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.

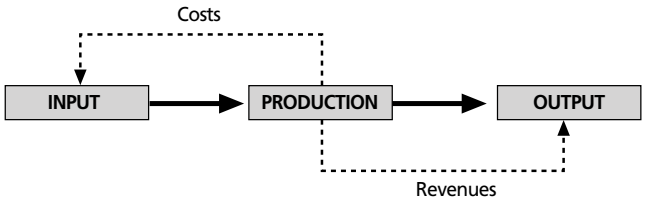
Legislation, however, will always be an external factor requiring compliance and enforcement. On the other hand, a company is an economic entity that has the aim of making a certain profit. This means that revenues, productivity and production costs have to be optimised. Managers have a wide array of 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_0: 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

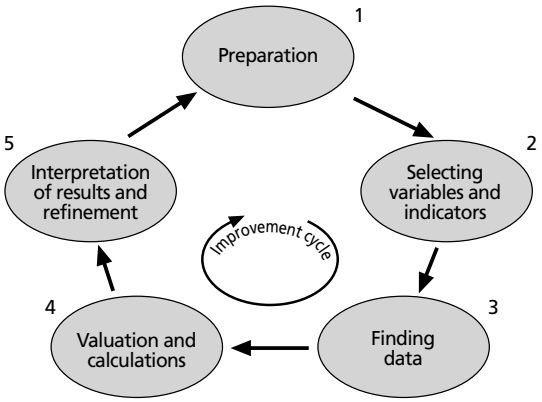
The cost-benefit analysis is used to make economic consequences visible. Qualitative and quantitative frameworks as described earlier form the basis of cost-benefit analyses. The aim is

([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)

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

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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