

# Economic Evaluation of Investments for Workplace Safety

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According to recent studies of ISSA (International Social Security Association, 2011), investment in prevention is a proper example of optimal utilization of companies' resources, because it involves relatively quick and competitive returns if compared with usual investments in production fields.

A complete feasibility study considers returns due not only to accident reduction, but also to recent introduction of public incentives, that are often the only tangible benefits for SMEs, statistically characterized by low rates of accidents at work.

For a deep analysis of investment in prevention it is necessary also to evaluate un-safety costs. These costs can be charged to community, like medical care and insurance costs for compensation, or to the companies, like loss of production, downtime associated with judicial activity, damage recovery, additional compensations and related legal costs, fines and penalties, increase in insurance premium, administrative and overtime work expenses.

Investments in prevention concern planning, implementation and maintenance of equipment, machinery and management systems that preserve health and safety of workers.

The paper deals with the issues mentioned above and presents an analysis model in the Italian context.

To calculate the present value of such investments made at different times, it is necessary to estimate their current effectiveness, taking into account the various maintenance costs. The result can be seen as "asset book of safety".

## 1. The cost of un-safety in Italy

According to the data of Inail (National Institute for Insurance against Accidents at Work) (Inail, 2011) there have been reported 745.000 work-related injuries that have resulted in consequential costs for Italy for about €20.4 10<sup>9</sup> (estimation made in 2011).

Injury cost is composed by the following factors: first rescue, medical cares, hospital stay and subsequent visits, bureaucratic process, legal expenses and increase of the insurance premium, compensation paid by Inail for temporary or permanent disability, absences from work following the accident at the expense of Inail and company, which also faces the loss of productivity.

Every single accident at work in 2012 (Inail, 2013) therefore cost on the average to the Italian system about 27,000 euro, of which, according to Inail's estimates, 60 % falls directly on enterprises, while remaining 40 % is charged to community.

### 1.1 Insurance cost, prevention cost and consequent cost

The total un-safety cost, charged both to enterprises and community, can be seen as composed by three different components: insurance cost, prevention cost and consequent cost. Insurance cost includes premiums (paid by enterprises) and compensations (paid by Inail or other private insurance companies) and depends on the risk level and accident rate of each enterprise.

Prevention cost concerns planning, implementation and maintenance of equipment, machineries and management systems that preserve health and safety of workers. Consequent (not insurance) cost deals with first rescue and medical cares for the injured, but also expenses for repair and replacement of equipment and the loss of productivity of company.

It is expected that the higher the costs of prevention, the lower the insurance and consequential costs. This theory is partially confirmed by Inail's estimates (2011), as described in Table 1.

The total un-safety cost in Italy, estimated as 3 % of GDP, is expected to grow from about 45 billion euro in 2002 to 51.510<sup>9</sup> in 2012 (+14 %).

Table 1: Un-safety cost in Italy in 2002, 2007 and 2012 (values in million euro)

cost item	2002			2007			2012			value 2012 vs 2002
	value	incidence %	incidence on GDP %	value	incidence %	incidence on GDP %	value	incidence %	incidence on GDP %	
insurance cost	10,877	24.20 %	0.78 %	10,846	22.60 %	0.71 %	10,752	20.90 %	0.64 %	-1.15 %
prevention cost	12,065	26.80 %	0.86 %	15,881	33.10 %	1.03 %	20,359	39.50 %	1.21 %	68.74 %
consequent cost	22,073	49.00 %	1.58 %	21,261	44.30 %	1.38 %	20,388	39.60 %	1.21 %	-7.63 %
<b>total cost</b>	<b>45,015</b>	<b>100.00 %</b>	<b>3.22 %</b>	<b>47,988</b>	<b>100.00 %</b>	<b>3.13 %</b>	<b>51,499</b>	<b>100.00 %</b>	<b>3.06 %</b>	<b>14.40 %</b>

Analyzing the single cost items as a time function, prevention cost is expected to increase progressively its relative incidence compared to the others (Figure 1), but its growth in value is not compensated by a proportional decrease of insurance cost and consequent cost (Figure 2).

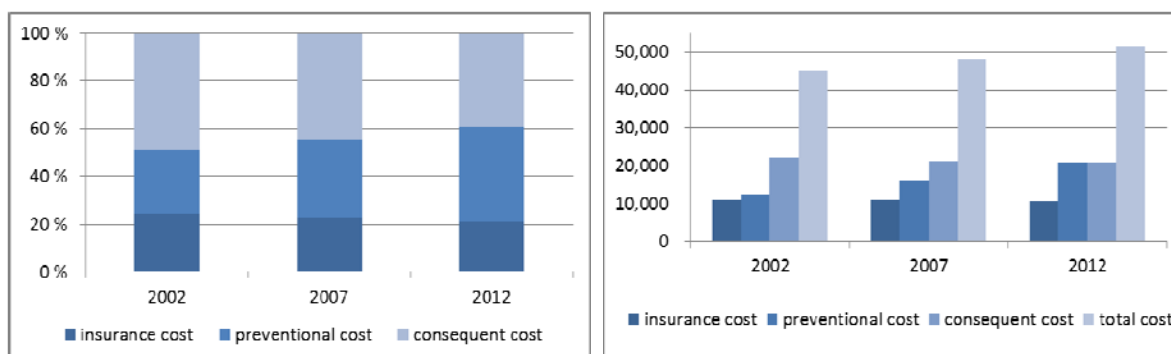


Figure 1: trend of cost items' percentage incidence

Figure 2: trend of cost items' value in million euro

Therefore in Italian context prevention investments seem to be positive for health and safety of workers but not yet cost-effective for enterprises.

## 2. The effectiveness of Occupational Health and Safety Management Systems (OHSMS) and incentives for their adoption

According to survey (Inail-Contarp, 2012) a comparison between injury rates of companies with OHSMS certified by Accredia (Italian Accreditation Body) and homologous companies by sector and geographic area in the observation period 2007-2009 shows on average:

- a reduction of injury frequency of -27 % (-15.4 % in 2005)
- a reduction of severity rate of -35 % (-22 % in 2005)

This data result in lower consequent costs due to injuries and in a reduction in the annual insurance premium paid to Inail, thanks to the bonus-malus mechanism and annual incentive for prevention measures, such as OHSMS (Robson et al., 2007).

### 2.1 Annual insurance premium discounts and on-off incentives on capital account

The calculation of annual compulsory insurance premium paid to Inail by an Italian company first of all takes into account the company's specific accident rate (total charges for injuries on total salaries during the three previous years) compared in absolute and percentage terms to the national average rate, according to the logic of a bonus-malus mechanism: the lower the accidents and their severity, the lower the rate to use to calculate the premium to pay to Inail. This procedure is called "rate fluctuation by accident trend", composed by the first or absolute fluctuation and by the second or relative fluctuation.

Secondly the corporate rate is optionally reduced by the discount related to prevention measures adopted: in this case it is called “rate fluctuation by prevention” or the third fluctuation.

The combination of rate fluctuation by accident trend and rate fluctuation by prevention determines the maximum reduction of annual insurance premium, as shown in Table 2.

Table 2: Rate fluctuations and insurance premium reduction

employees / year	rate fluctuation by accident trend	rate fluctuation by prevention	maximum insurance premium reduction
up to 10	from -22 % to + 22 %	-30 %	-52 %
from 11 to 50	from -22 % to + 22 %	-23 %	-45 %
from 51 to 100	from -22 % to + 22 %	-18 %	-40 %
from 101 to 200	from -25 % to + 25 %	-15 %	-40 %
from 201 to 500	from -28 % to + 28 %	-12 %	-40 %
over 500	from -35 % to + 35 %	- 7 %	-42 %

Through public tenders Inail also grants to companies one-off capital incentives for investment projects in prevention up to a maximum of 50% of the total eligible cost. For OHSMS adoption, the costs of consultancy and certification eligible are calculated according to the type of business activity and the number of employees, according to the tender technical notes.

## 2.2 Economic analysis of OHSMS adoption: calculation of investment Net Present Value (NPV)

Using real data provided by four companies of different sizes (two commercial companies of 14 and 70 employees and two public utilities of more than 1.000 and 2.000 employees), it has been evaluated the economic impact of the implementation of a OHSMS. The basis data of analysis have been:

- rate of return on capital: 7.5 %;
- capital incentives and insurance premium discount for accident prevention established by 2012 Inail's public tender (in which manufacturing, construction, mineral extraction, process and nuclear industry are equivalent in term of complexity level);
- companies' specific accident rate aligned to national average rate before OHSMS adoption.

As conservative assumptions the lower consequent not insurance costs related to minor injuries have not been considered. The only benefits considered have been minor insurance premium costs.

The results are shown in the following figures.

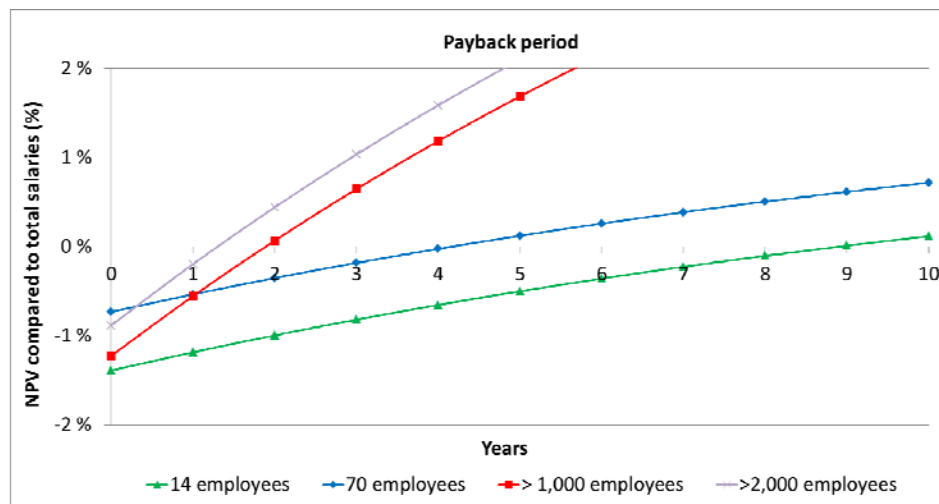


Figure 3: NPV in case of rate fluctuation by prevention and maximum rate reduction by accident trend

Figure 3 describes NPV in case of maximum rate reduction by accident trend: company's specific accident rate drops and becomes much lower than national average rate for given size and industry. The large enterprise gets back its investment in less than 2 y, while medium one in 4 y. The small enterprise has a payback period of about 9 y, therefore its investment is too risky and unprofitable. In order to align the risk to that of other companies, it should be reviewed its percentage discount by prevention.

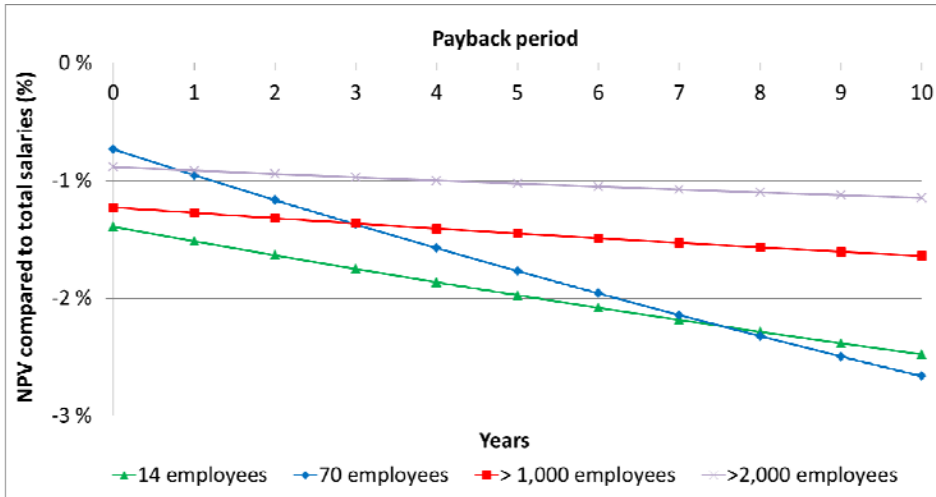


Figure 4: NPV in case of rate fluctuation by prevention and minimum (null) rate reduction by accident trend

Figure 4 describes NPV in case of minimum (since zero) rate reduction by accident trend: company's specific accident rate remains aligned to national average rate for given size and industry. For all types of companies safety investment doesn't have an economic return, indeed, management and maintenance costs of OHSMS, not compensated by insurance premium reduction, rise progressively.

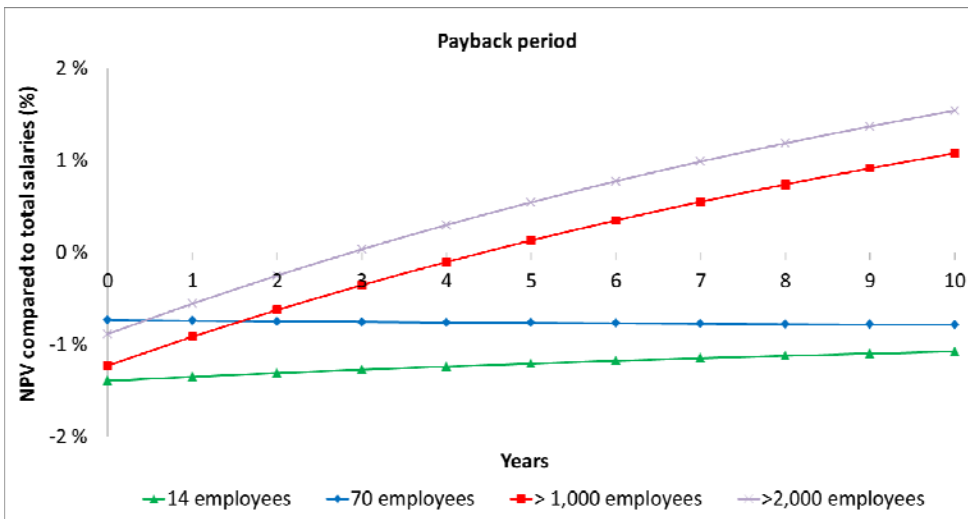


Figure 5: NPV in case of rate fluctuation by prevention and average rate reduction by accident trend

Figure 5 describes NPV in case of average rate reduction by accident trend: company's specific accident rate drops to an intermediate value compared to previous cases. Only the large enterprise has a return on its investment with a payback period of 3 or 5 y, while the small-medium enterprises support a constant cost.

Analysis carried out shows that in the most likely cases (Figure 4, 5) small and medium enterprises are heavily penalized by the adoption of an OHSMS because the investment is not recovered. To make prevention investment attractive even for small-medium enterprises Inail should review its bonus-malus mechanism. In particular, the adoption of OHSMS introduces a strong discontinuity in corporate life with the past, and the calculation of company's specific accident rate should not be made in accordance with the previous three years. The proposal is therefore to consider the small and medium enterprises which introduce an OHSMS as virtuous enterprises, eliminating their past and considering them in "first class", with maximum rate reduction by accident trend.

Only in this way, small enterprises, with real problems in safety, will be encouraged to change through the adoption of OHSMS.

### 3. Evaluation index of investments efficacy

As in the IPESHE index (Saracino et al., 2012a) and in M.I.M.O.S.A. project (Saracino et al., 2012), the introduction of OHSMS represents an effectively discontinuity with the past, but it could be adopted with different level of efficacy. About this parameter, recent Italian legislation (Testo Unico, 2008) is mainly characterized by a systematic approach to occupational safety: OHSMS adoption and efficacious execution by the employer determine a responsibility exempting efficacy for the employer itself. The efficacious execution is not an on-off value, but it can assume different value on a scale.

It becomes very important to introduce an index that can evaluate the efficacy level of OHSMS adoption. The efficacy index EI is defined by following Eq (1) (Bianchini A. et al., 2013):

$$EI(\text{EfficacyIndex}) = B/(A + B) \quad (1)$$

where:

A: consequent costs related to accident, incident, near miss and professional disease;

B: prevention costs to prevent and protect from accident, incident, near miss and professional disease.

More in detail it is possible to calculate A costs as following Eq (2):

$$A = A1 + A2 + A3 + A4 \quad (2)$$

where:

A1: costs directly related to accident, incident, near miss;

A2: insurance costs and its variation;

A3: complementary assurance costs;

A4: indirect costs for accident, incident, near miss management.

Before calculating B costs, an important characteristic must be explained: B is not an annual cost as A costs. So, the authors consider it as a cumulative cost that need to be actualized as function of devaluation and real investments efficacy:

$$B = \sum_k I_k \quad (3)$$

where  $I_k$  is the  $k^{\text{th}}$  investments in occupational safety prevention. These kind of cost can be described in three different main categories:

- 1<sup>st</sup> category: investments that don't lose their efficacy along time;
- 2<sup>nd</sup> category: investments that lose their efficacy and need maintenance to keep it;
- 3<sup>rd</sup> category: investments that stop their efficacy at a certain date.

In figure 6 behavior of Efficacy Index as a function of ratio between B and A costs is shown. Efficacy Index changes between 0 and 1. In fact, if A costs are 0, then EI=1, while if B costs are 0, then EI=0. An higher value of Efficacy Index means a good efficacy of investments and vice versa. If we examine example number 3 in figure 6 we find that consequent costs are equal to prevention ones and Efficacy Index assume a value of 0,5.

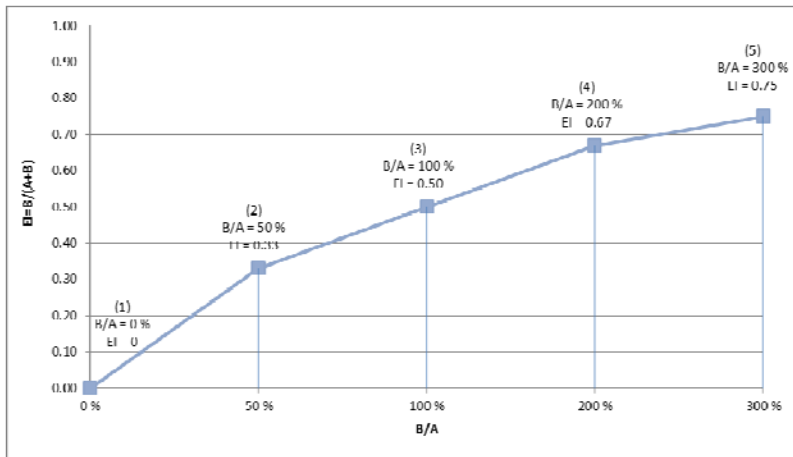


Figure 6: Behaviour of Efficacy Index as a function of ratio between B and A costs

By Efficacy Index it is possible to introduce a minimum level of efficacy, over which the OHSMS determines a responsibility exempting efficacy.

#### 4. Conclusions

The paper shows that investment in prevention made by enterprises can be considered competitive in terms of returns with usual investments in production fields only in certain condition. In particular, major benefit occurs if the enterprise is a large one. So, small and medium enterprises investment in safety prevention field, like OHSMS adoption, needs to be boosted by the Country, since injures reduction makes benefit also for the community and not only for the enterprise. With regard to Italian legislation, importance has been attributed to OHSMS. In fact, by OHSMS adoption and efficacious application it is possible to determine a responsibility exempting efficacy for the employer. The paper shows how OHSMS application efficacy can be measured by proposing a cost analysis model. The model needs to be implemented by experimentation in different kind of enterprises (like by size, by working field, by nation).

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