurance association, the public authorities and the companies) (Rühl and Wriedt, 2006).

A high proportion of workers with breathing or lung problems as the main work-related health problem experienced sickness absence in the past 12 months according to the LFS ad hoc module 2007 (71%). In total 45% of the persons that work or worked previously had sickness absence of less than one month, and 26% had sickness absence of at least one month. Hence, breathing or lung problems more often resulted in short term sick leave (< 1 month) compared to musculoskeletal health problems (35%) and stress, depression or anxiety (27%). However, the reverse was found for longstanding absence (at least 1 month) (Eurostat, 2010).

Causes

There were 230 different causative agents reported for the recognised occupational skin diseases, but most of the factors (59%) were defined by their industrial use purpose and not by their chemical structure. For occupational asthma there were 130 different causative agents reported. The most common specific agents were flour dust (10%), isocyanates (4%), dust from mammals (4%) and wood dusts (3%) (Eurostat, 2004a). However the above mentioned expert from the German statutory accident insurer for the construction sector (BG BAU) sees strong evidence provided by research of his institution that those diseases attributed to isocyanates are rather to be attributed to epoxy resin.

About 15% of Europeans report being exposed to breathing in vapours, fumes, dust or dangerous substances in their workplace for at least half of their working time and 9% handle or touch dangerous substances for at least half of their working time (Eurostat, 2004a).

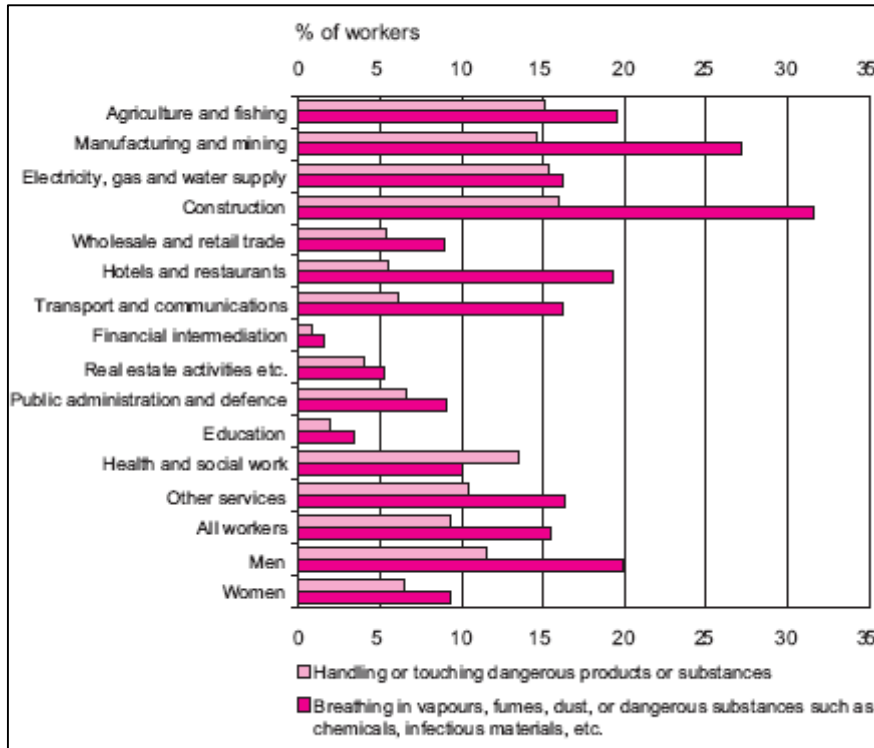
Regarding the different sectors this is distributed as follows (see also figure 42 below):

Breathing in vapours, fumes, dust or dangerous substances such as chemicals, infectious materials, etc.:

- Construction
- Manufacturing and mining
- Agriculture and fishing
- Hotels and restaurants
- Handling or touching dangerous products or substances
- Construction
- Electricity, gas and water supply
- Agriculture and fishing

- Manufacturing and mining
- Health and social work

Figure 23 - Percentage of workers breathing in vapours and of those handling dangerous substances half of the time or more, EU-15, 2000



Source: ESCW, 2000

Sector and occupation categories as identified by the European Agency for Safety and Health at Work by a survey at their national focal points in 2000 (European Agency, 2000):

Handling chemicals, sectors most at risk:

- Manufacture of chemicals and chemical products
- Agriculture, hunting and related service activities;
- Construction;
- Other service activities;
- Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel.

Occupation categories (ISCO code):

- Labourers in mining, construction, manufacturing and transport;
- Stationary-plant and related operators;
- Agricultural, fishery and related labourers;
- Metal, machinery and related trades workers;
- Extraction and building trade workers.

The study also lists the substances given by the Focal Points when asked to identify a maximum of five hazardous chemical/biological substances/factors within each hazardous exposure category that are to be considered to be the most important risks for the working population in the Member States (table 20) (European Agency, 2000, p.67).

Table 20 - Most identified hazardous substances

Exposure category	Most identified	Number of responses
Carcinogenic substances	• Asbestos.	13
	• Chromium (VI) compounds	9
	• Crystalline silica	8
	• Benzene	8
Neurotoxic substances	• Organic solvents	8
	• Organophosphates / pesticides	7
	• Lead and its compounds	7
	• Toluene/xylene, aromatic/chlorinated solvents	4
Reproductive hazards	• Lead and its compounds	11
	• Mercury and its compounds	3
	• Acrylamide, methoxy ethanol, ethoxy ethanol, ethylene oxide, organic solvents, halothane	2
Infectious biological factors	• Hepatitis Virus B/C	14
	• Tuberculosis	11
	• HIV	6
	• Leptospirosis	5
	• Borrelia burgdorferi	4
Non-infectious biological factors	• Endotoxins	4
	• Moulds	4
	• Thermophilic actinomyces fungi	3
	• Organic dust	2
	• Animal epithelium	2

Source: European Agency, 2000

Recognized occupational respiratory and skin diseases

For 2001 Eurostat estimates about 10,000 respiratory and 8,000 skin diseases for the EU-15 (table 21) (Eurostat, 2004a).

The European Agency for Health and Safety at Work states in a 2009 press release: "It is estimated that chemicals are responsible for 80-90% of skin diseases, which rank second (13.6%) on the scale of occupational diseases, following musculoskeletal disorders."¹⁵

¹⁵ Press release 01.05.2009, *European workers face new and increasing health risks from hazardous substances*, available under: http://osha.europa.eu/en/press/press-releases/european_workers_face_new_increasing_health_risks_hazardous_substances_01.11032009 (accessed 29 5 2009)

Table 21 - Estimated number of respiratory and skin diseases, EU-15, 2001

Disease	Number of cases in 12 Member States	Number of cases extrapolated to EU-15
Lung diseases	5,883	9,700
- Mesothelioma	1,168	1,900
- Asthma	1,075	1,800
- Asbestosis	738	1,200
- Coal worker's pneumoconiosis	547	910
- Chronic bronchitis	497	820
- Silicosis	485	800
- Pleural asbestos disease	481	800
- Allergic rhinitis	248	410
- Lung cancer	208	340
- Allergic alveolitis	189	310
- Other lung disease	247	410
Skin diseases	4,569	7,600
- Allergic, irritant or unspecified dermatitis	4,457	7,400
- Other skin disease	112	200

Source: Eurostat, 2004a

For dermatitis and asthma Eurostat gives a breakdown regarding the most affected sectors:

Dermatitis:

1. Mining and quarrying
2. Construction
3. Manufacturing
4. Other community, social, personal service activities
5. Hotels and restaurants

Asthma (almost all sectors are heavily affected):

1. Health and social work
2. Education
3. Transport and communications
4. Real estate activities etc.
5. Hotels and restaurants
6. Financial intermediation
7. Public administration and defence
8. Electricity, gas and water supply
9. Manufacturing and mining
10. Construction
11. Wholesale and retail trade
12. Agriculture and fishing

Conclusions

Summarising information of the above was entered into the summary table of chapter 3 Scoping study (Annex 3) in order to allow a better overview and comparison. Selected for the field study were the following sectors: production of chemicals, health and social work, electronics, manufacturing. As suitable preventive measures were suggested technical measures like wetting of flour and damp cleaning, instructions, improved work organisation and suitable PPE. The measures were discussed in more detail during the field study with experts.

3.3.4.5 Cardiovascular disorders

The most important risk factors associated with cardiovascular disorders are non-occupational. However, for example shift work and stress-related factors have been found to increase the risk of ischaemic heart disease. Long-term exposure to vibration is a well-established risk factor of peripheral circulation impairment in the hands (so-called vibration white-finger).

Only 1% of European workers consider their work affects their health in the form of heart disease. The prevalence of such risk is low, between 0.5 and 1.7 %, in all sectors of economic activity. According to the ad hoc module of the 1999 LFS, less than 0.2% of the respondents suffered from a cardiovascular health problem, which according to their own judgement was caused or made worse by work. This means that about 320,000 European workers (current or past) have such cardiovascular health problems. Based on scientific evidence, the above-mentioned work-related risk factors could contribute much more to cardiovascular morbidity and mortality (see chapter 3.8.). It is probably more difficult for workers to recognise the link between work-related exposure and cardiovascular diseases than to recognise the work-related risks of musculoskeletal, respiratory or skin disease (Eurostat, 2004a).

Conclusions

This issue will not be considered for the field study.

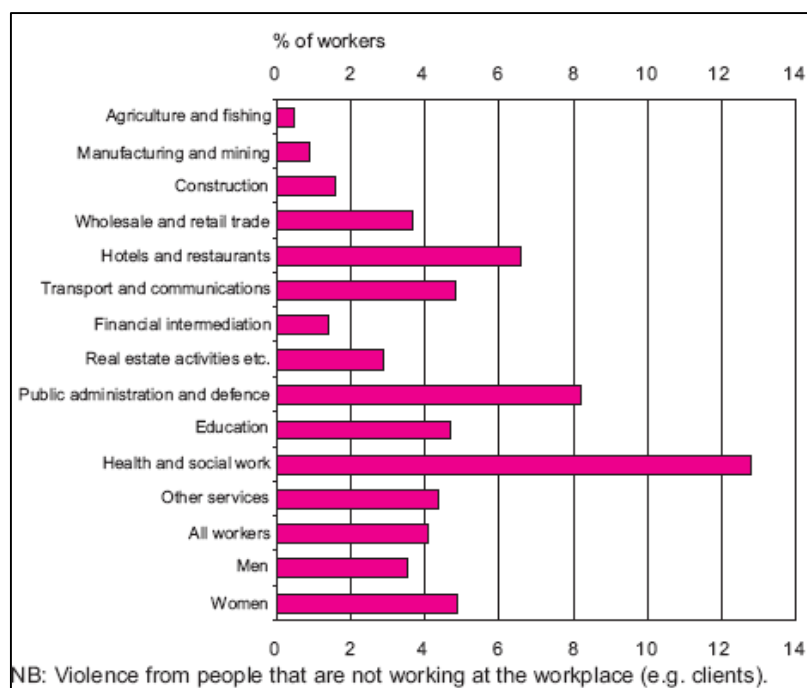
3.3.4.6 Violence and intimidation

Physical violence

According to the LFS ad hoc module 2007, in the EU27, 27.9% of the workers reported exposure affecting mental well-being, this corresponded to about 55.6 million workers. Exposure to time pressure or overload of work was most often selected as the main risk factor (23%), followed by harassment or bullying (2.7%), and violence or threat of violence (2.2%) (Eurostat, 2010).

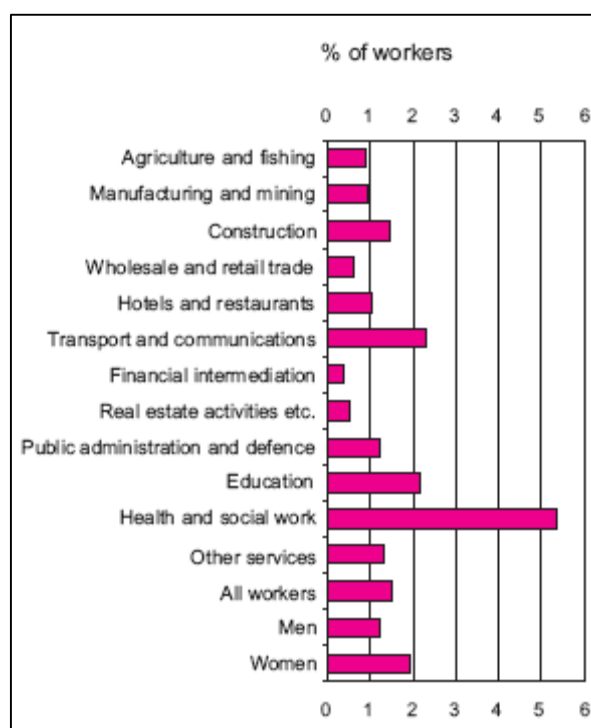
In addition to physical violence from people working at the same workplace, it is more common at work to be subject to violence from other people (clients, pupils, etc.). 4.5% of women and 3.5% of men report having been subject to such violence over the past 12 months. The rate is obviously higher in sectors where contacts with people not working at the workplace are common (Eurostat, 2004a):

Figure 24 - Percentage of workers having been subjected at work to physical violence from other people, EU-15, 2000



Source: EWCS, 2000

Figure 25 - Percentage of workers having been subjected at work to physical violence from people from the workplace, EU-15, 2000



Source: EWCS, 2000

Even though the above rates may not be very high, it should be noted that the threat of violence is felt by an even larger fraction of the workforce. 4% of people are aware of the existence of violence from people at their workplace and 8% are aware of the existence of violence from other people at their workplace.

The survey of the European Agency for Safety and Health at Work at their national focal points in 2000 (European Agency, 2000, p. 45), lists the following sectors as being most at risk regarding physical violence:

- Health and social work;
- Public administration and defence; compulsory social security;
- Land transport; transport via pipelines;
- Hotels and restaurants;
- Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods;
- Other service activities.

Occupation categories (ISCO code), as above:

- Personal and protective services workers;
- Life science and health associate professionals;
- Sales and services elementary occupations;
- Life science and health professionals;
- Customer services clerks;
- Models, sales persons and demonstrators.

It was reported in several national reports that they considered female employees to be more exposed to both physical violence and threats of violence in the workplace (European Agency, 2000).

Intimidation

The survey of the European Agency for Safety and Health at Work at their national focal points in 2000 (European Agency, 2000, p. 46), lists the following sectors as being most at risk regarding bullying and victimisation:

- Health and social work
- Hotels and restaurants
- Education
- Public administration and defence; compulsory social security
- Financial intermediation, except insurance and pension funding
- Manufacture of chemicals and chemical products

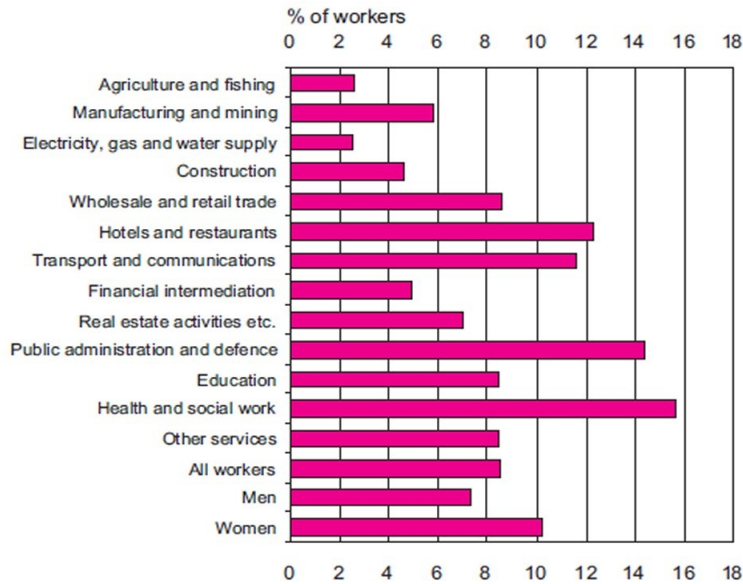
Occupation categories (ISCO code), as above:

- Sales and services elementary occupations
- Personal and protective services workers
- Customer services clerks
- Labourers in mining, construction, manufacturing and transport
- Other craft and related trades workers
- Models, sales persons and demonstrators
- Teaching professionals
- Life science and health professionals

Over the past 12 months, 10.2% of women and 7.3% of men have been subject to intimidation at work. The rate of intimidation is the highest in health and social work (15.7%), followed by public administration, hotels and restaurants and transportation. There are no important differences in the

occurrence of intimidation by age category or by size of the company, with the exception of a lower rate among those working alone (Eurostat, 2004a).

Figure 26 - Percentage of workers having being subjected to intimidation at work, EU-15, 2000



Source: EWCS, 2000

Conclusions

Summarising information of the above was entered into the summary table of chapter 3 Scoping study (Annex 3) in order to allow a better overview and comparison. Selected for the field study was the following sector: public transport. As suitable preventive measures were suggested: training, technical aid, workplace adjustment (e.g. surveillance). The measures were discussed in more detail during the field study with experts.

3.4 Severity of accidents at work and work-related ill-health cases

For the purpose of this project the severity of accidents at work and work related ill health is defined based on Schüler (2001) (see also box 13).

Schüler's first two categories are combined for this project to form "low severity" as well as the last two to form "high severity" (see below). Regarding work related ill health we considered the days of absenteeism, except for needle stick injuries involving patients with HIV and / or hepatitis C, which we classify also as high severity.

Thus the definition of severity in benOSH is as follows:

Low severity:

- No to slight functional impairments of body parts or organs after accident impact, ambulatory treatment may be necessary.
- E.g. slight bruises or strains, superficial wounds, breaks of minor bones (metacarpus, toes, metatarsus, fibula in the middle third, lost of teeth et al.).
- Days of absenteeism: 0 – 15.

Medium severity:

- Medium functional impairments of body parts or organs after accident impact, in-patient treatment where necessary (not more than three days).
- E.g. wounds transgressing the subcutaneous fatty tissue and beyond, face injuries, fractures of medium sized bones (clavicle, ulna, radius, ankle, wrist, neck of humerus, shoulder blade et al.) requiring an adjustment or a surgery.
- Days of absenteeism: 16 – 35.

High severity:

- High functional impairments of body parts or organs after accident impact, not or during a longer period to be compensated by medical treatment, in-patient treatment of more than three days necessary.
- Fatal accidents
- Accidents with a high risk of fatal effects like needle sticks involving patients with HIV and hepatitis C.
- E.g. open fractures of all kinds, fractures of major bones (shinbone, lower leg, several ribs, spine, skull et al.) injuries of the skull leading to unconsciousness, injuries of body cavities, injuries of major trunks, severe inner injuries, multiple injuries, indications of shock.
- Days of absenteeism: more than 35

Box 13 - Schüler's definition (pp. 14-16, translated)

“The severity assessment of accidents is possible by using the index system developed by ARNOLD¹⁶: Arbeitsdiagnostische Unfallkennziffern – **ADUK** (work diagnostic accident index numbers). Accidents ranging from low severity to fatal are classified according to the following ADUK:

ADUK 1: accident of low severity, not notifiable

- No functional impairments of body parts or organs after accident impact, ambulatory treatment not necessary
- E.g. slight bruises or strains, superficial wounds
- Days of absenteeism, see Popov¹⁷: 0 - 3
- Weighting factor 1

ADUK 2: accident of low severity (**L**)

- Slight functional impairments of body parts or organs after accident impact, ambulatory treatment necessary
- E.g. slight bruises or strains, superficial wounds, breaks of minor bones (metacarpus, toes, metatarsus, fibula in the middle third, lost of teeth et al.)
- Days of absenteeism: 4 - 15
- Weighting factor 2

ADUK 3: accident of medium severity (**M**)

- medium functional impairments of body parts or organs after accident impact, in-patient treatment where necessary (not more than three days)
- e.g. wounds transgressing the subcutaneous fatty tissue and beyond, face injuries, fractures of medium sized bones (clavicle, ulna, radius, ankle, wrist, neck of humerus, shoulder blade et al.) requiring an adjustment or a surgery.
- Days of absenteeism: 16 - 35
- Weighting factor 3

ADUK 4: accident of high severity (**S**)

- high functional impairments of body parts or organs after accident impact, not or during a longer period to be compensated by medical treatment, in-patient treatment of more than three days necessary
- e.g. open fractures of all kinds, fractures of major bones (shinbone, lower leg, several ribs, spine, skull et al.) injuries of the skull leading to unconsciousness, injuries of body cavities, injuries of major trunks, severe inner injuries, multiple injuries, indications of shock
- Days of absenteeism: more than 35
- Weighting factor 4

ADUK 5: fatal accident (**T**)

- Weighting factor 5

Source: Schüler, 2001

¹⁶ Arnold, K.; Wolf, M.: Zur Graduierung der Unfallschwere im VE Bauwesen. Deutsches Gesundheitswesen, 39 (1984) 48, S. 1915-1917.

¹⁷ Popov, K.: Untersuchungen des Unfallgeschehens bei Abstürzen aus geringen Höhen und Entwurf einer Empfehlung zur Anwendung differenzierter Schutzmaßnahmen bei Bauarbeiten und auf Baustellen. Schriftenreihe der Bundesanstalt für Arbeitsschutz: Forschung, Fb 856. Bremerhaven: Wirtschaftsverlag NW, Verlag für neue Wissenschaft, 1999

3.5 Selection of sectors and cases for the field study

Summarising information from the above chapters was entered into the summary table of chapter 3 Scoping study (Annex 3). This information was then closely analysed and relevant sectors together with occupations and causes were identified.

The selected cases were broken down further according to their severity. The decision to what extent to select fatal accidents will be done on a case by case analysis during the field research. In general fatal accidents are less costly from the companies' point of view than non-fatal ones, depending also on the incapacities caused.

An exception from the above strategy has been made regarding fires and explosions. Although the selected sector does not appear in the literature taken as basis, cases in automotive repair shops were considered nevertheless because these cases may force the owners of the affected businesses to close down¹⁸.

In the following step related prevention measures were discussed and assigned. The prevention measures are based on best practice cases from the European Agency for Safety and Health at Work and from other relevant institutions like accident insurers and the German Federal Institute for Occupational Safety and Health BAuA (BAUA, 2004). For the prevention of accidents we also used the study from the European Commission, DG for Employment, Social Affairs and Equal Opportunities, Causes and circumstances of accidents at work in the EU, which relied mainly on material from the French National Institute for Research and Safety, INRS (European Commission, 2009).

The measures observe the order of prevention principles: elimination of risks, combating risks at source, technical and organisational measures (e.g. instructions) before applying personal protective equipment. Yet also technical prevention measures often need to be supplemented by instructions, training and motivation of workers. However the measures were discussed during the field study with the company OSH professionals and the accident insurer and/or labour inspection staff in charge.

Finally the companies to be selected (sectors, types, sizes) in relation to accidents or diseases as well as severity and preventive measures were described as specific as possible in the final table below.

A large number of companies was contacted during the field study phase. Which companies in the end really took part in the project depended on the responses and interests from the approached firms. The finally selected cases also depended on the discussions with the company professionals.

¹⁸ Statement by German accident insurer

Table 22 - Selected scope for the case studies

Sectors	Companies	N	Causes, risks	Effects	No	Prevention measures
Construction	Electrician, preferably very small (1-9) or small company (10-49 employees)	2	Electric shock	Accidents of low, medium, high severity	6, 3, 1	Training, Motivation Residual Current Protective Device, and SPE-PRCD , Switched Protective Earth - Portable Residual Current Device
Construction	Construction, smaller companies (10-49, 50-249 employees)	2	Fall from platform, roof	Accidents of low, medium, high severity	6, 3, 1	Training, motivation Nets, guard-rails, harnesses
Construction / Power supply	Construction company, power supply company	2	Climbing	Accidents of low, medium, high severity	6, 3, 1	Training Highstep system
Construction	Construction, smaller companies (10-49, 50-249 employees)	2	Fall from ladder	Accidents of low, medium, high severity	6, 3, 1	Innovative ladders, roll able scaffolds, elevating work platform
Manufacturing	Metal workshop smaller companies (10-49, 50-249 employees)	2	Slipping	Accidents of low, medium, high severity	6, 3, 1	Slip resistant flooring; Appropriate and immediate cleaning in case of spills; Damage and unevenness of floors to be repaired
		2	Cuts from sharp edges (sheets, bars, ...)	Accidents of low, medium, high severity	8, 2, 0	Gloves
	Also maintenance workers	2	Machinery	Accidents of low, medium, high severity	6, 3, 1	Training, safety devices
Transport	Logistics companies (10-49 employees)	2	Struck by fork lift	Accidents of low, medium, high severity	6, 3, 1	Training, technical surveillance device for secure reversing
Car repair	Garages	2	Fire, explosion	Accidents of low, medium, high severity	6, 3, 1	Low VOC products, work org.

Sectors	Companies	No.	Causes, risks	Effects	No	Prevention measures
Construction	Construction company, small and medium	2	Slips, trips	severity Accidents of low, medium, high severity	8, 2, 0	Slip resistant flooring; Appropriate and immediate cleaning in case of spills; Damage and unevenness of floors to be repaired Cable covers, cordless tools Changes of level: improved lighting and highly visible tread nosings.
Manufacture of metal products	Metal workshop, small and medium	2	Slips, trips	Accidents of low, medium, high severity	8, 2, 0	Slip resistant flooring; Appropriate and immediate cleaning in case of spills; Damage and unevenness of floors to be repaired Cable covers, cordless tools Changes of level: improved lighting and highly visible tread nosings.
	Metal workshop, small and medium, fitters	2	Tools, eye injury by swarf, chips, fines e.g. while grinding	Accidents of low, medium, high severity	6, 3, 1	Goggles, instruction, motivation
Health and social work	Cleaning company or department	2	Slips and trips	Accidents of low, medium, high severity	6, 3, 1	Training, "dry" or damp cleaning
Manufacture of food products and beverages	Medium to big industry, assembling line	2	Repetitive movements	MSD low, medium, high severity	6, 3, 1	Work organisation
Mines or quarries	Small and medium companies	2	Vibrations	MSD low, medium, high severity	6, 3, 1	Technical aid, insulation of seats
Health and social work	Small and medium companies, nurses, caregivers	2	Heavy loads	MSD low, medium, high severity	6, 3, 1	Training, technical aid

Sectors	Companies	No.	Causes, risks	Effects	No	Prevention measures
Construction	Small and medium companies, masons, plasterers	2	Painful or tiring positions	MSD low, medium, high severity	6, 3, 1	Training, technical aids (scaffolds, long handles), PPE
Hotels and restaurants	Clerks, service personnel	2	High speed, interruptions	Stress symptoms low, medium, high severity	8, 2, 0	Instructions, work org., training
Manufacture of chemicals and chemical products	Small, medium and large companies, plant operators	2	Skin problems: surfactants, organic solvents, biocides	Skin problems low, medium, high severity	8, 2, 0	PPE, instructions, work org.
Health and social work	Nurses, cleaners	2	Skin problems: surfactants, organic solvents, biocides	Skin problems low, medium, high severity	8, 2, 0	As above, "dry cleaning" i.e. no liquids involved
	Nurses, workers	2	Infections, needle sticks	Infections low, medium, high severity	8, 2, 0	PPE, work org.
Food industry	Workers	2	Asthma: flour dust	Asthma low, medium, high severity	6, 3, 1	New methods to prevent dust
Communication, electronics	Workers	2	Epoxy resins	Allergies low, medium, high severity	6, 3, 1	PPE, instructions, work org.
Yacht builders or wind mill manufacturers	Workers	2	Epoxy resins	Allergies low, medium, high severity	6, 3, 1	PPE, instructions, work org.
Transport	Drivers	2	Violence	Physical and psychic problems low, medium, high severity	6, 3, 1	Training, workplace adjustment, technical measures e.g. surveillance
Total		50 companies			164, 68, 18	Total: 250 cases

4 Case studies

The Field research relies on multiple case studies in several companies. Several approaches exist to calculate the costs of accidents at work and work-related ill-health and to make economic assessments of occupational safety and health interventions (see above for a literature review). For this study the Matrix and the cost-benefit analysis methods were selected (4.1, 4.2). The data were collected using a data-gathering tool (4.3). The field study was executed by telephone, on site visits and reporting (4.4).

4.1 Calculating the costs of accidents and ill-health

4.1.1 Methodology

For calculating the costs of the accidents at work and work-related ill-health, the Matrix was used. The Matrix was developed by Prevent in collaboration with the occupational accidents insurance organisations in Belgium (De Greef and Van den Broek, 2006) (see also 2.5.3.2). This approach was selected on the basis on the following considerations:

- The Matrix is an activity based approach to calculate the cost of occupational accidents and work related ill-health. This approach is based on current financial management principles that are recognisable for company decision makers (see also 2.5.3.2).
- The Matrix is a tool that makes the link between financial management and prevention. The Matrix attributes to each cost item a cost centre and a cost category.
- The cost categories are clustered along the main cost categories in the accountancy system: the operating costs such as goods, services and staff and depreciation. The costs centres are clustered in the HEEPO categories: Human, Equipment, Environment, Product and Organisation; these clusters are very familiar to OSH professionals. The result offers a basis for discussion for both OSH professional and (financial) decision makers.
- Identifying the consequences of accidents at work and work-related ill-health is not always an easy task. OSH professionals are trained to search for causes of these cases but often they don't really look for consequences. The HEEPO clustering supports OSH professionals to identify the relevant consequences. Furthermore, since the supporting checklist (see 4.2.1) is based on the 5 clusters and can be filled out without any knowledge of the cost categories, the method can be used without fundamental knowledge of accountancy principles.
- The Matrix helps to mainstream OSH into the financial decision making process and stimulates OSH professionals to take into account the economic aspects of prevention.

4.1.2 The Matrix

As explained above the Matrix was used in this study to calculate the costs of accidents at work and work-related ill-health of the selected cases. The Matrix is based on the principles of activity based costing (see also 2.5.3.2 and 4.1.1).

The Matrix distinguishes cost categories and cost centres. For the cost centres a categorisation is used based on HEEPO. HEEPO stands for Human factor, Equipment, Environment, Product, Organisation. This categorisation allows inventorying costs related to the impact of the accident/case of ill health. In fact, every accident/case of ill health has an impact on the human factor (e.g. absence of the victim), the organisation (e.g. re-organisation of the work) and might also have an impact on the environment (e.g. spills), on the product (e.g. damaged goods) and on the equipment (e.g. damaged equipment).

The categorisation of the cost categories is based on the principles of cost accounting (accountancy). The costs are related to two main categories: operating costs (goods, services, staff) and depreciation.

By relating every cost to a cost centre and a cost category a matrix can be build up (see also table 16, p. 83). The total sum is the sum of all costs.

Clustering the consequences of accidents at work and work-related ill-health into the 5 cost centres helps to identify costs. However in order to facilitate the practical use of the method, a checklist was designed. This checklist brings together 40 cost items related to accidents at work or work-related ill-health subdivided into the 5 HEEPO clusters (table 23). After filling out the checklist, the cost items are brought together into the Matrix. The advantage relies on the fact that for filling out the checklist knowledge about the financial concepts underlying the cost categories is not needed.

Several cost items are expressed in working hours such as absence, time to reorganise the work, to train the replacement, ... Working hours are calculated on the basis of 5 salary categories. In that way there is no need to search for real salaries making it easier to collect data. A company has only to determine the 5 categories and the corresponding salary costs per working hour. Also overhead costs are taken into account. In this study the default value of the overhead costs is fixed at 10% of the calculated costs (of the non productive time).

The checklist also allows for including the re-imburement of the insurer. The re-imburement can be deducted from the total cost, the result being the net cost of the accident or case of ill-health for the company.

Because the Matrix focuses approach on the cost side of the consequences of accidents and cases of ill-health, it is not possible to take into account some consequences that might affect the income of a company such as a decrease in sale volume of a reduction in the production volume.

The Matrix does not take into account less tangible consequences such as the reduced job satisfaction, the damage to the company image, etc. This means that even though the Matrix allows for valuing the majority of consequences of accidents at work and work-related ill-health, the final result will in most cases not reflect all costs.

Table 23 - Cost items of the Matrix along the five HEEPO clusters

Human	
1	absence of the victim – time period during which the employer covers the salary
2	absence of the victim – after the time period during which the employer covers the salary
3	reduced productivity of the injured employee after re-employment (alternative work)
4	costs of a replacement (recruited employee) (difference in salary, reduced productivity)
5	costs of a replacement (temporary worker) (difference in salary, reduced productivity)
6	colleague accompanies the victim to first aid
7	colleagues interrupt the work
8	overtime of colleagues to compensate
9	first aid and reporting (first aid worker)
10	rehabilitation costs (paid for by the employer)
11	medical costs (paid for by the employer)
Equipment	
12	depreciation of damaged equipment
13	replacing damaged equipment
14	repair costs (external services)
15	purchasing/time spent by purchasing personnel
16	purchasing/time spent for management approval
17	repair of the damaged equipment (internal maintenance)
Environment	
18	damage to the environment (floors, buildings, surroundings)
19	clean up by external services
20	goods for repairing the environment
21	repair of the environment (external services)
22	purchasing/time spent by purchasing personnel
23	purchasing/time spent for management approval
24	repair (internal maintenance)
Product	
25	damaged goods
26	clean up by external services
27	purchasing/time spent by purchasing personnel
28	purchasing/time spent for management approval
29	clean up of damaged goods (internal maintenance)
30	interruption of the production/time lost by operators
31	interruption of the production /time lost by management
Organisation	
32	accident investigation/time spent by management
33	accident investigation/time spent by colleagues
34	accident investigation/time spent by OSH specialist (internal)
35	discussion of the accident in safety meeting/management
36	discussion of the accident in safety meeting/workers representatives (trade unions)
37	discussion of the accident in safety meeting/OSH specialist
38	administrative follow-up (reporting to insurance, hiring replacement)
39	reorganising the work
40	training of the replacement (time of the trainer)

4.2 Economic assessment of OSH interventions

4.2.1 Methodology

The selection of the cost-benefit methodology for making economic assessments on company level was based on the following considerations:

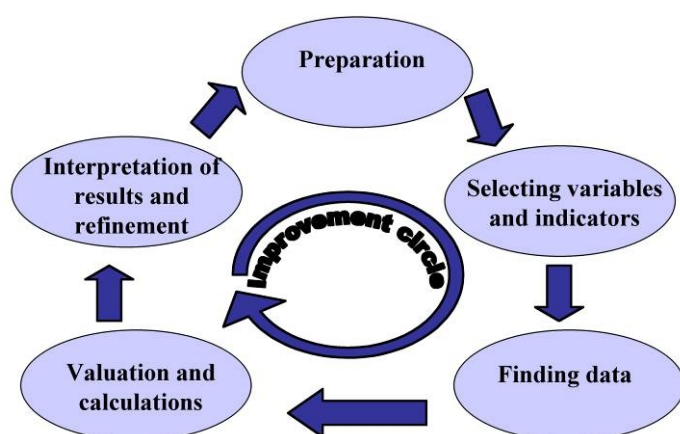
- The method uses monetary values for costs and benefits of occupational safety and health, offering a straightforward approach for decision-making on company level;
- It supports the assessment of the impact of health and safety interventions on reduction of the cost of accidents and ill-health and on the increase of productivity; these cost and revenue delta's will support the costs of the OSH intervention;
- The method focuses on prevention as an investment – instead of a cost – that can be depreciated and that generates an income or savings;
- Performing a cost-benefit analysis is common practice on company level; investments will only be approved if they are supported by a business case including a cost-benefit analysis;
- Companies often determine specific criteria to evaluate investments such as a maximum payback period or a minimum return on investment;
- A cost-benefit analysis offers the possibility to compare the financial performance of different alternative interventions; in this way, an important element is added to the decision-making process on company level.

4.2.2 Cost-benefit analysis

General approach

The cost-benefit analysis is used to make economic consequences visible. Qualitative and quantitative data form the basis of cost-benefit analyses. The aim is to compare input and output. In practice, the cost-benefit analysis demands a step-by-step approach (figure 27). Guidance about how to conduct cost-benefit analysis of health and safety interventions can be found in Mossink and De Greef (2002), Mossink (2002), Messonnier and Meltzer (2003) (policy makers), Tompa et al. 2008b and Meunier and Marsden (2009).

Figure 27 - Five-step improvement cycle for making estimations of costs of work accidents and preventive activities



Source: Mossink and De Greef, 2002

Preparation

The preparation of the cost-benefit analysis should focus on:

- The definition of the OSH-project that has to be analysed;
- The assessment of the specific health and safety risks, including the procedure for valuing the consequences;
- The identification of the intervention strategies that have to be evaluated;
- The assessment of the impact of the interventions strategies on the (possible) consequences of the health and safety risks.

Selecting variables and indicators

It is necessary to consider all possible effects of injuries and diseases, even though some of these costs might be hidden or difficult to assess. Moreover, companies tend to be very different from each other; these differences could have an important influence on the comparability of the results.

However, within the scope of this multiple case study, the Matrix was used (see above) to estimate the impact of the intervention strategy on the cost of accidents and ill-health. This approach guarantees that the avoided costs (benefits) of injuries and diseases were considered in a similar way throughout all the cases.

Economic valuation and calculation

The benefits of specific prevention measures will be evaluated by attributing monetary values to elements such as avoided accident costs, higher work speed, less damages, etc. This will allow making the necessary calculations of the costs and the benefits that result from an intervention aimed at reducing occupational accidents and ill-health at work.

Interpretation of the results

In a cost-benefit analysis all costs and benefits associated with an intervention are measured in monetary terms, allowing the calculation of economic indicators; these can help in deciding which interventions are financially attractive. Examples of such indicators are the payback period (PP), the net present value (NPV), the internal rate of return (IRR), the profitability index (PI) and the benefit-cost ratio (BCR) (see box 14).

Box 14 - Cost-benefit analysis: economic indicators

1) The Payback Period (PP)

The payback period is the amount of time before the initial investments are earned back, or the length of time required for cumulative incoming returns to equal the cumulative costs of an investment. The PP is usually measured in years. A PP of 2 to 3 years is usually accepted in industry; because of increasing uncertainty, the time horizon of economic decisions rarely exceeds a period of 4 years.

2) Net Present Value (NPV)

The net present value of a series of cash flows, both incoming and outgoing, is defined as the sum of the present values (PVs) of the individual cash flows. The NPV gives an indication of the amount a project adds to the value of a company. A project will be accepted when the NPV is larger than 0. A NPV equal to 0 means that the project adds no value to the company; in that case a decision maker could be indifferent whether to accept or reject the project.

A key element in calculating the NPV is the discount factor:

$$\frac{1}{(1+r)^t}$$

Where:

r: discount rate

t: the time of the cash flow

In general, discount rates of 3% to 5% can be applied in order to account for the time preference for money, i.e. it is preferable to have the money now 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 borrowing money from a bank and a compensation for risk taking. This means that discount rates at company level can be as high as 15% to 20%.

$$NPV = \sum_{t=0}^T \frac{R_t}{(1+r)^t}$$

Where:

T: Time horizon

R_t : net cash flow in year t (benefits t – costs t)

R_0 : initial investment (negative value)

The project has to result in $NPV > 0$

3) The Internal Rate of Return (IRR)

The internal rate of return on an investment or potential investment is the annualized effective compounded return rate that can be earned on the invested capital.

In other words, the IRR of an investment is the interest rate at which the costs of the investment lead to the benefits of the investment. This means that all gains from the investment are inherent to the time value of money and that the investment has a zero net present value at this interest rate. A project will be accepted if the internal rate of return exceeds the minimum rate of return that has been defined for that specific category of projects.

$$NPV = \sum_{t=0}^T \frac{R_t}{(1+r)^t} = 0$$

Where:

t: year of the cash flow

r: IRR

T: Time horizon

R_t : net cash flow in year t (benefits t – costs t)

R_0 : the initial investment (negative value)

4) Profitability Index (PI)

The Profitability Index is defined as the present value of expected cash flows over the value of the Initial Investment. It is a ratio of the present value of cash flows and the initial investment. A Profitability Index of one yields the internal rate of return. A Profitability Index of less than one suggests that the project should be rejected and value of one or greater suggests that investment should be accepted. If there is a choice between two or more alternative projects, the one with the largest PI should be chosen.

$$PI = \frac{\sum_{t=1}^T \frac{R_t}{(1+r)^t}}{I_0}$$

Where:

r: discount rate

t: the time of the cashflows

R_t : the net cashflow in year t (benefits t – costs t)

T: the time horizon

5) Benefit-cost ratio (BCR)

The benefit-cost ratio is the ratio of the benefits of a project relative to its costs. Both benefits and costs are expressed in discounted present values.

A project will be accepted when the BCR is larger than 1.

$$BCR = \frac{\sum_{t=0}^T \frac{B_t}{(1+r)^t}}{\sum_{t=0}^T \frac{C_t}{(1+r)^t}}$$

Where:

r = discount rate

t: the time of the benefits and costs

T: the time horizon

B_t: the benefits in year t

C_t: the costs in year t

Parameters used in the cost-benefit analysis

Based on the scope for the case studies several intervention strategies were proposed in order to deal with the various risks. These interventions were assessed using a cost-benefit analysis in which the following parameters were used:

- the initial investment costs (R₀): i.e. the costs to prepare and implement the intervention, e.g. study (the investment necessary to prepare the intervention, the choice of adequate measures), the change in the work organisation, the procurement of new equipment, the training to support the implementation of a new work procedure, etc.
- the yearly costs (C_t): the costs that have to be made to maintain and/or continue the intervention, e.g. training, maintenance; these costs can either be recurrent (i.e. they do not change throughout the project) or vary over the years.
- the yearly benefits (B_t): the benefits from the project on a yearly basis; the benefits equals mainly the avoided costs (the costs of the accidents at work or the cases of work-related ill-health calculated with the Matrix). Whenever possible, other benefits such as extra production or time gain were also calculated;
- the index: an index of 3% on annual basis was used in order to compensate for inflation;
- the time span: investments were considered over a time span of 4 years; because of increasing uncertainty, the time horizon of economic decisions rarely exceeds a period of 4 years;
- taxes: the net cash flow was calculated taken into account a tax rate of 40%, which is the average rate which is used to calculate income taxes for companies;
- the discount rate: a discount rate of 10% was applied; this rate takes into account the time preference for money, the no-risk interest rate for borrowing money from a bank as well as a small compensation for risk taking.

The results of the cost-benefit analysis highly depend on the underlying assumptions. For calculating the costs of the health and safety interventions we used data derived from the companies. For some cases these data were complemented by other sources such as a price offer for buying equipment or an estimate of a consultant for providing training.

The calculation of the benefits (yearly benefits, B) is mainly based on the avoided costs. This means that first the costs of accidents at work or cases of work-related ill health in a given time period were ascertained. Then, an estimate had to be made on the costs due to the cases of accidents at work or work-related ill-health that can be avoided when implementing the proposed intervention. This estimate was based on

discussions with the company, expert opinions, data from research, etc. If possible, three scenarios were analysed (see below).

Future outcomes of an investment project are never completely certain. This means that the impact of an intervention on the cost of accidents and ill-health may vary depending on the actual circumstances (e.g. the economic situation, the staff turnover, the production process, etc). The fact that a cost-benefit analysis relies on the causal relationship, that has to be established between the intervention and the expected effect, is indeed a crucial point (Mossink, 1997; Lehmann and Thiehoff, 1997; Niven, 2002; Verbeek et al., 2009; Rower, 2010).

In order to deal with uncertainty, a sensitivity analysis can be used. In this analysis of case studies, the calculations will be repeated with different values for the most important variables allowing an assessment of the impact of these variations on the final result. In such a way, a minimal effect of the intervention on the costs (a conservative assumption of the costs that will be avoided in the future) can be compared with a more optimistic scenario (assumption of higher avoided costs related to accidents at work and work-related ill-health).

4.3 Preparation and data-gathering tool

During the preparatory phase of the field study, the tool was prepared to gather the data (4.3.1). At the same time, companies were approached in order to make a selection of the cases according to the scoping study (4.3.2).

4.3.1 Development of the data-gathering tool

To collect and analyse the data gathered in the case studies, an excel sheet was prepared. Table 24 provides an overview of the contents of the excel tool.

This excel sheet contains the following information:

- worksheets based on the Matrix allowing to calculate several cases of accidents at work or work-related ill-health, according to severity (8 low severity, 3 medium severity and 1 high severity);
- a worksheet with the overview of the costs brought together in the Matrix;
- a cost summary allowing to calculate the avoided costs for the cost-benefit analysis;
- worksheets to insert data for the cost-benefit analysis; also intangible benefits were recorded if data were available;
- a worksheet showing the results of the cost-benefit analysis for five summary measures (the economic indicators of a cost-benefit analysis as presented in box 14, see 4.2.2).

The tool contains several functions to support the data input such as the calculation of the Matrix based on the cost items, the changing of salary costs based on a change in personnel category, the calculation of the sum of the totals, the calculation of the average, the calculation of the economic indicators, etc.

Annex 4 provides more details on the tool using a fictitious example.

Table 24 - Excel tool for gathering data: overview

Worksheet	Data																																			
Cost calculation and case description (1 for each case)	<i>Case description</i> date of the accident/work-related ill-health victim: profession (general) gender: male/female status: fulltime/parttime; blue collar/white collar age: selection of age category seniority (rounded) type of injury/sickness days of absenteeism short description of the case salary costs per working hour (5 categories) cost items (see table 23) total costs and costs according the matrix amount paid by insurer																																			
Overview of the costs	sum of all costs per category of severity and total (in matrix)																																			
Cost summary allowing to calculate the avoided costs for the cost-benefit analysis 3 scenario's	average cost per case median costs estimated number of cases per year estimated % of cases that could be avoided by the specified prevention measures																																			
Data for the cost-benefit analysis (1 for each scenario)	<table border="1"> <tr> <td rowspan="6">Type of preventive measure</td> <td>substitution/avoidance (I)</td> </tr> <tr> <td>organisational measure (II)</td> </tr> <tr> <td>new equipment/auxiliaries (III)</td> </tr> <tr> <td>workplace adjustment (IV)</td> </tr> <tr> <td>training (V)</td> </tr> <tr> <td>personal protective equipment (VI)</td> </tr> <tr> <td rowspan="4">initial investment</td> <td>study</td> </tr> <tr> <td>change of work organisation, working method</td> </tr> <tr> <td>equipment</td> </tr> <tr> <td>implementation</td> </tr> <tr> <td rowspan="3">annual costs</td> <td>training</td> </tr> <tr> <td>maintenance</td> </tr> <tr> <td>equipment</td> </tr> <tr> <td rowspan="4">annual benefits</td> <td>training</td> </tr> <tr> <td>extra production</td> </tr> <tr> <td>time gain</td> </tr> <tr> <td>lower costs</td> </tr> <tr> <td rowspan="6">Intangible benefits</td> <td>avoided costs (less cases of accidents at work/work-related ill-health)</td> </tr> <tr> <td>improvement of job satisfaction</td> </tr> <tr> <td>improvement of work atmosphere</td> </tr> <tr> <td>improvement of workers involvement</td> </tr> <tr> <td>improvement of corporate image</td> </tr> <tr> <td>less staff turnover</td> </tr> <tr> <td rowspan="5">Results of the cost-benefit analysis</td> <td>other</td> </tr> <tr> <td>pay-back period (years)</td> </tr> <tr> <td>internal rate of return</td> </tr> <tr> <td>net present value</td> </tr> <tr> <td>profitability index</td> </tr> <tr> <td>benefit-cost ratio</td> </tr> </table>	Type of preventive measure	substitution/avoidance (I)	organisational measure (II)	new equipment/auxiliaries (III)	workplace adjustment (IV)	training (V)	personal protective equipment (VI)	initial investment	study	change of work organisation, working method	equipment	implementation	annual costs	training	maintenance	equipment	annual benefits	training	extra production	time gain	lower costs	Intangible benefits	avoided costs (less cases of accidents at work/work-related ill-health)	improvement of job satisfaction	improvement of work atmosphere	improvement of workers involvement	improvement of corporate image	less staff turnover	Results of the cost-benefit analysis	other	pay-back period (years)	internal rate of return	net present value	profitability index	benefit-cost ratio
Type of preventive measure	substitution/avoidance (I)																																			
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	change of work organisation, working method																																			
	equipment																																			
	implementation																																			
annual costs	training																																			
	maintenance																																			
	equipment																																			
annual benefits	training																																			
	extra production																																			
	time gain																																			
	lower costs																																			
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	internal rate of return																																			
	net present value																																			
	profitability index																																			
benefit-cost ratio																																				

4.3.2 Selection of the companies

The scoping study forms the basis for the case studies. In order to attract companies both Prevent and KOOP communicated on the project through their normal communication channels such as website, e-zines, training sessions, etc.

Interested institutions/companies were contacted by phone. Explaining the study, the contact persons were presented with arguments how companies could benefit from participating in the study: individual companies could improve their prevention strategies by comparing the cost effectiveness and they could also identify savings in relation to needed investments. The calculated figures can be easily understood by the management and would thus improve the communication between management and OSH professionals. Companies in general could benefit by encouraging others to improve the health and safety situation, which would contribute to more fair competition.

Interested persons contacted by phone would then be sent the benOSH information sheet. They would be again contacted after about a week and in case of a positive reaction the further steps would be discussed. In general more than 80% of the approached persons responded positive in a sense that they regarded the idea as quite useful. Those who declined to support the study said that they had no time for this or said that they had established a high level of safety and health in their companies and there was no need to justify this investment and the recurrent costs. Some did not give any reasons at all and delayed a definite response.

The following institutions were approached:

Accident insurance associations

All together 25 persons in Germany, 5 in Austria, 5 in Switzerland were approached as well as the Belgian accident insurers. Most accident insurers were interested in the study but in practice it was not always possible to get into contact with companies that fitted the scope.

Companies directly

All together 100 companies in Germany, 75 in Belgium, 2 in Austria, 2 in Switzerland were approached directly without any intermediates. The selection was made based on the scoping study using the NACE codes.

Some, usually smaller, companies said that they had no time for the study. Smaller companies were also more reluctant to participate because they were afraid of the consequences (considered it to be an 'inspection'). In some cases, smaller companies did not meet with the conditions set out in the scoping study (not sufficient cases), so it was not possible to include them. Other companies, usually the bigger ones, said that they had established a high level of safety and health in their companies and there was no need to justify this investment and the recurrent costs. In some cases it was stated that in general the company would be interested but that management decided against taking part in the study.

External OSH services

A number of 25 institutes were approached. All of them reacted positively and promised to organise contacts to companies that could be interested in taking part in the field study. In Belgium three external OSH services collaborated in searching for companies.

Associations

A vast variety of associations were approached: employers', employees' and various sector associations were contacted. All contacted persons were interested in the study and offered support ranging from putting the benOSH information into their circulars to directly contacting their companies. However the number of companies that actually contacted us and took part in the study via these associations was quite low.

Health insurance associations

Five German health insurance associations were approached. All of them reacted positive and promised to organise contacts to companies that could be interested in taking part in the field study.

Approaching and convincing companies proved to be a time-consuming task. It required lots of phone-calls, e-mails and convincing. The interest of companies was high but it was also a question of fitting their interests into the scope (sometimes they wanted to study different types of accidents or work-related health problems) and into the planning of the project. The most difficult proved to be, finding enough cases of work-related ill-health. Although a lot of companies are faced with the burden of work-related illness, it is not easy to get any data. Sometimes the problem is not recognised ('we don't have any cases') or it is not recorded (data on absenteeism don't include information on the issue of work-relatedness or diagnosis, see also 5.2.2).

4.4 The field study

The execution of the field study consisted of several stages:

- contact by phone: collecting general information;
- on site visit: collecting cost information on specific cases and discussion about preventive measures;
- external expertise for identifying preventive measures;
- collection of data for preventive measures and cost-benefit analysis;
- analysis: reporting to the company.

Firstly companies were contacted by phone and to ask for information. This information resulted in general information about the company and, more particularly, about their accidents at work and cases of work-related ill-health.

For each of the companies the following types of data could be collected:

- company identification: name, address, contact person;
- size of the company;
- type of process;
- activity: NACE, short description of activities;
- total number of accidents at work/cases of ill health related to the risk;
- total number of accidents at work/cases of ill health.

During the on site visits interviews were conducted to gather cost data about the selected cases. Mostly the OSH professional was the contact person within the company. The interviews focused on the consequences of the selected cases allowing determining the costs. Cost data were introduced in the Matrix. Also a discussion took place about possible preventive measures, their costs and the estimated effectiveness. Often, it proved difficult to gather all data during these interviews due to the fact that the OSH professional did not have all information. This was mostly the case for data that are not recorded by them such as the amount paid by the insurer or the cost of equipment. If necessary, the companies were contacted by phone and/or e-mail to complete any lacking information.

The identification of preventive measures was also based on expert information (OSH experts or literature). External expertise proved to be useful since companies often focused on one measure and we also wanted to study alternatives. Furthermore, external expertise helped determining the effectiveness that could be expected of some measures (see also 4.2). If necessary, lacking information about the cost of preventive measures such as the price of equipment, training... was searched through manufacturers, service providers, etc.

Every company received a short report of its case study indicating the costs of the selected accidents at work or cases of work-related ill-health as well as the results from the cost-benefit analysis.

4.5 Overview of the results

4.5.1 The scope of the case studies

The case studies assessed the costs of cases of accidents at work and work-related ill-health in several companies. At the same time we evaluated the costs and benefits of preventive measures tackling the risks related to the cases in these companies.

In total 401 cases of accidents at work and work-related ill-health were analysed: 276 with low severity, 73 with medium severity and 52 with high severity. For each of this accident at work or case of work-related ill-health the costs were calculated based on an analysis of the consequences. The cases derived from 13 sectors (table 25). The best represented sectors are construction (29%), transport (17%) and hospital/social services (15%). For the chemical sector, the energy and distribution sector only a limited number of cases were investigated.

For the 56 projects for which a cost-benefit analysis was conducted, the distribution according to sector is similar. Most of the projects came out of the construction sector (25%) followed by metal (16%) and hospital/social services (14%).

The cases were clustered into 15 types of cases of accidents at work or work-related ill-health (table 26). Slips/trips (27%) and back problems (15%) comprise the largest number of cases. For other types, there were only a limited number of cases available e.g. stress, fire, asthma.

For the cost-benefit analysis, falls from height, back problems and slips and trips, account each for 14.3% of the cases.

Table 25 - Overview of the cases (cost-calculations and cost-benefit analysis) according to sector

	cases of accidents at work and work-related ill-health								cost-benefit analysis	
	low		medium		high		total			
	#	%	#	%	#	%	#	%	#	%
chemical sector	3	1.1	0	0.0	1	1.9	4	1.0	1	1.8
cleaning	12	4.3	2	2.7	0	0.0	14	3.5	2	3.6
construction	74	26.8	20	27.4	21	40.4	115	28.7	14	25.0
distribution	1	0.4	2	2.7	0	0.0	3	0.7	1	1.8
energy	5	1.8	1	1.4	0	0.0	6	1.5	1	1.8
food	17	6.2	10	13.7	3	5.8	30	7.5	4	7.1
hospital/social	44	15.9	10	13.7	7	13.5	61	15.2	8	14.3
metal	37	13.4	2	2.7	8	15.4	47	11.7	9	16.1
mining	14	5.1	6	8.2	2	3.8	22	5.5	3	5.4
services	0	0.0	0	0.0	1	1.9	1	0.2	1	1.8
textiles	7	2.5	2	2.7	1	1.9	10	2.5	1	1.8
transport	51	18.5	13	17.8	6	11.5	70	17.5	7	12.5
waste	11	4.0	5	6.8	2	3.8	18	4.5	4	7.1
	276	100.0	73	100.0	52	100.0	401	100.0	56	100.0

Table 26 - Overview of the cases (cost-calculations and cost-benefit analysis) according to type

	cases of accidents at work and work-related ill-health								cost-benefit analysis	
	low		medium		high		total			
	#	%	#	%	#	%	#	%	#	%
aggression	9	3.3	5	6.8	1	1.9	15	3.7	2	3.6
allergic reaction	15	5.4	1	1.4	3	5.8	19	4.7	4	7.1
asthma	0	0.0	1	1.4	0	0.0	1	0.2	1	1.8
back problems	38	13.8	16	21.9	7	13.5	61	15.2	8	14.3
car-accidents	9	3.3	1	1.4	1	1.9	11	2.7	2	3.6
cuts	31	11.2	2	2.7	4	7.7	37	9.2	6	10.7
electric shock	6	2.2	2	2.7	2	3.8	10	2.5	3	5.4
eye injuries	23	8.3	1	1.4	0	0.0	24	6.0	3	5.4
fall from height	11	4.0	5	6.8	12	23.1	28	7.0	8	14.3
fire	2	0.7	0	0.0	0	0.0	2	0.5		
forklift/pallet truck	16	5.8	6	8.2	2	3.8	24	6.0	2	3.6
machines	24	8.7	12	16.4	5	9.6	41	10.2	6	10.7
needle sticks	17	6.2	0	0.0	1	1.9	18	4.5	2	3.6
slips and trips	75	27.2	21	28.8	13	25.0	109	27.2	8	14.3
stress	0	0.0	0	0.0	1	1.9	1	0.2	1	1.8
	276	100.0	73	100.0	52	100.0	401	100.0	56	100.0

Comparing the actual scope with the proposed scope in chapter 3 (see table 22) it can be noted that more companies than proposed took part in the study and that much more cases were recorded (234 proposed cases – 401 actually recorded cases). However it was not always possible to get the data for proposed special cases like problems caused by vibrations and stress. This was due to the limited time frame and the general problem to get data on work related ill-health as further described in chapter 5.

4.5.2 Consequences of accidents at work and work-related ill-health

Cost consequences along the HEEPO clusters

Table 32 (annex 5) shows the data from the cost calculations clustered into the cost categories of the Matrix: Human, Equipment, Environment, Product and Organisation (see also tables 27 and 28). The results show that the most important consequences of accidents at work and work-related ill-health are related to the aspect Human: 88% of the cost consequences are situated in this area. Cost items such as absence, over time, first aid, etc. are part of the aspect Human. Organisation is affected by almost 10% of the cost consequences. Organisation comprises items such as investigation time, administration, training time, etc. The other categories are very small, less than 1%.

This distribution is more or less the same for the different severity categories. However, the more severe the accident or case of work-related ill-health, the greater the impact on the Human category. Or, for accidents or cases of work-related ill-health with low severity the impact of Organisation is relatively more important than for cases with medium or high severity: 16% for low severity cases compared to 6.8% and 5.3% for respective medium and high severity cases.

The way that accidents at work or cases of work-related ill-health affects the categories Human, Equipment, Environment, Product and Organisation is linked to the type of case. This is illustrated in table 27. Cases such as allergic reactions and back problems have almost no impact on the categories Equipment,

Environment and Product, whereas cases such as forklift and car accidents also affect Equipment, Environment and Product. This is due to the type of the accident. It is clear that these kinds of accidents can have considerable consequences that go beyond the human and organisational aspect.

Table 27 - Costs of accidents at work and work-related ill-health clustered into HEEPO (%), selection of specific types

	# cases		human	equipment	environment	product	organisation
allergic reactions	19	low severity	87.5	0.5	0.0	0.3	11.7
		medium severity	97.0	0.0	0.0	0.0	3.0
		high severity	96.9	0.0	0.0	0.0	3.1
		all	95.7	0.1	0.0	0.1	4.1
back problems	58	low severity	86.6	0.1	0.0	0.1	13.2
		medium severity	92.4	0.0	0.0	0.1	7.4
		high severity	97.4	0.0	0.0	0.1	2.5
		all	93.8	0.0	0.0	0.1	6.1
car-accidents	11	low severity	74.6	5.1	0.0	11.4	9.0
		medium severity	89.8	0.0	0.0	0.0	10.2
		high severity	74.7	2.2	0.0	21.1	2.0
		all	77.2	3.6	0.0	11.1	8.1
cuts	37	low severity	89.8	0.1	0.0	0.0	10.1
		medium severity	89.2	0.0	0.0	0.0	10.8
		high severity	95.8	0.0	0.0	0.0	4.1
		all	94.1	0.1	0.0	0.0	6.9
forklift/pallet truck	24	low severity	74.1	2.8	9.5	0.9	12.8
		medium severity	95.6	1.1	0.0	0.2	3.2
		high severity	68.6	15.2	0.0	8.4	7.7
		all	83.9	5.7	1.2	2.6	6.5
All cases	401	low severity	82.6	0.4	0.4	0.6	16.0
		medium severity	91.5	0.1	0.0	1.5	6.8
		high severity	92.8	0.9	0.0	1.0	5.3
		all	88.5	0.4	0.0	0.7	9.4

The sector has less impact on the distribution between the categories Human, Equipment, Environment, Product and Organisation. A case of back problems in the construction sector is comparable with that in a hospital or in social services. The same goes for slips and trips in the waste sector, the metal sector, transport and construction (table 28).

Cost consequences in monetary values

Table 33 (annex 5) shows data from all cost calculations (see also table 29). The data show a wide range of costs. Since the study also comprised cases with no absence, the costs were sometimes relatively small. A straightforward relationship could be established: the more severe the cases of accidents at work or work-related ill-health, the higher the costs. The median of accidents at work and work-related ill-health of cases with low severity is €1,651.54; for cases with medium severity, the median amounts to €4,985.9; for cases with high severity, the median is €11,760.35. These monetary values only represent the costs borne by the employers. Costs borne by the insurer were not calculated and if the insurer compensated the employer, this cost was deducted¹⁹.

¹⁹ In a limited number of cases, it proved impossible to obtain actual data on compensation; estimates were used.

Table 28 - Costs of accidents at work and work-related ill-health clustered into HEEPO (%), selection: sector/type with 8 cases and more

Sector	Type	# cases	low severity				medium severity				high severity				all					
			human	equipment	environment	product	organisation	human	equipment	environment	product	organisation	human	equipment	environment	product	organisation			
construction	back problems	9	73.1	0.0	0.0	0.0	94.0	0.0	0.0	6.0	97.9	0.0	0.0	0.0	2.1	96.1	0.0	0.0	0.0	3.9
construction	electric shock	10	51.5	0.1	0.0	0.0	48.4	75.1	1.1	23.8	50.1	1.7	0.0	0.0	48.3	56.0	1.5	0.0	0.0	42.5
construction	eye injuries	19	74.5	0.3	0.0	0.0	25.2	93.6	0.0	6.4	-	-	-	-	-	75.9	0.2	0.0	0.0	23.9
construction	fall from height	19	70.7	0.0	0.0	0.0	28.4	89.3	0.0	10.7	92.2	0.0	0.0	0.0	7.6	84.5	0.0	0.0	0.0	15.0
construction	slips and trips	47	81.4	0.2	0.0	1.9	16.5	91.9	0.0	7.2	95.5	0.0	0.0	0.4	4.0	90.7	0.1	0.0	1.0	8.3
hospital/social	back problems	26	90.2	0.0	0.0	0.0	95.5	0.0	0.0	4.5	98.1	0.0	0.0	0.0	1.9	95.9	0.0	0.0	0.0	4.1
hospital/social	needle sticks	18	72.0	0.0	0.0	0.0	28.0	-	-	-	98.5	0.0	0.0	0.0	1.5	81.6	0.0	0.0	0.0	18.4
metal	cuts	30	84.7	0.2	0.0	0.0	15.1	80.1	0.0	19.9	95.8	0.0	0.0	0.0	4.1	91.9	0.1	0.0	0.0	10.0
metal	slips and trips	8	87.1	0.2	0.0	0.0	12.6	-	-	-	94.6	0.1	0.0	0.0	5.3	91.6	0.1	0.0	0.0	8.3
transport	forklift/pallet truck	24	74.1	2.8	9.5	0.9	12.8	95.6	1.1	3.2	68.6	15.2	0.0	8.4	7.7	83.9	5.7	1.2	2.6	6.5
transport	slips and trips	8	94.9	0.0	0.0	0.0	5.1	98.2	0.0	1.8	98.7	0.0	0.0	0.0	1.3	97.3	0.0	0.0	0.0	2.7
waste	slips and trips	11	73.2	0.0	0.0	0.0	26.8	95.4	0.0	4.6	-	-	-	-	-	92.9	0.0	0.0	0.0	7.1
Overall average		401	82.6	0.4	0.4	0.6	16.0	91.5	0.1	6.8	92.8	0.9	0.0	1.0	5.3	88.5	0.4	0.0	0.7	9.4

Note: detailed results from all cases in table 32, annex 5

Table 29 - Costs of accidents at work and work-related ill-health according to severity, selection: sector/type with 8 cases and more

Sector	Risk	# cases	Low severity				Medium severity				High severity			
			# cases	lowest cost	highest cost	median	# cases	lowest cost	highest cost	median	# cases	lowest cost	highest cost	median
construction	back problems	9	6	€523.40	€1,782.54	€1,152.97	1	-	€4,429.84	€2,214.92	2	€18,073.49	€45,739.23	€31,906.36
construction	electric shock	10	6	€243.25	€4,879.66	€1,838.86	2	€3,522.05	€4,278.19	€3,900.12	2	€6,028.58	€22,667.00	€14,347.79
construction	eye injuries	19	18	€46.65	€6,353.56	€1,034.10	1	€6,173.69	€6,173.69	€6,173.69	0	-	-	-
construction	fall from height	19	10	€416.45	€3,070.49	€2,810.94	2	€652.14	€4,773.56	€2,712.85	7	€8,231.93	€22,249.93	€11,553.05
construction	slips and trips	47	28	€237.05	€4,335.75	€1,933.86	11	€2,970.49	€8,190.68	€4,594.59	8	€7,214.95	€29,295.72	€10,531.41
hospital/social	back problems	26	15	€642.28	€2,843.80	€1,096.51	8	€2,001.90	€8,282.30	€3,144.15	3	€8,002.04	€21,995.09	€9,375.30
hospital/social	needle sticks	18	17	€179.75	€747.10	€305.23	0	-	-	-	1	€3,467.75	€3,467.75	€3,467.75
metal	cuts	30	25	€221.93	€2,906.63	€1,983.18	1	-	€2,031.75	€1,015.88	4	€3,063.85	€11,760.35	€4,473.66
metal	slips and trips	8	7	€495.33	€11,873.06	€3,740.65	0	-	-	-	1	€30,276.05	€30,276.05	€30,276.05
transport	forklift/pallet truck	24	16	€278.27	€2,507.43	€1,063.83	6	€2,871.61	€12,239.48	€4,694.78	2	€8,555.10	€10,126.55	€9,340.82
transport	slips and trips	8	6	€2,120.15	€7,630.95	€4,875.55	1	€14,905.35	€14,905.35	€14,905.35	1	€14,436.67	€14,436.67	€14,436.67
waste	slips and trips	11	9	€421.10	€2,959.15	€650.78	2	€5,100.57	€6,852.89	€5,976.73	0	-	-	-
	All cases	401	276	€46.65	€11,873.06	€1,644.22	73	€521.13	€16,435.50	€4,985.90	52	€3,063.85	€45,758.18	€11,760.35

Note: detailed results from all cases in table 33, annex 5

Figures 28-30 present the lowest and highest cost as well as the median value for the accidents at work and cases of work-related ill-health clustered according to type. For cases with low severity, aggression has the highest median followed by car accidents. Back pain entails the most costs in the category of cases with high severity. Falls from height show high median values in all categories as well as accidents with machines. Slips and trips show rather average median values in all categories but since these kinds of accidents are common and widespread their total impact must not be underestimated.

Figure 28 - Costs of accidents at work and work-related ill-health based on the case studies according to type, cases with low severity

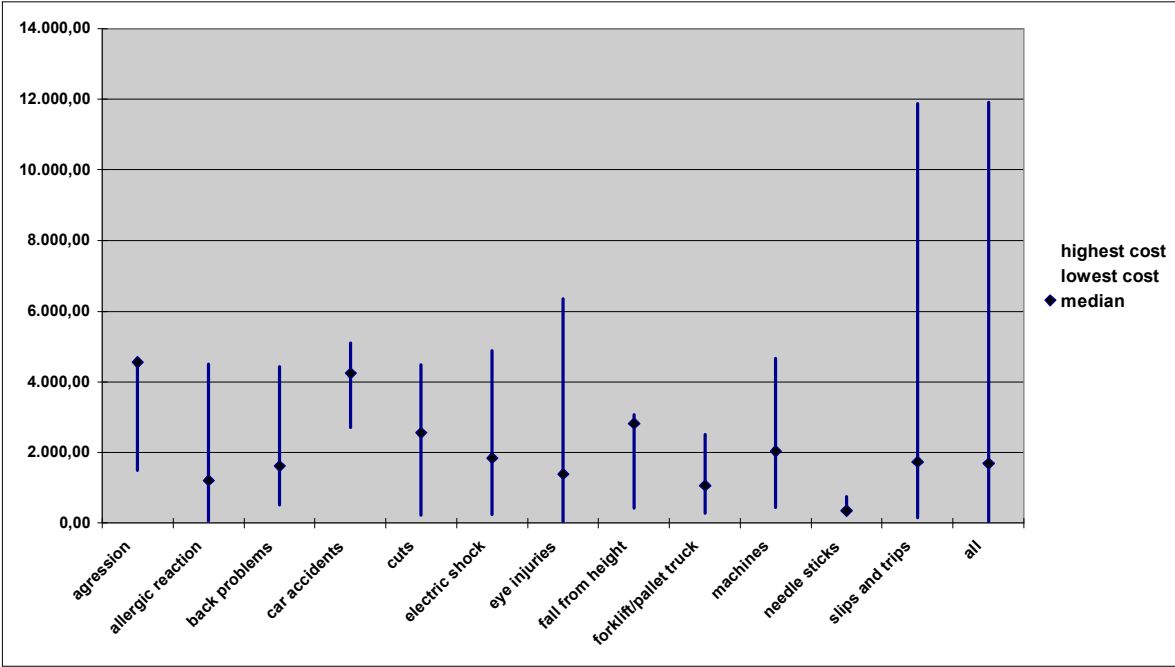


Figure 29 - Costs of accidents at work and work-related ill-health based on the case studies according to type, cases with medium severity

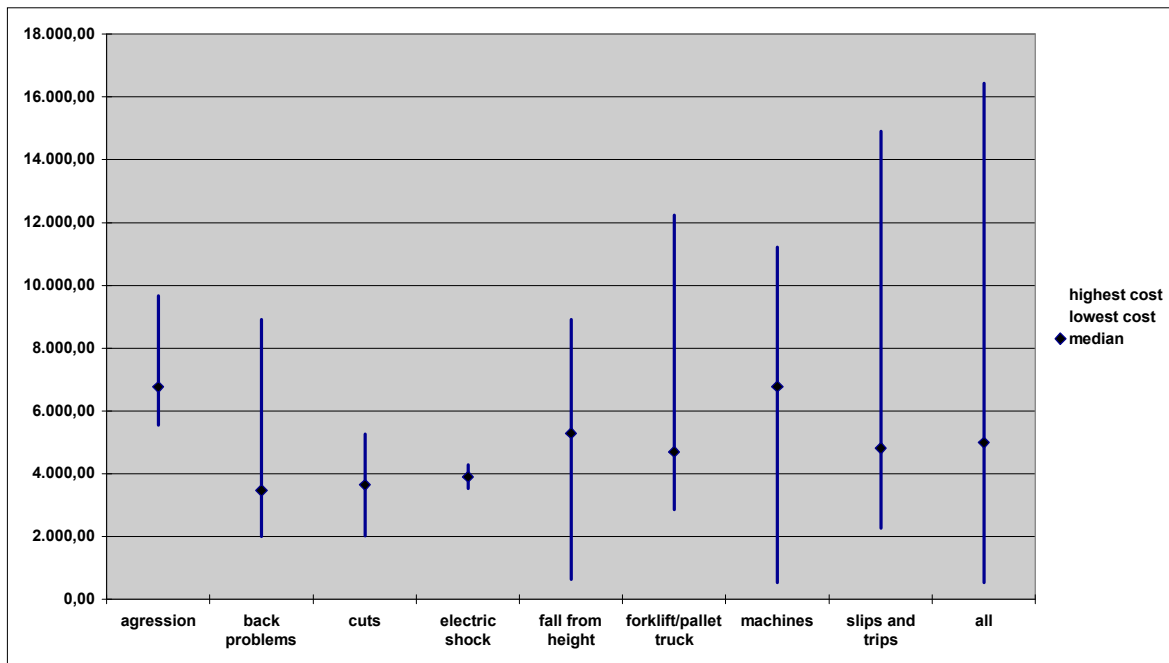
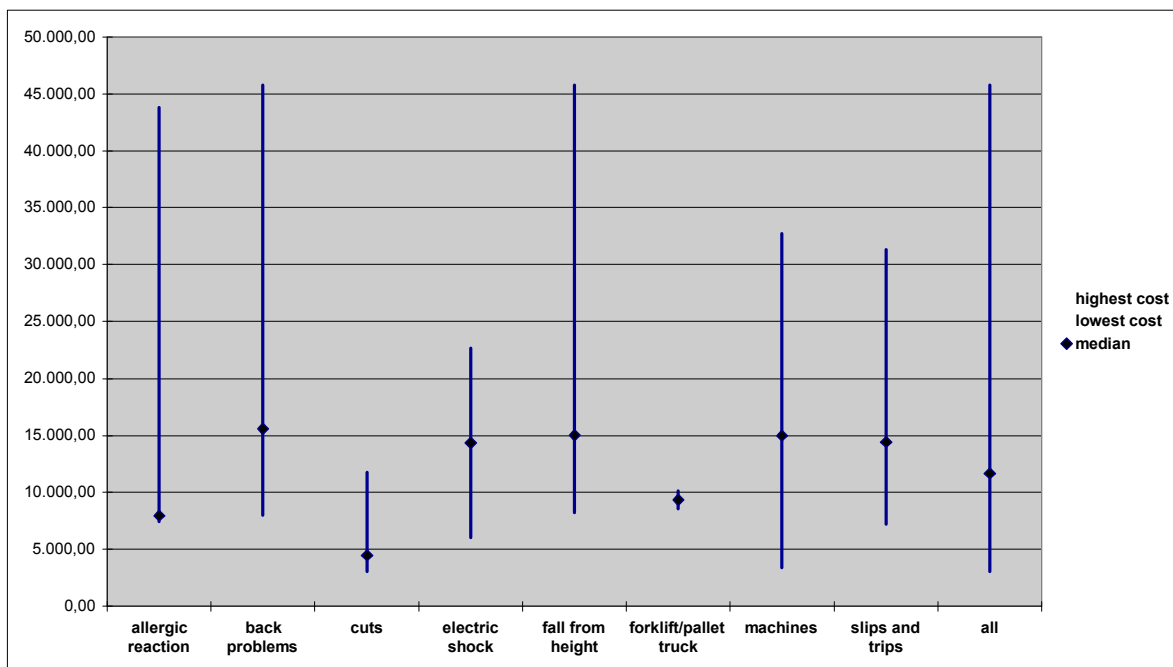


Figure 30 - Costs of accidents at work and work-related ill-health based on the case studies according to type, cases with high severity



Figures 31-33 present the lowest and highest cost as well as the median value for the accidents at work and cases of work-related ill-health clustered according to sector. The cleaning sector has the highest values in both the category with low and medium severity. Hospital/social services show the lowest values in those categories. However, the results tend to vary and it is difficult to discern a tendency. The economic sector seems to have less of an impact on the cost consequences than the type of case.

Figure 31 - Costs of accidents at work and work-related ill-health based on the case studies according to sector, cases with low severity

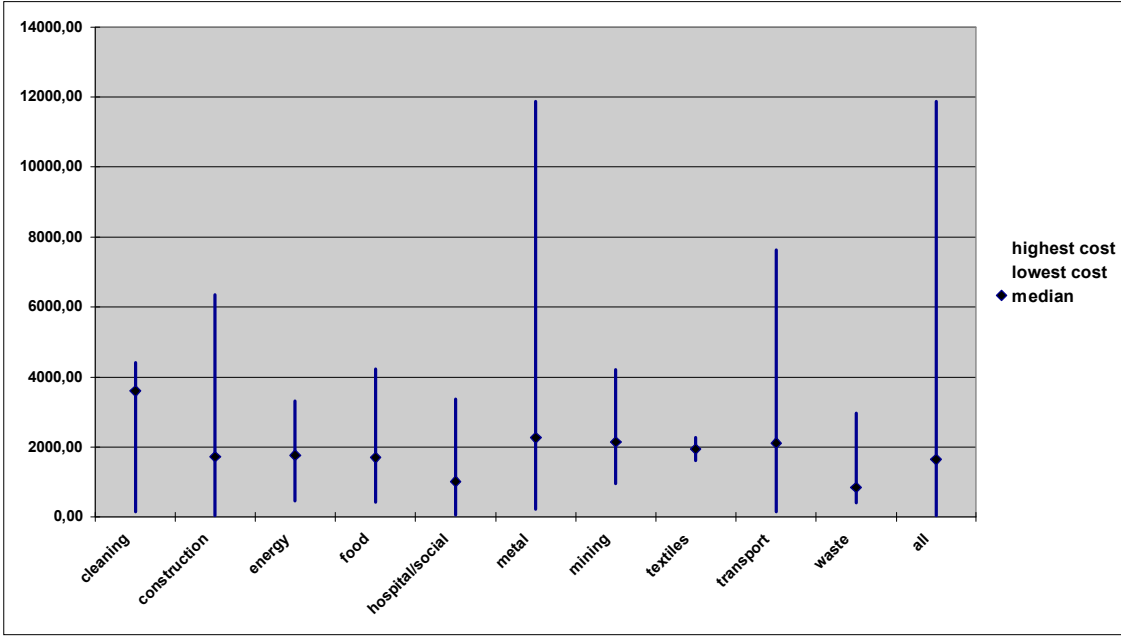


Figure 32 - Costs of accidents at work and work-related ill-health based on the case studies according to sector, cases with medium severity

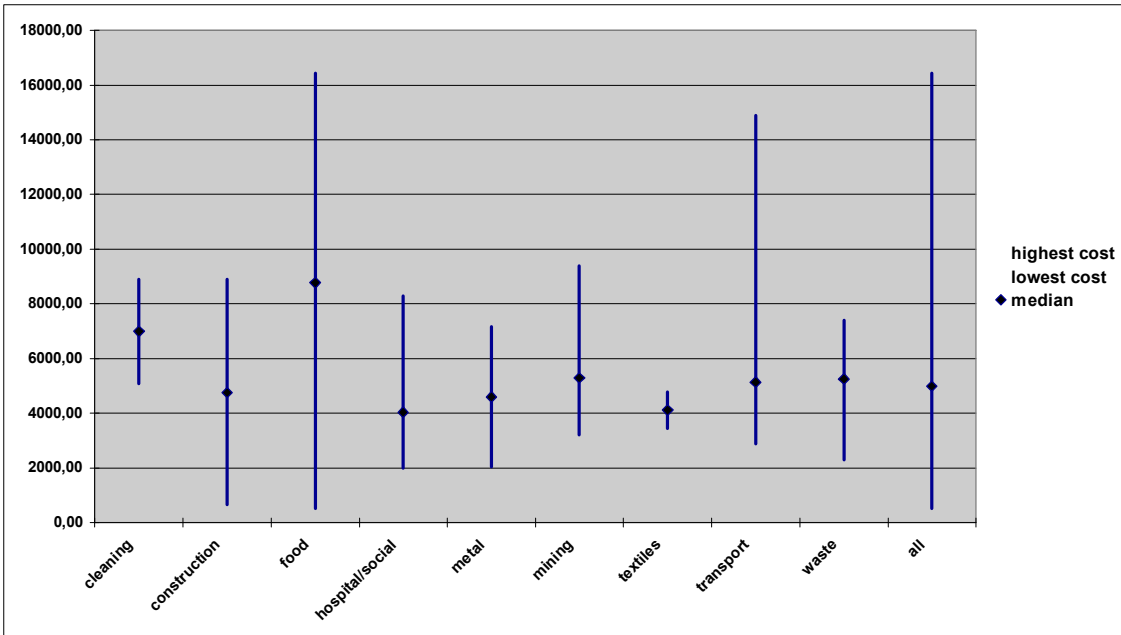
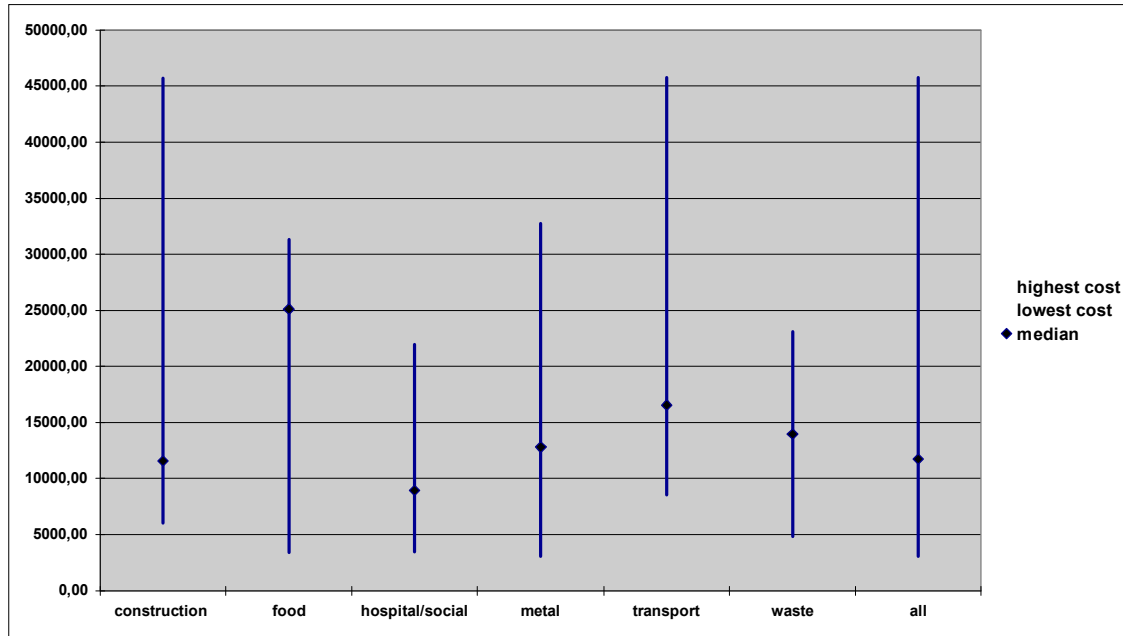


Figure 33 - Costs of accidents at work and work-related ill-health based on the case studies according to sector, cases with high severity



4.5.3 Benefits of preventive measures

The cost-benefit analyses show a variety of results (table 34, annex 5). The results give a short description of the measure and the economic indicators that came out of the analysis: Net Present Value, Profitability Index and Benefit-Cost Ratio. If possible, three scenarios were analysed. The first and second scenario assess the costs and benefits of the same set of prevention measures, but the first scenario is based on a conservative estimate of the costs of accidents at work or work-related ill-health that could be avoided, while the second scenario takes a more optimistic assumption. These assumptions of how many costs of accidents at work or work-related ill-health could be avoided are based on discussions with the company, expert opinions, data from research and good practice. This is then reflected in two estimates, a conservative one, calculated in the first scenario, and a more optimistic one, calculated in the second. The third scenario considered either an alternative measure or additional measures.

The measures were clustered along six main categories: substitution/avoidance (I), organisational measure (II), new equipment/auxiliaries (III), workplace adjustment (IV), training (V), personal protective equipment (VI). In many cases a set of preventive measures were considered but for clustering purposes, the main measure is indicated in the tables. In most projects the main measure was the purchase of new equipment, auxiliaries or adapting the equipment (table 30). Training, instructions, awareness raising campaign were in second place. It has to be noted that extra training was often a supportive or additional measure (scenario 3).

Table 30 shows the median values of the Net Present Value, Profitability Index and Benefit-Cost Ratio for all projects along the clusters of the six types of measures. The highest values can be found for measures aimed at substitution or avoidance. The lowest values can be found for measures such as training and personal protective equipment. These results seem to support the case that measures considered to be the most effective according to the prevention principles are also more cost-effective (profitable).

However, since the cost-benefit analyses derive from specific case studies the results have to be carefully interpreted. Numerous variables influence the results such as the number of employees, the measures that are already in place, the activities, the circumstances in the workplace, ... Table 31 gives examples where similar measures were considered for similar risks. The results however are different and not comparable. But, in general, the case studies support the fact that investing in occupational safety and health is profitable. The economic indicators differ but the projects do result in positive net present values. Both the profitability index and the benefit-cost ratio depict the positive impact of the projects. Especially when several measures are brought together into a comprehensive programme, a positive return can be expected.

Table 30 - Overview of the projects according to type of measure (main measure) – median values

Measure	Code	#	%	Scenario 1*			Scenario 2*		
				Net Present Value	Profitability Index	Benefit-Cost Ratio	Net Present Value	Profitability Index	Benefit-Cost Ratio
substitution/avoidance	I	3	5.4	2,207.52	2.56	1.60	13,857.89	4.08	2.25
organisational measure	II	6	10.7	2,310.96	1.74	1.04	21,829.57	3.18	1.36
new equipment/auxiliaries	III	20	35.7	1,713.35	1.41	1.40	8,983.74	2.76	2.70
workplace adjustment	IV	6	10.7	2,389.38	1.37	1.22	8,984.01	2.15	1.66
training	V	16	28.6	605.02	0.95	1.12	8,092.65	3.39	2.51
personal protective equipment	VI	5	8.9	154.38	1.05	1.18	11,038.12	1.83	2.10
<i>all</i>		56	100	1,434.875	1.29	1.21	9,218.81	2.89	2.18

*Scenario 1 is based on a conservative assumption of the costs related to accidents at work and work-related ill-health that can be avoided; Scenario 2 takes a more optimistic assumption.

Table 31 - Selection of cases with similar measures

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
construction	slips and trips	adapting the work organisation; at the end of each work day, 1 worker is responsible for clean-up (in turn) additional: awareness raising campaign	1	II	30%	2,418.46	3.42	1.02
			2	II	50%	14,904.80	15.90	1.10
			3	II	55%	17,343.37	9.67	1.12
construction	slips and trips	intensive awareness raising campaign additional: adapting the work organisation; at the end of each work day, 1 worker is responsible for clean-up (in turn)	1	V	10%	9,187.47	2.39	3.46
			2	V	20%	13,183.68	3.00	4.47
			3	V	55%	10,998.25	2.67	1.08
metal	cuts	Improved cut-resistant gloves & introduction of PET straps. The improved glove is more tear resistant and flexible than the previous. Workers can now carry out finer tasks while still experiencing a high degree of comfort. The introduction of PET straps will further increase accident reduction. additional: awareness-raising	1	IV	30%	2,799.20	1.43	1.24
			2	IV	50%	6,303.55	1.97	1.50
			3	IV	60%	7,372.72	1.98	1.55
metal	cuts	Improved cut-resistant gloves & introduction of PET straps. The improved glove is more tear resistant and flexible than the previous. Workers can now carry out finer tasks while still experiencing a high degree of comfort. The introduction of PET straps will further increase accident reduction. additional: awareness-raising	1	IV	30%	1,979.55	1.30	1.18
			2	IV	50%	4,937.48	1.76	1.40
			3	IV	75%	7,951.87	2.06	1.59

5 Conclusions

The results from the case studies demonstrate the positive effects of investing in occupational safety and health measures. Accidents at work and work-related ill-health account for considerable costs on company level. These costs can be reduced or even eliminated by implementing safety and health measures; these investments in health and safety turned out to be profitable (5.1). And although several problems were encountered in conducting the case studies, in practice it showed that both the costs and the benefits of occupational safety and health provide arguments on company level (5.2). In order to promote economic assessments of preventive safety and health measures, several needs and gaps need to be taken into account (5.3). Finally, based on the results of the literature review and of the case studies key messages are defined (5.4).

5.1 Economic assessments in support of OSH

5.1.1 Costs of accidents at work and work-related ill-health

The cost calculations showed that accidents at work and work-related ill-health bring about considerable costs. The case studies showed a median of €1,651.54 for cases of accidents at work and work-related ill-health with low severity, of €4,985.9 for cases with medium severity and of €11,661.69 for cases with high severity. These costs fall entirely on the employer. Most costs affect the category Human and to a lesser degree also the category Organisation of the HEEPO-classification. The areas Equipment, Environment and Product as used in the HEEPO classification, are negligible. Only in specific types of cases, such as car or forklift accidents, these areas are affected. The type of case also affects the monetary values. Falls from height entail overall the highest costs. The sector seems to have a limited impact on the cost level.

The costs mentioned are the costs borne by the employer. They have to be considered in light of the severity definition that was used for the study. For instance the cases with low severity also included very small cases with no absence and a limited impact. It can be argued that the study showed that these minor cases must not be ignored and bring about costs that seldom are noticed. Mostly they are not registered let alone reported to the insurer.

Furthermore, in valuing lost time it cannot be ignored that companies have buffers and spare capacity to deal with disruptions (see also Lehmann and Thiehoff, 1997). In the case studies this impact was valued to some extent (see case descriptions) but it is clear that these costs go beyond accidents at work and cases of work-related ill-health and affect the overhead costs of the company.

The cost assessments did not put monetary values to all consequences of accidents at work and work-related ill-health. Effects on staff morale, customer satisfaction, market share, etc. were not valued.

Therefore the costs must not be regarded as an absolute value (the price paid for a case) but seen in light of the possible benefits.

In analysing the consequences and the associated costs, it becomes clear that consequences reach beyond what is easy noticeable. As shown in the pond model (figure 12), consequences can occur in a later stage or in another place. In the case of needle stick injuries for instance, a nurse sometimes is confronted with a six month period of uncertainty about a possible infection. When a courier of a delivery company has an accident and can't make the delivery, the client has to be compensated. In that respect, the analysis and calculation proved to be highly interesting. It was maybe not so much the exact amount that came out of the analysis, but the fact that more consequences could be revealed, that served as an eye-opener. However, it

also demonstrated that it is not possible to capture all consequences. As stated before, the impact on staff morale for instance, is difficult to estimate. Discussions showed that these aspects do play a role but one has to accept that it is not always possible to calculate the economic value of every single consequence.

5.1.2 Benefits of preventive measures

The benefits of preventive measures seem to be higher for measures that are ranked high in the prevention hierarchy such as risk avoidance. These types of measures have the highest median values for Profitability Index and Benefit-Cost Ratio. However, because the results of a cost-benefit analysis are influenced by many variables, they have to be interpreted carefully. Studies mention variables such as the existing OSH practice (a return on investment could be greater in companies with a low level of OSH management), the type of intervention and the amount of the investment (Eurofound, 1998). These variables play certainly a role as well as many others such as the type of company, the safety culture, OSH knowledge, existing structures, procedures and measures, work organisation, market and competition, etc. The impact of all these variables cannot be excluded since they are an inherent part of tailor-made case studies.

But, in general, the case studies support the fact that investing in occupational safety and health is profitable. The economic indicators differ but the projects do result in positive net present values. Both the Profitability Index and the Benefit-Cost Ratio show the positive impact of the projects. Especially when several measures are brought together into a comprehensive programme, a positive return can be expected.

The median value for the Profitability Index was 1.29 for the conservative scenario and 2.89 for the more optimistic scenario. A recent German study (Kohstall, 2008) assessed the relation between prevention benefits and costs using standardised interviews. The ratios found are similar to our study (average 1.67; median 1.54).

Companies showed a great interest in the approach. Calculating the actual costs proved to be convincing and although the results did not always show large amounts, they still were eye-openers. The study did reveal that the costs are mostly underestimated and that it is a useful practice to calculate costs.

In times of crisis, restructuring and reorganisation, management is especially focussed on cost-cutting in order to maximise profits in a competitive market. This strategy often leads to cutting the expenditures for health and safety, instead of focussing at cutting avoidable costs that offer no added value; the costs of occupational accidents and ill-health belong to this category. By using the Matrix, these costs can be made visible and linked to the consequences of health and safety risks as well as to the bookkeeping system on company level.

The development and implementation of prevention measures focuses on the elimination or reduction of the occupational safety and health risks; these measures have to be considered as investments generating a reduction or elimination of avoidable costs linked to accidents and ill-health. In this way, investing in health and safety creates benefits - equal to the reduction of the avoidable costs – that add value to the firm. Moreover, investing in health and safety will also increase the productivity and the performance of the staff and the equipment, thus creating a double added value to the firms' profit.

By conducting a cost-benefit analysis, in which all costs are balanced against future benefits, an economic assessment of the health and safety investment can be made. The majority of the case studies have clearly demonstrated that health and safety interventions lead to positive economic indicators. Investments with positive net present values, internal rates of return outweighing the discount rate and payback periods

shorter than three years clearly indicate that occupational safety and health is not only ethically and legally necessary, but also economically sound.

By doing so, the cost-benefit analysis technique is useful to provide evidence for the profitability of a specific measure within the context of a specific company. It is a robust approach in support of OSH practitioners when making their case for management.

5.2 Methodological considerations

This study is to a large extent based on the results of case studies in companies. It is well known that companies cannot be compared to laboratories where all the parameters and variables can be perfectly controlled and managed. In order to conduct a successful case study, a certain number of prerequisites need to be fulfilled (5.2.1.).

While conducting the case studies, a certain number of difficulties have been encountered such as the involvement of smaller companies, the lack of available data concerning work related diseases on company level or simply to obtain the necessary data to make the economic evaluations and final assessments of the profitability of the OSH measure (5.2.2.).

5.2.1 Prerequisites for conducting (economic assessment) case studies

The case studies point out that an economic assessment needs to be tailor-made to the needs and the practice of the companies. The assessment has to tackle issues that are important in the context of the company and that find their relevance in the business strategy. However since the field study was conducted within the scope determined by the scoping study, it was not always possible to select an occupational safety and health problem that was high on the agenda of the company. In practice, the companies did express the need to get familiar with economic assessment techniques and considered it to be a useful experience to build on.

It is also necessary to select effective solutions. This effectiveness has to be considered from the angle "is this a solution for the given problem" and also from the angle "will it work in this company". The specific circumstances, the characteristics of employees and activities as well as the company culture are influencing factors in this regard.

The study also indicates the importance of using techniques that make actual calculations and do not rely on estimates deducted from global studies. In order to be acceptable and convincing, it is important to use the data that are available on company level.

And finally, in order to be successful, the outcomes of the assessment have to be presented in a language that is understandable and meaningful for management. Communication is essential in this regard and the use of the same "language" is an important success factor.

5.2.2 Difficulties when setting up the case studies

It turned out to be difficult to get the involvement of smaller companies. As required in the scoping study, the costs of a number of actual cases of accidents at work or work-related ill-health related to a specific type of

risk, had to be calculated. Small companies often did not meet this criterion. Moreover, they were more difficult to convince to participate in the study. Here lies a challenge for intermediary bodies such as employer organisations to channel relevant information to their members. Also, a broader approach enlarging the scope to a sector might be useful to gather relevant specific data.

Secondly, it was difficult to get specific data about work related diseases in companies. In Germany, this problem was due to the fact that, especially in larger companies, the safety professionals and the occupational physicians do not receive diagnoses when a person reports sick. This is partly due to the fact that the trade unions do not want diagnoses to become known to the employer for fear that this may lead to the termination of the contract. This results in a remarkable gap regarding the perception of work related ill-health and the introduction of tailor-made related measures. As has been mentioned in 3.3.4.2 especially persons at risk to develop musculo-skeletal disorders need individual and workplace tailored early interventions. The current practice to conduct rather general measures does not prevent the spread of these disorders.

Also the re-integration management system only comes into force if an employee has reached six weeks of sick leave. As many employees tend to report sick only as a last resort, it is usually too late for preventive measures. It should also be in the interest of the trade unions and the workers' representatives to intervene as early as possible, because even if they can avoid a termination they risk on the other hand that the health situation of the worker deteriorates until he/she is unfit for work. Communication improvement is urgently needed. Employers, management and the safety professional need to encourage their employees to disclose their health problems to the occupational physicians without fear of being disadvantaged. This information could possibly be channelled through the workers representatives' bodies or through a reliable person chosen by the employees and the procedure should be laid down in written agreements.

In one exemplary case an occupational physician serving as a consultant for different companies, was able to reach an agreement with the workers' representatives and the employees, in order to obtain the diagnoses and the number of sick days also for diseases. So he is able to detect early the related persons, where major problems may occur in future. He has developed appropriate prevention measures, which are related to the persons, individually tailored and work related, e.g. the Ergophys Consult concept, where the employees are instructed how to move at their places of work and during their work processes.²⁰ Such a strategy is also necessary to avoid the "healthy worker effect"²¹, i.e. laying off older and less healthy workers and only keep the healthier ones, because this means a loss of the very experienced employees, which may prove as a big disadvantage for the European industry considering the demographic development.

Fourthly, it proved difficult and time-consuming to gather the necessary data. Especially information that is not recorded by the health and safety professional such as the amount paid back by the insurance organisation, was not easy to obtain. And although the contact person within the company was the health and safety professional, he/she did not always come forward with the necessary information for preventive measures:

- proposal for an adequate measure;
- cost of the selected measure;
- assumption of the effectiveness of the selected measure.

In most cases external expertise was necessary to select the measures and make a well-founded assumption of the effectiveness. Additional information on costs was obtained through suppliers, service providers, etc.

²⁰ See <http://www.ergophys.netrix.org/> (similar to "moving with awareness" for the cleaning sector from Prof. Elke Huth).

²¹ Eurostat, Health and safety at work in Europe (1999-2007) – A statistical portrait, Inna Šteinbuka, Anne Clemenceau, Bart De Norre, not yet published (August 2010), pp. 41, 47, 59.

And although it was not the objective of this study, the results also contribute to offer concrete proposals for health and safety problems.

5.3 Needs and gaps

Occupational safety and health practitioners have the need to become more acquainted with techniques such as cost-benefit analysis. Often they lack proper training in the process of making economic assessments. They find the economic terms confusing and are not at ease to communicate the financial results. Training is also needed on communication strategies. In the end, the economic assessment has to be in support of a strategy to convince management to invest in safer and healthier workplaces. Communication strategies are essential in this respect.

To support occupational safety and health practitioners in making economic assessments, there is also a need for simple, easy to use tools that are accessible for practitioners. These tools would support the cost and benefit calculations as well as the process of economic assessments. If these data could be stored in a central database on national or even European level, they could offer interesting benchmarks for companies and institutions willing to perform economic assessments of health and safety measures.

On company level there was also a strong need for a knowledge base on effective solutions. Research can contribute to this knowledge base by providing evidence for the effectiveness of prevention strategies. Equally important elements for this knowledge base are action research derived from company practices and knowledge sharing in order to disseminate information on effective solutions.

5.4 Key Messages

Based on the results of the literature review and of the case studies key messages are defined. The key messages support the communication of the findings of our study and other studies in this field. The key messages are clustered into 3 headings. The headings and the key messages structure the publication of the benOSH project.

The impact of the costs of accidents at work and work-related ill-health

Key messages

Accidents at work and work-related ill-health hinder economic growth

Consequences of accidents at work and work-related ill-health go beyond the workplace

Costs are shifted to society and individuals

The cost of accidents at work and work-related ill-health on company level

Key messages

Consequences of accidents at work and work-related ill-health are not always noticed

Consequences of accidents at work and work-related ill-health increase company costs and decrease revenues

Calculating costs raises awareness about the necessity of prevention

Accidents at work and work-related ill-health bring about considerable costs

Prevention pays

Key messages

Investing in occupational safety and health contributes to company performance through tangible outcomes
Evidence derived from practice: cost-benefit analysis studies show that investing in occupational safety and health yields positive results

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Annex 1 Glossary

Accident at work: a discrete occurrence in the course of work which leads to physical or mental harm (Eurostat, 2010 based on European Statistics on Accidents at Work (ESAW)), *see also occupational accident*

Activity based costing: is a costing model that identifies activities in an organisation and assigns the cost of each activity resource to all products and services according to the actual consumption by each. Within the framework of calculating costs of accidents at work or work-related ill-health, this type of cost analysis is based upon documenting all the activities that the event in question has led to and then evaluating the costs of these activities

Benefit-cost ratio: the benefit-cost ratio (BCR) is the ratio of the benefits of a project relative to its costs. Both benefits and costs are expressed in discounted present values. A project will be accepted when the BCR is larger than 1.

Cost of an accident at work/case of work-related ill-health (on corporate level) = the effects on the costs and the revenue of an organisation (company) that would not have emerged if the accident/case of work-related ill-health would not have taken place (De Greef, Van den Broek, 2009)

Cost-benefit analysis: a method to make an economic evaluation of the costs and consequences of an action (implemented at the workplace). Cost-benefit analysis is the most commonly used method from an employer perspective. This method expresses all costs and consequences in the same unit, which is usually money.

Fatal accident: a fatal accident is defined as an accident which leads to the death of the victim within one year (Eurostat, 2010)

Human Capital approach: the Human Capital approach is an approach to valuing life in which productivity is based on market earnings and an imputed value for housekeeping services. In the human capital approach, a person is seen as producing a stream of output that is valued at market earnings and the value of life is the discounted future earnings stream. (Rice, 2000)

Incidence method: method for making cost estimates (on societal level); the method considers all present and future cost effects of new cases in one year (Mossink and De Greef, 2002), *see also prevalence method*

Internal Rate of Return: the internal rate of return (IRR) on an investment or potential investment is the annualized effective compounded return rate that can be earned on the invested capital. In other words, the IRR of an investment is the interest rate at which the costs of the investment lead to the benefits of the investment. This means that all gains from the investment are inherent to the time value of money and that the investment has a zero net present value at this interest rate. A project will be accepted if the internal rate of return exceeds the minimum rate of return that has been defined for that specific category of projects.

Net Present Value: the net present value (NPV) of a series of cash flows, both incoming and outgoing, is defined as the sum of the present values (PVs) of the individual cash flows. The NPV gives an indication of the amount a project adds to the value of a company. A project will be accepted when the NPV is larger than 0. A NPV equal to 0 means that the project adds no value to the company; in that case a decision maker could be indifferent whether to accept or reject the project.

Occupational accident: as part of Workers' Compensation Systems; The standard definition of occupational accident contains the following elements: (1) fortuitous, sudden, or unexpected external event (2) during working hours/on the way to or back from the workplace (3) arising out of work performed in the course and the scope of employment (4) bodily harm (5) causal link between the event and the harm (Munich Re, 2000), *see also accident at work*

Occupational disease: In a strict sense the concept of an occupational disease refers to cases for which the occupational origin has been approved by the national compensation authorities, *see also work-related ill-health*

Opportunity costs: An opportunity cost is the value to society of the goods or services (including leisure) it could otherwise have enjoyed had there been no diversion of resources resulting from accidents or illness at work (Dorman, 2000a)

Payback Period: the payback period (PP) is the amount of time before the initial investments are earned back, or the length of time required for cumulative incoming returns to equal the cumulative costs of an investment. The PP is usually measured in years.

Prevalence method: method for making cost estimates (on societal level); the method considers all costs within one year are taken (prevalence method) (Mossink and De Greef, 2002), *see also incidence method*

Profitability Index: the Profitability Index (PI) is defined as the present value of expected cash flows over the value of the Initial Investment. It is a ratio of the present value of cash flows and the initial investment. A Profitability Index of one yields the internal rate of return. A Profitability Index of less than one suggests that the project should be rejected and value of one or greater suggests that investment should be accepted.

Social costs: Social costs are typically described in losses or limitations in a person's ability to engage in major social roles and activities. These include working, parenting, or sharing leisure activities with or caring for friends and family. Impacts commonly discussed are the ability to perform tasks that are dictated by the work role (social consequences), as opposed to lost wages (economic consequences), or losing a range of motion (clinical consequences) (Keller, 2001)

Willingness To Pay: The Willingness To Pay approach measures the amount an individual would pay to reduce the probability of illness or mortality. There are various methods of determining an individual's willingness to pay, including surveys, examining the additional wages for jobs with high risks, examining the demand for products that lead to greater health or safety (e.g. seatbelts), and other related methods (Segel, 2006)

Workers' compensation system: Workers' compensation (insurance) systems can be defined as the social insurance arrangements providing compensation for occupational accidents and occupational diseases

Work-related ill-health based on the definition Work-related health problems as defined in Eurostat (2010): diseases for which occupational factors increase the risk of disease or aggravate an already existing disease, *see also occupational disease*

Annex 2 Literature review: studies on direct/indirect costs

Overview of results from some empirical studies based on the distinction direct, insured/indirect, uninsured costs (2.4.2.2)

Study	Methods	Terminology	Results
Heinrich (1959) US	Identifying consequences of accidents that have an economic impact Comparing direct with indirect (hidden) costs	Direct costs Indirect (hidden) costs (cfr. table)	Indirect costs are more important than direct costs The ratio between indirect and direct costs is 4:1
Simonds and Grimaldi (1956) US	Classifying accidents into four categories according to severity Determining the average cost for each category	Insured costs Uninsured costs: - costs due to labour lost time - costs due to complementary wages to the injured while absent - cost due to property accidents	- lost time injuries 456 \$ - doctor injuries 115 \$ - first aid injuries 25 \$ - material damage 850 \$ (\$US 1982)
Imre (1976) US	Identical methods as Simonds and Grimaldi	Insured costs Uninsured costs (identical to Simonds and Grimaldi)	- work accidents with lost time 190 \$ - work accidents requiring the intervention of a medical doctor 39 \$ - first aid work accidents 12 \$ - work accidents with no lost time 351 \$ (\$US 1976)
Leopold and Leonard (1987) UK Construction	sample of 1757 construction accidents calculation of direct and indirect costs according to severity of the injury	Direct costs: costs that appear in financial statements (directly measured in financial terms) indirect costs: first measured in labour time and subsequently translated into financial equivalents	direct/indirect severity I: £111/28 severity II: £557/106 severity III: £629/216
Laufer (1987) Israel Construction	Interviews of 50 building construction managers 19 construction firms 210 accidents	Insured/uninsured (cfr. Simonds and Grimaldi) uncontrollable/controllable costs	The value of the Total Uninsured Costs is equivalent to 1,59% of profit before tax
Klen (1989) Finland Forestry	2 large firms 473 accidents with temporary disablement	primary direct costs: payments required by law to indemnify injured	Total costs per accident (in Finn marks) - indirect costs: 925

		workers secondary direct costs: other payments to either the victim or the government indirect costs: costs that do not take the form of direct monetary outlays	- direct costs: 673 - total: 1598
Brody et al. (1990c) Canada	151 firms 311 cases Evaluating the amount of indirect costs The relationship between direct and indirect costs Influencing factors on this relationship	Direct costs: insurance costs (fixed and variable component). Indirect costs: - wage costs; - material damage; - administrators time; - production losses; - other costs; - intangible costs	a ratio of 1:0,83 between insured and uninsured costs
Larsson, Betts, 1996 Australia	Interviews, 14 companies, 43 cases Average costs for minor (≤ 7 days lost) and major (≥ 7 days lost) accidents who pays the costs: victim, compensation system, employer	Direct costs Indirect costs	minor accidents: victim: 30% employer: 70% major accidents: victim: 15% employer: 15% compensation system: 70%

Based on Gosselin, 2004

Annex 3 Summary table of chapter 3 Scoping study

Summarising information of the sub-chapters was entered into this table in order to allow a better overview and comparison. This information was then closely analysed and relevant sectors together with occupations and causes were identified and entered into the yellow marked lines. Thereafter suitable preventive measures were identified.

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
Fatal accidents	-Construction -Agriculture, hunting and related service activities -Land transport; transport via pipelines -Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing -Other mining and quarrying -Manufacture of fabricated metal products, except machinery and equipment -Forestry, logging and related service activities	-Labourers in mining, construction, manufacturing and transport -Drivers and mobile plant operators -Extraction and building trades workers -Agricultural, fishery and related labourers -Metal, machinery and related trades workers.	Accidents with vehicles Falling/ leaping from platform Falling/ collapsing objects Slips, trips and falls. Traffic routes Dangerous machinery. Entanglement/ entrapment. Contact with Electricity	Costs: Construction: 970 m € Manufacturing: 750 m € Transport, storage and communication: 585 m € Agriculture, hunting and forestry: 387 m € Wholesale and retail trade, repair: 360 m € Real estate, renting and business: 246 m €		Most fatal accidents occur in companies having 1-9 employees, followed by 10-49, 50-249 and 250 or more employees.
Selected:	Construction	Electrician	Electric shock		Training, Residual Current Protective Device, and SPE-PRCD , Switched Protective Earth - Portable Residual Current Device;	Selected because this type of accidents would not be considered under non-fatal accidents

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
Non-fatal accidents	-Manufacturing -Construction -Trade Health and social work -Agriculture, hunting and related service activities Most accidents occur in smaller companies (10-49, 50-249 employees)	-Machine operators and assemblers -Metal, machinery and related trades workers -Extraction and building trades workers; -Labourers in mining, construction, manufacturing and transport -Stationary-plant and related operators.	-Slips, trips and falls (clearly the main cause). -Manual handling. -Struck by moving objects. -Solid objects and articles. -Tools. -Transportation within the company. -Struck by falling objects. -Work environment and structure. -Machinery.	Number: 4.8 m Costs: 21.5 bn. € - Manufacturing: 13 bn. € - Construction: 9.5 bn. € - Wholesale and retail trade, repair...: 5.7 bn. € -Transport, storage and communication: 4.7 bn. € - Agriculture, hunting and forestry: 3.6 bn. € - Real estate, renting and business: 4.2 bn. € Non-fatal accidents (≤ 3 d absence) : Number 2.7 m Costs: 0.76 bn. €		
Selected	Construction	Building trades worker	Fall from platform, roof Climbing Fall from ladder		Nets, guard-rails, harnesses Highstep system Innovative ladders, rollable scaffolds, elevating work platform	Most accidents occur in smaller companies (10-49, 50-249 employees)

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
	Man. of metal products	Metal worker	Slipping Cuts from sharp edge (sheets, bars, ...) Machinery		Cleaning Gloves Safety devices	Most accidents occur in smaller companies (10-49, 50-249 employees)
	Transport	Labourer in transport	Struck by fork lift		Training, technical surveillance device for secure reversing	As above
	Car repair	Worker	Fire, explosion		Low VOC products, work org.	As above
	Construction		Slips, trips		Safe cleaning, trip protection	
	Manufacturing		Slips, trips		Safe cleaning, trip protection	
	Manufacturing	Assemblers	Tools, eye injury by swarf, chips, fines e.g. while grinding		Goggles, instruction, motivation	
	Manufacturing		Cuts		Safety knives	
	Health sector	Nurses, cleaners	Slips, trips		Dry or damp cleaning	
Occupational disease (recognised)	- manufacturing, (38%), - construction (13%), - wholesale retail trade, repair (7%), - health and social work (5%).	- workers in craft and related trades (41%), -plant, machine operators, assemblers (21%), - workers with elementary occupations (19%).		See below		

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
		<ul style="list-style-type: none"> -Metal, machinery and related trades workers -Labourers in mining, construction, manufacturing and transport -Machine operators and assemblers -Extraction and building trades workers -Drivers and mobile plant operators -Personal and protective services workers -Other craft and related trades workers 				
Non-accidental health problems	<ul style="list-style-type: none"> - Agriculture, hunting and forestry - Mining and quarrying - Health and social work - Construction - Manufacturing - Education - Transport, storage and communication - Public administration and defense; compulsory social security 	<ul style="list-style-type: none"> -Labourers in mining, construction, manufacturing and transport; -Agricultural, fishery and related labourers; -Drivers and mobile plant operators; -Precision, handicraft, craft printing and related trades workers; 		Estimated to cause 1.6 to 2.2 times more days of temporary incapacity to work than do accidents at work, while there are 2.4 times more people reporting long-standing health problems or disability due to work-related diseases than due to		

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
Musculo-skeletal problems	<ul style="list-style-type: none"> - Electricity, gas and water supply - Wholesale retail trade, repair - Hotels and restaurants <p>Small companies were commented as being more at risk because they have fewer resources available for both monitoring and implementing suitable control measures to combat occupational diseases at work.</p>	<ul style="list-style-type: none"> -Extraction and building trades workers; -Personal and protective services workers; -Teaching professionals; -Life science and health professionals. 	17% of European workers report being exposed to vibrations from hand tools or machinery for at least half of their working time, 33% are exposed to painful or tiring positions for at least half of their working time, 23% to carrying or moving heavy loads, 46% to repeated hand or arm movements and 31% are working with a computer at least half of their working time	accidents at work. This indicates that work-related non-accidental health problems may cause at least two times more temporary and permanent incapacity as compared to accidents at work		In both small (< 10 persons) and larger firms, musculo-skeletal health problems contributed importantly to work related health problems.

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
	<p>Lifting/moving heavy loads:</p> <ul style="list-style-type: none"> -Construction (14); -Agriculture, hunting and related service activities (9); -Health and social work (8); -Manufacture of fabricated metal products, except machinery and equipment (6); -Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials (4); -Other mining and quarrying (3). 	<ul style="list-style-type: none"> -Labourers in mining, construction, manufacturing and transport (11); -Metal, machinery and related trades workers (7); -Life science and health associate professionals (6); -Extraction and building trades workers (5); -Sales and services elementary occupations (5); -Machine operators and assemblers (5). 	<p>23% to carrying or moving heavy loads</p>			
	<p>Repetitive movements:</p> <ul style="list-style-type: none"> -Manufacture of food products and beverages; -Manufacture of wearing apparel; dressing and dyeing of fur (5); -Manufacture of textiles; -Land transport; transport via pipelines; -Manufacture of fabricated metal products, except machinery and equipment; -Tanning and dressing of leather; 	<ul style="list-style-type: none"> -Machine operators and assemblers (11); -Labourers in mining, construction, manufacturing and transport (8); -Customer services clerks (7); -Sales and services elementary occupations (7); -Other craft and related 	<p>46% to repeated hand or arm movements</p>			

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
	manufacture of luggage, handbags, saddlery, harness and footwear.	trades workers				
	Strenuous working postures: -Construction; -Agriculture, hunting and related service activities; -Health and social work; -Other service activities; -Manufacture of textiles; -Manufacture of food products and beverages	-Labourers in mining, construction, manufacturing and transport (9); -Renting of machinery and equipment without operator and of personal and household goods; -Metal, machinery and related trades workers (6); -Agricultural, fishery and related labourers (4); -Other craft and related trades workers (4); -Water transport	33% are exposed to painful or tiring positions for at least half of their working time			
	Vibrations: -Construction); -Manufacture of fabricated metal products, except machinery and equipment; -Other mining and quarrying; -Land transport; transport via pipelines; -Agriculture, Hunting and related service activities;	-Labourers in mining, construction, manufacturing and transport (10); -Extraction and building trades workers (10); -Drivers and mobile plant operators (10); -Metal, machinery and related trades workers (9);	17% of European workers report being exposed to vibrations from hand tools or machinery for at least half of their working time			

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
	-Forestry, logging and related service activities	-Agricultural, fishery and related labourers (6); -Machine operators and assemblers				
Recognised MSD	the most common musculoskeletal occupational diseases were tenosynovitis of the hand or wrist (5 379 cases) and epicondylitis of the elbow (4 585 cases) occurring especially in mining and quarrying and in manufacturing					
Selection proposal:	Manufacture of food products and beverages	Assemblers	Repetitive movements		Work organisation, in combination with individual and workplace matching training especially of the movements	
	Mines or quarries	Worker	Vibrations		Technical aid, insulation of seats	
	Health and social work.	Nurses, caregivers	Heavy loads		Training, technical aid, in combination with individual and workplace matching training especially of the movements	
	Construction	Masons, plasterers	Painful or tiring positions		Training, technical aids (benches, long	

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
Psychosocial health problems	<ul style="list-style-type: none"> - Stress, depression or anxiety: - education, - financial intermediation, - public administration and defense - real estate, renting and business activities - health and social work. <ul style="list-style-type: none"> Affected by stress: -Health and social work -Education -Transport and communications -Real estate activities -Hotels and restaurants -Financial intermediation -Public administration and defence -Electricity, gas and water supply <ul style="list-style-type: none"> affected by irritability: -Education -Transport and communications -Mining and quarrying -Health and social work 	<ul style="list-style-type: none"> Occupation categories re stress: -Life science and health professionals; -Teaching professionals; -Corporate managers; -Labourers in mining, construction, manufacturing and transport; -Managers of small enterprises. 	<p>About 28% of workers consider their work affects their health in the form of stress, about 10% in the form of irritability and about 7% in the form of anxiety</p> <p>Causes: a whole set of factors, some key factors:</p> <ul style="list-style-type: none"> Working at very high speed: Sectors most affected - Hotels and rest. - Construction - Manuf. and mining - Health and soc. Work <p>Unforeseen interruptions: Sectors most affected</p> <ul style="list-style-type: none"> - Health and soc. Work - Hotels and rest. 		<p>handles), in combination with individual and workplace matching training especially of the movements, PPE</p>	<p>stress, depression or anxiety was slightly more often experienced as the main work-related health problem by persons working in firms larger than 10 persons compared to firms of 10 persons or less</p>

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
	<ul style="list-style-type: none"> -Public administration and defence -Hotels and restaurants <p>affected by anxiety:</p> <ul style="list-style-type: none"> -Education -Health and social work -Transport and communications -Mining and quarrying -Public administration and defence -Hotels and restaurants <p>High speed work, sectors most at risk:</p> <ul style="list-style-type: none"> -Hotels and restaurants; -Post and telecommunications (3); -Land transport; transport via pipelines; -Construction (3); -Financial Intermediation, except insurance and pension funding (3); -Manufacture of wearing apparel; dressing and dyeing of fur (3); -Manufacture of food products and beverages; -Manufacture of motor vehicles, trailers and semi-trailers (3); -Manufacture of office, accounting and computing machinery; 	<p>High speed work</p> <ul style="list-style-type: none"> -Corporate managers (5); -Customer services clerks (5); -Drivers and mobile plant operators (4); -Metal, machinery and related trades workers 	<ul style="list-style-type: none"> - Fin. intermediation - Real estate activities etc. - Wholesale and retail 			

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
	<ul style="list-style-type: none"> -Publishing, printing and reproduction of recorded media (3). Workpace dictated by social demand, sectors most at risk: -Hotels and restaurants; -Health and social work; -Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (4); -Public administration and defence; compulsory social security (3); -Other service activities. 	<p>Workpace dictated ..</p> <ul style="list-style-type: none"> -Customer services clerks -Personal and protective services workers -Life science and health associate professionals -Life science and health professionals; -Models, salespersons and demonstrators 				
Selection proposal:	Hotels and restaurants	Clerks, service personnel	High speed, interruptions		Instructions, work org.,	
Skin problems:	<ul style="list-style-type: none"> - Mining and quarrying - Manufacturing - Construction - Health and social work <p>Handling or touching dangerous products or substances</p> <ul style="list-style-type: none"> -Construction -Electricity, gas and water supply -Agriculture and fishing -Manufacturing and mining -Health and social work 	<ul style="list-style-type: none"> -Labourers in mining, construction, manufacturing and transport; -Stationary-plant and related operators ; -Agricultural, fishery and related labourers ; -Metal, machinery and related trades workers; -Extraction and building trades workers. 	<p>There were 230 different causative agents reported for the recognised occupational skin diseases.</p> <p>Most important risk substances (Focal Points):</p> <p>Carcinogenic: Asbestos Cr VI Crystalline silica Benzene</p>	<p>German BG BAU estimates the costs for occupational epoxy resin diseases at minimum 40 million Euro in 2008 in the EU</p>		<p>No information regarding company sizes, however from the structure of affected sectors, it can be assumed that small and large companies are likewise affected.</p>

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
	<p>Handling chemicals:</p> <ul style="list-style-type: none"> -Manufacture of chemicals and chemical products (8); -Agriculture, hunting and related service activities; -Construction (5); -Other service activities; -Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel. 		<p>Neurotoxic: Organic solvents Organophosphates, pesticides Lead and its compounds Toluene/xylene, aromatic/chlorinated solvents Reproductive: Lead and its compounds Mercury and its compounds Acrylamide, methoxy ethanol, ethoxy ethanaol, ethylene oxide, organic solvents, halothane Infectious: Hepatitis Virus B/C Tuberculosis HIV Leptospirosis Borrelia burgdorferi Non-infectious: Endotoxins Moulds Thermophilic actinomycetes</p>			

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
			fungi Organic dust Animal eothellium			
Respiratory difficulties:	-Construction -Manufacturing and mining -Electricity, gas and water supply -Agriculture and fishing Breathing in vapours, fumes, dust or dangerous substances such as chemicals, infectious materials, etc.: -Construction -Manufacturing and mining -Agriculture and fishing -Hotels and restaurants		For occupational asthma there were 130 different causative agents reported. The most common specific agents were flour dust (10%), isocyanates (4%), dust from mammals (4%) and wood dusts (3%) BG BAU expert sees strong evidence that isocyanate diseases should rather be attributed to epoxy resins.			
Allergies:	-Agriculture and fishing -Health and social work -Other services -Construction -Manufacturing and mining Handling or touching dangerous products or substances -Construction -Electricity, gas and water supply					

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
	-Agriculture and fishing -Manufacturing and mining -Health and social work					
Recognized occupational respiratory diseases	Asthma (almost all sectors are heavily affected) : -Health and social work -Education -Transport and communications -Real estate activities etc. -Hotels and restaurants -Financial intermediation -Public administration and defence -Electricity, gas and water supply -Manufacturing and mining -Construction -Wholesale and retail trade -Agriculture and fishing					
Recognized occupational skin diseases	-Mining and quarrying -Construction -Manufacturing -Other community, social, personal service activities -Hotels and restaurants		There were 230 different causative agents reported for the recognised occupational skin diseases.			
Selection proposal:	Manufacture of chemicals and chemical products	Plant operators	Skin problems: surfactants, organic solvents, biocides		PPE, instructions, work org.	
	Health and social work	Nurses, cleaners	Skin problems:		As above, "dry"	

Effects	Sectors most affected (in descending order)	Occupations most affected (dto.)	Causes, risks	Consequences*	Suitable prevention measures	Company sizes, remarks
			surfactants, organic solvents, biocides		cleaning"	
	Health and social work or food industry	Nurses, workers	Infections, cuts, needle sticks		PPE, work org.	
	Food industry	Workers	Asthma: flour dust		New methods to prevent dust	
	Communication, electronics	Workers	Epoxy resin caused diseases		PPE, instructions, work org.	
	Yacht builders or wind mill manufacturers	Workers	Epoxy resin caused diseases		PPE, instructions, work org.	
Physical violence	-Health and social work; -Public administration and defence; compulsory social security; -Land transport; transport via pipelines; -Hotels and restaurants; -Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods; -Other service activities.	-Personal and protective services workers; -Life science and health associate professionals; -Sales and services elementary occupations; -Life science and health professionals; -Customer services clerks; -Models, sales persons and demonstrators female employees more at risk				There are no important differences in the occurrence of intimidation by age category or by size of the company, with the exception of a lower rate among those working alone
Selection proposal:	Public transport	Drivers			Training, technical aid, workplace adjustment (e.g. surveillance)	

* Source of the indicated costs: Eurostat, 2004b, see also 3.3.1 and 3.3.2

Annex 4 Tools used in the field study: the Matrix and Cost-benefit analysis (fictitious case study)

Overview of the cases

	severity	absenteeism	description
case 1	low	1 day	The worker fell from 1.5 m height from a pile and sprained his left ankle
case 2	low	0 days	The worker fell from low height from a platform and received a light sprain
case 3	low	2 days	The worker fell from 1.5 m height from a pile and sprained his left ankle
case 4	low	0,5 days	The worker fell from 1.5 m height from a pile and sprained his right ankle
case 5	medium	16 days	The worker fell from almost 2 m height into a trench and sprained his right ankle
case 6	medium	32 days	The worker fell from almost 2 m height from a sand pile and broke his left ankle
case 7	high	96 days	The worker fell from 5 m height from a scaffold and received severe injuries. When a container was lifted by a crane, the reeling was opened, worker stepped back and fell through the gap.

Worksheet Case description and cost calculation

Example: case 5

1 Filling out the case identification, the short description and the data for the cost of the working time (these costs are the same for the whole case study (1 company); a change in these categories/costs will be reflected in all cases of accidents at work, work-related ill-health

A Identification		
A1	Date of the accident/work-related ill-health (ca.)	
A2	Victim: profession (general)	Construction worker
A3	Gender	male
A4	Status	worker
A5	Age	35-44 years
A6	Seniority (rounded)	
A7	Type of injury/sickness	Fall, sprain
A8	Days of absenteeism	1

B Short description of the case	
	The worker fell from almost 2 m height into a trench and sprained his right ankle.

C Costs of working time

C1	work time, costs per hour	salary category 1	23.00
		salary category 2	30.00
		salary category 3	35.00
		salary category 4	50.00
		salary category 5	100.00

2 Select the relevant cost items and provide data

For this accident only consequences for Human and Organisation were identified:

- absence of the victim
- a reduced productivity when the worker returned to his job
- overtime of the colleagues
- time for the first aid treatment
- time to reorganise the work

D Cost items

Human					
D1	absence of the victim – time period during which the employer covers the salary	salary category 1	30	128	3840.00
D3	reduced productivity of the injured employee after re-employment (alternative work)	salary category 1	15.00	4	60.00
D8	overtime of colleagues to compensate	salary category 1	30	120	3600.00
D9	first aid and reporting (first aid worker)	salary category 1	35	0.5	17.50

Organisation					
D39	reorganising the work	salary category 3	35	1	35.00

3 The Matrix for this case is calculated as follows

	Human	Equipment	Environment	Product	Organisation	
Goods	126.61	0.00	0,00	0,00	1,23	127,84
Services	108.53	0.00	0,00	0,00	1,05	109,58
Personnel	7,607.94	0.00	0,00	0,00	35,88	7.643,81
Depreciation	36.18	0.00	0,00	0,00	0,35	36,53
	7,879.25	0.00	0,00	0,00	38,50	7.917,75

4 Compensation made by the insurer can be deducted (if relevant)

<i>Compensation by the insurer to the employer</i>	
Compensation paid by insurer	0.00
<i>Costs borne by the employer</i>	
Costs	7,917.75
Compensation	0.00
	7,917.75

Worksheet Cost overview

Costs for all 7 cases according to severity and in total

Low

	Human	Equipment	Environment	Product	Organisation	
Goods	15.44	0.00	0.00	0.00	0.86	16.29
Services	13.23	0.00	0.00	0.00	0.74	13.97
Personnel	1,772.03	0.00	0.00	0.00	25.11	1,797.14
Depreciation	4.41	0.00	0.00	0.00	0.25	4.66
	1,805.10	0.00	0.00	0.00	26.95	1,832.05

Medium

	Human	Equipment	Environment	Product	Organisation	
Goods	253.23	0.00	0.00	0.00	2.45	255.68
Services	217.05	0.00	0.00	0.00	0.00	217.05
Personnel	18,575.88	0.00	0.00	0.00	0.00	18,575.88
Depreciation	72.35	0.00	0.00	0.00	0.00	72.35
	19,118.50	0.00	0.00	0.00	2.45	19,120.95

High

	Human	Equipment	Environment	Product	Organisation	
Goods	126.61	0.00	0.00	0.00	1.23	127.84
Services	108.53	0.00	0.00	0.00	1,05	109.58
Personnel	10,967.94	0.00	0.00	0.00	35.88	11,003.81
Depreciation	36.18	0.00	0.00	0.00	0.35	36.53
	11,239.25	0.00	0.00	0.00	38.50	11,277.75

Total

	Human	Equipment	Environment	Product	Organisation	
Goods	395.27	0.00	0.00	0.00	4.53	399.81
Services	338.81	0.00	0.00	0.00	1.79	340.59
Personnel	31,315.84	0.00	0.00	0.00	60.99	31,376.83
Depreciation	112.94	0.00	0.00	0.00	0.60	113.53
total	32,162.85	0.00	0.00	0.00	67.90	32,230.75

Worksheet Avoided Costs

Overview of the cost per case, average costs and total number of cases per year.

	low	medium	high
Case 1	367.70	7,917.75	11,277.75
Case 2	120.00	11,277.75	
Case 3	1,022.95	0.00	
Case 4	321.40		
Case 5	0.00		
Case 6	0.00		
Case 7	0.00		
Case 8	0.00		
	1,832.05	19,195.50	11,277.75
Number of cases	4	2	1
Average cost per case	458.0125	9,597.75	11,277.75
Median value	344.55	9,597.75	11,277.75

	low	medium	high	total
Average Cost per Case	458.01	9,597.75	11,277.75	
(Estimated) number of cases per year	1.00	0.33	0.20	
Total costs per year	458.01	3,199.25	2,255.55	5,912,81
Estimated % of cases that could be avoided by the specified prevention measures	90%	90%	90%	
	412.21	2,879.33	2,030.00	5,321,53

Worksheet Cost-benefit analysis

The prevention measures, their initial investments and their annual recurrent costs are entered in the worksheet "CBA". Usually these interventions are combinations of technical, organisational and personal measures. Also here different measures and their costs can be entered and the different results can be compared.

Prevention Measure	
Type of measure	Description
New equipment/auxiliaries	Guard rails for raised piles and trenches, safety harnesses, related instructions;
Organisational Measure	Production of films together with the employees of re-acted accidents and of the correct behaviour; the films then being screened in the break room.
Personal Protective Equipment	

Costs					
Initial investment	study			€400.00	
	adaptation org/method			€-	
	equipment			€5,000.00	
	implementation			€250.00	
	training			€1,500.00	
	total			€7,150.00	
Annual costs					
	year 1	year 2	year 3	year 4	
maintenance	€500.00	€500.00	€500.00	€500.00	
equipment	€-	€-	€-	€-	
training	€200.00	€200.00	€200.00	€200.00	
total	€700.00	€721.00	€742.63	€764.91	
				€800.00	
Benefits					
Productivity gains	year 1	year 2	year 3	year 4	
	extra production	€-	€-	€-	€-
	lower costs	€-	€-	€-	€-
	time gain	€-	€-	€-	€-
	Avoided costs	€5,321.53	€5,321.53	€5,321.53	€5,321.53
total	€5,321.53	€5,481.18	€5,645.61	€5,814.98	
				€21,286.13	

Intangible Benefits	comments
improvement of job satisfaction	
improvement of work atmosphere	
improvement of workers involvement	
improvement of corporate image	
less staff turnover	
other	Avoiding shock for colleagues and management caused by severe accidents.

Worksheet Cost-benefit analysis results

The results of the calculations appear in the worksheet „CBA results“. In this fictitious but close to reality case the results are:

pay-back period	2.02	The investment pays back in 2.2 years
internal rate of return	35.1%	On the initial investment the company can achieve a return of 35.1 %
net present value	4,277.48	The sum of the discounted benefits is 4,277.48 € higher than the invested amount
profitability index	1.60	For each euro invested in the project, the return will be 1.6 €
benefit-cost ratio	7.60	The ratio between the total discounted benefits and the total discounted costs is 7.6

Sector	Risk	# cases	low severity					medium severity					high severity					all				
			human	equipment	environment	product	organisation	human	equipment	environment	product	organisation	human	equipment	environment	product	organisation	human	equipment	environment	product	organisation
hospital/ social	back problems	11	94.5	0.0	0.0	0.0	5.5	96.9	0.0	0.0	0.0	3.1	97.2	0.0	0.0	2.8	96.1	0.0	0.0	0.0	3.9	
hospital/ social	needle sticks	8	90.4	0.0	0.0	0.0	9.6	-	-	-	-	-	-	-	-	-	90.4	0.0	0.0	0.0	9.6	
construction	back problems	8	73.1	0.0	0.0	0.0	26.9	94.0	0.0	0.0	6.0	96.4	0.0	0.0	3.6	92.8	0.0	0.0	0.0	7.2		
construction	fall from platform	7	88.9	0.0	0.0	0.0	11.1	89.3	0.0	0.0	10.7	94.4	0.0	0.0	5.6	92.9	0.0	0.0	0.0	7.1		
food	machines	12	80.5	0.0	0.0	0.0	19.5	89.7	0.0	0.0	7.8	89.7	0.0	0.0	7.8	82.7	0.0	0.0	0.0	15.1		
metal	cuts	10	85.2	0.0	0.0	0.0	14.8	80.1	0.0	0.0	19.9	95.0	0.0	0.0	5.0	86.5	0.0	0.0	0.0	13.5		
metal	cuts	10	82.4	0.0	0.0	0.0	17.6	-	-	-	-	97.2	0.0	0.0	2.8	88.9	0.0	0.0	0.0	11.1		
metal	cuts	7	65.4	1.2	0.0	0.0	33.4	-	-	-	-	95.3	0.1	0.0	4.6	93.8	0.5	0.0	0.0	15.7		
textiles	back problems	10	82.4	0.5	0.0	0.0	17.1	83.4	0.3	0.0	15.8	94.5	0.1	0.0	5.0	86.8	0.3	0.0	0.2	12.7		
metal	slips and trips	7	81.3	0.5	0.0	0.0	18.3	-	-	-	-	94.6	0.1	0.0	5.3	90.1	0.2	0.0	0.0	9.7		
construction	electric shock	3	29.1	0.0	0.0	0.0	70.9	58.2	2.2	0.0	39.6	-	-	-	-	44.6	1.2	0.0	0.0	54.3		
construction	electric shock	6	73.9	0.2	0.0	0.0	25.9	92.1	0.0	0.0	7.9	21.0	0.0	0.0	79.0	44.4	0.0	0.0	0.0	55.6		
distribution	aggression	3	31.0	0.0	0.0	5.0	64.0	49.5	0.0	0.0	46.9	-	-	-	-	44.7	0.0	0.0	0.0	51.4		
transport	pallet truck	12	71.9	8.3	0.0	0.1	19.7	96.1	3.2	0.0	0.2	88.6	1.5	0.0	9.1	86.4	4.3	0.0	0.4	8.9		
transport	forklift	6	56.7	0.0	28.4	2.5	12.4	92.1	0.0	0.0	7.9	48.6	29.0	0.0	6.3	68.1	12.9	3.7	7.5	7.8		
construction	eye injuries	6	82.8	1.0	0.0	0.0	16.1	93.6	0.0	0.0	6.4	-	-	-	-	87.2	0.6	0.0	0.0	12.2		
waste	slips and trips	4	52.0	0.0	0.0	0.0	48.0	95.4	0.0	0.0	4.6	-	-	-	-	91.4	0.0	0.0	0.0	8.6		
metal	cuts	2	91.9	0.0	0.0	0.0	8.1	-	-	-	-	-	-	-	-	91.9	0.0	0.0	0.0	8.1		
metal	machines	5	92.4	0.0	0.0	0.0	7.6	-	-	-	-	-	-	-	-	92.4	0.0	0.0	0.0	7.6		
metal	slips and trips	1	93.0	0.0	0.0	0.0	7.0	-	-	-	-	-	-	-	-	93.0	0.0	0.0	0.0	7.0		

Sector	Risk	# Cases	low severity					medium severity					high severity					all				
			human	equipment	environment	product	organisation	human	equipment	environment	product	organisation	human	equipment	environment	product	organisation	human	equipment	environment	product	organisation
metal	cuts	1	98.5	0.0	0.0	0.0	1.5	-	-	-	-	-	-	-	-	-	98.5	0.0	0.0	0.0	0.0	1.5
metal	fall machines	2	-	-	-	-	-	43.8	0.0	0.0	55.9	0.4	98.8	0.0	0.0	0.0	80.1	0.0	0.0	19.0	0.0	0.9
metal	fall from height	1	-	-	-	-	-	-	-	-	-	-	99.4	0.0	0.0	0.6	99.4	0.0	0.0	0.0	0.6	0.6
metal	fall from height	0	-	-	-	-	-	-	-	-	-	-	89.9	0.0	0.0	10.1	89.9	0.0	0.0	0.0	10.1	10.1
metal	machines	1	-	-	-	-	-	-	-	-	-	-	97.3	0.0	0.0	2.7	97.3	0.0	0.0	0.0	2.7	2.7
construction	machines	2	100.0	0.0	0.0	0.0	0.0	-	-	-	-	-	94.4	1.1	0.0	4.5	95.3	0.9	0.0	0.0	3.8	3.8
construction	eye injuries	8	95.0	0.0	0.0	0.0	5.0	-	-	-	-	-	-	-	-	-	95.0	0.0	0.0	0.0	5.0	5.0
construction	electric shock	1	-	-	-	-	-	-	-	-	-	-	79.1	3.3	0.0	17.6	79.1	3.3	0.0	0.0	17.6	17.6
construction	back problems	1	-	-	-	-	-	-	-	-	-	-	99.4	0.0	0.0	0.6	99.4	0.0	0.0	0.0	0.6	0.6
construction	eye injuries	5	45.6	0.0	0.0	0.0	54.4	-	-	-	-	-	-	-	-	-	45.6	0.0	0.0	0.0	54.4	54.4
construction	allergic reaction	1	99.8	0.0	0.0	0.0	0.2	-	-	-	-	-	-	-	-	-	99.8	0.0	0.0	0.0	0.2	0.2
construction	allergic reaction	1	-	-	-	-	-	-	-	-	-	-	99.5	0.0	0.0	0.5	99.5	0.0	0.0	0.0	0.5	0.5
construction	allergic reaction	4	99.0	0.0	0.0	0.0	1.0	97.0	0.0	0.0	0.0	3.0	-	-	-	-	97.5	0.0	0.0	0.0	2.5	2.5
food	machines	3	-	-	-	-	-	99.4	0.0	0.0	0.0	0.6	99.5	0.0	0.0	0.5	99.5	0.0	0.0	0.0	0.5	0.5
food	cuts	1	91.4	0.0	0.0	0.0	8.6	-	-	-	-	-	-	-	-	-	91.4	0.0	0.0	0.0	8.6	8.6
food	car-accidents	2	91.7	0.0	0.0	0.0	8.3	89.8	0.0	0.0	0.0	10.2	-	-	-	-	90.5	0.0	0.0	0.0	9.5	9.5
food	asthma	1	-	-	-	-	-	99.3	0.0	0.0	0.0	0.7	-	-	-	-	99.3	0.0	0.0	0.0	0.7	0.7
hospital/social	needle sticks	7	59.4	0.0	0.0	0.0	40.6	-	-	-	-	-	-	-	-	-	59.4	0.0	0.0	0.0	40.6	40.6
hospital/social	slips and trips	3	94.5	0.0	0.0	0.0	5.5	97.6	0.0	0.0	0.0	2.4	-	-	-	-	96.5	0.0	0.0	0.0	3.5	3.5

Sector	Risk	# Cases	low severity					medium severity					high severity					all										
			human	equipment	environment	product	organisation	human	equipment	environment	product	organisation	human	equipment	environment	product	organisation	human	equipment	environment	product	organisation						
hospital/ social	slips and trips	4	96.7	0.0	0.0	0.0	3.3	97.7	0.0	0.0	0.0	2.3	-	-	-	-	97.2	0.0	0.0	0.0	-	97.2	0.0	0.0	0.0	0.0	0.0	2.8
hospital/ social	cuts	1	98.1	0.0	0.0	0.0	1.9	-	-	-	-	-	-	-	-	-	98.1	0.0	0.0	0.0	-	98.1	0.0	0.0	0.0	0.0	0.0	1.9
hospital/ social	fall from height	1	-	-	-	-	-	-	-	-	-	-	99.3	0.0	0.0	0.0	99.3	0.0	0.0	0.0	0.0	99.3	0.0	0.0	0.0	0.0	0.0	0.7
hospital/ social	back problems	1	-	-	-	-	-	-	-	-	-	-	99.6	0.0	0.0	0.0	99.6	0.0	0.0	0.0	0.4	99.6	0.0	0.0	0.0	0.0	0.0	0.4
hospital/ social	machines	2	94.1	0.0	0.0	0.0	5.9	-	-	-	-	-	-	-	-	-	94.1	0.0	0.0	0.0	-	94.1	0.0	0.0	0.0	0.0	0.0	5.9
hospital/ social	needle sticks	3	66.1	0.0	0.0	0.0	33.9	-	-	-	-	-	98.5	0.0	0.0	0.0	-	98.5	0.0	0.0	1.5	94.9	0.0	0.0	0.0	0.0	0.0	5.1
hospital/ social	slips and trips	3	93.8	0.0	0.0	0.0	6.2	-	-	-	-	-	99.0	0.0	0.0	0.0	-	99.0	0.0	0.0	1.0	98.2	0.0	0.0	0.0	0.0	0.0	1.8
cleaning	back problems	2	97.7	0.0	0.0	0.0	2.3	97.2	0.0	0.0	0.0	2.8	-	-	-	-	-	97.3	0.0	0.0	-	-	97.3	0.0	0.0	0.0	0.0	2.7
cleaning	allergic reaction	6	96.3	0.0	0.0	0.0	3.7	-	-	-	-	-	-	-	-	-	-	96.3	0.0	0.0	-	-	96.3	0.0	0.0	0.0	0.0	3.7
cleaning	slips and trips	6	96.4	0.0	0.0	0.0	3.6	97.2	0.0	0.0	0.0	2.8	-	-	-	-	-	96.7	0.0	0.0	-	-	96.7	0.0	0.0	0.0	0.0	3.3
mining	cuts	1	100.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	100.0	0.0	0.0	-	-	100.0	0.0	0.0	0.0	0.0	0.0
mining	eye injuries	2	100.0	0.0	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-	100.0	0.0	0.0	-	-	100.0	0.0	0.0	0.0	0.0	0.0
mining	fall from ladder	1	-	-	-	-	-	-	-	-	-	-	95.9	0.0	0.0	0.0	-	95.9	0.0	0.0	-	-	95.9	0.0	0.0	0.0	0.0	4.1
mining	machines	9	96.9	0.0	0.0	0.0	3.1	96.2	0.0	0.0	0.0	3.8	-	-	-	-	-	96.5	0.0	0.0	-	-	96.5	0.0	0.0	0.0	0.0	3.5
mining	back problems	3	100.0	0.0	0.0	0.0	0.0	97.7	0.0	0.0	0.0	2.3	99.2	0.0	0.0	0.0	-	98.9	0.0	0.0	0.8	-	98.9	0.0	0.0	0.0	0.0	1.1
mining	slips and trips	6	97.3	0.0	0.0	0.0	2.7	95.1	0.0	0.0	0.0	4.9	99.2	0.0	0.0	0.0	-	98.0	0.0	0.0	0.8	-	98.0	0.0	0.0	0.0	0.0	2.0
transport	aggression	12	90.1	0.0	0.0	0.0	9.9	95.9	0.0	0.0	0.0	4.1	98.7	0.0	0.0	0.0	-	95.5	0.0	0.0	1.3	-	95.5	0.0	0.0	0.0	0.0	4.5
transport	cuts	2	94.6	0.0	0.0	0.0	5.4	-	-	-	-	-	-	-	-	-	-	94.6	0.0	0.0	-	-	94.6	0.0	0.0	0.0	0.0	5.4
transport	eye injuries	1	88.1	0.0	0.0	0.0	11.9	-	-	-	-	-	-	-	-	-	-	88.1	0.0	0.0	-	-	88.1	0.0	0.0	0.0	0.0	11.9

Table 33 - Costs of accidents at work and work-related ill-health, overview of the cases

Sector	Type	# cases	Low severity				Medium severity				High severity			
			# cases	lowest cost	highest cost	median	# cases	lowest cost	highest cost	median	# cases	lowest cost	highest cost	median
transport	car-accidents	9	8	€2,693.11	€5,090.49	€3,919.27	0	-	-	-	1	€18,706.36	-	€18,706.36
construction	slips and trips	12	8	€237.05	€4,335.75	€1,339.07	3	€6,425.27	€8,190.68	€6,639.53	1	€17,115.40	-	€17,115.40
construction	slips and trips	14	6	€1,737.68	€2,130.03	€1,868.19	3	€2,970.49	€3,590.03	€3,280.26	5	€8,828.66	€11,274.57	€10,051.61
construction	slips and trips	10	6	€513.98	€2,469.66	€2,062.62	3	€4,439.32	€6,438.88	€5,350.20	1	€7,214.95	-	€7,214.95
construction	slips and trips	11	8	€425.45	€2,851.89	€782.91	2	€3,259.75	€4,749.87	€4,004.81	1	€9,788.26	€29,295.72	€19,541.99
chemical sector	allergic reaction	4	3	€696.45	€1,305.64	€727.68	0	-	-	-	1	€7,444.12	-	€7,444.12
hospital/social	allergic reaction	3	2	€65.01	€996.13	€530.57	0	-	-	-	1	€7,962.50	-	€7,962.50
transport	back problems	11	8	€741.69	€2,695.18	€1,227.01	3	€3,042.17	€3,493.07	€3,381.45	0	-	-	-
food	slips and trips	11	7	€427.57	€1,684.13	€1,585.12	3	€2,275.30	€2,373.70	€2,275.30	1	€31,320.23	-	€31,320.23
construction	fall from ladder	7	4	€1,985.86	€3,068.74	€1,985.86	0	-	-	-	3	€8,231.93	€11,563.04	€11,563.04
construction	fall from ladder	5	3	€2,885.64	€2,736.23	€2,885.64	0	-	-	-	2	€18,508.59	€22,249.93	€20,379.26
hospital/social	back problems	4	2	€642.28	€811.90	€727.09	2	€2,001.90	€2,236.30	€2,119.10	0	-	-	-
hospital/social	back problems	10	6	€1,176.28	€2,843.80	€1,849.51	3	€3,267.96	€8,282.30	€4,693.79	1	€21,995.09	-	€21,995.09
hospital/social	back problems	11	7	€1,016.74	€1,866.01	€1,514.71	3	€3,020.35	€4,885.52	€3,187.59	1	€8,002.04	-	€8,002.04
hospital/social	needle sticks	8	8	€747.10	€747.10	€747.10	0	-	-	-	0	-	-	-
construction	back problems	8	6	€623.40	€1,782.54	€985.28	1	€4,429.84	-	€4,429.84	1	€45,739.23	-	€45,739.23
construction	fall from platform	7	3	€416.45	€3,070.49	€1,213.25	2	€652.14	€4,773.56	€3,911.10	2	€8,475.15	€11,543.06	€8,966.18
food	machines	12	8	€444.83	€1,734.15	€818.35	3	€521.13	€2,892.45	€2,858.96	1	€3,407.04	-	€3,407.04
metal	cuts	10	8	€921.31	€1,600.73	€1,266.62	1	€2,031.75	-	€2,031.75	1	€3,063.85	-	€3,063.85
metal	cuts	10	8	€221.93	€2,553.25	€825.28	0	-	-	-	2	€4,090.58	€4,856.74	€4,473.66
metal	cuts	7	6	€336.38	€1,983.18	€933.31	0	-	-	-	1	€11,760.35	-	€11,760.35
textiles	back problems	10	7	€1,616.22	€2,279.36	€2,035.14	2	€3,444.15	€4,779.73	€4,111.94	1	€13,115.32	-	€13,115.32
metal	slips and trips	7	6	€495.33	€11,873.06	€503.03	0	-	-	-	1	€30,276.05	-	€30,276.05
construction	electric shock	3	2	€660.68	€2,817.03	€1,838.86	1	€3,522.05	-	€1,761.03	0	-	-	-
construction	electric shock	6	4	€243.25	€4,879.66	€1,010.75	1	€4,278.19	-	€4,278.19	1	€22,667.00	-	€22,667.00
distribution	aggression	3	1	€4,548.92	-	€4,548.92	2	€5,561.97	€9,677.73	€7,619.85	0	-	-	-
transport	forklift/pallet truck	12	8	€889.50	€2,507.43	€1,332.33	3	€4,423.92	€4,694.78	€4,619.81	1	€8,555.10	-	€8,555.10

Sector	Type	# cases	Low severity				Medium severity				High severity			
			# cases	lowest cost	highest cost	median	# cases	lowest cost	highest cost	median	# cases	lowest cost	highest cost	median
transport	forklift	6	3	€624.45	€1,238.15	€1,190.65	2	€2,871.61	€5,571.72	€4,221.67	1	€10,126.55	-	€10,126.55
construction	eye injuries	6	5	€513.35	€1,554.85	€1,351.50	1	€6,173.69	-	€6,173.69	0	-	-	-
waste	slips and trips	4	2	€421.10	€793.70	€607.40	2	€5,100.57	€6,852.89	€5,976.73	0	-	-	-
metal	cuts	2	2	€2,598.45	€2,906.63	€2,752.54	0	-	-	-	0	-	-	-
metal	machines	5	5	€1,567.13	€4,654.13	€2,042.50	0	-	-	-	0	-	-	-
metal	slips and trips	1	1	€3,740.65	-	€3,740.65	0	-	-	-	0	-	-	-
metal	cuts	1	1	€2,775.22	-	€2,775.22	0	-	-	-	0	-	-	-
metal	falls_machines	2	0	-	-	-	1	€7,160.50	-	€7,160.50	1	€13,861.90	-	€13,861.90
metal	falls	1	0	-	-	-	0	-	-	-	1	€32,722.95	-	€32,722.95
metal	machines	1	0	-	-	-	0	-	-	-	1	€32,740.00	-	€32,740.00
construction	machines	2	1	€1,730.00	-	€1,730.00	0	-	-	-	1	€8,995.60	-	€8,995.60
construction	eye injuries	8	8	€61.26	€1,618.95	€580.30	0	-	-	-	0	-	-	-
construction	electric shock	1	0	-	-	-	0	-	-	-	1	€6,028.58	-	€6,028.58
construction	back problems	1	0	-	-	-	0	-	-	-	1	€18,073.49	-	€18,073.49
construction	eye injuries	5	5	€46.65	€6,353.56	€46.65	0	-	-	-	0	-	-	-
construction	epoxy	1	1	€4,494.61	-	€4,494.61	0	-	-	-	0	-	-	-
construction	epoxy	1	0	-	-	-	0	-	-	-	1	€43,789.99	-	€43,789.99
construction	epoxy	4	3	€411.42	€1,208.14	€809.78	1	€6,497.75	-	€6,497.75	0	-	-	-
food	machines	3	0	-	-	-	2	€11,073.54	€11,200.04	€11,136.79	1	€25,142.10	-	€25,142.10
food	cuts	1	1	€2,561.11	-	€2,561.11	0	-	-	-	0	-	-	-
food	car-accidents	2	1	€4,233.65	-	€4,233.65	1	€6,473.65	-	€6,473.65	0	-	-	-
food	asthma	1	0	-	-	-	1	€16,435.50	-	€16,435.50	0	-	-	-
hospital/social	needle sticks	7	7	€262.81	€262.81	€262.81	0	-	-	-	0	-	-	-
hospital/social	slips and trips	3	2	€1,275.25	€2,048.05	€1,661.65	1	€5,381.34	-	€5,381.34	0	-	-	-
hospital/social	slips and trips	4	3	€1,608.85	€3,380.04	€2,494.45	1	€4,811.04	-	€4,811.04	0	-	-	-
hospital/social	cuts	1	1	€1,707.75	-	€1,707.75	0	-	-	-	0	-	-	-
hospital/social	falls	1	0	-	-	-	0	-	-	-	1	€9,408.30	-	€9,408.30
hospital/social	back problems	1	0	-	-	-	0	-	-	-	1	€9,375.30	-	€9,375.30
hospital/social	machines	2	2	€2,335.30	€2,536.05	€2,435.68	0	-	-	-	0	-	-	-
hospital/social	needle sticks	3	2	€179.75	€347.65	€263.70	0	-	-	-	1	€0.00	€3,467.75	€1,823.75
hospital/social	slips and trips	3	2	€476.41	€1,224.52	€850.47	0	-	-	-	1	€8,933.09	-	€8,933.09
cleaning	back problems	2	1	€4,418.33	-	€4,418.33	1	€8,901.00	-	€8,901.00	0	-	-	-
cleaning	allergic	6	6	€2,979.29	€4,171.00	€3,736.76	0	-	-	-	0	-	-	-

Sector	Type	# cases	Low severity				Medium severity				High severity						
			# cases	lowest cost	highest cost	median	# cases	lowest cost	highest cost	median	# cases	lowest cost	highest cost	median			
	reaction																
cleaning	slips and trips	6	5	€146.56	€3,602.31	€1,091.80	1	€5,086.29	-	€5,086.29	0	-	-	-	-	-	-
mining	cuts	1	1	€4,209.90	-	€4,209.90	0	-	-	-	0	-	-	-	-	-	-
mining	eye injuries	2	2	€1,785.00	€2,136.86	€1,960.93	0	-	-	-	0	-	-	-	-	-	-
mining	fall from ladder	1	0	-	-	-	1	€5,292.50	-	€5,292.50	0	-	-	-	-	-	-
mining	machines	9	6	€1,400.00	€4,023.00	€2,888.57	3	€4,125.21	€6,776.36	€6,085.00	0	-	-	-	-	-	-
mining	back problems	3	1	€2,142.00	-	€2,142.00	1	€9,394.50	-	€9,394.50	1	€26,194.50	-	€26,194.50	-	€26,194.50	-
mining	slips and trips	6	4	€960.00	€3,495.43	€1,800.00	1	€3,221.36	-	€3,221.36	1	€25,894.50	-	€25,894.50	-	€25,894.50	-
transport	aggression	12	8	€1,487.40	€4,647.73	€2,557.09	3	€6,579.73	€6,966.13	€6,579.73	1	€34,120.50	-	€34,120.50	-	€34,120.50	-
transport	cuts	2	2	€2,678.46	€4,476.68	€3,577.57	0	-	-	-	0	-	-	-	-	-	-
transport	eye injuries	1	1	€1,385.56	-	€1,385.56	0	-	-	-	0	-	-	-	-	-	-
transport	fall from height	1	0	-	-	-	0	-	-	-	1	€45,758.18	-	€45,758.18	-	€45,758.18	-
transport	slips and trips	7	6	€2,120.15	€7,630.95	€3,938.75	1	€14,905.35	-	€14,905.35	0	-	-	-	-	-	-
transport	fire	2	2	€161.54	€5,132.04	€2,646.79	0	-	-	-	0	-	-	-	-	-	-
transport	forklift	6	5	€278.27	€1,276.88	€878.52	1	€12,239.48	-	€12,239.48	0	-	-	-	-	-	-
transport	slips and trips	1	0	-	-	-	0	-	-	-	1	€14,436.67	-	€14,436.67	-	€14,436.67	-
waste	fall from platform	1	0	-	-	-	1	€7,383.36	-	€7,383.36	0	-	-	-	-	-	-
waste	fall from ladder	1	0	-	-	-	0	-	-	-	1	€23,087.50	-	€23,087.50	-	€23,087.50	-
waste	machines	2	0	-	-	-	1	€2,297.00	-	€2,297.00	1	€4,800.00	-	€4,800.00	-	€4,800.00	-
construction	falls	2	1	€65.95	-	€65.95	1	€8,904.98	-	€8,904.98	0	-	-	-	-	-	-
construction	machines	1	0	-	-	-	1	€6,990.50	-	€6,990.50	0	-	-	-	-	-	-
waste	cuts	2	1	€906.23	-	€906.23	1	€5,256.54	-	€5,256.54	0	-	-	-	-	-	-
waste	eye injuries	1	1	€906.23	-	€906.23	0	-	-	-	0	-	-	-	-	-	-
waste	slips and trips	7	7	€507.87	€2,959.15	€2,109.35	0	-	-	-	0	-	-	-	-	-	-
energy	eye injuries	1	1	€540.34	-	€540.34	0	-	-	-	0	-	-	-	-	-	-
energy	slips and trips	2	2	€1,767.40	€2,676.70	€2,222.05	0	-	-	-	0	-	-	-	-	-	-
energy	hand	3	2	€468.40	€3,326.20	€1,897.30	1	€6,898.45	-	€6,898.45	0	-	-	-	-	-	-
service	stress	1	0	-	-	-	0	-	-	-	1	€38,704.00	-	€38,704.00	-	€38,704.00	-
Total number of cases		401	276	€46.65	€11,873.06	€1,651.54	73	€521.13	€16,435.50	€4,985.90	52	€3,063.85	€45,758.18	€11,760.35			

Table 34 - Cost-benefit analysis, 3 scenarios, overview of the case studies

Scenario's

- Scenario 1: Conservative assumption
- Scenario 2: More optimistic assumption (same prevention measure)
- Scenario 3: Alternative or additional measure

Measures

I	substitution/avoidance
II	organisational measure
III	new equipment/auxiliaries
IV	workplace adjustment
V	training
VI	personal protective equipment

Cost-benefit analysis (see also box 14)

Net Present Value NPV

The net present value of a series of cash flows, both incoming and outgoing, is defined as the sum of the present values (PVs) of the individual cash flows. The NPV gives an indication of the amount a project adds to the value of a company. A project will be accepted when the NPV is larger than 0.

Profitability Index PI

The Profitability Index is defined as the present value of expected cash flows over the value of the Initial Investment. It is a ratio of the present value or cash flows and the initial investment. A Profitability Index of one yields the internal rate of return. A Profitability Index of less than one suggests that the project should be rejected and value of one or greater suggests that investment should be accepted. If there is a choice between two or more alternative projects, the one with the largest PI should be chosen.

Remark: the PI is not calculated when the project doesn't involve investments, only yearly costs

Benefit-cost ratio BCR

The benefit-cost ratio is the ratio of the benefits of a project relative to its costs. Both benefits and costs are expressed in discounted present values. A project will be accepted when the BCR is larger than 1.

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
transport	car-accidents	training. 1 day. awareness raising. defensive driving techniques	1	V	10%	-5,242.82	0.81	0.87
			2	V	30%	33,244.16	2.20	2.60
			3	V	40%	138,646.67	1.42	1.66
construction	slips and trips	additional: technical adjustments to the vans adapting the work organisation; at the end of each work day. 1 worker is responsible for clean-up (in turn)	1	II	30%	2,418.46	3.42	1.02
			2	II	50%	14,904.80	15.90	1.10
			3	II	55%	17,343.37	9.67	1.12
construction	slips and trips	intensive awareness raising campaign additional: awareness raising campaign	1	V	10%	9,187.47	2.39	3.46
			2	V	20%	13,183.68	3.00	4.47
			3	V	55%	10,998.25	2.67	1.08
chemical sector	allergic reaction	adjustment of the personal protective equipment; extra protection (glove/sleeve)	1	VI	70%	360.64	1.54	1.85
			2	VI	85%	554.75	1.83	2.25
			3	I	100%	-33,253.33	0.87	0.87
hospital/social	allergic reaction	personal protective equipment; another type of glove alternative: automatic cleaning system	1	VI	30%	6,499.09	6.51	3.99
			2	VI	50%	12,279.24	11.41	6.66
			3	I	100%	-33,253.33	0.87	0.87
transport	back problems	yearly an extra training in lifting techniques focused on specific tasks additional: intensive training by external expert. including advice focused on specific tasks/workplace. followed by a yearly training	1	V	10%	241.46	-	1.04
			2	V	20%	7,111.32	-	2.07
			3	V	30%	9,632.45	2.35	1.98
food	slips and trips	slip resistant floor additional: awareness raising campaign housekeeping	1	IV	30%	41.86	1.00	1.14
			2	IV	45%	11,664.46	1.34	1.71
			3	IV	50%	14,855.65	1.42	1.85
construction	fall from ladder	adaptations of the ladders (the accidents occurred going from the platform onto the ladder) additional: awareness raising campaign	1	III	30%	6,375.38	1.41	1.45
			2	III	50%	22,807.29	2.47	2.42
			3	III	55%	26,232.26	2.59	2.57
construction	fall from ladder	purchase of new ladders equipped with additional safety accessories (better grip. ...) additional: training for all workers focused on ladders	1	III	30%	7,851.73	1.77	2.23
			2	III	50%	18,373.38	2.81	3.71
			3	III	55%	20,369.56	2.62	3.85

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
hospital/social	back problems	lifting aid	1	III	40%	-9.25	1.00	1.00
			2	III	60%	3,599.56	1.65	1.50
			3	III	70%	6,902.17	1.05	1.20
hospital/social	back problems	purchase of adjustable beds (high low beds); training of all personnel (care) additional: training	1	V	50%	-2,216.58	0.98	1.00
			2	V	60%	21,245.53	1.16	1.20
			3	V	70%	6,902.17	1.05	1.20
hospital/social	back problems	yearly budget for purchase of lifting aids; regular training additional: training	1	V	30%	-11,991.10	-	0.89
			2	V	50%	55,801.06	-	1.49
			3	V	70%	120,593.22	41.20	2.03
hospital/social	needle sticks	purchase of a new integrated system for injection. needles are automatically retracted ²²	1	V	95%	-174,801.34	-4.74	0.60
construction	back problems	investing in a winch and a lifting aid for bricks additional: training	1	III	25%	1,280.60	1.04	1.20
			2	III	50%	27,151.42	1.88	2.30
			3	III	75%	35,701.02	1.63	2.10
construction	fall from platform	purchase of rolling scaffolds; training of foremen (assembly and use) additional: training for all workers on working at heights	1	V	50%	123.87	1.00	1.14
			2	V	70%	8,983.74	1.29	1.60
			3	V	75%	-168.96	1.00	1.10
food	machines	implementing a yearly training for the machine operators additional: awareness raising campaign	1	V	10%	-648.96	-	0.82
			2	V	20%	2,369.24	-	1.65
			3	V	25%	1,931.75	1.68	2.06
metal	cuts	Improved cut-resistant gloves & introduction of PET straps. The improved glove is more tear resistant and flexible than the previous. Workers can now carry out finer tasks while still experiencing a high degree of comfort. The introduction of PET straps will further increase accident reduction. additional: awareness-raising campaign	1	IV	30%	2,799.20	1.43	1.24
			2	IV	50%	6,303.55	1.97	1.50
			3	IV	60%	7,372.72	1.98	1.55
metal	cuts	Improved cut-resistant gloves & introduction of PET straps. The improved glove is more tear resistant and flexible than the previous. Workers can now carry out	1	IV	30%	1,979.55	1.30	1.18
			2	IV	50%	4,937.48	1.76	1.40

²² This case could not be fully calculated; insufficient data were available on benefits from savings e.g. equipment which is currently in use doesn't have to be purchased anymore, less medical waste.

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
		finer tasks while still experiencing a high degree of comfort. The introduction of PET straps will further increase accident reduction.						
		additional: awareness-raising campaign	3	IV	75%	7,951.87	2.06	1.59
metal	cuts	purchase of another type of cut-resistant gloves; training of all workers	1	VI	40%	-256.35	0.99	1.07
		additional: awareness raising campaign	2	VI	60%	15,411.62	1.59	1.60
		adapting the workplace: installing screens and barriers. adjustment of the machine	3	VI	45%	38,006.04	5.80	3.10
textiles	cuts	additional: training: recognizing hazards	1	IV	60%	11,192.41	2.87	3.55
		implementing 5S procedures (housekeeping)	2	IV	80%	16,619.62	3.77	4.73
		purchase of another type of knives	3	IV	20%	-1,456.97	0.84	0.93
metal	slips and trips	additional: training: recognizing hazards	1	II	30%	-10,032.52	0.95	1.06
		purchase of another type of knives	2	II	50%	38,750.72	1.19	1.45
construction	electric shock	additional: awareness raising campaign: safe working practices	1	III	20%	-0.98	1.00	4.34
		yearly training of middle management	2	III	40%	530.36	1.88	8.67
		new registration system and follow-up training of line managers	3	III	50%	113.01	1.07	10.84
construction	electric shock	additional: installing sound signals on pallet trucks	1	V	10%	2,279.70	-	1.21
		implementing a new. more intensive induction procedure and training	2	V	20%	15,495.92	-	2.42
distribution	aggression	purchase of an integrated safety helmet with safety goggles (instead of separate equipment)	1	II	10%	2,606.27	1.03	0.63
		Mostly hands and fingers are injured; campaign involving the employees (encouraging to make proposals. competition); purchase of a new type of glove	2	II	20%	66,943.42	1.87	1.27
transport	pallet truck	training of pallet truck drivers	1	V	10%	1,132.58	-	1.29
		purchase of an integrated safety helmet with safety goggles (instead of separate equipment)	2	V	20%	4,284.40	-	2.08
		implementing a new. more intensive induction procedure and training	3	V	25%	1,079.21	1.15	1.20
transport	forklift	purchase of an integrated safety helmet with safety goggles (instead of separate equipment)	1	V	10%	26,392.97	-	2.96
		Mostly hands and fingers are injured; campaign involving the employees (encouraging to make proposals. competition); purchase of a new type of glove	2	V	20%	66,382.22	-	5.92
construction	eye injuries	purchase of an integrated safety helmet with safety goggles (instead of separate equipment)	1	VI	30%	149.86	1.05	1.18
		Mostly hands and fingers are injured; campaign involving the employees (encouraging to make proposals. competition); purchase of a new type of glove	2	VI	50%	1,804.56	1.64	1.97
energy	machines	purchase of an integrated safety helmet with safety goggles (instead of separate equipment)	1	V	30	4,209.64	1.53	1.3
		Mostly hands and fingers are injured; campaign involving the employees (encouraging to make proposals. competition); purchase of a new type of glove	2	V	50	19,116.39	3.39	2.1

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
		Additional: photos taken by the employees themselves and showing them in the break rooms etc. (based on study from Rupprecht). demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	3	V VI	60	25,243.82	4.08	2.4
metal	cuts	Safe tools (e.g. safety knife or side cutting pliers) and related instruction after accidents. and during normal annual safety instructions. Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	1 2 3	III III V	30 50 60	4,538.49 8,903.46 9,213.58	4.78 8.42 5.19	3.4 5.7 3.5
metal	machines	Usage of special chip-hooks (available at all machines); use of special cut resistance gloves; instruction after accidents. and during normal annual safety instructions. Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	1 2 3	III III VI V	30 50 60	12,079.86 22,488.53 25,820.5	9.63 17.06 11.76	4.6 7.6 6
metal	slips and trips	Procedures to eliminate all obstacles. barriers; additional instructions in case of accidents or near misses. Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	1 2 3	IV IV V	50 70 80	81 377.6 50.31	1.28 2.32 1.09	1.2 1.6 1.1
metal	falls from height	Employees sent to seminars (use of safety harnesses etc.) offered by accident insurance company Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the	1 2 3	V V V	20 40 50	-1,710.08 4,575.63 4,370.21	0.43 2.53 1.87	0.8 1.6 1.4

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
		correct behaviour by the employees themselves						
metal	machines	Special machine to cut trenches into walls (powersaw). Additional instructions.	1 2	I I	70 90	1,677.76 2,975.74	2.56 3.77	1.6 2.1
construction	machines	Purchase of an online instruction software to be used on site but also individually as Web Based Training. Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	1 2 3	V V V	10 30 40	-730.89 4,838.19 4,547.65	0.83 2.1 1.76	0.9 2.7 1.8
construction	electric shock	Use of a SPE-PRCD (Switched Protective Earth - Portable Residual Current Device); Instructions how to use Additional: awareness raising	1 2 3	III III III	50 70 80	565.67 1,043.68 1,405.57	2.53 3.82 3.6	2 2.8 3.1
construction	back problems	electrical lift bench. instruction Additional: agreement between employees' representative body, employees and occupational physician, so that the physician gets all diagnoses and absent days. allowing an early detection and adapted intervention strategy, e.g. tailor-made movement training (e.g. Ergophys).	1 2 3	III III II	50 70 80	2,219.93 3,652.97 75.02	2.2 2.97 1.02	3 4.1 1.1
construction	eye injury	organisational measures: vacuum instead of pressurised air. shorten cable clip. obligatory use of goggles for certain work; technical measures: control windows at the furnace. Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	1 2 3	II II III. V	40 60 70	18,287.2 28,754.33 31,439.2	6.81 10.13 7.48	8.8 13.2 7.6
food	car accident	Instructions. courses (12 persons per year for 1 day). Additional: Photos taken by the employees	1 2 3	V V V	10 30 40	3,198.92 21,866.98 29,443.57	2.39 10.5 9.66	1.6 4.7 4.9

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
		themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves						
food	asthma	Local exhaust at all workplaces and appropriate air flow in the whole room Machine to moisten the flour (in general the use of the moistening machine would render the exhaust system obsolete) Dust reduced release flour	1 2 3	I I I	90 100 1000	-618.38 2,325.56 15,985.83	0.98 1.06 1.96	1.1 1.2 2.4
hospital/social	slips and trips	Repair of elevator. of park deck floor. optimising cable layout Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	1 2 3	IV IV IV	60 70 80	15,883.34 19,447.88 21,406.59	4.15 4.86 4.6	4.2 4.9 4.3
hospital/social	cuts	Reinforcing procedures: hallways to mopped half-sided. signposts to be set during cleaning. water puddles to be removed. windows to be closed. Use and purchase of transport trolleys (e.g. for glass bottles) Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	1 2 3	III III III	30 50 60	3,675.31 7,737.54 8,537.71	2.13 3.38 4.97	2.8 4.7 3.5
hospital/social	needle sticks	Instruction (e.g. no re-capping); safe instruments for taking blood samples. injections and intravenous catheters; safe containers for disposing of used needles; vaccinations (e.g. hepatitis B). Additional: measures to improve risk perception of employees by presenting examples of typical and severe cases (e.g. where employees had to give up their profession)	1 2 3	III III III	25 50 50	8,986.13 41,070.18 41,070.18	1.85 4.87 4.87	1.4 2.9 2.9

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
cleaning	back problems	Purchase of service trolleys; adapted mop sizes; adjustable handles; special holder for the mops. which allows changing without bending down; use of micro fibre cloths (weight reduction); extensions that allow dusting while standing; smaller water buckets (5l instead of 10); specific training (carrying buckets with both hands); vacuum cleaner with rollers with high quality bearings; 1l water bottles instead of 10l; adapting working schedule allowing longer breaks. Additional: agreement between employees' representative body, employees and occupational physician, so that the physician gets all diagnoses and absent days, allowing an early detection and adapted intervention strategy. e.g. tailor-made movement training (e.g. Ergophys).	1	III	20	20,299.53	1.5	1.3
			2	III	40	111,665.68	3.78	2.7
			3	III	50	157,348.75	4.91	3.4
cleaning	allergic reaction	Use of skin friendly cleaning agents based on mild surfactants without disinfectants or alcohol. Increased use of micro fibre cloths for dry cleaning or cleaning with very little liquid. Skin protection and care programme; use of appropriate gloves; training and instructions.	1	I	80	16,019.68	3.19	1.9
			2	I	100	24,740.03	4.39	2.4
mining	eye injury	Already implemented: Every worker has a bottle of eye rinse liquid; supervisors lead by example; instructions. Additionally: Full protection goggles for cleaning and maintenance work; instructions. Additional: Photos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves	1	VI	20	154.38	1.04	1
			2	VI	40	11,038.12	3.69	2.1
			3	VI	50	13,131.71	3.15	2
mining	fall from ladder	Continuous check-up and maintenance of ladders. instructions Additionally safety ladders	1	II	20	2,203.45	2.44	1.6
			2	II	30	5,350.77	4.49	2.4
			3	II	50	8,297.12	3.35	2.2

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio	
mining	MSD (back problems)	Technical solutions (lifting devices, adjustable benches. ...); Ergonomics training focussed on the working processes in place Additional: agreement between employees' representative body, employees and occupational physician, so that the physician gets all diagnoses and absent days, allowing an early detection and adapted intervention strategy, e.g. tailor-made movement training (e.g. Ergophys).	1	III	V	20	2,975.07	1.03	1.1
			2	III	V	40	175,959.36	2.7	2.1
			3	III	V	50	259,036.44	3.38	2.6
transport	aggression	De-escalations training including role plays for all drivers conducted; equipping busses with video surveillance systems. Additional: measures following the best practice case of the Bilbao public transport company: - Staff involvement in improvement teams and prevention activities - Coordination with police in sensitive areas - Incident log and guide to prevention	1	V	III	70	1,662.99	1.02	1.2
			2	V	III	90	16,774.13	1.22	1.5
			3	V	III	95	1,895.08	1.02	1.1
transport	fall from height	Technical measures: covers for the pit, stopmark for the bus drivers (so that there will be no open pit space in front of the busses); Discussion of the accidents during the normal annual instructions.	1	III		60	324.81	1.08	1.1
			2	III		80	2,138.89	1.5	1.5
transport	slips and trips	Campaign focussing on the slip and trip hazards in the workplace	1	V		10	-176.61	0.95	1
			2	V		20	8,975.19	3.56	2
waste	fall from platform	Guardrail on top of machines; new design of door opening for Volvo wheelloader cabins (meanwhile implemented by Volvo). Instructions.	1	III		40	112.65	1.2	1.4
			2	III		60	406.37	1.74	2.1
waste	fall from ladder	Safety ladders; instructions.	1	III		40	1,206.76	3.87	3.1
			2	III		60	2,122.06	6.05	4.7
waste	machines	Regular check-up of safety appliances (are often tampered with); instructions. Repeated notification of all contractors/Customers not	1	II		30	-162.69	0.12	0.7
			2	II		50	57.56	1.31	1.2

Sector	Type	Description	Scenario	Type of measure	Assumption % of avoided costs due to cases	Net Present Value	Profitability Index	Benefit-Cost Ratio
waste	slips and trips	to allow wire rolls getting into the loads to be delivered to the concrete shredders. Intensive training course (external)	1	V	10	968.58	1.42	1.2
			2	V	20	6,922.95	4.14	2.6
			3	V	30	3,250.07	1.47	1.3
construction	allergic reaction	Additional: Photos/videos taken by the employees themselves and showing them in the break rooms etc.. demonstrating the re-enacted accidents and the correct behaviour by the employees themselves Allergic reaction to epoxy. General instructions and special instructions for new employees. focusing on the use of ppe Alternative: adequate ppe. safe containers (hardener can be added to the resin without contact). purchase of special mixers limiting splashes. etc.	1	V	1	-382.75	0.67	0.9
			2	V	5	7,210.11	7.27	3.5
			3	III VI	70	23,411.59	1.32	1.2
service sector	stress	Internal meeting. increasing support additional: management training course	1	V	1	-17.31	0.93	1
			2	V	5	596.46	3.39	5.1
			3	V	30	1,069.12	1.4	1.4

European Commission

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