

COST ANALYSIS OF WORK ACCIDENTS IN ENERGY FIELD

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Abstract - This paper presents, identify and analyzes the consequences of work accidents in the energy field and estimates their costs or economical effects from the worker point of view and also from employers' perspective. It proposes a calculation method for evaluation of the cost and losses for the victims and companies that were involved in an accident.

Every work accident has consequences that affect not only the workers and companies involved, but also the work collective, their families, and the society.

A very useful instrument for achieving the optimal level of safety is represented by the cost analysis of the work accidents that augments the need of the safety measures to be taken at a micro and macro level by all involved parties.

Keywords: work accidents, cost analysis, economical effects, occupational health and safety, energy field, accident losses estimation.

1. INTRODUCTION

Accidents at work can mean suffering, disability and may affect a worker's life, both inside and outside the workplace. Production interruptions and bad publicity following an accident are some of the costs to businesses and organizations. Also, increased demands for public services such as health care and social security. The estimated cost for Member States as a result of accidents at work varies from 1 to 3% of gross national product (GNP).

The European Commission is interested in financial losses caused by 'non-social policy' for Europe and prioritizing the need to develop knowledge of social and economic costs resulting from accidents and work-related illnesses in the report on a new Community strategy on safety and health.

Providing companies an insight in the costs and benefits of occupational safety and health can contribute to healthy work but also to a healthy economy. According to the International Labour Organisation (ILO) the total costs of work-related accidents and ill-health amount to approximately 4 per cent of the world's Gross Domestic Product (ILO, 2006).

A considerable loss that has a negative impact on economic is growing and puts a burden on society. Thus preventing occupational accidents and diseases should make economic sense for society as well as being good business practice for companies.

Many workers in Europe continue to perceive that their jobs pose a threat to their health or safety. According to a recent Eurostat study (2010) 3.2% of the workforce in the EU-27 reported an accident at work in the past 12 months (data from 2007).

This means that approximately 6.9 million workers were confronted with an accident at work. The figures for work-related health problems are even higher. No less than 8.6% of the workers in the EU-27 reported a work-related health problem in the past 12 months (data from 2007). This means that no less than 1 out of 10 European workers is every year affected by an accident at work or a work-related health problem.

All these cases of accidents at work and work-related ill-health hinder economic growth. If the proportion of people with ill-health increases, economic growth will slow down. A correlation can also be noticed (ILO, 2006) between national competitiveness and the national incidence rates of occupational accidents.

Countries with the best records on accidents at work are the most competitive leading to the conclusion that poor working conditions put a heavy burden on the economy. This leads to economic losses. The ILO has estimated that the total costs of accidents at work and work-related ill-health amount to approximately 4 per cent of the world's GDP (ILO, 2006). According to the European Agency for Safety and Health at Work, the costs to Member States of all work-related accidents and diseases range from 2.6% to 3.8% of GDP (European Agency, 1997).

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

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

To support occupational safety and health

practitioners in making economic assessments, there is also a need for simple, easy to use tools that are accessible for practitioners.

These tools would support the cost and benefit calculations as well as the process of economic assessments. If these data could be stored in a central database on national or even European level, they could offer interesting benchmarks for companies and institutions willing to perform economic assessments of health and safety measures.

By definition, an **accident at work** is a discrete occurrence in the course of work which leads to physical or mental harm (whilst engaged in an occupational activity or during the time spent at work).

Accidents at work are mainly of two types:

- *Serious*: more than 3 days' absence from work
- *Fatal*: leading to the death of the victim within one year.

An accident includes: accidents in public places or means of transport during a journey in the course of work acute poisoning; accidents occurred within the premises of another company; willful acts of other persons; accidents that occur during the journey between home and the workplace; and excludes: commuting accidents; deliberate self-inflicted injuries; accidents from strictly natural causes; accidents to members of the public.

2. THE PERSPECTIVES

Electrical risks are risks of death, electric shock or other injury caused directly or indirectly by electricity. The most common electrical risks and causes of injury are:

- Electric shock causing injury or death. The electric shock may be received by direct or indirect contact, tracking through or across a medium, or by arcing. For example, electric shock may result from indirect contact where a conductive part that is not normally energized becomes energized due to a fault (e.g. metal toaster body, fence)
- Arcing, explosion or fire causing burns. The injuries are often suffered because arcing or explosion or both occur when high fault currents are present
- Electric shock from 'step-and-touch' potentials
- Toxic gases causing illness or death. Burning and arcing associated with electrical equipment may release various gases and contaminants
- Fire resulting from an electrical fault.

Even the briefest contact with electricity at 50 volts for alternating current (V.a.c.) or 120 volts for direct current (V.d.c.) can have serious consequences to a person's health and safety. High voltage shocks involving more than 1000 V.a.c. or 1500 V.d.c. can cause contact burns and damage to internal organs.

3. EFFECTS OF ELECTRIC SHOCK ON THE HUMAN BODY

Burns

Electricity can burn deeply the tissues. The burn is caused by energy dissipation as heat resulting from the

opposition (resistance) of the human body to the passing current through it.

Nervous systems

Another effect of electric current on the human body, perhaps the most dangerous, is on the nervous system. If through a human body is passing an electric current large enough, the current will overload the nervous system, preventing muscles operation through a normal signal. When muscles are driven by an external source of power, they will contract involuntarily.

Failure release of under voltage

We all know that there are situations in which the victim of electric shock can not be off from a element found in circuit (bar, wire, etc.). The impression is that the victim is joined to the element under voltage. What is actually happening? Forearm muscles responsible for the contraction of the fingers are better developed than those responsible for its impact. Lack of control over voluntary muscles because of "taking control" by electricity, muscles "contract" will win, and the person will be forced to shake hands and to maintain such. If the wire touches the palm exactly, this tightening will force his hand to catch the thread tightly in hand leading to a worsening of the situation due to the excellent contact between body and thread through the hand. The victim will not be able to leave the wire down without external help. To release the victim from the source of power is needed considerable force. To avoid electric shock, the "saviour" must use an object that is not electrically conductive, such as dry wood.

Fibrillation and cardiac arrest

Controlling the heart muscle can also be locked by the effect of electric current. Even currents too weak to induce normal "bonding" element under voltage are sufficient to destabilize the smooth functioning of the heart. Induction fibrillation (disappearance normal rhythm and arrhythmia) is the act of pumping blood to the vital organs of the body is no longer effective; the risk of death by suffocation or cardiac arrest.

Electric shocks from faulty electrical equipment may also lead to related injuries, including falls from ladders, scaffolds or other elevated work platforms. Other injuries or illnesses may include muscle spasms, palpitations, nausea, vomiting, collapse and unconsciousness.

Workers using electricity may not be the only ones at risk—faulty electrical equipment and poor electrical installations can lead to fires that may also cause death or injury to others.

Costs of accidents at work and work-related ill-health need to be analysed on three levels: the society, the company and the victim. These three levels are affected by the consequences of poor working conditions and bear the costs. The costs are not equally distributed between the three groups. Furthermore, the costs are not perceived in the same way.

The difference in perspective on costs of accidents at work and work-related ill-health has several consequences. First, it means that other assessment methods must be used on all three levels to make realistic cost estimates. Moreover, when using economic arguments based on these costs, one has to take into account this difference in perspective. The decision-making process of a government is totally different from

a decision-making process of a company. This means that other cost arguments will have to be developed.

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

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

4. THE DIFFERENT LEVELS OF ACCIDENTS COSTS

At the macroeconomic level, where Romanian society, according to the law Nr.346/2002 amended and supplemented, the amount of compensation in case of death in the event of accidents is 4 gross average wages, by the National Institute of Statistics.

For occupational diseases and accidents at work followed by invalidity society outweigh the costs when accidents.

Calculation basis of social insurance allowances stipulated in art.5 (sickness benefit) is the average monthly insured income in the last 12 calendar months

preceding the month of the insured risk, income from which were calculated individual social security contributions.

The survivor's pension is calculated from:

- retirement pension in payment or who would be entitled, under the law, advocate died;
- first-degree disability pension if the death occurred before the meeting sponsor the conditions for obtaining retirement pension and payment was invalidity of any degree, partial early retirement or early retirement.

The survivor's pension is determined as a percentage of average annual score achieved proponent, for the old-age pension in payment or who would be entitled, under the law, advocate died, according to the number of followers justified as follows:

- a) 50% - for one survivor;
- b) 75% - for two survivors;
- c) 100% - 3 or more survivors.

To calculate these payments should be taken into account that in 2012 the pension point was 732.8 lei. This value was indexed, so that in 2013 a pension point worth 762.1 lei.

For traineeships potential to persons entitled to the disability pension, monthly score is:

- a) 0.70 points for degree I of disability;
- b) 0.55 points for degree II of disability;
- c) 0.35 points for grade III of disability.

There are many variables to be taken into account when estimating the costs of accidents to society as a whole. A brief description and the costs they generate are shown in Table 2.

Table 2. Variables and costs involved in work accidents at society level.

Variables	Description	Costs
Health	Hospitalization (days of hospitalization) Other medical treatment outside the hospital, medicines Permanent disability (number, age) Nonmedical rehabilitation (training), housing adaptation	Actual expenses for medical treatment and rehabilitation
Fatal accidents Number Age of patients	Lifetime according to quality Lifetime according to the disability	Compensation, pensions, devices, medical rehabilitation
Life quality	Life Expectancy Healthy life expectancy Lifetime according to quality Lifetime according to the disability	The total value of indemnity and compensation
Losses of current production	Tax loss due to sick leave, absenteeism and disability	Total loss of income during absence
Loss of possible future income and loss of production	Tax loss during the entire period of permanent disability	The amount of taxes lost during the disability
Managing sickness absence, etc.	The granting of sick leave, medical benefits of rehabilitation	The cost of sick leave and other performances

In case of work accidents in electro-energy field generated by the danger of electricity, the consequences

are usually serious consequences, most often fatal.

Economic effects in the companies

Economy of each company can be regarded as a system type:

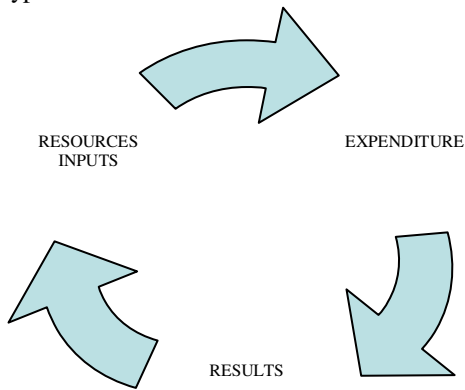


Fig.1. Company system layout

Its performance will be determined by the quality and how to fructifying resource, respectively factors of production.

The first category of economic effects of accidents occurs in relation to inputs and consumption inputs, namely labor and capital in the form of destruction; alteration of the structure, quality, and their use for purposes other than was scheduled, etc.

Work means interruption of production by work accident causes two types of labor factor consequences of the company:

a) impossibility to exercise the transformer action respectively not using workforce or use for purposes other than those scheduled, both for the victim and other employees, which translates into loss of working time;

b) changing "human capital" - people's ability to produce goods and services efficiently

Human capital, a notion which prevails in economic science from the 60s, reflecting the stock of professional knowledge, skills, abilities, etc..

Economic indicators expressing the effects on factor "labor" are:

- a) the dynamics of staff;
- b) staff stability;
- c) training of the staff;
- d) use of working time;
- e) labor productivity.

There are many accidents that results are in the destruction of raw materials in the workplace so that or stored near its finished products that had not yet been removed and other materials.

A second category of economic effects of the accident is manifested by change indicators:

- a) turnover;
- b) value added;
- c) production costs.

For companies, the variables considered for the cost analysis are presented in Table 3.

Table 3. Variables and costs involved in work accidents at company level.

Variables	Description	Costs
Fatal accidents, deaths	Number of fatal accidents	Total costs for up activities, research, registration, penalties and payments
Absenteeism or sick leave	Working hours lost due to absenteeism	Total costs of lost work hours, replacement and losses of production; indirect effect is caused by sick leave which reduces flexibility and ability to handle unexpected situations
Fees due to improper working environment or early retirement and disability	Percentage or number of staff	Total costs of replacement activities, additional training, loss of production, recruitment procedure
Early retirement and disability	The proportion or number of people in a certain period of time	Amount of costs arising from disability or retirement activities early, penalties, compensation for victims
Nonmedical rehabilitation	Money spent by the employer to facilitate the return to work (counseling, training, workplace adaptations)	Invoices
Managing sickness absences, injuries, etc.	Activities (administrative) to be made by the company in connection with sick leave	Total salaries for the time spent at work
Fault equipment	Damages or costs of repairs of machinery, premises, materials or products associated with occupational injuries	Replacement costs Invoices
Others (eg. investigations, time management, external costs)	Time and money spent on investigating injuries, workplace assessment	Total salaries for the time spent at work
Effects on the variable portion of insurance premiums, premiums for high risks	Changes in premiums as a result of the incidence of work-related injuries	Invoices
Responsibilities legal costs, penalties	Time, people, money for their achievement	Invoices, claims, costs, fines, penalties
Additional salary payment hazardous tasks	Additional expense to pay for the work dangerous or inconvenient	additional payments (salaries)
Loss of production time, outstanding service	Loss of production time due to an event that generates injuries (eg. because it takes time to replace machines, or production must be halted pending investigation)	The total value of lost production

Opportunity costs	Orders lost property	The estimated value of lost production
Lack of return on investment	Unrealised gains due to accident costs - expenses caused by accidents that are not invested in an activity which generates interest	Interest on amounts spent, invested
Additional costs for modified work procedures	The price difference between the previous ways of working and new, directly or indirectly related to the prevention	Market prices Invoices

For example, it can be estimated *the calculation of gross income loss* due to various costs involved in production of a work accident.

All occupational accidents involve a number of direct costs strictly financial, reflected in the accounting records of the company, such as:

- a). sick pay to the victim (on site or in specialized institutions, to the extent that the payment is not for the company's policyholder);
- b). payment of various benefits for the victim or his heirs;
- c). pay money experts employed during the accident investigation;
- d). payment of training courses and / or qualifications of the persons injured or replacements thereof;
- e). telephone payment generated by various actions to be taken after the event (personal commitment, communication, accident investigation, discussion with clients, lawyers, etc.);
- f). pay of the court costs;
- g). pay compensation to partners established by final judgment.

Summing of all these charges lead to a value that represents the loss of gross income of the company, which can be reduced only by the amounts recovered legally from people found guilty of causing the accident.

The calculation formula is:

$$\Delta L_{gi} = \sum C_f \cdot N - C_r \quad (1)$$

where:

- ΔL_{gi} - loss of gross income from various financial loss;
- C_f - costs financial direct;
- N - number of types of financial expenses;
- C_r - recovery from persons declared guilty;

The costs at the level of the worker

At the worker level, we can say that it is very difficult to estimate the impact of the consequences of accidents or, where appropriate, on his family because it's a human life or suffering in human terms can not be economically fundamental value.

Table 4 shows the variables that should be considered if we want to estimate the cost of the worker's employment injury.

Table 4. Variables and costs involved in work accidents at worker level.

Variables	Description	Costs
Health Status	Hospitalization (days of hospitalization) Treatment outside the hospital, medicines Permanent disability Rehabilitation nonmedical (eg. Vocational), change the house	Medical expenses which are not compensated by the insurer or employer
Life quality	The life expectancy Healthy life expectancy Lifetime according to quality Lifetime according to the disability	Willingness to accept, to bear the amount of claims and compensations It can not be evaluated in costs
Pain and suffering	For the victims, but also for relatives and friends - family stress, desire to live, emotional and mental effects	
Loss of income	The loss of income from the first and second job	Reduce current income Loss of salary
Loss of future earnings potential	Including second job (income household activities)	Differences between total future income and total compensation or possible pension The sum of all other expenses for the victim and / or family (not compensated)
Expenses not covered by insurance or compensation	Examples are costs of transport, hospital visits, costs due to fatal accidents, such as funeral costs, inheritance, actions of obtaining rights, compensation, etc.	

The calculation formulas for determining the final loss of personal income are:

- a). Loss of personal income from incapacity for work (including temporary disability third degree completed return to activity):

$$\Delta L_{pi_a} = [S_{am} - I_d(P_{inv})] \cdot \beta \cdot T_{dd} + C_{bp} \cdot N_1 - \sum A_1 \cdot N_a \quad (2)$$

- b). In case of accidents that resulted in disablement victim, the relationship for calculating personal income loss due to permanent loss of working capacity is:

$$\Delta L_{pi_b} = (S_{am} \cdot N_{ms} - P_{inv} \cdot 12) \cdot N_p + (C_{bp} \cdot N_1 - N_a \sum A_1) \cdot N_{al} \cdot \varphi + (P_{ela} - P_{inv}) \cdot 12 \cdot D_{al} \cdot \varphi \quad (3)$$

where:

- S_{am} - average monthly salary before accident;
- I_d - indemnity disease;
- P_{inv} - invalidity pension;
- β - transformation coefficient monthly income daily income;
- T_{dd} - temporary disability duration in days;
- C_{bp} - monthly expenses cost in personal budget;
- N_1 - number of months that records the expense of personal income;
- $\sum A_1$ - monthly amount of aid received by the victim and / or survivors of the state budget, local budgets, companies other institutions and corporate;

N_a - number of months in which the victim receives aid;
 N_{ms} - average number of months with salary in a year;
 N_p - projected number of years receiving survivor's pension;
 N_{al} - number of years from the date of the accident until the average length of life;
 ϕ - the discount rate amounts dependent on the rate of inflation, growth, etc., projected for the calculation period;
 P_{ela} - expected pension age limit (if the accident would not have produced);
 D_{al} - number of years from retirement age for age limit to death.

5. CONCLUSIONS

According to statistics of occupational accidents (Table 5), they are falling at the end of 2013 to 2012, their share in the electro-energy industry being about 2, 8%.

	2012	2013
Total Work Accident Victims	4176	3627
Work Accidents with up to 3 days' absence from work	3686	3428
Fatal Accidents	308	199
Total Route related Accidents	610	401
Total Deaths in Route related Accidents	42	9
Total Collective Accidents	30	24
Total Victims involved in Collective Accidents	158	115
Fatalities in Collective Accidents	12	10

However, their number remains high, the impact of their consequences generate not only physical suffering for the injured and his family but also direct economic consequences for business and society as a whole.

From the analysis of situations previously presented in the paper it can be seen that accidents at work means significant costs to be explored systematically low.

Analysis of occupational accidents and work data presented justify the conclusion (the idea) that the market economy health and safety must be viewed in terms of cost-benefit.

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