European Agency for Safety and Health at Work

RESEARCH

Quality of the working environment and productivity

Working Paper

European Agency for Safety and Health at Work

EN

Quality of the working environment and productivity

Research findings and case studies

Prepared by
the Topic Centre on Research — Work and Health

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European Agency for Safety and Health at Work

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Foreword

According to its regulation, the European Agency for Safety and Health at Work (the Agency) shall collect and disseminate technical, scientific and economic information in the Member States in order to pass it on to the Community bodies, Member States and interested parties. The Agency shall also provide technical, scientific and economic information on methods and tools for implementing preventive activities, paying particular attention to the specific problems of small and medium-sized enterprises.

Members of the European Commission are concerned about costs of 'non-social policy' for Europe. They have prioritised the need to develop knowledge of economic and social costs due to occupational accidents and illnesses in their Community strategy on safety and health at work for 2002–06.

This was the background to why the Agency's board decided to launch an information project on 'Workers' safety and health, productivity and quality' in 2003. This working paper is the project outcome consisting of a literature survey and case studies collected from Member States. A special web feature on economic aspects in occupational safety and health (OSH) has also been developed.

We hope that this working paper presents new viewpoints on OSH and productivity and stimulates and contributes to discussions on the topic. Increasing knowledge of the economic and social benefits of good safety and health performance at company level plays an important part in raising occupational health and safety levels.

As a parallel activity, an Agency information project on 'Corporate social responsibility and occupational safety and health' was carried out, also in 2003. Good practice examples and policies were collected from Member States. The report published by the Agency on this topic will greatly complement the findings from this study.

The Agency's Topic Centre on Research — Work and Health, a consortium of European research institutions, prepared this working paper. Prevent from Belgium coordinated the work. The Agency would like to thank Marc De Greef and Karla Van den Broek (Prevent) for drafting the working paper. The Agency is also grateful to the other Topic Centre task partners, 'Focal Points' and all those who contributed to the preparation of this working paper.

European Agency for Safety and Health at Work
March 2004

Executive summary

Aim and background

The purpose of this working paper is to look at the link between a good working environment and productivity. A better understanding of positive effects of a good working environment would support the implementation of effective health and safety policy at company level. It would complement the set of rules and regulations with a significant parameter that is directly linked to the intrinsic motivation of a company. Companies need to be convinced that making OSH objectives their own and integrating them into their own company objectives is worth the effort.

This working paper attempts to make a contribution to these issues. Especially, it aims to:

- explore the research findings on the relationship between a good working environment and company productivity;
- exchange good practice examples at company level among Member States; and
- contribute to the discussion on the relationship between a good working environment and company productivity by providing new perspectives.

However, the economic approach to health and safety at company level cannot replace the value of the human requirements. Health and safety is part of the social and ethical role of a company. A company policy cannot only be based on economic parameters. It is difficult or even impossible to evaluate qualitative costs such as suffering, reduction in the quality of life, family problems, decrease of lifespan, and so on, in monetary terms.

The Community strategy on health and safety at work, 2002–06, of the European Commission states that it is necessary to set up initiatives to 'develop knowledge of, and to follow-up the "cost of non-quality", i.e. the economic and social costs arising from occupational accidents and illnesses. The Commission will, in conjunction with the Bilbao Agency, instigate work on collecting data and other information with a view to improving the fund of knowledge on this subject.'

Furthermore, the Commission strategy indicates that 'a safe and healthy working environment and working organisation are performance factors for the economy and for companies.'

This working paper is one of the publications on this topic published by the European Agency for Safety and Health at Work.

Methodology

This working paper focuses on the level of the individual company. The consequences of occupational safety and health hazards will encompass individual workers/victims as well as their families and social networks. Society as a whole has to deal with these negative outcomes of the production process.

This study is based on the conceptual framework (Figure 1) showing that health and safety measures have an influence both on safety and health performances and on the productivity of companies. In addition, a better safety and health performance has positive effects on the company performance and adds to the initial effects of the health and safety measures. This model gives a qualitative overview of the economic effects of health and safety at company level and it is aimed to support the literature review and the analysis of practical cases.

However, when using this framework it has several aspects, which are addressed in this report.

The information was collected in the form of literature, on the one hand, and case studies, on the other hand. The literature focused on evidence and methods used to measure the productivity effects of OSH investments at company level.

The collection of the case studies from the Member States aimed to give practical examples of companies who have conducted projects and programmes that allowed them to verify the impact of OSH on productivity and quality. The cases from Member States were collected by the Agency's Topic Centre on Research and 'Focal Points'. An expert meeting was organised for the preparation of the report. The draft manuscript was sent to the Agency network for consolidation. Based on the comments received the final working paper was prepared.

Main research findings

The literature survey was written in order to give an overview of recent research on the subject. Although the survey was fairly limited, research findings support the existence of an important link between a good working environment and the performance of a company. Thus, the quality of a working environment has a strong influence on the productivity and profitability.

A number of success factors are identified in the literature:

- combining business targets and human resources activities, in order to achieve better results;
- taking a wider approach to health promotion to include not only health conditions but also employee attitudes and corporate culture;
- using OSH improvement programmes, as they seem to provide better results than implementing only specific prevention measures;
- including technical innovations and organisational improvements;
- carrying out measurement and evaluation. Demonstrating return on investment, both prospectively and retrospectively, is needed.

On the other hand, it was discovered that poor OSH performance can lead to a competitive disadvantage impairing the firm's status among stakeholders. This is a motivating factor to company management to invest in OSH. Stress prevention was found not only to reduce costs but also to improve productivity by improving the motivation of staff and the working climate.

This working paper also presents a number of methods, strategies, tools, and so forth, that can be useful when implementing an efficient health and safety policy. A successful policy at company level will have positive effects on the level of individual workers as well as on their families, on their social networks and on the whole of society.

Many companies are still unaware of the economic aspects of occupational safety and health. Nevertheless, company management concepts have changed to such a degree that company performance is not only measured in financial terms, but other aspects such as the customer, internal business, innovation and learning factors are also taken into consideration. This provides possibilities for identifying health and safety as important business enablers that can push companies to better performance.

Main results of the case studies

The case studies were collected from different Member States and from various economic sectors. Emphasis was put on the results of the projects in order to present evidence of the link

between quality of work and productivity. The projects present a wide range of interventions in companies ranging from limited intervention (e.g. an adaptation of a work station) to the implementation of a comprehensive health and safety management system.

Although the types of case studies differ considerably, some common elements were found:

1. The high overall quality of a working environment, including good housekeeping, is essential for improving productivity. There was a statistically significant correlation between the TR Audit Index and the contribution margin of the construction sites in Finland. It was obvious that construction sites with a poor working environment could seldom achieve good margins. It even showed that a good safety level could be used for the prediction of future profitability of that construction site. These findings were similar in the Spanish study.
2. The quality of cooperation between the management and employees is an important contributing factor in improving productivity. However, it was found that it is difficult to change existing old working methods to which people are accustomed. Also, development itself is important because it can be a practical tool for teaching cooperation between the management and employees in concrete ways.
3. Work organisation is another important contributing factor to productivity. It was found that work organisation providing more challenges and responsibilities and more job autonomy to the employees may have a positive effect on productivity. In the Austrian study, a new shift system was found to be beneficial for improving the quality of life. It was stated that this would improve the corporate image on the labour market and lower staff turnover.
4. Furthermore, some cases indicated that by developing new working methods and equipment it was possible to improve working postures and decrease the strain level of physical work. These improvements also allow worker productivity to increase. Such investments therefore directly influence the productivity of work.
5. Some case studies also demonstrated that creative solutions for specific OSH problems are needed to reduce accidents while increasing the productivity and competitiveness of the company.
6. The projects were evaluated in a thorough manner and the management was given feedback on the results. Often, this evaluation contributed to OSH, as it was then not just seen as a cost, but as a way to achieve improvements in company performance. In this way, the foundations were laid for a sustainable approach to safety and health at work. It is important to make an in-depth analysis of the different production costs that can be directly or indirectly related to the hazard (costs of accidents, loss of productivity and quality, and other production costs due, for example, to the use of inadequate materials). The objective should always be to identify the maximum number of different costs that can be linked to the hazard and that will be eliminated or reduced as a consequence of the implementation of the solution.

Conclusions

This working paper demonstrates that health and safety measures have a positive impact not only on safety and health performance but also on company productivity. However, identifying and quantifying these effects is not always straightforward. In addition, although experience shows that in many cases proof of profitability can be given, it might be rather difficult in a certain number of cases to develop solid evidence. This might be the case when some of the important consequences of health and safety risks can be externalised (e.g. hazards with long-term effects), thus putting a strain on society and not immediately on the company.

Safety and health of workers is a moral responsibility within our society that cannot only depend on productivity criteria within a particular company. This responsibility fits into the

broader concept of the performance of a company. The final evaluation concerns not only the short term, but is more an issue of the long term.

Based on the findings of this study it is strongly recommended to research these topics in the future. When integrating occupational safety and health in everyday management of the company it is possible to find win-win situations where workers' safety and health and productivity of the company can be improved. It is proposed that the European Agency for Safety and Health at Work organises an expert workshop, where these topics can be discussed in detail.

1. Introduction

1.1. Challenge

The purpose of this working paper is to look at the link between a good working environment and productivity. Better understanding of positive effects of a good working environment would support the implementation of effective health and safety policy at company level. It would complement the set of rules and regulations with a significant parameter that is directly linked to the intrinsic motivation of a company. Companies need to be convinced that making OSH objectives their own and integrating them into their own company objectives is worth the effort.

Work is essentially an economic activity. Companies are established in order to manufacture products or provide services for the market. Every company tries to do this in the most efficient way and to improve its performance. In this respect, it can be noted that over the last decade, the concept of business performance has been broadened. The approach takes not only financial factors, but also customer, internal business and innovation and learning perspectives into a full and 'balanced' account (Kaplan and Norton, 1992). This provides possibilities for identifying health and safety as an important business enabler that can drive companies to a better performance.

Many companies already recognise this fact.

A survey among 102 senior directors in the United Kingdom revealed that, on the whole, most opinion views occupational safety and health as a significant determining factor of performance (Box 1).

Box 1: Opinions of managers on occupational safety and health

In the survey, 102 senior managers were interviewed. Specific questions were asked on occupational safety and health, particularly about its relationship with corporate reputation. The main results were:

(i) 79% cited health and safety as currently having a great or fair amount of tangible impact upon corporate reputation, 68% foresaw a similar impact in the future, 58% saw the impact of occupational safety and health on the protection of the brand, 81% rated the management of corporate reputation as very important to their organisation;

(ii) 88% indicated that employee morale and reputation would be adversely affected by poor health and safety practice;

(iii) 78% saw occupational safety and health as a determining factor with regard to insurance;

(iv) 68% viewed poor occupational safety and health as having an influence on productivity and efficiency, 58% viewed it as having an impact on the quality of products and services, and 64% saw it as a determining factor of sales or profit;

(v) 64% considered that a poor occupational safety and health culture has an influence upon customer satisfaction;

(vi) 29% attributed legal responsibility for occupational safety and health to the chief executive officer (CEO), 15% attributed it to the managing director, 13% attributed it to another board director, and 20% attributed it to another manager. 5% attributed responsibility to a safety manager, whilst 9% did not know who was legally responsible for occupational safety and health in their organisation.

Source: G. Smallman, G. John, 'British directors' perspectives on the impact of health and safety on company performance', *Safety Science*, 38, 2001, p. 229.

In a US survey, 33% of employers also stated that investing in safety and health programmes increases profitability. The argument is third in the top 10 of most cited arguments after 'the cost of worker's compensation insurance' and 'the right thing to do' (ASSE, 2002).

Although these opinions are present and evidence can be found to link safety and health at work with productivity, investing in the quality of the working environment is not necessarily standard practice. According to a paper presented to the Health and Safety Executive (HSE) and the Health and Safety Commission (United Kingdom) this has to do with the lack of information on costs, assessments and performance at company level (Court, 2003). Thus, there exists a challenge to offer companies information and tools relating costs and benefits of health and safety to the business process.

This working paper attempts to make a contribution to these issues. Especially, it aims to:

- explore the research findings on the relationship between a good working environment and company productivity;
- exchange good practice examples at company level among Member States; and
- contribute to the discussion on the relationship between a good working environment and company productivity by providing new perspectives.

The working paper is aimed at the following target groups:

- the social partners and intermediaries;
- OSH experts, researchers and practitioners;
- employers;
- safety representatives.

1.2. European priority in social and employment policy

The European Union considers the development of knowledge about the economic and social costs that arise from 'non-quality' work a priority for the years to come. The Community strategy states that it is necessary to set up initiatives to:

– 'Develop knowledge of, and to follow-up, the 'cost of non-quality', i.e. the economic and social costs arising from occupational accidents and illnesses. The Commission will, in conjunction with the Bilbao Agency, instigate work on collecting data and other information with a view to improving the fund of knowledge on this subject.' (A new Community strategy on health and safety at work 2002–06, European Commission, Brussels, 11.3.2002, COM(2002) 118 final)

Furthermore, the Commission strategy indicates that:

– 'a safe and healthy working environment and working organisation are performance factors for the economy and for companies.'

In its social policy agenda, the Commission declared the overall focus to be the promotion of quality (Box 2) as the driving force for a thriving economy, more and better jobs and an inclusive society. The quality dimension was underlined by the Stockholm conclusions (2001) as:

– 'regaining full employment not only involves focusing on more jobs, but also on better jobs etc. including equal opportunities for the disabled, gender equality, good and flexible work organisation enabling better reconciliation of working and personal life, lifelong learning, health and safety at work, employee involvement and diversity in working life'.

Box 2: Quality in work

Quality reflects the desire, not just to defend minimum standards, but also to promote rising standards and ensure a more equitable sharing of progress. It delivers results — embracing the economy, the workplace, the home and society at large. It links the dual goals of competitiveness and cohesion in a sustainable way, with clear economic benefits flowing from investing in people and strong, supportive, social systems.

Source: Employment and social policies: a framework for investing in quality, Brussels, 20.6.2001 COM(2001) 313 final.

Therefore, the Commission has established quality indicators to reinforce the effectiveness and efficiency of policy while moving towards the goal of increasing quality in work. These indicators include health and safety aspects and indicators such as:

- composite indicators of fatal and serious accidents at work, including costs;
- rates of occupational disease, including new risks like repetitive strain;
- stress levels and other difficulties concerning working relationships.

(Employment and social policies: a framework for investing in quality, European Commission, Brussels, 20.6.2001, COM(2001) 313 final)

In the summer of 2003, the Commission confirmed in its mid-term review of the social policy agenda that it will promote:

– 'investments in high performance standards (including health and safety) at the workplace — which raise productivity and reduce accident losses'. (Mid-term review of the social policy agenda, European Commission, Brussels, 2.6.2003, COM(2003) 312 final)

1.3. Developing knowledge

The European Agency for Safety and Health at Work has focused in recent years on the economic and social costs and benefits of occupational safety and health in order to develop knowledge on the subject.

The findings have been presented in several publications.

- Report: European Agency for Safety and Health at Work, *Economic impact of occupational safety and health in the Member States of the European Union*, Luxembourg, Office for Official Publications of the European Communities, 1997
- Magazine, Issue 1: European Agency for Safety and Health at Work, *Health and Safety at work. A question of costs and benefits*, Luxembourg, Office for Official Publications of the European Communities, 1999
- Factsheet 9: European Agency for Safety and Health at Work, *Inventory of socio-economic information about work-related musculoskeletal disorders in the Member States of the European Union*, Luxembourg, Office for Official Publications of the European Communities, 2000
- Factsheet 27: European Agency for Safety and Health at Work, *Inventory of socio-economic costs of work accidents*, Luxembourg, Office for Official Publications of the European Communities, 2002
- Factsheet 28: European Agency for Safety and Health at Work, *Economic appraisal of preventing work accidents at company level*, Luxembourg, Office for Official Publications of the European Communities, 2002
- Report: Mossink, J. (TNO), De Greef, M. (Prevent), European Agency for Safety and Health at Work, *Inventory of socio-economic costs of work accidents*, Luxembourg, Office for Official Publications of the European Communities, 2002

The report of J. Mossink and M. De Greef gives an insight into the costs of accidents and the potential benefits of accident prevention. The authors state that accidents — as well as accident prevention — have simultaneous effects on both employee health and on company performance. In addition, the employee health effects have an additional effect on company performance.

The theoretical framework introduced in J. Mossink and M. De Greef's report forms the basis of this report. Chapter 2 introduces this framework in detail and outlines the concept of economic and social costs and benefits of safety and health at work.

The European Agency on Safety and Health at Work considered the impact of occupational safety and health on the quality and productivity of companies as a key topic of 2003. It was included in the activities of the Topic Centre on Research — Work and Health (TC/WH). The Topic Centre on Research is a consortium of national safety and health institutions which collect and analyse existing national data to support key areas of the work programme of the European Agency for Safety and Health at Work.

2. Methodology

2.1. Focus on company level

This working paper 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, do not only encompass the company but also individual workers/victims as well as their families and social networks. Society as a whole has to deal with these negative outcomes of the production process.

This means that the motives for developing an effective occupational safety and health policy stem from social 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. Table 1 demonstrates the complexity of the costs of occupational accidents and diseases for the individual employee, for the company and for society as a whole.

Table 1 **— Costs of occupational accidents and ill-health**

	Non-tangible	Tangible
Victim	Pain and suffering Moral and psychological suffering (especially in the case of a permanent disability)	Loss of salary and premiums Reduction of professional capacity Loss of time (medical treatments)
Family and friends	Moral and psychological suffering Medical and family burden	Financial loss Extra costs
Colleagues	Bad feeling Worry or panic (in case of serious or frequent accidents)	Loss of time and possibly also of premiums Increase of workload Training of temporary workers
Company	Deterioration of the social climate Bad reputation Weakening of human relations	Internal audit Decrease in 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 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 Decrease of the standard of living

Table 1 shows clearly that occupational accidents and ill health can have serious consequences for individual workers, for their families and social networks, as well as for companies and society as a whole. Some of the cost items are impossible or very difficult to quantify. However,

this does not mean that they cannot be used as arguments in support of a more economical appraisal of health and safety measures.

This working paper is focused on the relation between safety and health, productivity and quality at company level. The purpose is to identify methods, strategies, tools, and so on, that can be useful when implementing an efficient health and safety policy. A successful policy at company level will have indirect positive effects on the level of individual workers as well as on their families, on their social networks and on the whole of society.

2.2. A theoretical framework

It is necessary to study the economic effects of health and safety policy at company level in order to be able to:

- take a balanced decision with regard to the allocation of company resources;
- bridge the gap between health and safety needs and management requirements and desires;
- encompass the limited effectiveness of legislation.

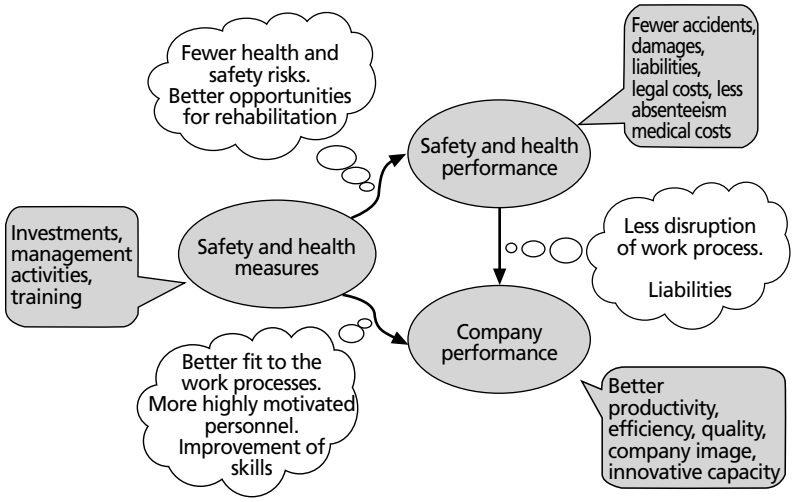
However, the economic approach to health and safety at company level cannot replace the value of human requirements. Health and safety is part of the social and ethical role of a company. Policy cannot only be based on economic parameters. It is difficult or even impossible to evaluate qualitative costs such as suffering, reduction of the quality of life, family problems, decrease of lifespan, and so on, in monetary terms.

Moreover, society is faced with additional 'costs' such as:

- loss of production and production capacity
- loss of purchasing power
- reduction of standard of living
- reduction of labour potential.

In this working paper, the economic effects of health and safety will be studied on the basis of the following theoretical model (Figure 1).

Figure 1: **Economic effects of safety and health at company level (Mossink, J., De Greef, M., 2002)**



This model gives a **qualitative** overview of the economic effects of health and safety at company level. It indicates that safety and health measures have an influence on safety and health performance as well as on company performance. In addition, a better safety and health performance has positive effects on the company performance and adds to the initial effects of the health and safety measures.

The theoretical framework is aimed to support the literature review and selection and analysis of cases. However, when using this framework there are several aspects which have to be addressed.

Focusing only on occupational safety and health, we run the risk of looking at OSH investments in isolation from other investments. This may leave OSH out of management's concerns. Starting from the idea — as expressed in this working paper — that OSH is not only a cost but also a way of maximising investment, why not consider as a starting point, investment? Most investments are of a technical nature and incorporating OSH would help maximise them and provide a faster return. These might be described as **socio-technical investments**. As an example, ex ante costs in better design, training, and so on, may result in achieving production and quality targets quicker (such as fewer breakdowns, reduced adjustments and corrections). Therefore, OSH (in a wide sense, as it is often seen as only accidents and diseases) should be integrated not added into investment processes.

The framework does not include the **time dimension**, which may have an important effect on decision-making. If looking only from the short-term perspective, OSH can be seen only as a cost item. If the life expectancy of a company is short, minimising OSH investments might look to be profitable. And many small companies have a short life expectancy.

Although the focus is at corporate level, many external variables have to be taken into account if any model is to be developed. One of the most important variables is whether costs are **(i) internalised, or (ii) externalised**. In the first case (i) companies need to invest in OSH. In the second case (ii) they don't need to: either society or other companies are going to bear the costs of poor OSH. A well-managed company might well be the one that knows best how to externalise such costs. National policies and features may well also be differentiating factors. Companies often do not bear the full costs of occupational accidents, diseases, occupational injuries, or work-related illnesses. For instance, healthcare costs (inflicted by work accidents) may not be covered by the company, or disability pensions may be borne by collective funds.

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

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

Jos Mossink and Marc De Greef (2002) have summarised the following ways in which internalisation may take place:

- liabilities (e.g. workers or insurance companies can claim damages due to occupational injuries or diseases);

- legal sanctions, fines (e.g. labour inspectorate can give financial penalties, demand improvements or temporarily stop production);
- differentiation in premiums (e.g. 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 (e.g. obligation to (partly) pay wages during period of sick leave or disability);
- market regulation (e.g. attractiveness for new personnel, advantages in obtaining government orders; improvement of the 'accident rating' for subcontractor in case of calls for tender; effects of company image).

More details and background information for the methodology are presented in Annex 2.

2.3. Data collection

This working paper is an outcome of the activities of the Topic Centre on Research. The work plan of the Topic Centre on Research consisted of eight tasks in 2003, where Task 5 was entitled 'Workers' safety and health, productivity and quality'. Several European institutes worked together on the activities of this task (see Annex 1).

The information was collected for this task in the form of literature, on one hand, and case studies, on the other (see Figure 2). The literature focused on models and methods used to measure the productivity effects of OSH investments at company level. Each literature reference consists of a short description and an expert opinion. The references are included in the reference list and quoted throughout the working paper.

The case studies aim to give practical examples of companies which have conducted projects and programmes that allowed them to verify the impact of OSH on productivity and quality. The cases are presented in detail in Chapter 4.

For the selection of cases a set of criteria was used for individual cases as well as for all cases as a whole (Box 3).

Box 3: Cases: selection criteria

For each case:

Subject: the case should describe an example at company level, focusing on the analysis of the relationship between safety and health measures and company performance.

Validity: the case must include results that can be verified. These results can be quantitative or qualitative data.

Transferability (optional): the methods used by the company should be easily transferable to other companies, other branches or other countries.

For cases as a whole:

Companies: the cases should cover:
- different countries (it is not necessary however to cover all Member States)
- different branches
- different sizes (if possible, examples from small, medium-sized and large companies).

Safety and health measures: the measures taken by the companies should cover different types such as measures concerning:
- workers, e.g. training
- equipment, e.g. personal and collective protective equipment
- working environment, e.g. ventilation
- product, e.g. reducing the weight of products that are manually lifted
- organisation, e.g. safer work methods.

Outcomes in terms of safety and health and company performance: the outcomes can be identified using indicators related to safety, productivity and quality.

The case studies were collected by the Task 5 members of the Topic Centre on Research (Annex 1) and by the 'Focal point' network of the Agency.

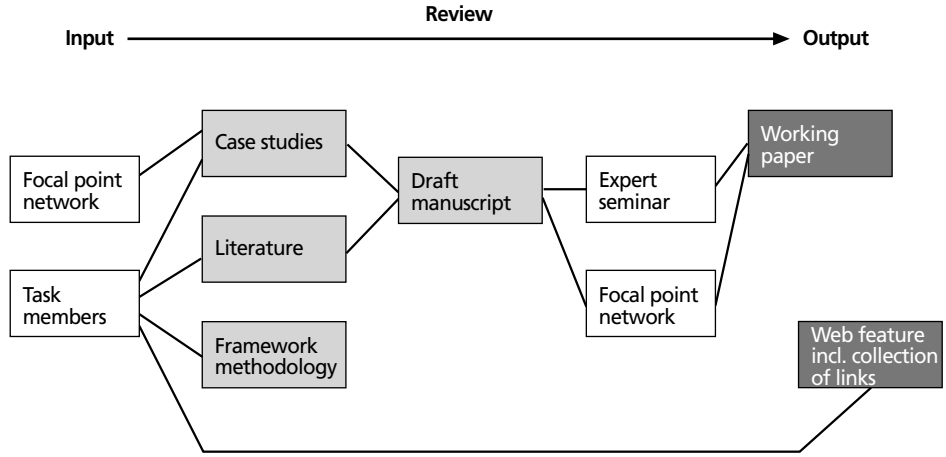
In practice, not every case presented was able to meet these criteria. Some were not at company level and not every case could present results that could be verified. The decision as to whether or not to retain individual cases was made at the expert seminar held in September 2003 in Brussels organised by the task group.

The expert seminar also looked at the draft working paper. Reflections made and opinions expressed during this seminar are included in this working paper. Conclusions of this working paper are based on the discussions in this seminar.

The final draft manuscript was sent to the Agency network partners ('Focal Points' and 'Thematic network group on research') for consolidation. Based on the comments received, the final working paper was written.

Relevant web links were also collected. These links are brought together in a special web feature on the topic of workers' safety and health and productivity. This feature is available at the Agency's web site: http://europe.osha.eu.int/research/.

Figure 2: **The activities of Task 5, 'Workers' safety and health, productivity and quality'**



2.4. Scope

Company level

The working paper only looks at costs and benefits of occupational safety and health at company level. Effects on individual workers and on society are not considered (see also 2.1).

Decision-making

Cost-benefit information can be an important influencing factor for the decision-making process in companies. However, it would be wrong to presume that it is the only factor taken into account by managers in the decision-making process. Decision-making is a complex process and one can distinguish several influencing factors such as:

- legislation
- history with regard to accidents and ill health
- corporate culture
- results of the participation process (workers' consultation)
- business forecasts (e.g. forecasts of growing markets)
- cost-benefit information on investments, etc.

This working paper does not deal with the question of costs and benefits of OSH having a determining role in the decision-making process. Nevertheless, some findings provide input for the question on how cost-benefit information on OSH could relate to the process of decision-making. The question of decision-making is not tackled in detail and remains an important topic for future studies.

Productivity and quality

The working paper focuses on the relationship between safety and health at work and productivity. It covers quality issues as well. In order to understand these relationships it is important to agree on the definitions of these parameters.

Productivity is defined briefly as the amount of output per unit of input (labour, equipment, and capital). Productivity is a measure of the efficiency with which productive resources are used. It is the ratio of the output quantity (the number of correctly produced products that fulfil their specifications) divided by the input quantity (all types of resources that are consumed in the transformation process).

There are many different ways of measuring productivity. For example, in a factory productivity might be measured on the basis of the number of hours it takes to produce an item. In the service sector productivity might be measured based on the revenue generated by an employee divided by his/her salary.

Productivity links together economic outcomes (such as value-added or physical output) with the resources used to create them. Improvements in productivity can take two forms: through producing more output with the same input and through producing the same output with less input. The principal drivers of improvements are product, process, service, and organisational innovations and the upgrading of human and physical capital.

Productivity improvements will help companies to increase profits and wages leading to increases in consumption and investment and, hence, the creation of additional demand across the economy.

This description of productivity demonstrates a close link with quality. In order to improve quality, a company can focus on the characteristics of the product and service and on the process by which they are produced. From here, beneficial outcomes that lead to increased profits result both within and outside the organisation.

Outside the organisation (i.e. externally), quality leads to more satisfied customers who continue to buy the product and are more likely to buy new products and/or refer new customers. In addition, the product price may decrease due to efficiency gained in the production process. Both outcomes serve to increase the organisation's market share. Within the organisation (i.e. internally), productivity will increase as the production process becomes more efficient. This leads to a decrease in production costs, which in turn creates greater profits.

This working paper aims to demonstrate that investments in health and safety at work can lead to an increase in productivity as well as to an improvement in quality. In some cases, however,

one will not be able (or only after an in-depth study) to identify the benefits of a health and safety investment. This happens mainly because several cost items due to accidents or ill health are externalised to the social security system or transferred to the victim (such as the consequences of a reduction in human capabilities). If these 'transfers' are taken into account in the cost calculations, this approach can be very useful in convincing management and society to take necessary health and safety measures.

3. Research findings on a good working environment and productivity

3.1. Introduction

This overview gives an insight into literature that is available on the subject. In compiling this working paper, the objective has not been to give a complete overview. The selection focuses mainly on recent publications and on references that highlight the key issues. The literature has been divided into three groups in this chapter. Firstly, a limited number of references dealing with related management issues is presented in 3.2, 'A management challenge'. Many of these references give reasons why a company should invest in a safer working environment. The process of company decision-making is not included in the scope of this working paper. Secondly, a selection of references that give evidence on the link between a good working environment and productivity is presented in 3.3. This evidence is mostly based on case studies but sometimes more extensive research lies behind the evidence. Thirdly, a more elaborate overview is given of references that present models on how the costs and benefits of OSH can be measured (3.4, 'From costs to performance').

3.2. A management challenge

The reasons why companies set up a safety and health management system is often related to issues such as legislation, incentives, profit, corporate social responsibility, quality management, performance, and so forth. However, if company management has an insight into the costs and benefits of safety and health interventions, this could be a strong driver for setting up safety and health management systems.

The overview below reviews some interesting references on the challenge for management to deal with occupational safety and health.

Dorman, 2000

The author gives an overview of issues relating to the economics of safety, health, and well-being at work. He deals with such issues as the costs of accidents and ill-health for individual workers as well as for companies and society. He argues that, for companies to provide effective improvement of safety and health conditions, the costs of ill-health must be:

- economic (whether the cost of damages to goods or services can be quantified or can be given prices);
- internal (whether the cost is paid by the economic unit that generates it);
- variable (whether the cost remains constant despite changes in the incidence and severity of injuries and illnesses);
- visible (whether the cost is measured and allocated through routine accounting methods. The invisible or indirect costs are often not calculated) (Box 4).

Furthermore, he raises two additional issues that are closely linked to decision-making and economics and occupational safety and health. Firstly, concerning market strategies, the cost of injury and disease depends on the extent to which workers are assets. The market strategy of some companies is aimed at short-term effects. Secondly, expenditures on improvements in working conditions are investments and investments have to be financed. For some companies, especially smaller ones, this might be a problem.

Box 4: The reasons why most companies do not calculate indirect costs:

- measurement problems: measuring these costs can be difficult and expensive
- management overload
- low status of (or non-existence of) OSH departments
- conspiracy of silence surrounding working conditions.

Source: Dorman, 2000.

European Centre for Total Quality Management, Total quality management and the management of health and safety, 1997

Many forward-looking companies are adopting strategies to achieve 'business excellence' and 'world-class performance', through the use of total quality management (TQM) to develop an integrated approach to business management. An investigation has been carried out to determine to what extent the core principles of TQM are applied to health and safety management. Data were collected from 24 organisations, which were known to be advanced in the use of TQM in their core business, and were using an adaptation of the European quality award assessment criteria.

The study identified 19 features of TQM and assessed the following aspects:

- the effectiveness of each link established between TQM and health and safety management;
- the nature of the differences at each end of the link;
- the reasons why such differences exist; and
- where organisations have chosen to incorporate health and safety management into their TQM development programme and why.

Case study extracts were used extensively to illustrate good practice, the nature of the differences that exist and to substantiate the analysis and the conclusions. The study concluded that:

- TQM principles are applied less to health and safety management than to other aspects of the core business;
- health and safety management is lagging behind other facets of the business on the road to quality;
- greater integration will be encouraged by a more informed and improved application of process management and performance measurement skills to the management of health and safety.

This study presented no quantitative data to support the hypothesis that better health and safety management leads to better business performance. If one accepts that there is a proven link between TQM and business performance then by analogy, the integration of health and safety management within the TQM framework should also be expected to lead to better results.

Goetzel, 1999

Goetzel has introduced a method called 'Health productivity management'. It aims to establish links between today's business climate, people, operational challenges, and ultimately the productivity of an organisation. The method is based on the idea that improving worker health is directly related to how productive and profitable organisations can become. A benchmarking study was carried out to identify best practice companies. Some interesting common success factors could be established for these best practice companies (Box 5).

Box 5: Success factors

(i) Best practice companies focused on health productivity management not because it was a human resources activity but because it was aligned with the business purpose of the organisation.

(ii) Best practice organisations considered many factors that impact on workforce productivity in addition to those associated with specific health conditions, for example corporate culture and employee attitudes.

(iii) Prevention, health promotion and occupational health professionals were the primary drivers and champions.

(iv) Best practice companies emphasised health productivity management not just because it was cost-effective but also because it meant an improvement of the quality of life.

(v) Data measurement and evaluation are vital for the best practice companies. One CEO stated 'if you can't measure it, you can't manage it'.

(vi) Best practice companies act on their beliefs that internal benchmarking is as important as external benchmarking.

(vii) To support investments over time, best-practice organisations are able to demonstrate return on investments for specific programmes, related to health management, both prospectively and retrospectively.

Source: Goetzel, 1999.

HSE, Factors motivating proactive health and safety management, 1998

This study concludes that there are two main factors in the United Kingdom that motivate both SMEs and large organisations to initiate health and safety improvements, namely the fear of loss of corporate credibility and a belief that it is necessary and morally correct to comply with health and safety regulations. Information on costs and benefits of health and safety at work was not considered as a main factor. However, research in the United States indicates that the need to reduce the costs of ill-health and injury are strong motivating factors but this finding is not corroborated in the United Kingdom and other countries (Box 6).

The researchers argued that this can be related to differences in healthcare insurance and compensation arrangements. US organisations directly incur a high proportion of the cost of injury and ill-health (health and worker compensation insurance premiums), whereas the State bears the main cost of injury and ill-health in the United Kingdom. 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.

Box 6: Management of health and safety as a core management responsibility

The extent to which health, safety and business management share the same motivation varies greatly between organisations and is determined by a number of factors, including the following:

- Is health and safety performance perceived to be a critical commercial success factor?
- Are the costs of ill-health and injury perceived to be significant?
- Do customers or standards bodies exert pressure or make demands to achieve certain health and safety standards?

If the answer to one or more of these questions is yes, it is probable that the management of health and safety will be seen as an important commercial consideration and treated as a core management responsibility. This is true for SMEs as well as larger organisations.

Source: HSE, Factors motivating proactive health and safety management, 1998.

HSE, Changing business behaviour, 2002

The authors explored the question 'would bearing the cost of poor health and safety performance make a difference?' In order to be able to do this, they present experiences from insurance systems that are comparable with the insurance system in the United Kingdom. They also carried out surveys among UK insurers and UK employers.

The survey of employers revealed, for instance, the following statements:

(i) The majority of large and medium-sized firms report that they are trying to reduce the cost of employer liability. Only a minority of small firms state this view.
(ii) Employers believe that they control health and safety in their organisation but only half belief that the cost of employer liability is related to the employers' standard of management.
(iii) There is a clear association between company size and the perceived link between their health and safety performance and the cost of employer liability. While the majority of large and medium-sized firms believe that the cost of employer liability is related to their performance, only a small minority of small firms share this belief.

Smallman and John, 2001

The authors conducted a study in order to assess and evaluate the state of directors' thinking on health and safety. The study aimed to get an insight into perception and attitudes towards health and safety. The method used was qualitative. The researchers interviewed business leaders. The conclusion was that good OSH performance is perhaps increasingly seen as part of corporate culture and a source of pride among company bosses. The arguments for OSH are evolving away from mere legal compliance towards competitive advantage and world-class business performance. Among the most sophisticated firms, OSH is viewed not as a separate function or responsibility but as a consequence of broader initiatives targeting productivity, competitiveness and profitability.

OSH performance can impact on corporate reputation but in a negative rather than positive sense. It seems that poor OSH performance can lead to a competitive disadvantage, for example by impairing a firm's status in the eyes of one or more of its stakeholders.

At the most senior level, companies have little idea of their ongoing outlay on OSH-related items. Nor do they assess the financial return on such investment, considering the very idea to be distasteful.

The authors concluded that it seems likely that the 'high ground' in OSH lies in thinking about moving beyond monetary values or indeed corporate reputation. The target, it seems, is to bind OSH in with business excellence within which OSH is a performance determinant rather than an end in itself. OSH should not be seen as the aim but as a determinant to measure the performance of the company. The answer may lie in the use of more novel models, relating to corporate social performance.

Vassie and Lucas, 2001

Management of health and safety is dependent on the way teams are managed. This study used semi-structured interviews to assess how UK manufacturing companies have addressed a range of health and safety management issues (i.e. setting, communicating, and measuring company objectives, employee participation/empowerment, and risk assessment) in relation to different styles of group working (i.e. supervised groups, groups with team leaders, and self-managed groups). It is noticeable although not significant that, within organisations using team leaders and self-managed groups, there was evidence of greater management involvement, more open communication, and greater employee involvement in health and safety.

3.3. Evidence

Several references focus on evidence that there is a link between a qualitative working environment and the productivity of a company. The overview comprises, on the one hand,

more comprehensive works — literature that reviews other literature or that brings together evidence, and on the other hand, publications on particular case studies.

ASSE, 2002

The American Society of Safety Engineers (ASSE) has produced a White Paper addressing the return on investment for safety, health, and environmental management programmes. The White Paper argues that the ASSE 'knows from data and anecdotal information that investment in a safety, health and environmental programme is a sound business strategy, for any organisation regardless of size, and will lead to a positive impact on the financial bottom line'. The White Paper presents the (hidden) costs of failed safety and health systems, examples of companies and the positive outcome of programmes that are aimed at improving safety and health at work (Box 7). The programmes presented include the voluntary protection programme (VPP) and the Agency e-CAT initiative.

Box 7: Some savings figures that are attributable to OSH programmes

In 2001, Liberty Mutual Insurance Company released a report entitled 'A majority of US businesses report workplace safety delivers a return on investment'. The Liberty Mutual survey reveals that 61% of executives say USD 3 or more is saved for each USD 1 invested in workplace safety.

A safety, health and environment director for an environmental services company in Massachusetts reported that its tracking data indicated USD 8 saved for each dollar spent on a safety, health and environment programme.

A coal-mining company in Charleston West Virginia has attained a competitive advantage through investment in safety, health and environment programmes. The company claims its worker compensation rate is USD 1.28 per USD 100 in payroll as opposed to its competitor's rate of USD 13.78.

Participation in the Agency's voluntary protection programme has saved one company USD 930 000 per year and the company had 450 fewer lost-time injuries than the industry average.

At Monsanto Chemical Company's Pensacola, Florida Plant, which employs 1 600 workers, the lost workday case rates steadily declined during the period in which the worksite implemented effective safety and health programmes and in the four years since approval to the VPP. The rates fell from 2.7 in 1986 to 0.1 in 1994.

Source: ASSE, 2002.

Barefoot economics, 2001

This paper is based on the joint project between the Finnish Ministry of Social Affairs and Health and the ILO-SafeWork programme, in close collaboration with an international working group. The paper cites several — mainly Finnish – studies.

Jurvansuu et al. (2000) revealed that personnel's high work ability, work satisfaction and organisational commitment had a positive relationship to workplace success. However, in successful workplaces staff had a higher level of exhaustion but the link between these two aspects was rather weak. Variables describing personnel well-being had a similar effect on success in metal industry and retail trade, and also in workplaces of different sizes. Some statistical significant interactions were found between variables of personnel's well-being. Staff well-being seems to be one factor affecting company performance. However, different dimensions of well-being seem to affect performance as a complicated interactive network.

Bunn, Pikelny, Slavin, Paralkar, 2001

The health and productivity management model at the International Truck and Engine Corporation includes the measurement, analysis, and management of the individual component programmes affecting employee safety, health, and productivity. The key to the

success of the programme was the iterative approach used to identify the opportunities, develop interventions, and achieve targets through continuous measurement and management. The economic impact has been documented following intervention. For example, a comprehensive corporate wellness effort has had a significant impact in terms of reducing both direct healthcare cost and improving productivity, measured as absenteeism.

Cooper, Liukkonen, Cartwright, 1996

The authors assessed the costs and benefits to organisations of stress prevention in the workplace. They presented three case studies (organisations in Sweden, the Netherlands and the United Kingdom) and found that stress prevention presents a means whereby an organisation cannot only reduce or contain the costs of employee health but can also positively maintain and improve organisational health and productivity.

The effects they found are:

- reduced staff turnover
- reduced absenteeism
- fewer occupational injuries and illness cases
- improved service levels
- improved job satisfaction
- improved relations between co-workers and management
- improved working conditions.

Court, 2003

The paper entitled 'Links between the quality of working life and productivity — Evidence to the enquiry submitted by the Health and Safety Commission and Health and Safety Executive' is a response to the Work Foundation enquiry (United Kingdom) into links between the quality of working life and productivity. The paper argues that creating better work environments and preventing harm from work are key means of improving productivity. The evidence that is presented is based on national data for UK work-related injuries, diseases, and their impact on absenteeism and the costs for society and companies. According to the paper, there is a difference in sickness absence rates between the best and worst performing companies. The paper also gives an overview of evidence found in literature sources and in case studies.

Galliker, 2000

The author states that improving the well-being of its workers, offers a company the opportunity to enhance its performance. This is illustrated with cases from companies such as Beiersdorf AG (Hamburg), Suva Niederlassung (Berne) and Volkswagen AG.

Hendrick, 2003

The author states that it is important to identify the costs and economic benefits that can be expected from ergonomic programmes and to outline how they will be measured. He determines four major classes of costs: personnel, equipment and materials, reduced productivity or sales and overheads. The benefits fall into three general classes: those associated with personnel, those relating to materials and equipment, and those to do with increased sales. On the basis of documented cases, the author describes the common characteristics of successful ergonomics interventions (Box 8). If followed these characteristics greatly enhance the likelihood of a high cost-benefit result. The documented cases resulted in benefits such as less sick leave, fewer injuries, greater employee satisfaction, higher productivity, and so forth.

Box 8: Factors of successful ergonomic interventions

- Real management commitment
- True professional ergonomics leadership and expertise
- Participatory ergonomics
- Pick the 'low hanging fruit' first (quick wins)
- Ergonomic improvements to reduce work-related musculoskeletal disorders usually improve productivity and vice versa
- Macro-ergonomic approach
- Integrate with TQM or other ongoing continuous improvement efforts
- Look for simple solutions first
- Human-centred rather than technology-centred design.

Source: Hendrick, 2003.

Korbijn, 1996

By presenting examples of agricultural and construction companies this book argues that investing in better occupational safety and health can create a competitive edge. Technical innovations can be carried out to improve the quality of work. These technical innovations are often accompanied by organisational renewal. Furthermore, this book scrutinises health and risk factors at work, the role of the management and ergonomic innovation in the design phase.

Kuusela, Bjurström, Rouhesmaa, 1997

Studies on the inter-relationship between the working environment and productivity have revealed a positive correlation between the two. Steps taken to develop the working environment have also improved productivity and measures adopted to increase productivity have had a positive impact on the standard of the working environment. As safety at work improves, material damage and malfunction decrease and accidents and the number of sick days decline, while the volume of production increases and quality improves. The authors compare different kinds of interventions and their effects on productivity. They conclude that although specific measures/interventions have positive effects, programmes focusing on work climate, management and participation have a greater impact on productivity.

Kreis, Bödeker, 2003

The authors studied the evidence found in literature sources for the effectiveness of workplace health promotion. They looked at 25 reviews of published sources and more than 400 studies for programmes in the workplace on alcohol, nutrition, stress, tobacco, and so on. They commented on effects found and methods used. An overview in the form of a table collates the results.

The positive effects of workplace health promotion programmes were:

- reduced health risks, in other words, for indicators such as blood pressure, cholesterol, smoking, alcohol consumption;
- improved work climate as in job satisfaction; and
- reduced costs, that is to say, less absenteeism, fewer sick days.

This project was based on a health and work initiative (IGA). It was carried out in cooperation between the Federal Association of the Company Health Insurance Funds and the Federal Association of the Accidents Insurance Funds in Germany.

Literature review: evaluations of workplace health promotion programmes

Given all the difficulties of conducting and comparing evaluation studies at the worksite, the study concludes that decision-makers need to look for the 'general weight of the evidence' across the best studies available, rather than the definitive study *per se*.

The study selected 18 published papers on eight programmes. So how strong and consistent are the results of the published outcome and economic evaluations? The evidence leans towards indicating a positive effect of worksite health promotion programmes on health behaviour, health outcomes, and other factors such as absenteeism, sick leave and healthcare costs. From an economic viewpoint, the weight of the evidence also suggests such programmes are a good financial investment for the employer — returning benefits which outweigh programme-related costs (Box 9).

Box 9: Problems with evaluation studies

Selection: in most of the cases employees volunteer to participate in health promotion programmes and there is considerable evidence that participants are healthier and more motivated to improve their health than non-participants.

Regression to the mean: for example, a worksite may decide to develop a programme because of unusually high rates of poor health, absenteeism, turnover, and so on. 'Regression to the mean' refers to the fact that these high rates may evolve naturally over time towards the norm.

External validity: whether results are mirrored in other workplaces and generalisations can be made.

Reliability and validity of measurements.

The wide-ranging nature and scope of workplace health promotion interventions.

Source: Literature review: evaluations of workplace health promotion programmes.

Langhoff, 2002

Occupational safety and health contributes to corporate goals. To make this relationship visible is a challenge for a results-oriented occupational safety and health system. The author proposes an approach based on the balanced scorecard. He used several examples of companies to back up his case. Among the positive effects he found were: better product quality, more job motivation, improved work organisation, less production disruptions, and so on (see also Chapter 3.4.3).

NSC, 2003

This book, in preparation, contains several case studies on safety and productivity. One case that is presented concerns an intervention project where an ergonomic dolly was installed (Ergo Dolly). The effects of the intervention were measured. The conclusion was that the hazard was corrected with such a large payback that it will be achieved for the life of the process. Furthermore, the investment in safety and the success that followed reinforced the change in practice that money invested in safety and ergonomic design provides a return on investment. Safety and labour as part of a team creates a competitive, high-quality-producing organisation where the reduction of injuries adds to the bottom line.

Pelletier, 1997, 1999, 2001

The author reviews (mostly US) studies of clinical-effectiveness and cost-effectiveness of comprehensive health promotion and disease prevention programmes at the worksite. Interventions included: exercise and fitness programmes, back care, weight control, health risk

assessment, and so forth, and a range of comprehensive wellness programmes. The weight of the evidence confirms that multi-component or comprehensive interventions have higher clinical effectiveness and cost-effectiveness than single factor programmes, for example, a programme on tobacco. The author concludes that most studies provide moderate to strong evidence for the cost-effectiveness of health promotion programmes.

Seeley, Marklin, 2003

During a two-year study, a large Midwestern US electric utility provided a university with a team representing workers and management staff. They evaluated, recommended and monitored interventions for 32 common line worker tasks that were rated at medium to high in risk factor terms for musculoskeletal disorders. A business case was formulated that took into account medical injury and illness statistics, workers' compensation, worker replacement and retraining costs.

Serxner, Gold, Anderson, Williams, 2001

The authors examined the impact of a worksite health promotion programme on short-term disability days in a large telecommunications company. The evaluation used a quasi-experimental, multiple time-series design with inter-group comparison of workdays lost due to short-time disability to determine impact. This study found that participation in a health promotion programme had a significant impact on average net days lost for employee short-term disability absence. These findings represented potential savings in excess of USD 1 371 600 over a two-year period.

Tuinzaad, van Rhijn, van Deurssen, Koningsveld, 2000

This book contains the success stories of nine different assembly companies that made use of an integrated ergonomic assembly design method in which consultants worked together with employees to design a human-friendly and organisation-friendly assembly process. The nine companies are: Roberine (lawn-mowing machinery), Inalfa (roof systems), JVH (gaming machinery), Kverneland (agricultural machinery), Bakon Food Equipment (food industry), Moba (egg sorting machinery), Ahrend (furniture), Nooteboom trailers (trailer production) and JM de Jong (coffee machine assembly). The case studies describe positive effects such as decreased physical and mental stress, increased motivation and improved productivity.

Vaartjes, 1997

From 1991 to 1995, the construction company Nelissen van Egteren Bouw Zuid in Heerlen (the Netherlands) conducted an OSH project. The project was co-financed by the Ministry of Social Affairs and Employment and the Ministry of Health. The goal of the project was to reduce absenteeism using an integral approach. Firstly, questionnaires were used to identify the most important bottlenecks. Secondly, these bottlenecks were tackled in the following sub-projects: absenteeism control, social relations, stress management, physical workload and lifestyle. The evaluation of this project showed a huge decrease in absenteeism. Finally, the results of the project provided critical success factors for integral project management.

3.4. From costs to performance

The literature provides a wide range of methods that can be used to demonstrate the link between a good working environment and productivity. These methods can be divided into three categories:

(i) methods calculating the costs of accidents;
(ii) methods analysing the costs and benefits or effects of OSH interventions;
(iii) methods focusing on the performance of the safety and health system.

This chapter provides some cost calculation examples in these categories.

3.4.1. Calculating the costs of accidents

Cost calculating methods have derived from theories developed by pioneers in safety at work such as Heinrich and Bird. Heinrich studied the cost effects of accidents at company level in the United States as early as the 1920s. He developed the so-called iceberg theory. According to his theory, accident costs can be divided into direct and indirect costs. Only the direct costs are perceived by a company, for example, costs of medical treatment. Indirect costs remain invisible (like most of an iceberg remains invisible beneath the surface of the water). F. Bird adapted the theory in the 1960s by including material damages as costs due to accidents. The theories of Heinrich and Bird are still commonly used and are the basis of various methods for calculating the costs of accidents (Box 10).

Box 10: Studies have given different ratios for insured/uninsured costs

- A study in a cheque-clearing department of a financial institution (a lower risk environment) found the insured/uninsured ratio to be 1:3.3. That means for every GBP 1 recoverable from their insurance, the company had to meet a further GBP 3.30 themselves.
- HSE studies found that the ratio of insurance premium paid to uninsured losses ranged from 1:8 to 1:36. That meant that for every GBP 1 they paid in insurance premiums, the companies had to meet a further GBP 8 to GBP 36 themselves for losses arising from accidents.

Source: http://www.hse.gov.uk/costs/costs_overview/costs_overview.asp

HSE ready reckoner

This tool allows a company to calculate its costs due to accidents, incidents and ill-health. The tool differentiates between insured costs and uninsured costs such as:

- lost time
- sick pay
- damage or loss of product and raw materials
- repairs to factory and machinery
- extra wages, overtime working and temporary labour
- production delays
- investigation time
- fines
- loss of contracts
- legal costs
- loss of business reputation.

Using three different methods, the annual accident calculator allows the potential annual uninsured costs of accidents to an organisation to be estimated. The three different methods are used to provide illustrative estimates of the annual costs of accidents. These methods are based on:

- annual insurance premiums
- the number of employees
- the number of three different types of accidents.

Presented as an interactive tool on the web site, the annual accident calculator allows a company to compare their accident records with the national average (benchmarking).

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 accidents, like 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 (Box 11).

Box 11: The systematic accident costs analysis (SACA) — A study summary

Within the SACA project, a study was carried out involving nine Danish companies. In each company three 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 and 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 six activity groups. The six 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, P., Impgaard, M., Mogensen, B., Søgaard Melchiorsen, A., 2002.

The Tyta model

The Tyta model was developed by the Department for Occupational Safety and Health, Ministry of Social Affairs and Health, Finland. The Tyta model gives information on costs caused by absenteeism due to illness, accidents, turnover, disability and changes to working conditions. Accident costs are divided into direct costs and indirect costs (Box 12).

The tool allows the costs of accidents to be estimated and an estimation to be made of the relationship between direct and indirect costs. Since this relationship differs for different types of accidents (e.g. slips and falls compared to traffic accidents), it has to be calculated for various types.

Box 12: Tyta model: direct and indirect costs

Direct costs:

- payroll costs of time of absence due to accident.

Indirect costs:

- 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: The Tyta model, 1999.

Estimating the economical cost of accidents at work

In 2000, the Instituto Nacional de Seguridad e Higiene en el Trabajo (Spain) developed a method for estimating the economic value of accidents at work. The project was carried out with the support of the European Commission and resulted in a questionnaire that gives a company an insight into the costs arising from an accident. The method was tested and evaluated in several companies, including small ones. The method is based on five types of costs and nine variables. Each variable can be an influencing factor on one or several types of costs (Box 13).

Box 13: Economic value of accidents at work: types of costs and variables

Types of costs:

- lost time
- damages
- productivity losses
- general expenses
- loss of time caused by the accident for other personnel.

Variables:

- wages
- gravity of the accident
- lost days due to the accident
- complications after the accident
- type of process, e.g. production line work or not
- degree of specialisation of the victim
- activity of the company
- size of the company
- type of accident.

Source: Gil, A., Pujol, L., 2000.

Calculating the costs of investments

These methods are aimed at calculating the cost of safety investments, in other words, how much it costs to achieve safe working conditions. One example is the method developed by the Instituto Superiore per la Prevenzione e la Sicurezza del Lavoro (Ispesl-It) for calculating the investments in optimising machine safety (Box 14).

Box 14: Identification of the elements of safety costs for the development of a best procedure regarding machine design

The project was aimed at:

- evaluating the parameters defining the costs of safety for machines;
- identifying limits within which one can find the best compromise between safety and cost of a machine.

Within the project two aspects were analysed:

1. A study of the characteristics of safety of industrial products: analysis of the properties which influence most the safety of a product (reliability, maintenance rate, ergonomics); analysis of statistics regarding accidents at work and activities of market surveillance; analysis of non-safety costs.
2. Identification and analysis of methodologies of design techniques aimed at the improvement of safety and the evaluation of their economic impact.

The approach adopted followed the 'methodical design', which consists of guiding the designer from the assignment of the project task up to the definition and finalisation of the machine design. Designers are supported by the use of methodologies and tools able to solve any 'specific' problem encountered during their activities.

The result of the project is a tool that allows designers to implement acceptable solutions in safety and in economic terms.

Source: Di Mambro A., Ispesl, 2003.

3.4.2. Cost-benefit analysis and cost-effectiveness analysis

The cost-benefit analysis (CBA) and the cost-effectiveness analysis are used to compare input and output (see also Annex 2 and Box 15). The basic questions in these kinds of analyses are: How many euro will I get back for every euro that I invest? What is the return? That is why the term 'return on investment' (ROI) is also sometimes used.

Box 15: Definitions of cost-benefit analysis and cost-effectiveness analysis

'Cost-benefit analysis is a technique for evaluating total costs and benefits in monetary units at company project level. Cost-benefit analysis compares the prevention costs with the benefits (i.e. reduction in corrective costs or damages plus additional gains). Essentially, cost-benefit analysis is a tool that makes economic consequences visible, which may in turn contribute to political discussions and improve in-company decision-making.'

Source: European Foundation for the Improvement of Living and Working Conditions, 1998.

'A cost-effectiveness analysis balances the results of an intervention against the (monetary) costs. The effects need to be expressed in terms of money. Cost-effectiveness analysis is especially useful in comparing several options for achieving the same goal'.

Source: European Foundation for the Improvement of Living and Working Conditions, 1998.

'When analysts use cost-effectiveness analysis they attempt to measure benefits without assigning dollar values to life and health. Cost-effectiveness analysis is a comparison of costs with the number of physical benefits. The ratio of dollar costs to physical benefits is the cost per physical benefit. The programme with the lowest cost per benefit is the most-effective'.

Source: Kuchler, F., Golan, E., 1999.

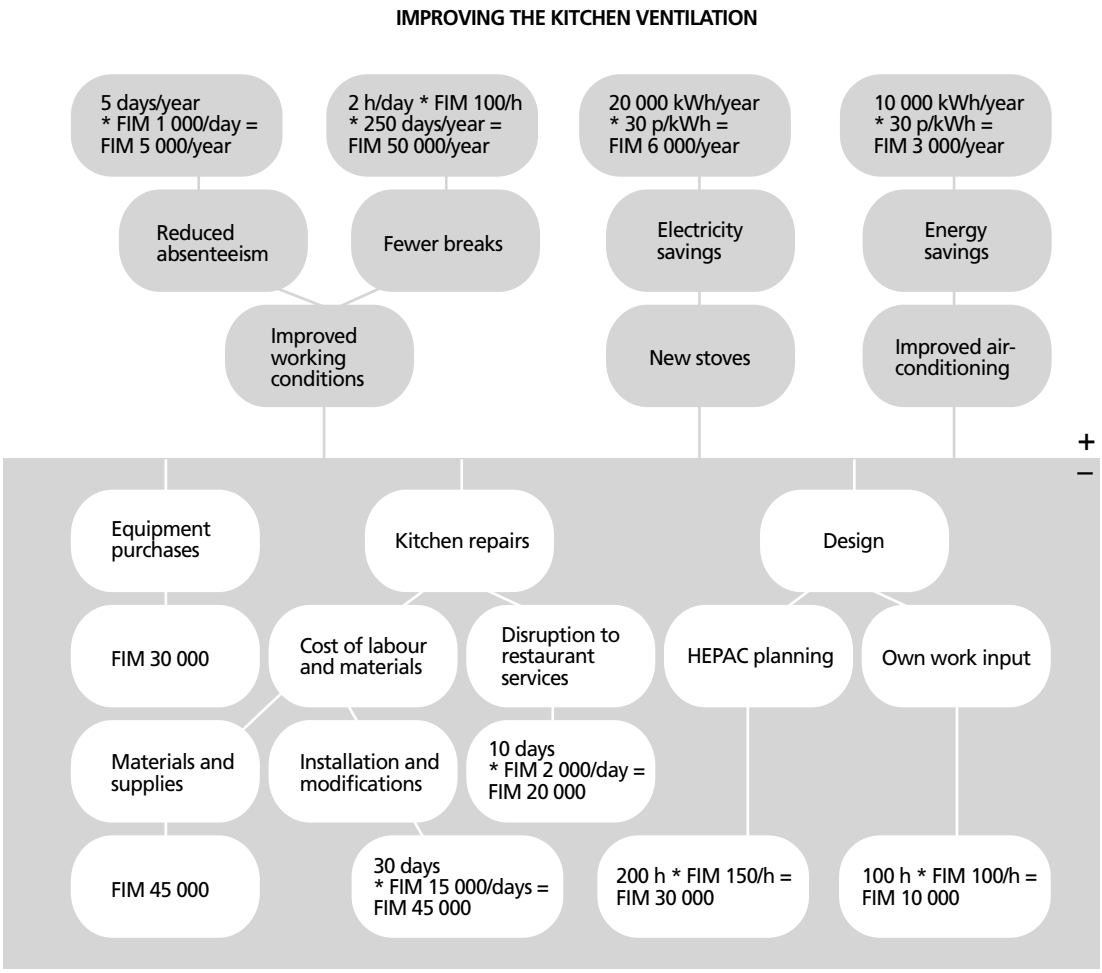
Several methods have been developed based on the principles of the cost-benefit analysis or the cost-effectiveness analysis. Some of these methods are presented below.

The balloon model

The balloon model was developed by Ulf Johanson and Anders Johrén (1993). This model describes the costs and benefits of an investment by presenting them as balloons (Figure 3). The figure shows the costs, on one hand, and the benefits, on the other. To establish the costs and benefits a step-by-step approach is proposed:

- Step 1: Defining the problem.
- Step 2: Identifying optional courses of action.
- Step 3: Describing the consequences of proposed measures. At this stage, the effects of every measure being considered must be described. In order to do so, a diagram can be used to note the costs beneath a horizontal line and the positive effects above. For the sake of clarity, the figures are placed in balloons to depict the causes and effects as tangibly as possible.
- Step 4: Calculating the costs of improvements: at this stage the effects that have been described in Step 3 have to be expressed as monetary values.
- Step 5: Input–output analysis: comparing input and output and calculating the payback period for a specific investment.

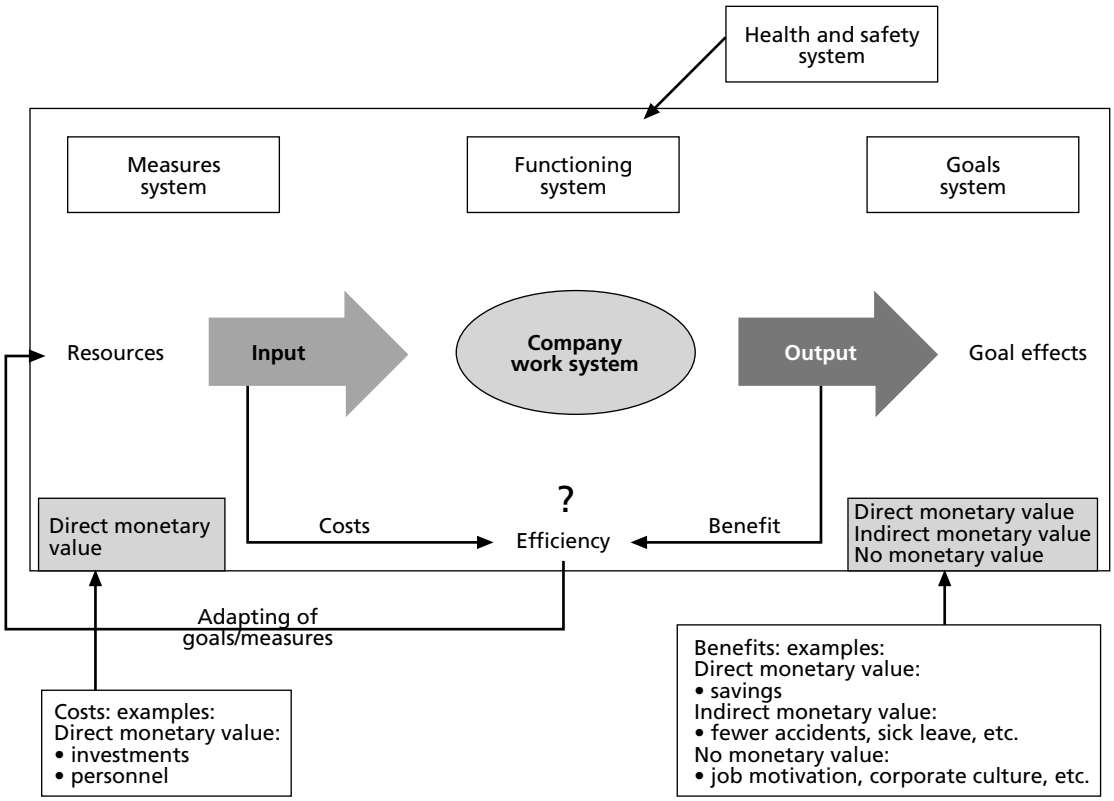
Figure 3: **The balloon model, example improving the kitchen ventilation (Kupi, Sumelathi, Bjurström, 1997)**



Broadened economic analysis

During the 1970s and 1980s, several specific methods were developed based on the principle of broadened economic analysis (Erweiterte Wirtschaftlichkeitsanalyse (EWA)). The EWA considers data on profitability (that can be calculated using classical financial methods) as well as benefits that are more difficult to put into figures. Sengotta, 1998, and Langhoff, 2002, have given an overview of the methods based on EWA. Most of the methods are based on a cost-benefit/effectiveness analysis. Zangemeister, 1999, uses the following model, for example, as the basis for his EWA method (Figure 4).

Figure 4: **Towards efficiency (Zangemeister, 2000)**



This method is useful in the decision-making process of a company. In order to take sensible decisions, it is necessary to compare the costs of measures with the benefits. The costs are calculated on the basis of their direct monetary value. The benefits, however, are subdivided into three different groups:

- benefits with a direct monetary value;
- benefits with an indirect value; and
- benefits with no monetary value.

Safety and health measures are considered as purposeful investments aimed at improving the performance of the company, and as measures that have mid- or long-term results.

Undisturbed working hours

This method is based on the fact that every company aims to work without any disruption in its production process. Therefore, the number of undisturbed working hours is an important criterion. An increase in the number of undisturbed working hours gives an improvement in company performance. The method examines what level of resources is necessary to maintain the number of undisturbed working hours.

$$\text{Health and safety costs per undisturbed working hour} = \frac{\text{Costs of the health and safety system}}{\text{Number of undisturbed working hours}}$$

This method does not measure the effects or benefits of a specific measure but considers the performance of the whole system. The result is an efficiency indicator. This 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 16).

Box 16: Costs of undisturbed working hours in Germany

The costs per undisturbed working hour depend on the type of production. In Germany, the costs per undisturbed working hour are, on average, EUR 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, W., Meis, S., 1991.

3.4.3. Performance measurement

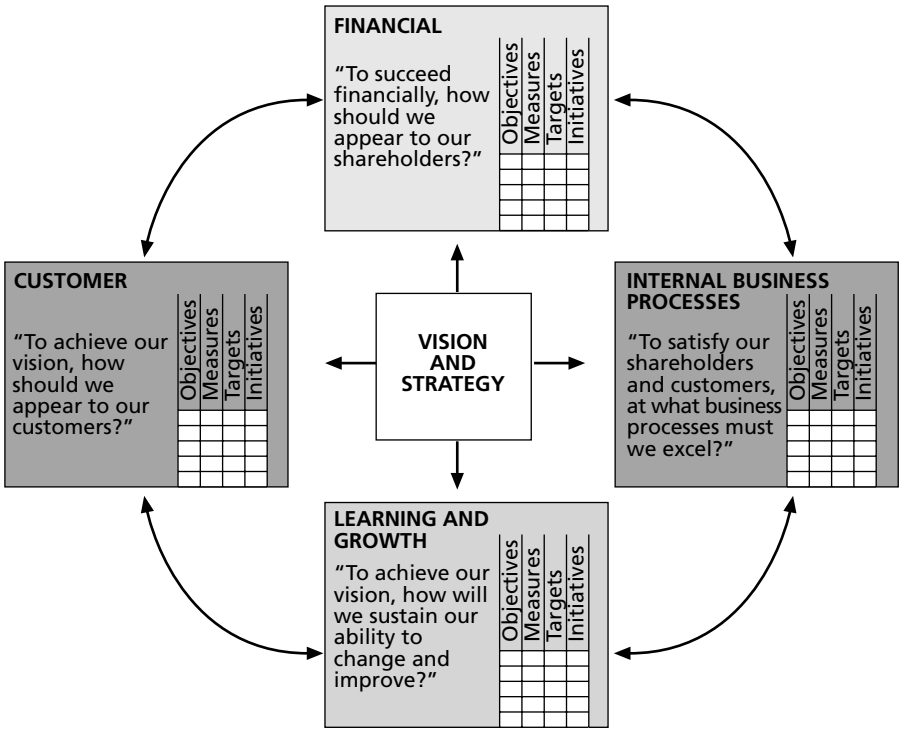
Performance measurement is the next logical step. It should be evaluated to what extent health and safety measures can contribute to company's goals and performance. Some specific methods based on this principle are presented below.

Balanced scorecard

In his research report, Langhoff (2002) outlines that it is necessary to evaluate to what extent health and safety measures contribute to the goals of the company. OSH performance must be made visible. Therefore, OSH should be integrated into a management monitoring concept so that the OSH system can be managed and evaluated. Langhoff proposes to use here the Balanced Scorecard method because it is a well-known management concept. Another advantage is that this concept enables the setting of company goals and indicators in a balanced way in four aspects (Figure 5):

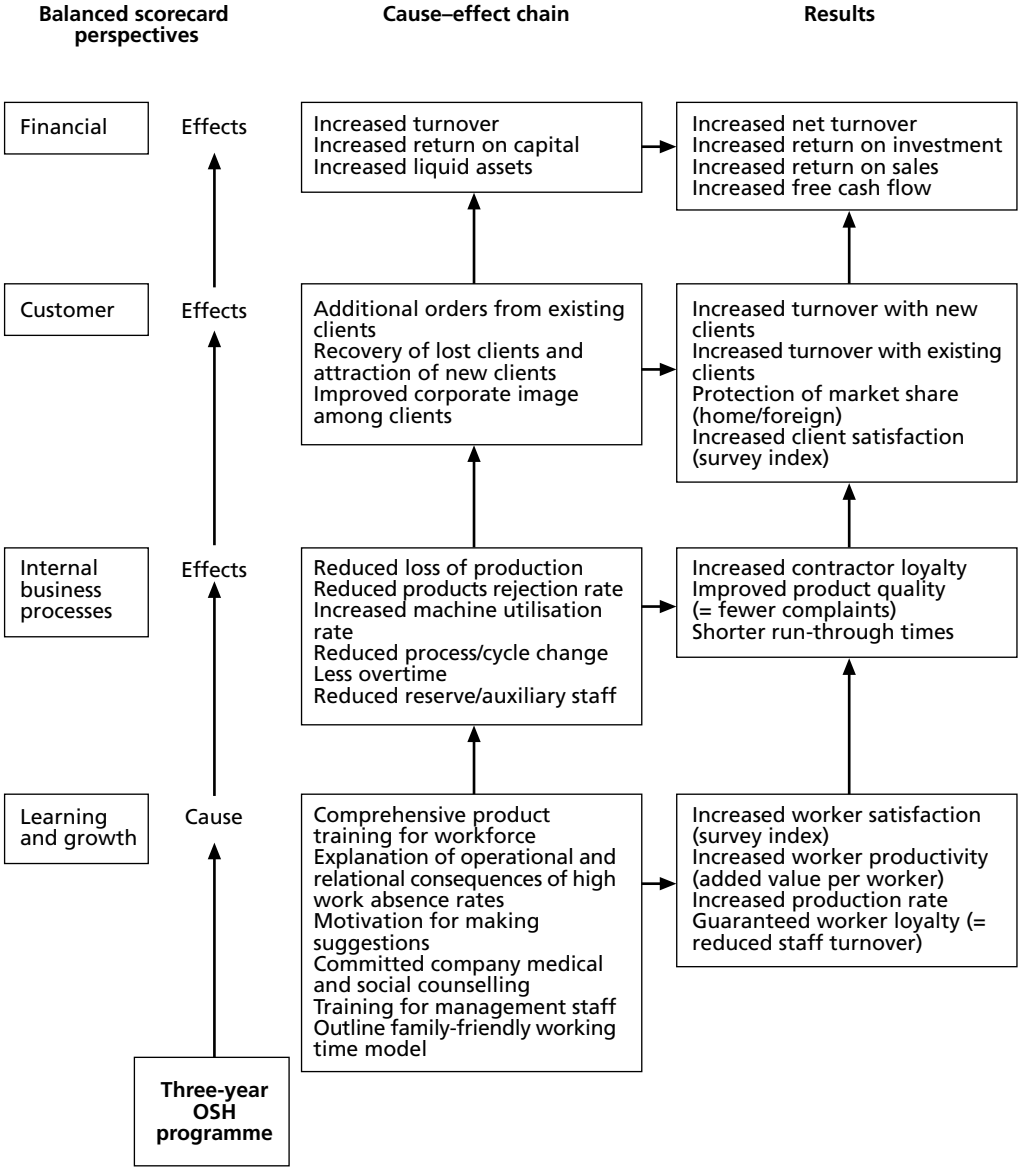
- financial terms
- customer related issues
- internal business processes
- learning and growth.

Figure 5: **The balanced scorecard management system (R. Kaplan, et al., 1996)**



The balanced scorecard concept and the use of indicators situated within the four areas allows the effects of health and safety measures on the company's goals to be analysed. Figure 6 shows the effects of OSH. It is based on a car construction company that has set up a three-year health and safety management programme. The company employs about 1 000 workers. The company's target is to achieve an undisturbed and high-quality production, which would ensure survival in a highly competitive market. The OSH programme contributed to this aim and resulted in a reduction of the rate of absences. Absenteeism dropped from 8 to 4 %. Furthermore, several positive effects were identified. The cause-–effect chain can be presented using the model of the balanced scorecard (Figure 6).

Figure 6: **Effect chain of OSH measures presented in a balanced scorecard (T. Langhoff, 2002)**



Quality management

The Instituto Nacional de Seguridad e Higiene en el Trabajo (Spain) developed a performance assessment method based on the EFQM model of excellence and on the RADAR approach (results, approach, deployment, assessment, review). The assessment comprises a questionnaire with quantitative and qualitative criteria. Several indicators are used to evaluate leadership, policy and strategy, HR management, management of resources and processes, and so on (Salido, M., 2001).

3.5. Main findings

Many companies are still unaware of the economic aspects of occupational safety and health. They often do not recognise the costs of accidents and ill-health and even if they are conscious of the fact that a poor working environment may result in costs for the company, they rarely measure these (Dorman, 2000; Court, 2003). Cost-benefit information on health and safety at work cannot always be considered as a motivating factor for companies to invest in health and safety management. Moreover, the perception that investing in health and safety is only a cost item can become a demotivating factor (HSE, 1998).

Nevertheless, company management concepts have changed to such a degree that company performance is not only measured in financial terms but also other aspects such as the customer, internal business, innovation and learning factors are also taken into consideration. This provides possibilities for identifying health and safety as an important business enabler that can push companies to better performance (Smallman and John, 2001). The consequence of this is that it is less important to show which costs investment in safety and health brings and more important to indicate to what extent safety and health can make a contribution to the achievement of company objectives (Goetzel, 1999; Langhoff, 2002). This does not alter the fact that practitioners need to have methods available to them to help them work out the costs and benefits values of OSH interventions.

To this end, several methods have been developed. These methods can be divided into three main categories:

- methods for calculating the costs of accidents;
- methods for analysing the costs and benefits or effects of OSH interventions;
- methods focusing on the performance of OSH systems.

Each of these methods has its advantages and disadvantages.

Various overview studies and published case studies already demonstrate that there is a link between the quality of a company's working environment and its productivity. A number of recommendations and success factors have been identified, for example the following (Goetzel, 1999; Korbijn, 1996; Kuusela et al., 1997):

- combining business targets and human resources activities, in order to achieve better results;
- taking a wider approach to health promotion to include not only health conditions but also employee attitudes and corporate culture;
- using OSH improvement programmes, as they seem to provide better results than implementing only specific prevention measures;
- including technical innovations and organisational improvements;
- carrying out measurement and evaluation. The demonstration of a return on investment, both prospectively and retrospectively, is needed.

On the other hand, it was found out that poor OSH performance can lead to a competitive disadvantage, impairing the firm's status among stakeholders. This is a motivating factor to company management to invest in OSH (Smallman and John, 2001). Stress prevention was found not only to reduce costs but also to improve productivity by improving the motivation of staff and the working climate (Cooper et al., 1996). Liberty Mutual Insurance Company has revealed in a survey that 61 %of executives say USD 3 or more is saved for each USD 1 invested in workplace safety (ASSE, 2002).

However, many studies are not based on validated methods and it is difficult to extend the results to other sectors and firms (Literature review, 2002; Pelletier, 2001; Kreis, Bödeker, 2003). Nevertheless, reports in which the reliability of the evidence found has been verified also come to the same conclusion, namely that there is a link between the quality of the working environment and the productivity of the company.

In its conference summary, the European Foundation (1998) made the following conclusions about the productivity effects of OSH at company level:

- Improvements in working conditions generally have a beneficial effect on productivity.
- Productive and innovative companies generally have good working conditions.
- Major productivity improvements can be made by focusing on the jobs with the poorest working conditions.
- There is a lack of easy-to-use comprehensive methods for CBA at company level. This may lead to a situation where currently available models will be misused.

4. Case studies on a good working environment and productivity

The case studies presented in this chapter were collected by the task members of the Topic Centre for Research (Annex 1) and by the 'Focal point' network of the Agency (see 2.3 on data collection).

The case studies give examples of projects that were set up in different Member States and in various economic sectors. Emphasis was put on the results of the projects in order to present evidence of the link between quality of work and productivity. The projects present a wide range of interventions in companies ranging from limited intervention (e.g. an adaptation of a work station) to the implementation of a comprehensive health and safety management system.

Firstly, descriptions are given of each case study (see 4.1 and Annex 3). The second part presents the main findings (4.2).

4.1. Description

In this chapter a selection of case studies is provided. For each case study a description is given, which gives information about the context and the project itself. Secondly, the methods that were used to evaluate the project are described, and thirdly, the results of the project are presented. This chapter includes seven cases but more practical examples are also found in Annex 3.

Case study 1: Improvement of working conditions using a human resources action

Context

The case study was set up in the context of a doctoral thesis by J. Portillo ([1]). The project was carried out within the Qualyman project promoted by the regional government of Galicia (*Xunta de Galicia*). The main objective of the project was to improve the management efficiency of the companies using a human resources action. The project involved 33 companies.

Measuring efficiency

The efficiency of each company's management was measured in terms of five functional areas:

- organisation and human resources
- quality
- innovation
- environment
- health and safety.

Specific indicators were developed for each of these five functional areas. For the area of safety and health, the following indicators were used:

- safety policy
- accident indicators

([1]) J. Portillo, 'Diseño de modelos participativos e integrados de gestión de la prevención de riesgos laborales aplicables a poblaciones reales y representativas del tejido industrial de la PYMEs en España', Seville, 2002.

- risk assessment
- training
- accident investigation
- integration of OSH within company policy
- emergency planning.

The researcher carried out the efficiency analysis using data envelopment analysis (DEA). This is a technique that allows multiple inputs as well as multiple outputs (relative efficiency) to be taken into account.

Measuring company performance

The project also evaluated the performance of the company, using the productivity–man ratio.

Comparing efficiency with performance

The performance and efficiency analysis allowed the companies to be categorised and presented into a matrix, as shown in Figure 7. An example of such a matrix in the granite sector can be seen in Figure 8.

Figure 7: **Productivity and efficiency matrix (Portillo, 2002)**

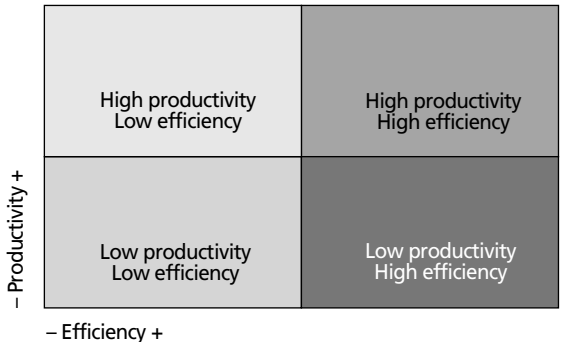
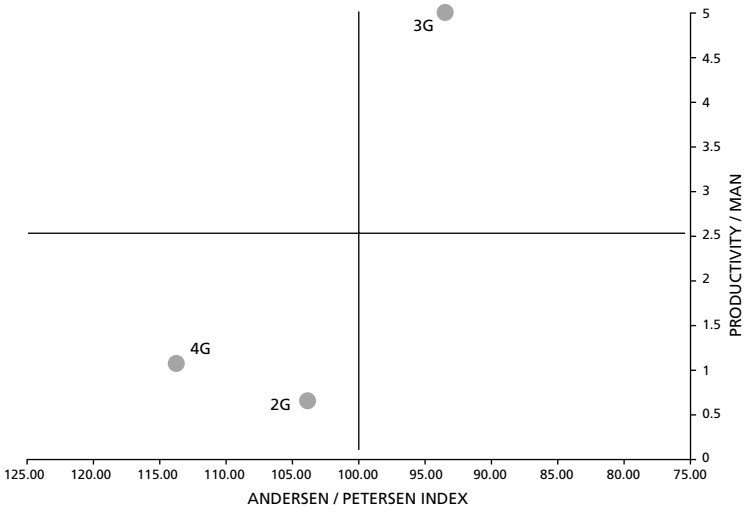


Figure 8: **Productivity–efficiency matrix — An example in the granite sector (Portillo, 2002)**



NB: X axis: efficiency. Y axis: productivity.
The dots represent three companies in the granite sector.

Conclusions

The overall conclusion of the research project was that good efficiency levels (including safety and health) were critical and parallel to excellence in terms of productivity. A direct relationship could be established between the performance level of the company and good practices in the field of OSH.

Source: J. Portillo, 'Diseño de modelos participativos e integrados de gestión de la prevención de riesgos laborales aplicables a poblaciones reales y representativas del tejido industrial de la PYMEs en España', Seville, 2002.

Case study 2: Working environment and productivity — A research and development project

Context

Four different companies were involved in the study: one construction company (including 142 different construction sites) and three metal product companies (company I: 130 employees, company II: 300 employees and company III: 30 employees). The project was carried out in cooperation between the research programme 'Workplace 2000' of the Finnish Institute of Occupational Health and the Tampere University of Technology's Institute of Industrial Management. It was financed by the Finnish Work Environment Fund.

The project aimed to continue similar studies made earlier in Finland and to clarify some contradictory results of these. The project consisted of four sub-projects. The findings of these sub-projects were summarised and final conclusions were drafted.

The overall aim of the project was to increase knowledge on the relationship between working conditions and productivity by using longitudinal and crosswise research methods. Specific research questions were the following.

- In what ways will changes in the working environment influence productivity? Which factors will or will not have an impact?
- What are the mechanisms that effect changes in productivity? Which types of cause-effect relations will exist between the specific working environment factors and productivity?

Project

The projects that were carried out in the various companies consisted of different kinds of interventions. The following types of measures were taken:

- improving order and tidiness
- continuous improvement programme
- fitness improvement programme
- better use of computer systems
- investment in technology
- improving ventilation
- improving the ergonomics of tools and equipment
- improving the work methods
- reorganisation of work
- changes in salary systems
- use of team work.

Analysis

The project was based mainly on quantitative assessment resulting in many diagrams between safety and productivity measures (correlations, regression analysis, etc.). In addition, interviews of personnel were used for carrying out qualitative analyses.

Several methods were used to measure the performance.

For the safety and health performance:

- construction company: TR safety observation method ([2]);
- metal company I: order and tidiness index, interviews;
- metal company II: order and tidiness index, OWAS ergonomic analysis, sick leave statistics, questionnaires;
- metal company III: job diagnostic survey (JDS).

For company performance:

- construction company:
  productivity: achieved output per working time (m^2/h)
  profitability:
  (1) achieved contribution margin of the construction site (%)
  (2) relation between the achieved contribution margin and the targeted contribution margin costs of achieved output;
- metal company I: Production output per working hours
- metal company II: Cost/benefit analysis, quality of cooperation
- metal company III: productivity: output per working hour, questionnaire on the fluency of the work.

Results

- Construction company
  There was a statistically significant correlation between the TR index and the contribution margin of the construction sites. On the basis of this study it was obvious that construction sites with a poor working environment (i.e. low TR index) could seldom achieve good margins. The critical level of the TR index seemed to be 70 %. Only one of six construction sites with a lower TR index than 70 % could achieve a 10 % margin. However, three out of five construction sites, with a TR index higher than 70 %, could earn a margin of more than 10 %.

- Metal company I
  The most important contributing factor in improving the productivity was found to be the quality of cooperation between the management and employees. However, it was difficult to change the old working methods to which people were accustomed.

- Metal company II
  The housekeeping index showed a clear improvement between the situation before and after the interventions. Many changes in equipment and working methods improved not only the ergonomics and occupational safety but also the fluency of work, and the work was done more quickly than before. Improvement in work postures was significant and the strain index decreased by 40 %. The working atmosphere, information flow and cooperation

([2]) Laitinen, H., Marjamäki, M., Päivärinta, K., 'The validity of the TR safety observation method on building construction', *Accident analysis and prevention*, 31 (1999) pp. 463–472.

improved as well. The share of sick leave from total working time decreased from 13 to 10 % during the intervention period. In monetary terms this resulted in savings of FIM 4.5 million (EUR 0.76 million). During the first two years, the costs of the project and achieved savings were about equal, but in the third year, costs were decreasing and the total net savings were more than FIM 2.5 million.

- Metal company III

  There was a correlation between the autonomy of the work and the productivity, even though it was not statistically significant. It was concluded that the work organisation should provide enough challenges and responsibilities to the employees for them to develop within their jobs.

Conclusions

It was possible to identify the eight most import factors influencing productivity based on four sub-projects: (1) physical working environment, (2) work methods, (3) investments, (4) salary basis, (5) fluency of work, (6) work content, (7) internal cooperation and development, and (8) market situation of products.

It was concluded from all sub-projects that the total quality of working environment and good order is essential for improving productivity. The case of the construction sites showed that a good safety level (high TR index) could even be used for the prediction of future profitability of that site. Another important factor in improving the productivity was internal cooperation and its development. Indeed, the development itself was found to be essential, because it can be a practical tool for teaching cooperation between the management and employees in concrete ways.

Furthermore, the cases indicated that by developing new working methods and equipment it was possible to improve working postures and decrease the strain level of physical work. This was the way to create the necessary conditions for increasing productivity. Investments will naturally directly influence the productivity of work. The adaptation in changes of product demand was a success factor in productivity as well as the content of the work. The study also found that clearly, salary basis and the fluency of work have an impact on productivity.

Source: Kemppilä Sari, Laitinen Heikki, Leinonen Mikko, Työympäristö ja tuottavuus — Tutkimus- ja kehityshanke. Tampereen teknillinen korkeakoulu, tuotantotalouden osasto, teollisuustalouden laitos, tutkimusraportti ISBN 952-15-0875-2, ISSN 1458-6770. 76 s. + 1 liite.2002
http://www.tsr.fi/tutkittu/hanke.php?id=99080 (in Finnish).

Case study 3: Integral participatory approach — A new assembly concept

Context

The company (Faber Electronics, the Netherlands) produces and develops different types of emergency lighting. Products are traditionally assembled on large tables in batches of 60. Two people per batch are working along the long side of a table, sorting and mounting piece by piece. The work at the tables begins with fetching the required components from different locations: pallets and trolleys, and further away, the warehouse. Then 60 products are assembled from the parts and packed and stored away.

The new assembly concept was based on flow assembly using three workstations. Two similar workstations manned by two sitting workers do most of the assembly work per product. At another workstation in the middle, manned by a standing worker, final assembly and packing of the products is carried out. Rotation between the workstations occurs at least every two hours but usually more frequently.

Analysis

Six subjects, experienced in assembling in the original and the improved situation, took part in the evaluation experiment. The subjects worked a whole day (eight hours and five minutes) in the old situation and a whole day in the new situation. During the assembly of 60 products, video recordings were made of each subject in both situations. From these recordings, the workers' postures were categorised using the Noldus Observer software. Risky static postures and repetitive movements were determined on the basis of current guidelines. The mass of the large or heavy materials to be lifted was determined. Risky lifting was determined on the basis of NIOSH calculations using the available guidelines.

The Observer software was also used for quantifying productivity in both the initial and the improved situation: time for both added value activities (mounting, assembling) and non-added value activities (walking, handling, searching) were determined. Calculations were made for the number of products per person per day and lead time. The required floor surface was also measured including the workbench, walking space in the workplace and material storage space.

Further insight into physical workload, mental workload, worker satisfaction and health risks were obtained using standardised questionnaires. The subjects had to fill in these questionnaires at the end of a working day in either the original or the improved situation.

Results

Physical workload was demonstrated according to working postures, NIOSH equations and experienced workload. There were no major differences in scored working postures, except for raising arms in the category of 0°–20° (p = .003) and in the category of 20°–60° (p = .001). There was a significant decrease, respectively increase, in these categories in the new situation.

The NIOSH equations for lifting boxes (9.16 kg per box) in the old and new situation showed an improved and safe way of lifting in the new situation. In the old situation the maximum weight allowed was 7.1 kg merely because of the low placement (the vertical factor) of the pallets on the floor (30 cm). In the new situation the boxes were placed on a pallet at adjustable height (70–80 cm), because a lifting table was used. The maximum allowed weight was then 17.8 kg.

Results from the questionnaire showed that fatigue experienced in the new situation was significantly lower than in the old situation (p = .038). There was no difference in experienced workload when picking parts, no difference in experienced workload of the neck, shoulders, arms and wrists when assembling parts and no difference in physical workload experienced in all tasks.

The effects on productivity were considerable (see Table 2).

Table 2 **— Productivity numbers**

Productivity indicator	Results: Change from old to new situation
Added value activity	Increase of 17.5 % (from 74.1 % to 91.6 % [1])
Lead time	Reduction of 46 %
Number of products per person per day	Increase of 44 %
Usage of room needed	Reduction of 44 %

([1]) $P = .001$

There were no significant differences in experienced mental workload and mental efforts.

Five out of six subjects felt more satisfied in the new way of working. Among the main reasons for this were changes of tasks, increased productivity, improved workstation design and reduction of lifting tasks.

Source: 'The right track for ergonomics in assembly work? Comparison between two production concepts on ergonomics and productivity'. L. Groenesteijn, M. D. de Groot, J. W. van Rhijn, M. P. de Looze, G. H. Tuinzaad. TNO Work and Employment, Ergonomics and Innovation, Hoofddorp, the Netherlands. TNO Industrial Technology, Assembly Engineering, Eindhoven, the Netherlands.

Case study 4: Implementation of a new health and safety system by South West Water

Context

South West Water was privatised in 1989. Following the privatisation, a new health and safety management system was introduced in 1991. Investment for improving operational sites followed, and with carefully monitored accounts of the gains made by reducing both the number and the seriousness of accidents. A long-term business plan was developed jointly with the Health and Safety Executive.

The examples of the problems that the company dealt with were the following:

- Work-related upper limb disorders — use of keyboards. Preventive actions included risk assessment, modifications of the workstations, maintenance, etc.
- Hand–arm vibration syndrome — working with vibrating tools in cold conditions. Preventive actions included risk assessment, selecting low vibratory tools, maintaining the tools, educating employees, job rotation, protective gloves, health surveillance.
- Musculoskeletal problems — manual weir cleaning. Preventive actions included installation of an automatic weir-cleaning machine, implementation of a health and safety management system as a contribution to company gains.

Analysis

The health and safety management system has been evaluated, with the following indicators taken into account:

- number of accidents
- lost working time
- (avoided) costs due to ill health
- (avoided) costs of liability claims.

Results

In 1991–92 there were 136 accidents per 1 000 employees. This had decreased to 53 accidents per 1 000 employees by 1995–96. Using the industry-wide representative cost for an accident, South West Water calculated that it had saved GBP 2 546 000 through its accident prevention measures over the period April 1992 to March 1998.

The company also ran two proactive health programmes and analysed the cost savings using the industry-wide representative cost of work-related ill-health. The programmes produced the following projected savings:

- The work-related upper limb disorder prevention programme was immediately self-financing, providing loss control savings of GBP 88 500 per annum over the next 10 years.
- The hand–arm vibration syndrome prevention programme became self-financing within two years and subsequently provided loss control savings of GBP 19 300 per annum over the next 10 years.

More details at: 'The Frank Davies project — Health protection and accident prevention as business imperatives in the water industry', Rob Gwyther, HSS Manager South West Water http://www.hse.gov.uk/costs/case_studies/case_studies.asp

Case study 5: Occupational safety and health at Brabantia

Context

Brabantia produces non-electronically driven household articles. It is a multinational company with plants in several countries. The project took place in three plants. The project was set up because a stress analysis conducted in the early 1990s showed that the workers lacked job satisfaction. This had resulted in health problems such as headaches, stomach-ache as well as in high absenteeism rates.

Project

A health programme was set up. The general aims of the project were:

- health promotion (healthier workers)
- increase of workers' well-being
- increase of safety.

The more specific aims were:

- the promotion of healthy habits and lifestyle
- the promotion of initiatives that support lifestyle activities
- the promotion of communication and coordination between workers
- an adaptation of the job content and work organisation in order to improve job satisfaction.

The programme consisted of interventions of two types.

1. Healthy habits and lifestyle:
   - measures at individual level, e.g. promotion of fitness;
   - measures at organisational level, e.g. offering facilities for fitness.

2. Job content and work organisation:
   - measures at individual level, e.g. communication between workers;
   - measures at organisational level, e.g. more job autonomy, responsibilities.

The interventions were based on an integrated approach combining the commitment of the management and active involvement of the workers. The list of specific measures, which were applied, is shown in Box 17.

The project compared the situation before the interventions with the situation after the interventions. A comparison was also made with a control group. The project started in 1990 and ended in 1993.

Box 17: Examples of specific measures taken at Brabantia

- Health screening
- Intensive nutrition programme for workers at high risk: counselling, meetings
- High blood pressure intensive programme for high risk workers: relaxation techniques
- Fitness programme
- Information sessions on nutrition, smoking, headaches, alcohol, etc.
- Social skills training, leadership
- Fitness facilities
- Smoking policy
- Job/function description
- Adaptation of the jobs.

Source: Maes, S., Kittel, F., Scholten, H., Verhoeven, C. (1994).

Results

One assessment was done before the project started. During the project, three assessments took place (one each year). The assessments took place within the experiment group and within the control group. The assessment comprised an interview, a questionnaire, and a biomedical exam. The results were assessed using the following six factors:

- lifestyle
- health risks
- stress reactions
- work stress
- work organisation and content
- absenteeism.

The study did not produce significant results with regard to lifestyle. However, there were less health risks noted. The risk for cardiovascular diseases decreased. Also, stress reactions lessened. The results for work stress were ambiguous. Initially, a clear improvement was noted but towards the end of the project, the level of stress increased. This was probably due to changes in work organisation. Long-term research is needed in order to be conclusive. The work organisation and job content improved during the project. Absenteeism figures decreased. The rate of absenteeism went down by 8 %, thus influencing productivity.

Source: Stan Maes, France Kittel, Hetty Scholten, Chris Verhoeven, Gezonder werken bij Brabantia, Ministerie van Sociale Zaken en Werkgelegenheid, 1994, Den Haag.

Case study 6: The prevention of slips and falls during the production of pre-stressed concrete

Context

The company (ECHO nv, Belgium) employs 284 workers, mainly blue-collar workers. It is a construction company specialised in the production of pre-stressed concrete floor elements. The company had an average of two accidents a year resulting in absences of 25 days. These accidents were mainly due to slips and falls during a specific stage of the production process. During the drying of the concrete, the pre-stressed concrete floor elements were covered with plastic foil. The foil made it impossible for the workers walking over the pre-stressed concrete floor elements to see holes resulting from the specific design of the elements, creating a serious risk for the workers involved.

On the basis of this analysis the safety officer took the initiative to search for an alternative solution. The project was set up in cooperation with the health and safety committee. In order to prepare the project and to convince the company management, a cost-benefit analysis was made.

The project was aimed at

- reducing work-related accidents
- improving the production process and quality
- reducing production costs
- increasing productivity
- reducing pollution.

Solution

The project team that analysed the problem proposed implementing a new machine. The R&D department worked on this solution. The curing compound machine moisturises the pre-stressed concrete elements during the drying process. This was an alternative way for using plastic foil that covered all the holes (for stairs, tubes, etc.) in these elements.

Method

An investment analysis was used in order to calculate:

- the payback period (annual earnings divided by the level of investment);
- the net present value (the sum of the actual value of all future annual earnings minus the investment); and
- the internal rate of return (the value of the discount rate for which the net present value is equal to zero).

For example, the selection criteria of investment projects required the payback to be less than three years and the internal rate of return to be greater than 10 %.

Results

The number of occupational accidents dropped to zero. Productivity increased because the moisturisation process was faster than when plastic foil was used. The production costs dropped dramatically as a consequence of the elimination of accidents and the replacement of the foil.

The moisturisation technique also improved the quality of the product. In addition, there were positive effects on the external environment because plastic foil is no longer used (reduction of waste).

These results had a positive impact on the competitiveness of the company. The return on investment for this project was 11.8 %, with a payback period of three years.

Conclusions

Work-related accidents have serious consequences and not merely in human terms. Their cost at company level exceeds the money available for prevention measures, especially when productivity factors are taken into account. This case demonstrated that a creative solution for a specific OSH problem can reduce accidents while increasing the productivity and competitiveness of the company.

This case also demonstrated that it is important to make an in-depth analysis of the different production costs that can be directly or indirectly related to the hazard (costs of accidents, loss of productivity and quality, and other production costs due, for example, to the use of inadequate materials). The objective should always be to identify the maximum number of different costs that can be linked to the hazard and that will be (partly) eliminated as a consequence of the implementation of the solution.

Finally, this case also emphasised the importance of good preparation and constructive teamwork, bringing together health and safety experts, workers' representatives, production experts, financial analysts and management staff.

Source: Bert De Ryck, Steven Hermans, Marc Nys, Laurent De Groof, Marlie Michiels. 'Kostenbatenanalyse: De glijbekistingsmachine', unpublished project work in the framework of a vocational training course leading to a certificate for health and safety officers.
Contact details: Marc Nys, Echo NV, Donderslagweg 25, B-3530 Houthalen, (+32-8) 984 03 11; web site: http://www.echobel.com/

Case study 7: The purchase of an automatic winding machine

Context

The project was set up in a distribution department of Coca Cola Enterprises. It distributes non-alcoholic beverages and syrups employing 25 to 30 workers, depending on the time of the year. In order to protect containers or other units — e.g. pallets with products — from physical damage, the containers are wound with plastic film. This is a manual process. The process requires that the worker turn at least five times around the object with the plastic film in his/her hands using a lot of force. From an ergonomic point of view this is not a healthy working position. Moreover, the manual winding is sometimes not powerful enough. This can cause problems or damage while transporting the cargo.

The aims of the project were to:

- optimise the workplace in order to improve the well-being of workers;
- reduce the number of working accidents and days of incapacity;
- deliver the cargo undamaged to the client.

The project consisted of purchasing a new winding machine and equipping the pallet trucks with a back support.

Analysis

The cost-benefit analysis used indicators such as the number of days of incapacity for work (sick leave or work accident), the amount of plastic foil used and maintenance costs for the winding machine.

Results

The analysis showed that the number of days of incapacity for work could be reduced by 23 days, which means a significant gain for the company. Furthermore, a lot of money could be saved on the amount of plastic foil used because the winding machine uses less foil because it wraps it a lot tighter.

The extra costs occurred mainly due to the facts that the new machine involved maintenance costs, and because a second winding machine had to be purchased since the first winding machine could not deal with the workload.

The overall results of the cost-benefit analysis (Table 3) were positive and contributed to the implementation of the suggested solution. Immediately after installation of the first winding machine, everybody agreed that it was a major improvement, certainly from an ergonomic point of view. Moreover, investing in a winding machine showed the concern of the employer for his employees. The employees were also enthusiastic about the back support on the pallet trucks. Nevertheless, it remained difficult to integrate non-quantifiable factors (such as the reorganisation of the work scheme, quality of the products, the working climate, reintegration problems, etc.) into the cost-benefit analysis.

Table 3 **— Cost-benefit analysis (EUR)**

Item	Year 1	Year 2	Year 3	Year 4	Year 5
Maintenance	– 500	– 525	– 551	– 578	– 607
Savings on the use of plastic foil	+ 5 592	+ 5 592	+ 5 592	+ 5 592	+ 5 592
Decrease in sickness absenteeism	+ 1 906	+ 1 944	+ 1 983	+ 2 022	+ 2 063
Decrease in workplace accidents absenteeism	+ 2 079	+ 2 120	+ 2 163	+ 2 206	+ 2 250
Cash flow before taxes	+ 9 077	+ 9 132	+ 9 187	+ 9 243	+ 9 298
Depreciation	4 265	4 265	4 265	4 265	4 265
Profit before taxes	4 812	4 866	4 922	4 978	5 033
Taxes 45 %	– 2 165	– 2 190	– 2 214	– 2 239	– 2 264
Cash flow after taxes	+ 6 912	+ 6 942	+ 6 972	+ 7 003	+ 7 033
Actualisation coefficient	0.91	0.83	0.75	0.68	0.62
Result	+ 6 284	+ 5 737	+ 5 238	+ 4 783	+ 4 367

Because the initial investment amounted to EUR 21 329, the net present value of this project equals EUR 5 081 (= 6 284 + 5 737 + 5 238 + 4 783 + 4 367 – 21 329). On the basis of this financial evaluation, the project was accepted.

Source: Tielen, Eddy Laenens, Patrick Vanmeerbeeck, Jules Van Engeland, 'Kosten-batenanalyse: de aanschaf van een automatische wikkelmachine', unpublished project work in the framework of a vocational training course leading to a certificate for health and safety officer.
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More case studies are found in Annex 2 (CS8) and Annex 3 (CS9–CS16).

4.2. Discussion

Although the stories told by the case studies are different from one another, they all present evidence that investing in health and safety can contribute to the productivity in a company. However, not all evidence can be considered 'strong' and not every case study is based on a solid methodology.

4.2.1. Research

Two case studies are based on a research study (CS1 and CS2). Both studies present a strong methodology, clear definitions and quantitative analyses. These case studies show that there is a link between a good working environment and productivity.

In CS1, the existing working environment in the company was measured using criteria for five functional areas. This analysis gives an indication of the efficiency of the management of each company. The performance of the company was measured using the productivity/man ratio. A comparison between the efficiency and the performance of the company led the researchers to the conclusion that a direct relationship exists between the performance level of the company and good practice in the field of OSH.

Using a different methodology, CS2 came to a similar conclusion. This study involved four different companies, one construction company and three metal sector companies. Safety and health performance for these four companies was compared with their productivity. Several quantitative and qualitative analyses were used in order to measure safety and health and company performance. Results demonstrated that the quality of the working environment has a strong influence on the productivity and profitability of the company.

4.2.2. Types of interventions

The interventions of the case studies present a wide range of safety and health interventions. These cover measures related to:

- work organisation (CS1, CS2, CS5, CS12);
- training (CS2, CS4, CS5, CS10, CS11, CS13);
- (ergonomic) adaptations of the workplace (CS2, CS3, CS4, CS8, CS10, CS11);
- health promotion (CS2, CS5, CS11); and
- adjustment of working methods/work equipment (CS2, CS4, CS6, CS7, CS14, CS15, CS16).

Based on these case studies it is difficult to draw conclusions on the effectiveness of one type of intervention compared with another. However, case studies where several types of interventions are combined in comprehensive programmes (e.g. CS2, CS4 and CS5) show

convincing results. In order to present conclusions on the effectiveness of one type of intervention in comparison with other types, further research is needed.

4.2.3. Cost-benefit analysis

Several cases are based on the methodology of cost-benefit analyses (CS6, CS7, CS8, CS12, CS14, CS15, CS16). In these companies the costs and benefits of an OSH measure were calculated before implementing/deciding upon the measure.

In most of these cases the safety and health officer of the company involved performed the analysis. This shows not only that the method is a technique that can be used at company level but also that it can be successfully implemented by practitioners. The cost-benefit analysis was performed before implementing a safety and health intervention. Thus, the cost-benefit analysis contributed to the process of decision-making within the company. The case studies proved that the technique and the outcome of a cost-benefit analysis are very similar to the practice of investment decisions. Moreover, the safety and health practitioners involved testified that the results of their cost-benefit analysis presented a strong argument in convincing management to invest in safety and health.

The case studies also illustrate the limitations of the technique. It remains difficult to measure effects that are difficult to quantify. However, this should not be considered as a disadvantage. Moreover, company decisions are usually taken on the basis of estimates (e.g. market growth) and business forecasts are used. In this respect, the putting forward of different scenarios and the use of the net present value is an approach linked to entrepreneurial practice.

The results obtained following the interventions confirm the calculations of the cost-benefit analysis. Sometimes the interventions even bring about unforeseen benefits.

4.2.4. Safety and health outcomes

Various methods were used in order to establish the effects of the safety and health projects. These methods are often based on a comparison between the situation before and after an OSH intervention. In order to make this comparison, data such as data on sick leave and the results of questionnaires are used.

At Katjes (CS10) for instance, it was found that the number of sick days lost due to musculoskeletal disorders decreased from 2 011 to 752 (from 1995 until 2002). South West Water (CS4) managed to decrease the number of occupational accidents from 136 accidents per 1 000 employees to 53, after implementing a health and safety management system.

Other companies made a comparison in an experimental study using one or more control and experimental groups. Polyfelt (CS9) implemented a new shift system. Comparisons with control groups showed significant improvements for the health of the shift workers. Brabantia (CS5) compared the situation before and after the implementation of a workplace promotion programme and also made a comparison with a control group. The results showed improvements in health factors and a decrease in the amount of sick leave taken.

Results in these case studies are mainly (or solely) based on the analysis of safety and health factors. Only a few case studies can present results also in terms of productivity. Naturally, this will limit our possibilities in drawing overall conclusions. But even these few cases provide clear evidence that a link exists between a good working environment and company productivity. Future research should study these relations in more detail.

4.2.5. Foundations for a sustainable approach

Although the types of case studies differ considerably, some common elements were found.

1. The high overall quality of working environments, including good housekeeping is essential for improving productivity. There was a statistically significant correlation between the TR audit index and the contribution margin of the construction sites in Finland. It was obvious that construction sites with a poor working environment (i.e. low TR index) could seldom achieve good margins. It even showed that a good safety level (i.e. high TR index) could be used for the prediction of future profitability of that construction site (CS2). These findings were similar in the Spanish study (CS1).

2. The quality of cooperation between management and employees is an important contributing factor in improving productivity. However, it was found that it is difficult to change existing old working methods to which people are accustomed. Also, development itself is important because it can be a practical tool for teaching cooperation between management and employees in concrete ways (CS2).

   Another study (CS6) emphasised the importance of good preparation and constructive teamwork, bringing together health and safety experts, workers' representatives, production experts, financial analysts and management staff.

3. Work organisation is another important contributing factor to productivity. It was found that work organisation providing more challenges and responsibilities and more job autonomy to the employees may have a positive effect on productivity (CS2, CS5). In the Austrian study, a new shift system was found to be beneficial for improving the quality of life. It was stated that this would improve the corporate image on the labour market and lower the staff turnover (CS9).

4. Furthermore, some cases indicated that by developing new working methods and equipment it was possible to improve working postures and decrease the strain level of physical work. These improvements also allow worker productivity to increase. Such investments, therefore, directly influence the productivity of work (e.g. CS2, CS7, CS8, CS10, CS11).

5. Some case studies also demonstrated that creative solutions for specific OSH problems are needed to reduce accidents while increasing the productivity and competitiveness of the company (CS6, CS7).

6. The projects were evaluated in a thorough manner and the management given feedback on the results. Often, this evaluation contributed to OSH, as it was then not just seen as a cost, but as a way to achieve improvements in company performance. In this way, the foundations were laid for a sustainable approach to safety and health at work. It is important to make an in-depth analysis of the different production costs that can be directly or indirectly related to the hazard (costs of accidents, loss of productivity and quality, and other production costs due, for example, to the use of inadequate materials). The objective should always be to identify the maximum number of different costs that can be linked to the hazard and that will be eliminated or reduced as a consequence of the implementation of the solution.

5. Conclusions

5.1. The theoretical framework

This working paper is based on a conceptual framework (see Figure 1), showing that health and safety measures have an influence not only on safety and health performance, but also on company performance. In addition, improved safety and health performance has positive effects on the company performance and adds to the initial effects of the health and safety measures.

This framework was supported both by the research findings and the results from the case studies. However, when using this framework there are several aspects which have to be addressed.

OSH investments should not be isolated from other investments as this may leave OSH out of management's concerns. Most investments are of a technical nature and incorporating OSH would help maximise them and provide a faster return. These might be described as socio-technical investments.

The framework does not include the time dimension, which may have a strong effect on decision-making. When looked at from only the short-term perspective, OSH often appears as only a cost.

Although the focus is on the corporate level, many external variables have to be taken into account. One of the most important variables is whether costs are internalised or externalised. National policies and features may also have an influence. Companies often do not bear the full costs of occupational accidents, diseases, occupational injuries, or work-related illnesses. Thus, the costs of occupational safety and health for companies, but also for individual workers, are very much influenced by the national system of social security.

This working paper 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 encompass individual company level. Individual workers/victims especially, and their families and social networks suffer from the consequences of occupational accidents and diseases. Society as a whole has to deal with these negative outcomes of the production process.

5.2. Research findings

The literature survey was written in order to give an overview of the recent research on the subject. Although the survey was fairly limited, research findings support the existence of an important link between a good working environment and the performance of a company. Thus, the quality of a working environment has a strong influence on productivity and profitability.

A number of success factors are identified in the literature:

- combining business targets and human resources activities, in order to achieve best results;
- taking a wider approach to health promotion to include not only health conditions but also employee attitudes and corporate culture;
- using OSH improvement programmes, as they seem to provide better results than implementing only specific prevention measures;
- including technical innovations and organisational improvements;
- carrying out measurement and evaluation. The demonstration of return on investment, both prospectively and retrospectively, is needed.

On the other hand, it was found that poor OSH performance can lead to a competitive disadvantage impairing the firm's status among stakeholders. This is a motivating factor to company management to invest in OSH. Stress prevention was found to not only reduce costs, but also to improve productivity by improving the motivation of staff and the working climate.

This working paper also presents a number of methods, strategies, tools, and so on, that can be useful when implementing an efficient health and safety policy. A successful policy at company level will have positive effects on the level of individual workers, as well as their families, on their social network and on society as a whole.

Many companies are still unaware of the economic aspects of occupational safety and health. Nevertheless, company management concepts have changed to such a degree that company performance is not only measured in financial terms, but other aspects such as the customer, internal business, innovation and learning factors are also taken into consideration. This provides possibilities for identifying health and safety as important business enablers that can push companies to better performance.

Several methods have been developed for economic evaluations. These methods can be divided into three main categories:

- methods for calculating the costs of accidents;
- methods for analysing the costs and benefits or effects of OSH interventions;
- methods focusing on the performance of OSH systems.

Each of these methods has its own advantages and disadvantages.

5.3. Collection of the case studies

The research findings were supported by the collection of case studies. The results of the cases showed that the cost-benefit analysis can contribute to the decision-making process within the company. The case studies proved that the technique and the outcome of a cost-benefit analysis are very similar to the practice used to take investment decisions. Moreover, the safety and health practitioners involved testified that the results of the cost-benefit analysis presented a strong argument in convincing management to invest in safety and health.

By making the link between health and safety and the performance of the company, the case studies demonstrate that OSH should no longer be seen as purely a cost, but also as an instrument to improve the overall performance of a company, meaning that OSH should be an integral parameter in general management.

However, the case studies do not allow us to draw general conclusions with regard to effectiveness of different OSH measures. Although the types of case studies differ considerably, some common elements were found.

1. The high overall quality of working environments, including good housekeeping, is essential for improving productivity. There was a statistically significant correlation between the TR audit index and the contribution margin of the construction sites in Finland. It was obvious that construction sites with a poor working environment could seldom achieve good margins. It even showed that a good safety level could be used for the prediction of future profitability of that construction site. These findings were similar in the Spanish study.

2. The quality of cooperation between the management and employees is an important contributing factor in improving productivity. Also, development itself is important because

it can be a practical tool for teaching cooperation between management and employees in concrete ways.

3. Work organisation is another important contributing factor to productivity.

4. Some cases indicated that by developing new working methods and equipment it was possible to improve working postures and decrease the strain level of physical work. These improvements allow worker productivity to increase. Such investments, therefore, directly influence the productivity of work.

5. Some case studies also demonstrated that creative solutions for specific OSH problems are needed to reduce accidents while increasing the productivity and competitiveness of the company.

6. Projects were evaluated in a thorough manner and the management was given feedback on the results. Often this evaluation contributed to OSH, as it was then not just seen as a cost, but as a way to achieve improvements in company performance.

5.4. Final remarks

This working paper demonstrates that health and safety measures have a positive impact not only on safety and health performance but also on company productivity. However, identifying and quantifying these effects is not always straightforward. In addition, although experience shows that in many cases proof of profitability can be given, it might be rather difficult in a certain number of cases to develop solid evidence. This might be the case when some of the important consequences of health and safety risks can be externalised (e.g. hazards with long-term effects), thus putting a strain on society and not immediately on the company. Safety and health of workers is a moral responsibility within our society that cannot only depend on productivity criteria within a particular company. This responsibility fits into the broader concept of the performance of a company. The final evaluation is not only a question of the short term, but more an issue of the long term.

Based on the findings of this study it is strongly recommended to make future research into these topics. When integrating occupational safety and health in everyday management of the company it is possible to find win-win situations where workers' safety and health and productivity of the company can be improved. It is proposed that the European Agency for Safety and Health at Work organise an expert workshop, where these topics can be discussed in detail.

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Annex 1. Project organisation

Agency project manager

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Project members of the Topic Centre on Research

Task 5: Workers' safety and health, productivity and quality

Task leader

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- Dr J-L. Marié
- Dr J-C André

Expert seminar

An expert seminar was organised at Prevent offices in Brussels on 18 September 2003.

'Focal point' network

Agency's 'Focal point' network contributed to the project.

Annex 2. Background information for the methodology

The development of an effective health and safety policy can be considered a moral obligation for every company. This obligation created by society is the basis for the legal framework regarding occupational safety and health.

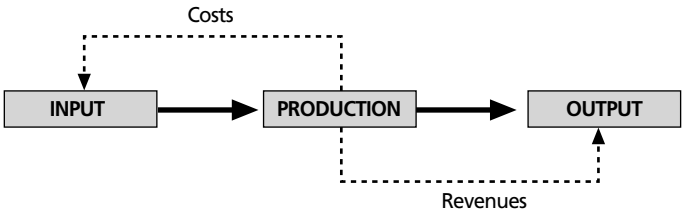
Legislation, however, will always be an external factor requiring compliance and enforcement. On the other hand, a company is an economic entity that has the aim of making a certain profit. This means that revenues, productivity and production costs have to be optimised. Managers have a wide array of instruments at their disposal, one of which is the health and safety policy.

This annex provides some background information for the study methodology.

An economic model of the firm: a framework for the quantification of effects

In order to **quantify** the economic effects of safety and health at company level, a good understanding of the relationship between hazards and effects or between safety and health, productivity and quality is necessary. To describe this complex system of different interrelated processes, a simple and straightforward economic model of the firm can be used (Figure 9).

Figure 9: **Economic model of a firm**



In this model, the input, for example, human resources, capital, raw materials, and so on, form the basis for the production process that leads to a certain output, that is, products and services. The input creates costs while the output generates revenue. The profit of the company is calculated by subtracting the costs from the revenues.

profit = revenues – costs

In the classic economic environment, a company will attempt to maximise profit, in other words, to increase revenue and decrease production costs.

It is clear that health and safety measures can have important consequences on a company's profitability, by affecting revenue and production costs. The optimal scenario would be:

- **a decrease of the production costs** (owing to fewer accidents and damages, less absenteeism, etc.); and
- **an increase of revenue** (owing to better productivity, efficiency, quality, etc.).

In this scenario, revenue will increase while costs decrease (Box 18).

The increase of revenue and the decrease of costs will have a positive effect on the profit of the company. In general, different scenarios can be identified, each of them having different effects on the profits of the company (Box 18).

Box 18: Safety and health measures: the effects on production costs and revenues

Δ R = R2 – R1
Δ C = C2 – C1

where

R1 and C1: revenues and costs before health and safety measures
R2 and C2: revenues and costs after health and safety measures

Possible scenarios

Effect on revenues

Δ R revenue positive (> 0): e.g. increase of productivity due to better motivation of staff;
Δ R revenue negative (< 0): decrease of the productivity due to safety procedures.

Effects on costs

Δ C cost positive (> 0): e.g. increase of the costs of safety equipment (only when considered as an operational cost, otherwise these expenses have to be considered as investments);
Δ C cost negative (< 0): e.g. reduction of staff costs due to less absenteeism.

Source: De Greef, 2003.

The combined influence of health and safety measures on the profits of a company can be calculated using a formula (see Box 19, Formula 1).

When the health and safety measure must be considered as an investment (i.e. as an expense with an effect on future revenue and costs), the effect on profit has to be calculated by making the sum of the different effects during the lifespan of the investment (Formula 2).

The formula does not take into account the time value of money. The profits made in future do not have the same value as those made at present. This is because an economic actor is not indifferent regarding receiving an amount of money at the end of the present year and receiving the same amount at the end of any future year. A discount rate needs to be applied on all future profits in order to be able to compare them with the amount of the initial investment. This technique allows calculating the net present value and the internal rate of return of a project ([3]).

Box 19: Influence of combined health and safety measures on the profit of a company

Formula 1

$$\Delta P = \sum_{i=1}^{4} \Delta R_i - \sum_{i=1}^{4} \Delta C_i$$

where
ΔP: difference between the profit of period 1 and period 2
ΔR: difference between the revenue of period 1 and period 2
ΔC: difference between the production costs of period 1 and period 2

Formula 2

$$\Delta P = \sum_{n=1}^{N} \left\{ \sum_{i=1}^{4} \Delta R_i - \sum_{i=1}^{4} \Delta C_i \right\} - I_o$$

where
I_o: the amount of the investment
N: the lifespan of the investment

Source: De Greef, 2003.

([3]) This is why a cost-benefit analysis calculates the net present value. Several case studies present this technique.

Probability of the effects

As explained above, the quantification of the changes in the revenues and the costs is closely linked to the identification of the different effects of the health and safety investment. However, there is one more difficulty, namely the probability of the future effects. A certain hazard may have different consequences depending on the specific circumstances. In addition, the implementation of a health and safety measure can have different effects on a particular hazard, leading to a different impact on the health and safety performance as well as on the company performance. In other words, the outcome of the investment is not certain ([4]).

In order to deal with this, the expectations of the company of the possible future gains must be based, in part, on more or less certain historical data of past performance, and, in part, on forecasts of future events, which can usually be made only on a highly tentative basis. In practice, the best a company can do is to make some estimation of the range of possible future costs and benefits and the relative chances of earning a high or a low profit on the investment. The expected profit can be defined using Formula 3 in Box 20.

In most cases, the evaluation of probabilities will be subjective, that is, based on personal judgement regarding the chances of realising the future differences in revenues and costs (Δs). The expected profit will be the result of a sensitivity analysis of the profitability, taking into account a set of data ranging from a maximal difference (with a small probability) to a minimum difference (with a large probability).

In order to measure the risk of achieving the outcome, the variance (or standard deviation σ^2) can be calculated. This parameter measures the dispersion of the profits around the mean (expected) value. As shown in Formula 4 in Box 20, the variance provides information on the extent of the possible deviations of the actual profit from the expected profit.

Box 20: Probability of effects

Formula 3: Calculation of expected value for the profit E(x)

$$E\left(x\right) = \sum_{i=1}^{N} P_i X_i$$

where

E(x): expected value of the profit

Pi: the probability of obtaining the outcome Xi

Xi: the possible outcome (profit)

N: the number of possible outcomes

Formula 4: Calculation of the risk of achieving the outcome

$$\sigma^2 = \sum_{i=1}^{N} P_i\left(X_i - Ex\right)^2$$

σ^2 = standard deviation or variance

Source: De Greef, 2003.

Making economic consequences visible using a cost-benefit analysis

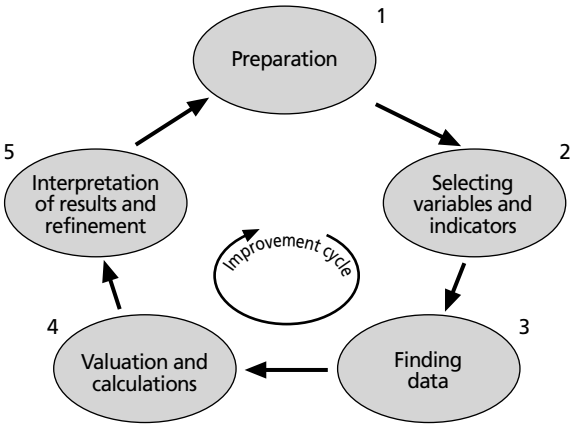
The cost-benefit analysis is used to make economic consequences visible. Qualitative and quantitative frameworks as described earlier form the basis of cost-benefit analyses. The aim is

([4]) See also: *Capital investment and financial decisions*, H. Levy and M. Sarnat, London, 1978. Additional literature: *Cost accounting: A managerial emphasis*, Charles T. Horngren, London, 1977.

to compare input and output. In practice, the cost-benefit analysis demands a step-by-step approach. A case study on the costs and benefits of an investment in ergonomic keyboards, demonstrates how this technique works in a specific company.

In their report entitled *Inventory of socio-economic costs of work accidents,* Mossink and De Greef outline a step-by-step approach on how to go about analysing the costs and benefits of health and safety programmes (Figure 10).

Figure 10: **Five-step improvement cycle for making estimations of costs of work accidents and preventive activities (Mossink, J., De Greef, M., 2002)**



Case study 8: Introducing an ergonomic keyboard

At Texaco Belgium, a company with 220 employees and a part of the Chevron Texaco Corporation (petroleum industry — downstream), a project was set up to replace the classic qwerty/azerty keyboards with 'ergonomic' keyboards. This project was a part of a large programme on preventing repetitive strain injuries (RSI).

Repetitive strain injuries represent a major safety and health risk to employees. As an example, in Chevron North America (USA and Canada), data spanning five years show an increase of nearly 67 % of RSI complaints related to computer use. Forty-two percent of all incidents in 2000 at Texaco Belgium were related to these kinds of complaints. The RSI programme that was set for all employees using a computer comprised the following phases:

- risk assessment and initial awareness raising
- training
- implementing preventive measures
- encouraging safe behaviour
- early reporting of complaints and rapid response intervention
- evaluation.

One of the actions undertaken was to implement computer hardware compliant with strict ergonomic demands. This hardware was selected after a risk assessment and a study of the different hardware available. The keyboard chosen after this selection process was the 'Goldtouch' keyboard. This keyboard can be tilted both vertically and horizontally thus avoiding aggravating positions for the wrists, neck and shoulders.

Calculating the costs

The costs (Table 4) involved in this project are listed below.

- Investments: Since the keyboards had to be changed anyway in 2003, the calculated costs are the difference between the cost of a classic keyboard and the 'Goldtouch' keyboard.
- Installation: Costs for IT personnel for installing the numeric keypads (the keyboards had to be installed anyway, only the keypads themselves involved additional costs).
- Personnel: Loss of productivity due to the fact that the staff had to learn how to use the new keyboard. This learning process was spread over three years. In 2003, staff learn to use the new keyboard regarding the new position of function keys and numeric keys. In 2004, they learn how to use the horizontal split, and in 2005, how to use the vertical split.
- Loss of productivity: The loss of productivity is estimated based on figures of research data (literature) that are extrapolated from the Texaco data.
- Other costs: These costs are the costs for communication and training, for instance.

Table 4 **— Keyboard project: costs (EUR)**

Investment costs	**2002**	**2003**	**2004**	**2005**
Keyboards	12 538	0	0	0
Installation	433	0	0	0
Total	**12 971**	**0**	**0**	**0**

Recurrent costs	**2002**	**2003**	**2004**	**2005**
Personnel	—	1 502	1 744	2 132
Other	—	3 508	2 437	2 437
Total	**—**	**5 010**	**4 181**	**4 569**

Calculating the benefits

The benefits (Table 5) of the project concern personnel: reduced absenteeism and reduced loss of productivity.

The reduction in absenteeism is calculated using a formula that takes into account the number of RSI cases that could be avoided, the average number of days of absenteeism due to RSI and the average cost of one day of absence. The number of RSI cases that could be avoided is estimated with a formula using data from the risk assessment, research and personnel costs.

The drop in loss of productivity is based on the fact that employees who suffer from RSI are less productive. They have to take more breaks, can spend less time at the computer and the pain effects their capacity to concentrate as well as their motivation. These benefits are calculated by taking into account the number of employees that could develop RSI problems (risk assessment), the average number of days to recover, the time lost due to working at a 'recovery rhythm'. Some of this data was obtained using a software program for computer breaks. Since this software program keeps track of the working rhythm of the employee, this enabled the rhythm/use of time of 'normal' employees and 'recovering' employees to be compared.

Other benefits include avoided costs in the treatment of complaints and the intervention of occupational health specialists.

Table 5 **— Keyboard project: benefits (EUR)**

Benefits	2003	2004	2005
Absenteeism reduced	11 212	14 935	20 641
Increased productivity	3 326	4 397	6 021
Avoided interventions	1 333	2 553	3 535
Total	**15 871**	**21 885**	**30 197**

Comparing costs and benefits

In order to evaluate the project, the costs and benefits had to be compared, taking into account the initial investment as well as the time value of the money and the taxes. This can be done using the net present value (NPV) method. An investment proposal's NPV is derived by discounting the net cash receipts at a rate that reflects the value of the alternative use of the funds (the discount rate), extrapolating them over the life of the proposal and deducting the initial investment (Box 21).

It is obvious that a project can be accepted from a financial point of view when the NPV is positive, in other words, when the sum of all discounted future revenues is larger than the amount of the initial investment.

A common variant of the NPV criterion is the profitability index (PI). The PI is defined as the present value of the project divided by the value of the initial investment (Box 21). A project can be accepted when the profitability index is greater than 1. It should be rejected when the index is less than 1.

Box 21: Net present value and profitability index

Net present value (NPV)

$$NPV = PV - I_0 = \sum_{t=1}^{n} \frac{S_t}{\left(1+k\right)^t} - I_0$$

where

S_t: the net cash receipt at the end of year t
I_0: the amount of the initial investment
k: the discount rate, i.e. the required minimum rate of return on new investment
n: the project's duration in years
PV: present value

Profitability index (PI)

$$PI = \frac{PV}{I_0}$$

In the case of introducing the 'Goldtouch' keyboard, the tax rate is 35 %, the depreciation is linear over three years and the discount rate is 10 % (Table 6).

Table 6 **— Keyboard project: present value (EUR)**

Item	Year 1	Year 2	Year 3
Benefit	15 871	21 885	30 197
Cost	5 443	4 181	4 569
Cash flow	10 428	17 704	25 628
Amortisation	4 324	4 324	4 324
Taxable	6 104	13 380	21 304
Tax	2 137	4 683	7 457
Net cash flow	8 291	13 021	18 171
Present value	**7 538**	**10 760**	**13 652**

In this case, the present value of the project equals (EUR) 7 538 + 10 760 + 13 652 = 31 950. The NPV equals (EUR) 31 950 – 12 971 = 18 979. The profitability index equals 2.5 (31 950/12 971). This means that the NPV is positive and that the profitability index is greater than 1. The project has thus a sound financial basis and can be accepted.

Source: Feys, B., Roets, T., Van Hurck, G., 'Kosten-Batenanalyse ergonomisch toetsenbord, Goldtouch, projectwerk', Leuven, 2003 (unpublished).
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tel. (32-2) 639 99 61, e-mail: feysb@chevrontexaco.com

Annex 3. Selection of case studies

Case study 9: A new shift system

Context

The new shift system was introduced at Polyfelt and Agrolinz Melamin. Both companies are located in the Chemiepark Linz (Austria) and affiliated with the OMV group. The companies are chemical production plants. Polyfelt produces geosynthetic products that are mainly used in construction. Agrolinz Melamin produces fertilisers.

Shift and night work are important elements of their work organisation. Both companies have developed programmes to change their work organisation in order to maintain workers longer at work (employability, ageing workers) and to remain attractive (shift work) to employees on the labour market. An important adjustment they made was the introduction of a new shift plan. This adjustment was accompanied by other health measures.

The shift plan was adjusted as follows:

- reduced working hours per week: from 39 to 35 hours;
- number of shifts increased from four to five;
- five shift working days are followed by three days off, and every fourth week by four days off;
- number of night-shifts per month reduced from eight to six.

The aim was to improve the quality of work in order to maintain the workforce. At the moment, the average age of the workers is 40. However, as the workforce ages shift work conditions will become more important.

Analysis

A far-reaching evaluation was made by comparing the new shift plan before and after implementation and by comparing it with control groups within and outside the company (control groups). Evaluations were carried out before the implementation, six months after the implementation and 12 months after the implementation. The evaluation aimed to measure the effects of the change in the shift plan on the following factors:

- health, stress, sleep, shift tolerance;
- job capability, job motivation, job satisfaction;
- commitment, corporate culture;
- quality of life, private life.

The evaluation consisted of medical examinations and a survey based on:
- work ability index
- shift work index
- occupational stress questionnaire
- *Existenztypologie und Existenzanalyse der Arbeit ([5])*
- *Effekt-Typologie ([3])*
- health — strengths and weaknesses analysis.

([5]) Method developed by Karazman, Rudolf, Karazman-Morawetz Inge (1996), Sinnfindung und zwischen-menschliche Entwicklung als Kriterien betrieblicher Gesundheitsförderung. Evaluationsversuche mittels „Existenz-Typologie' und"Effekt-Typologie"; in: Lobnig H. und Pelikan J. (Hrsg.): Gesundheitsförderung in Settings: Gemeinde, Betriebe, Schule und Krankenhaus, Gesundheitswissenschaft/ Gesundheitsförderung".

Results

The results show that the objectives of the new shift plan have been reached. The quality of life and the recovery capacity of the workers have been improved. Significant improvements, compared with the control groups, were found for the following items:

- better quality of sleep and better shift tolerance;
- improvement of the quality of life;
- high job capability, improvement of the quality of work and stress reduction;
- improvement of relations within the company and a reduction of problems associated with shift organisation/planning;
- improvement of the subjective level of health.

According to the study, these effects will also lead to better company performance, for example, better corporate image on the labour market, lower staff turnover, and so on.

Schichtplanreform bei Polyfelt und Agrolinz, http://www.ibg.co.at/referenzen_polyfelt.htm
Contact details: Manfred Lüftner, Fa. Polyfelt, Schachermayerstr.18, A-4020 Linz, tel. (43) 732 69 83

Case study 10: Back health at Katjes

Context

Katjes is a producer of sweets such as fruit gums. They produce annually 45 000 tonnes of sweets. It is a dynamic family-owned enterprise and today employs 440 skilled workers. Katjes, a brand that uses a cat as its logo, is well-known among discerning consumers. The most important quality objectives and principles of the company are:

- ensuring premium quality
- customer satisfaction
- safeguarding and extending the company's innovative and competitive lead
- safety and environmental friendliness of its products
- a committed and motivated workforce.

This quality policy is important for the economic efficiency of the Katjes company. It can only be achieved if every employee makes a contribution. The heavy nature of work at the production line has meant that back problems are common. Musculoskeletal disorders (MSD) have been more frequent than the regional average. This was the start of comprehensive back-health activity.

Project

The project started in 1995 and involved all 300 workers. The activities are still ongoing because the project forms part of the health management system. The objective was the reduction of sickness leave cases due to musculoskeletal disorders.

The project involved:

- training all production line workers in health-oriented behaviour (sitting, lifting, handling of loads);

- adapting the workplaces: handling lifter, vacuum lifter for sugar bags, sitting at the control places, ergonomic design of the assembly line, etc.

Results

The project was evaluated using health insurance sickness leave records, ergonomic analysis and discussion groups. The sickness leave cases due to musculoskeletal disorders have been reduced (per 100 employees) from 1995: 42.69, 1996: 31.18, 1997: 28.81, 1998: 27.21, to 1999: 27.14. The number of days lost due to MSD dropped from 2 011 in 1995 to 752 in 2002. In this way, Katjes has reduced costs due to MSD by up to EUR 1 583 600 in the last seven years (Table 7).

Table 7 **— Figures on sickness leave**

Year	1995	1996	1997	1998	1999	2000	2001	2002
Days lost due to MSD	2 011	1 054	926	1 016	686	996	729	752
Cost for one lost day (EUR)	200	200	200	200	200	200	200	200
Total costs (EUR)	402 200	210 800	185 200	203 200	137 200	199 200	145 800	150 400
Reduced costs compared to 1995 (EUR)		**191 400**	**217 000**	**199 000**	**265 000**	**203 000**	**256 400**	**251 800**

Contact details: Mr Klaus Pelster, Institute for workplace health promotion of the AOK Rheinland, Cologne, Germany; web site: http://www.katjes.de/

Case study 11: Fit and fair in one team

Context

The company is an international market leader in the production of grey iron engine parts for the automotive industry. It is a foundry producing engine blocks and employs 1 500 people. Working in a foundry involves heavy work with sick leave due to musculoskeletal disorders as a consequence. The ill health costs have been high and the survival of the company was critical.

In 1995, a health management programme was established. Since 1994, the company has had the explicit aim of making foundry work healthier. The economic objective was to reduce the high sick leave costs, which amounted to 2.5 % of the total turnover (turnover in 2002: EUR 220 million). A comprehensive safety and health programme was set up, which included adapting workplaces, improving working conditions, implementing health promotion measures, and so on. The measures taken were:

- systematic training in handling and lifting
- back training
- lifting equipment
- training of all managers in health-oriented leadership styles
- health weeks
- sports groups
- joint sporting activities for employees, etc.

Results

The results of the project were assessed using quantitative and qualitative methods. Two surveys were conducted, one before the project and one after. This enabled comparisons of conditions before and after implementing the project. The surveys dealt with subjects such as regular employee surveys about perceived workload, well-being, company climate and health hazards. Quantitative data included the relation of turnover to sick leave costs and the number of sick leave days per 100 employees due to musculoskeletal disorders.

Results showed that the number of sick leave days could be reduced from 1 080 days/100 employees (1994) to 706 days/100 (1997) and to 550 days/100 (2000). Sick leave costs dropped from 2.5 % of total turnover to 1.1 % (2001).

Contact details: Eisenwerk Brühl, Kölnstrasse 262–266, D-50321 Brühl
Executive Manager: Josef Vehelen, Controlling: Elmar Schneider, Personnel Manager: Helmut Antz, Work Council: Udo Schäfer; web site: http://www.eb-bruehl.com/

Case study 12: Safety cameras on buses

Context

At De Lijn Vlaams-Brabant, a public bus company with 1 050 employees, violence against bus drivers has escalated since 1999. A number of measures has been taken to protect the bus drivers.

One of the measures was the installation of cameras in the bus. 13 buses (of a total of 370 buses) were equipped with a video recorder and four to six cameras. One camera was pointed at the pay table and the passenger without capturing the bus driver. The other cameras were pointed towards the interior of the bus. Furthermore, the bus driver could use an «anti-aggression button», which could be pushed discreetly. At that moment, the camera recorded three minutes of film that cannot ordinarily be overwritten. After 24 hours, the camera tape was automatically overwritten (except those parts recorded after the activation of the anti-aggression button).

Analysis

A cost-benefit analysis was made. The following indicators were used:

- number of incidents since the installation of the video recorder and cameras;
- supplementary hours due to incapacity for work or immediate replacement of an attacked driver (avoided costs);
- psychosocial consequences or burnout of the assaulted driver;
- premiums for the insurance company (the premiums decreased by EUR 19 680);
- vandalism (avoided costs);
- company image.

Results

The number of incidents decreased after the installation of cameras in the buses. The risk analysis of the job of bus driver demonstrated that aggression and violence were taken very seriously. Installing cameras made the bus drivers feel safer and improved the company image.

A cost-benefit analysis was very helpful in convincing the board of directors about the safety measures. Several scenarios were developed (Table 8). Some benefits such as the image of the company and psychosocial consequences for the driver are difficult to quantify.

Table 8 **— Costs of different scenarios**

Scenario	Output	Net present value (EUR)
1	Two aggression controllers less	247 655
2	One aggression controller less	114 785
3	Same number of aggression controllers	– 18 084

Source: *Patricia Giribuola, Tom Maroy, Patrick Reynders, Richard Willems, Kosten-batenanalyse: Veiligheidscamera's op autobussen van De Lijn, unpublished project work in the framework of a vocational training course leading to a certificate for health and safety officer.*
Contact details: Patrick Reynders, Diestsesteenweg 486, B-3010 Leuven, tel.: ++32 (0)16 35 98 35, e-mail: patrick.reynders@delijn.be

Case study 13: Safety tutorship

Context

The project involved a total of 140 employees of 70 very small construction firms. The objective of the project was to reduce accident risks in small and very small construction firms. They represent the highest number of companies present in the area and registered in Confartigianato, in the Region of Sardinia. In 2000 there were about 10 000 such firms (1 700 registered in Confartigianato).

Project

A project was set up in order to:

- reduce accident risks;
- train and inform employers, workers and tutors;
- implement a local monitoring system network helping micro-companies to sustain safety management costs.

Among other things, on-site safety training of 140 employees was carried out within the framework of the project. The training courses lasted 20 hours each and were held in Cagliari and in several centres of the Province of Sassari. Also, the project set up a local OSH monitoring system. The system was based on two elements:

1. Human resources: 10 company tutors were trained with the aim of preparing 'proximity operators' to work alongside SME workers in order to help monitor and solve safety problems.
2. Organisation resources: A checklist model was prepared in order to monitor the state of construction sites. An electronic network for data gathering and processing was established for the tutors in their monitoring activities.

Results

During the project period (2001–02), no accidents at work occurred in the participating companies. Nor was any irregularity notified by official monitoring bodies. The introduction of the formal management system allowed participating companies to improve their process organisation with significant results in terms of productivity.

Moreover, companies could avoid the potential costs of building-site stoppages caused by administrative issues (e.g. notifications of irregularities). The fact that the project was spread across several activities meant that different result verification methods were necessary.

With regard to training activities that targeted employers, workers and company tutors, qualitative and quantitative monitoring was carried out. As far as safety monitoring was concerned, all data on the state of building sites, collected by tutors through the checklist, were introduced to the database and statistically processed.

As a conclusion, the project could meet all its objectives:

1) To implement ongoing work safety training within the highest possible number of companies and workers the available budget allow.
2) To test an original organisation model which could, via the implementation of a local network for safety management, allow participating companies to reach economies of scale, supporting them with a monitoring system they could not afford individually.
3) To influence safety culture within micro-companies, and show that with suitable tools it is possible to manage safety as an integral part of the production process, leading to organisational and productivity improvements.

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Case study 14: Shock absorbing posts to prevent material damage by forklift trucks

Context

At Master Foods, a Belgian company producing rice, many material damages inside the warehouse were caused by collisions with forklift trucks. To solve this problem, crash barriers and rigid posts were installed to protect the most critical places. However, when one of these protective materials is hit, the repair cost is high, which causes a significant loss of productivity. A project was set up to reduce or even eliminate the repair cost caused by the collision of forklift trucks with protective materials such as barriers and posts.

Analysis

The investment in shock-absorbing posts, concrete, and metal protection was investigated for four different types of workplace accidents:

(1) low frequency — low severity
(2) high frequency — low severity
(3) low frequency — high severity
(4) high frequency — high severity (see an example in Table 9).

In addition, the possibility of a training programme for the forklift truck drivers has been taken into account.

A cost-benefit analysis was carried out. The analysis used data such as:

- investments for the installation of protection profiles in concrete and metal;
- training costs;
- material damages;
- frequency of workplace accidents;
- severity of workplace accidents.

Results

The results showed that protection with shock-absorbing posts was profitable for collisions or damages with a relatively high frequency per year (see Table 9). There were less material damages and therefore fewer repair costs.

One forklift truck driver was trained, who then was giving internal training to the other forklift truck drivers. After the project was carried out, the results in practice showed to be consistent with the results of the cost-benefit analysis made before the investment. Moreover, the cost-benefit analysis increased the credibility of the project and proved to be an essential part in the decision-making process.

Table 9 **— The cost-benefit analysis for workplace accidents with a high frequency and a high severity (EUR)**

Item	Year 0	Year 1	Year 2	Year 3
Investment cost	7 124	—	—	—
Benefits	—	5 925	6 103	6 286
Costs				
— Maintenance and parts	—	365	367	378
— Depreciation	—	2 375	2 375	2 375
Taxes	—	479	504	530
Profit	—	+ 2 715	+ 2 857	+ 3 003
Cash flow	—	5 090	5 232	5 378
Present value	—	4 942	4 932	4 921

Note: In this case, the discount rate used at the company was only 3 %, leading to a rather important NPV of EUR 7.671 (PV – I = 14.795 – 7.124).

Source: *Johan Alers, Joël Vanlerberghen, Erik Everaert, Mark Labé, Kosten-batenanalyse: Schokabsorberende palen ter voorkoming van materiële schade door vorkliften, unpublished project work in the framework of a vocational training course leading to a certificate for health and safety officers.*
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Case study 15: Storage of dangerous products in a laboratory

Context

The Hogeschool Limburg (285 employees) is a higher education establishment. One of its programmes is teacher training. The teacher training programme includes compulsory biology and chemistry classes, in which dangerous products are used. In order to create a safe storage place, a cost-benefit analysis was performed to analyse the options, i.e. interior or exterior storage.

Analysis

The cost-benefit analysis took several indicators into account, e.g. distance between place of storage and laboratory, investment costs, etc.

Results

The cost-benefit analysis showed that the greater the distance, the smaller the negative interaction between the dangerous product and the individual but the higher the loss of time when this distance has to be covered. Exterior storage is more expensive than interior storage. For financial and infra-structural reasons, interior storage proved to be the most effective (Table 10).

Table 10 **— Financial analysis for interior storage of dangerous products (EUR)**

Item	Year 1	Year 2	Year 3	Year 4	Year 5
Benefits (+)	7 416	7 416	7 416	7 416	7 416
Costs (–)	1 723	1 723	1 723	1 723	1 723
Lower absence (–)	18	18	18	18	18
Cash flow before taxes	5 675	5 675	5 675	5 675	5 675
Depreciation (–)	4 675	4 675	4 675	4 675	4 675
Profit before taxes	1 000	1 000	1 000	1 000	1 000
Taxes (35 %)	350	350	350	350	350
Profit after taxes	650	650	650	650	650
Cash flow after taxes	5 325	5 325	5 325	5 325	5 325
Actualisation coefficient	0.98	0.95	0.93	0.91	0.88
Present value	**5 219**	**5 059**	**4 952**	**4 846**	**4 686**

The present value of the project is EUR 24 761 over five years. Because the total investment amounts to EUR 23 372, the net present value equals EUR 1 388.

The option of interior storage was introduced in 2002–03. One positive outcome that was not included in the cost-benefit analysis was that assistants and lecturers had a more positive attitude towards prevention because of the attention created by the project.

The cost-benefit analysis process proved to be very enriching since different elements such as prevention, technique, environment, financial aspects, etc. were taken into account. Often only the costs are considered but a cost-benefit analysis enables consideration of other benefits, too.

Source: *Rik Claes, Jean-Pierre Cuppens, Dominic Hermans, Lieven Verhoeven, 'Opslag van gevaarlijke producten in een labo', unpublished project work in the framework of a vocational training course leading to a certificate for health and safety officer.*
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Case study 16: Use of an elevator for patients in the general surgery department of a general hospital

Context

In a division (22 nurses) of the A.Z. Sint-Lucas Sint-Jozef in Bruges, lower back pain was a frequent complaint of nurses caused by the manual lifting of bedridden patients. In 1994, for example, two nurses were absent for a total of 93 days due to lower back pain. A project was set up to reduce the number of days of incapacity for work caused by lower back pain. The project aimed at implementing the use of 'steel nurses', i.e. machines for lifting patients, in every division, and training the nurses in the use of these devices.

Analysis

A cost-benefit analysis was carried out. The following indicators were used:

Costs:
- investment cost
- maintenance cost
- training of the employees
- loss of time due to the use of the 'steel nurse'
- stock cost
- damage caused by the 'steel nurse'
- disturbance (e.g. in the corridors when moving the equipment).

Benefits:
- lower number of lost days due to back pain
- better working conditions (less stress), better atmosphere
- compliance with legislation
- avoided administration costs
- avoided cost for hiring temporary staff
- quality of the service to the patient (the patient is treated in a safer and more comfortable way).

Results

In spite of the inconveniences of the 'steel nurse' — it took more time and space — the introduction of the 'steel nurse' was a good investment. It improved not only the working conditions for the nurses but also the quality of the service. The present value of the project was EUR 8 737, with a net present value of EUR 6 569 (= 8 737 – 2 168). The project had a sound financial basis (table 11).

Table 11 **— Cost-benefit analysis (EUR)**

Item	Year 1	Year 2	Year 3	Year 4	Year 5
Benefits					
Reduction of sick leave	4 828	5 165	5 527	5 914	6 328
Reduction in temporary agent workers	2 148	2 298	2 298	2 631	2 816
Reduction in administration costs	36	38	41	44	47
Other	230	246	246	281	301
Total	7 241	7 748	8 112	8 870	9 491
Costs					
Maintenance	135	142	149	156	164
Training	3 153	3 310	3 476	3 649	3 832
Total	3 287	3 452	3 624	3 806	3 996
Cash flow ([1])	1 540	1 714	1 903	2 108	2 332
Present value	**1 495**	**1 615**	**1 741**	**1 873**	**2 012**

([1]) A hospital is a non-profit making organization and is not subjected to tax. The cash flow before tax equals the cash flow after tax.

Source: *Walter Alofs, Peter De Wortelaer, Bert Raes, Sabine Theeuwissen, 'Kosten-batenstudie: Gebruik van de patiëntenlift op een verpleegafdeling algemene heelkunde in een algemeen ziekenhuis' unpublished project work in the framework of a vocational training course leading to a certificate for health and safety officer.*
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European Agency for Safety and Health at Work

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