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Sicurezza Industriale ed Analisi dei Rischi**

**XXVI Ciclo**

**TECHNIQUES FOR IN-DEPTH ANALYSIS OF  
INJURIES AND WORK RELATED HEALTH  
IMPAIRMENTS AS AN ESSENTIAL TOOL FOR  
PREVENTION: A POST-EVENT SURVEY  
PROTOCOL DEVELOPED TO SUPPORT THE  
WORK OF ANALYSTS**

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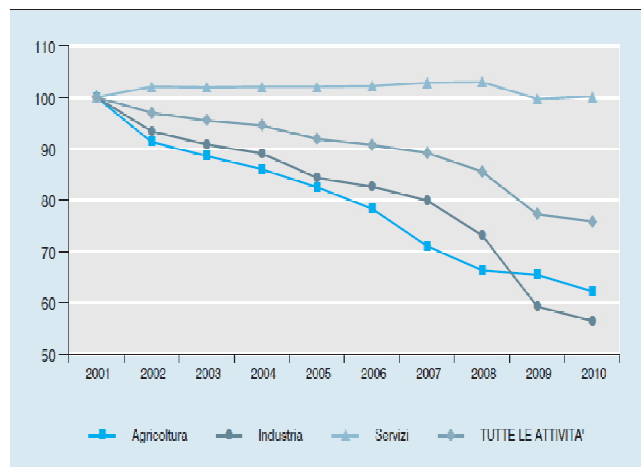
## FOREWORD

Industrial accidents represent a high cost on the social economy. They represent a threat to workers physical integrity and their safety. Moreover, companies are responsible for the cost of damages incurred due to accidents and accident prevention. In 1997, INAIL (italian institute for the insurance against on-the-job injuries) registered a total of 1,249 fatal injuries. In 1951 fatal injuries registered were 2,328, taking into consideration all job activities in the whole country .

As far as job injuries are concerned, 2010 is considered as an year of improvement. In fact, in 2009 injuries have decreased by almost 10%.

In 2010, INAIL reported 775 thousands injuries, with an increase of 1.9%: 980 fatal injuries, decreased by 6,9% (equal to 1.053) over the year. Year 2010 also faced a decrease of 0.7% on employment (data registered by ISTAT, National Institute of Statistics).

Figure 1: Percentage of injuries on the period 2001-2010 - ACTIVITIES  
Numbers (2001 = 100)

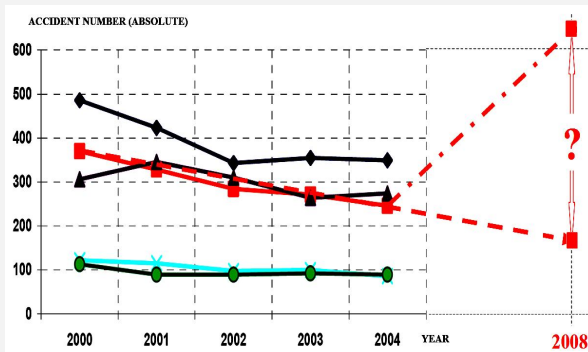


But as indicated above these, does not necessarily reflect future performance or a decline in accidents at work in all the activities, as the statistical data to represent a real situation must be founded on basic principles such as:

The statistical data should be carefully understood:

Possible misuses and misleading of statistical data:

- inference of the effectiveness of safety audits
- forecasting of expectable accident rates



what did it happen?

The disappointing result is three possible sets of errors:

1 – reduced statistical basis (region or even province, without due consideration of the local industrial situation)

2 – insufficient analysis of boundary data (e.g. economical situation)

3 – yearly data instead of packaged mean values on 3 or more years

some precious info for an effective prevention can however be obtained on special circumstances (e.g. in case of technological modifications)

Therefore, in this case the statistics analyses on hand do not have to be considered a real and complete representation of the working panorama, in fact the INAIL data are underestimated, as they are excluded by the calculation the work of the books, the irregular foreign workers, victims of accident while travelling from home to the workplace and youth dead are not considered in those categories that do not depend on INAIL management. Regarding the occupational diseases, it's enough to compare the official figures with, for example, the three thousand dead, mostly former workers or ex former workers, caused by the asbestos, to realize the real chasm that divides the counting of the agency from the dramatic truth of all days.

The relative decrease of the number of the work's accidents is due moreover to the crisis' effects that has led to the closure of thousands of companies, that has emptied the factories and the places of work and that has raised one hand illegal employment, and on the other side workers on redundancy payment, the workers in mobility, the young people without job and the unemployed. So, regular occupation is diminished and, consequently, officially figures reported killed and injured on the job are dropped in proportion smaller. It is always found to us therefore in front of a decrease that probably is in relative terms less marked than that appearing, granted that a decrease effectively has happened.

The trend of work's accidents follows, therefore, step by step the transformations of the labor market in these last decades.

There is no doubt that the greater problems are where the workers organizations are weakened, where are systematically eroded the rights and practiced the most odious forms of blackmail, pressure, threat and division of labor.

Both the amount and the jobs dynamics (risk exposure) are the best criteria used on the job injury phenomenon within the country. In fact, this criteria allows to bring the injuries from an absolute value to a relative value. In order to obtain the right evaluation, an index between the number of injuries and the total of workers (provided by ISTAT) must be considered.

By analyzing this data a minor number of injuries is caused by a lack of safety of both plant and machinery. Although there is an increase of injuries caused by a lack of organization and right procedure, such as maintenance, transport, etc.

The main goal of this research is to create a useful method of accidents prevention in the workplace: a software that analyzes accidents would lead to a better understanding of the injuries causes.

## **INTRODUCTION**

Industrial accidents is not necessarily a result of misfortune and the decrease of accidents is not a result of fortune. In fact, it is the result of a long, determined and smart effort of a large group of workers together with a smaller group of technicians, trade-unionists, entrepreneurs, researchers, public officers and magistrates.

Figure 1 shows the monument to 48 people (out of a total 4.000) who died after on-the-job-accidents during the construction of the Frejus railway tunnel (1857-1871). Time has changed and people suffering injuries while working in mountainous areas is not considered just fate anymore. Today assuring prevention and preserving safety and health of both workers and environment is mandatory.

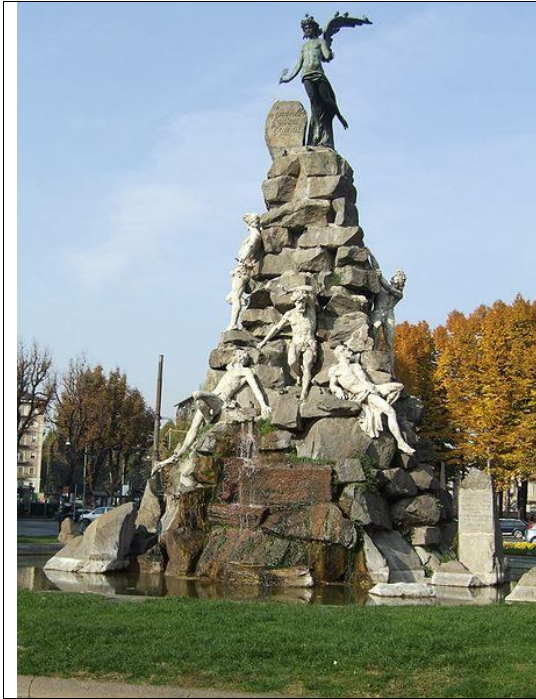


Figure 2: monument to the workers who contributed to the construction of the Rail Tunnel Frejus, Tourin (1879). Project by Luigi Belli – picture by K.Weise

Prevention is basic. Preventing job injuries is a social goal with a multitude of benefits of short, medium and long term. Besides being ethically correct, it is also a way to save, as an injury can lead to death (in the worst scenario) or to a permanent inability to work that is a high social cost directly paid by the worker with his health. On top of this, the whole country needs to face an economical cost for every person injured (e.g. 800000 injuries cost approx. 32billion euros, roughly 2% of the GNP).

Every small contribution to reduce the causes of accidents must be considered. Prevention is the connection of connect various complementary activities such as: the regulation and standardization of work environments, devices, machinery, tools, equipment, the inspection and supervision from the safety, the information, formation and training on actual risks on work sites. It is important to create and execute programs of prevention focused on the specific job research and development. This goal can be reached by Prevention through Design as a virtuous system of conception and actuation of the project.

This approach has some limits:

- the quality and complete enforcement of the updated regulations, on T.L.V., etc., as general values such as the 5 commandment *you shall not murder* – are not sufficient for the engineering- technology;
- scenarios not defined by technical laws cannot be directly taken into consideration. Only in few cases it can be taken into consideration, such as the fine technical-analytical interferences as method of analysis of functional volumes (Pinzari, 2001) and of computerized simulations of the operational phases (Bersano et al., 2009);
- the management of Residual Risk requires specific in depth analysis in order to take into consideration the technical and organizational progress, new materials and substances, etc..

Applying the right use of the proposed technique, particularly in the phase of identification of the causes of hazard is basic. Moreover, it is also important a deep knowledge of the causes (initiating events) which are at the origin of injuries. Indeed it is difficult to follow this procedure and no database on injuries developed for statistic

purposes is enough. Today in many industrial situations the chain of connected events is so complex that the most serious problems can result hidden at first sight. In fact, the available statistics do not guarantee a deep analysis on the investigation. The contemporary methods of elaboration of data, based on fuzzy logic approaches and neural nets (*Demichela et al., 2009, 2011*), need to extended cases that are not always available when focusing on the analysis of specific work areas (e.g. the subgroup of the activities within a construction site made of the underground job. Obviously, the analysis of a set of non-homogeneous or incomplete data can only lead to partial results, as strengthened by many Authors (*NOHSC, 2004*), the problems due to the significant consistency of the database, the correct use of the stored data, and the difficulties in the evaluation of the main internal and external parameters being unfortunately often underestimated, this leading to omitted or ineffective Risk Management actions, poor Residual Risk Management, and inefficient use of the national inspection resources (typically where flimsy subsets of national data are arbitrarily used for local policy), as discussed in (*Ariano et al., 2009*).

## **OBJECTIVES**

Quantitative and qualitative study of occupational accident events is useful both because it can contribute to the choices of priorities and lines of action, both because it can assess the results and measures and the means put in place preventive purposes.

What is, however, the starting point for a proper analysis of an injury? Where should we stop? What level of depth of the event's dynamics have?

Injury is a complex phenomenon to be addressed as they enter in different games parameters, see the place where the event happened, the location and nature of injury, the dynamics of the event.

So in dealing with the analysis of the accident causes in order to highlight initiating events, the first aim to ask it is the absolute necessity of objectivity: one of the typical accidents where you may incur is the tendency to focus mainly on possible behavioural deviations, such as dangerous actions, errors or violation of security procedures by victims or their colleagues.

Consistency, completeness and objectivity of post-event survey constraints, the development of an appropriate operational Protocol, as in General in the various processes of safety analysis.

The Operating Protocol post-event survey developed in this research may therefore constitute a useful reference for the refinement of risk assessment and management, also because it will make possible a discussion about intermediate and initiators events that have originated the result, apart from the need to hire as only reference statistical data published and then freeing the analyst from the issues invoked; also shall be able to be used as a preventive tool in the identification of the actions necessary to eliminate or where it is not possible to minimize the risk exposure of workers.

### ***Steps developed***

The research consists of several sections:

1. First introduces the topic and goals.
2. In the second part, is succinctly explained, as far as possible, the methods and models of analysis developed to date, with the aim of contributing to the prevention of work's accidents, focusing on the distinction of the problems that characterize the identified approaches and discussing the contribution

to the analysis of accidents and to improve the conditions of safety at work and then I'll discuss what these different methods converge.

3. Third part focuses on the explanation of the technique of analysis prepared on the basis of the old study and analysis approaches and theories of elaborate analysis until nowadays. In the final part is offered an overview of actual accident events to which is applied the software worked.

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## SAFETY AT WORK: THE APPLICATION OF LAWS AND TECHNICAL REGULATIONS

The introduction of Safety concept in terms of Prevention (all the provisions or measures necessary according to the particularity of the work, experience and technique, to prevent or reduce occupational risks) in the workplace, find in 4 cornerstones of national legislation basis:

- Italian Constitution - art. 41: "private economic initiative is free. Cannot be in contradiction with the social utility or to harm the safety, freedom, human dignity ..";
- art. 2087 of the Civil Code: "the entrepreneur is obliged to adopt in the course of measures that, according to the particularity of the work, experience and technology, are necessary to protect the physical integrity and the moral personality of providers of work";
- art 437, Malicious removing or omission of precautions against accidents at work and articles 589 and 590, respectively on manslaughter and culpably caused personal injuries of the Penal Code;

- Statute of workers n° 300 – art. 9: "workers through their representatives, have the right to monitor the implementation of standards for the prevention of accidents and occupational diseases and to promote research, development and implementation of all appropriate measures to protect their health and their physical integrity (art. 2087 C.C.).

The concept of " safe work" depends essentially on two factors:

- Technical progress: switching from mechanized production cycle in that automated. The breakdown of work involves the repetition of actions carried out by the worker. The change in pace of work causes consequences on workers such as estrangement, anonymity, anxiety, lack of motivation ... which increase the risk of injuries and/or illnesses
- Development of labour relations:
  - until the 50 's "the injury is a price to be paid to the social and economic growth of the country";
  - during the years 1950-1970 is a conscience "prevention" whose goal is the "safety in the work;
  - risk mapping for each production department is based on the experience of the laundry workers.

### ***From Protection to Prevention in order to eliminate work related accidents***

In the Italian legislation on safety has a considerable evolution in approach. It has been left from a model of accidents prevention at work and occupational diseases, where the beginning until about the second half of the 50s, the health of workers constituted a dependent variable of the production process and work-related accidents and illnesses were considered a price to pay for industrial development.

Afterwards the prevention concept has assumed a new role, where in the first place is put safety and health of employees and the identification of a general duty of prevention and safety, which belongs to the employer.

DPR 547/55, 164/56 and 303/56 are the first organic normative witnesses in matter of accidents prevention and occupational hygiene, and are an important first answer, though marked by political and socio-economic conditions of the moment.

The first interventions in the safety world were the introduction of protective systems, such as the outside of the machine to prevent contact of the worker with the moving and the dangerous parts of machinery, that of the "individual safety devices" in order to guarantee a barrier that ensured the safety worker.

The adopted solution, however, turned out to be not sufficient in order to assure the concrete fine to prevent accidents effectively.

Around the years 90, thanks to the fact that the European market demanded a unitary concept of safety, were issued directives that have gradually designed a system according to which the danger to safety and health workers depended not only by the lack of protections "objective" of the machines, as the manner of their use in the workplace. It was born and took increasingly popular the thought that safety was derived from the analysis and dynamic knowledge of the production process, which could be acquired only by defining the necessary procedures and coherent organizational solutions with the aim, returning them mandatory.



The bench marks of prevention theory were:

- ❖ information formation and training of individuals in the workplace;
- ❖ the participation of workers in the organized process of prevention;





The directives, that were born on the basis of this approach, become operational as the result of publication on the Official Gazette of the Community, and shall include a commitment to transpose into national law by each Member State within a predetermined period of time <sup>(1)</sup> and are:

A) Directive 89/391 - June 12, 1989: "A minimum requirements for improving the protection of the safety and health of workers," discipline is a general matter, albeit within the minimum limits, which with its 13 directives "daughters" \* To: D. Decree 81/08, as amended. (T.U. security);

| EC Directive   |  | National Transposition  |
|--|--|---|
| REGULATIONS ON MINIMUM REQUIREMENTS FOR IMPROVING THE SAFETY AND HEALTH OF WORKERS (SOCIAL DIRECTIVES) | GENERAL  | <p>89/391</p> <p>Directive on minimum requirements for improving the workers' safety and health</p>    |
|  | SPECIFIC ENVIRONMENTS WITH POTENTIALLY EXPLOSIVE ATMOSPHERES | <p>Directive on minimum requirements for improving the safety and health of workers exposed potentially at risk from explosive atmospheres</p> <p>99/92/CE (ATEX-137) <sup>23</sup></p>  |
|  |  | <p>Statement on the safety of users</p> <p>Consolidation Act on protection of health and safety in the workplace</p> <p><a href="#">D.Lgs-81/08-Titolo-XI</a></p>   |

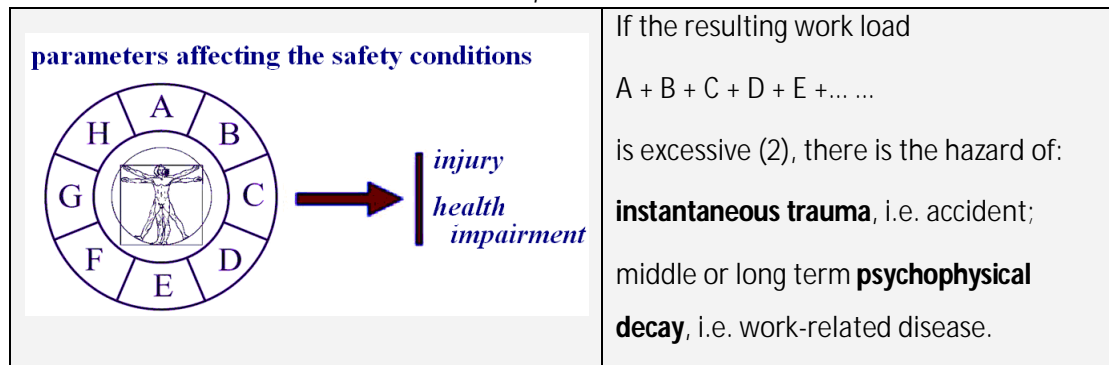
B) Directive 89/392 - June 14, 1989 : "approximation of the laws of the Member States relating to machinery" and subsequent additions (currently the 89/392 'replaced by 06/42 EU) " \* Presidential Decree 459 of 24 July 1996;

| EC Directive  |  | National Transposition  |
|---|--|---|
| REGULATIONS ON THE SAFETY FEATURES OF EQUIPMENT AND PROTECTIVE SYSTEMS (ECONOMIC DIRECTIVE) | GENERAL  | <p>Machinery Directive 89/392</p> <p>2006/42/CE</p>    |
|   | SPECIFIC ENVIRONMENTS WITH POTENTIALLY EXPLOSIVE ATMOSPHERES | <p>Directive concerning equipment and protective systems intended for use in potentially explosive</p> <p>94/9/CE (ATEX-95)</p>  |
|   |  | <p>Regulations for the implementation of the directives for the approximation of the laws of the Member States relative machines</p> <p><a href="#">DLgs-17/2010</a></p>  |
|   |  | <p>Regulations for the Implementation of the Directive 94/9/CE</p> <p>DPR-126/1998</p> <p>entered into force with the D.Lgs 233/03</p>  |

1 That is, in particular as regards the rules of a technical nature - "self-executing" - the principle that the Community directives after the expiration of the term in vain for their transposition by Member States, however, are directly involved in national law, in virtue of what was stated by the Court of Justice of the Union and by the Constitutional Court (see eg. judgment 8 to 18 April 1991. 1 OJ special edition, # 17, 04.24.1991).

## The scenario for the worker

The view, which arises from the application of safety normative, see the operator subject to a number of parameters which, if taken in excessive doses, can carry to situations industrial accident researches, sometimes not recoverable.



Despite the application of the "Prevention", the workplace can result in the accidental event and according to some logic, for being able to eliminate it the focus should be brought on the factors that characterize the workplace and the activities carried out in it, but first you need to understand what are the consequences which are to be made a thorough analysis.

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## The accident event and evolution of the accident analysis for prevention purposes

Injury: injurious event to workers, that occurred for violent cause at work and from which is derived the death or permanent incapacity to work, absolute or partial, or total temporary disability resulting in an absence from work for more than three days (art. 2, DPR 1124/65).

Accident: sudden and unexpected negative event that alters the normal pattern of work and determines damage to equipment and fittings.

<sup>2</sup> sometimes the resulting work load can be heavier than the one expected from a direct sum of the different contributions, e.g. when some parameters interact (such as cold and hand-arm vibrations), due the synergic effect [*sinergismi = an action where the total effect of two active causes is greater than the sum of their individual effects*].

Near Miss: events, failures or adverse circumstances in any event that could lead to an accident or injury.

Deviation: variation of process parameters from the operation optimal values - in the concepts are included Human Error <sup>(3)</sup>, and human error of J.Reason (Reason, 2000) approach on the system:

Table 1: Approaches that can be adopted with reference to human errors according to J.Reason

| Approach      | Consisting   | Consequence   |
|---------------|--|---|
| On the person | It considers the occurrence of adverse events exclusive responsibility of individuals, and consequently of their mistakes (or the failure to comply with procedures that you do not call into question the quality) is certainly easy, simple and convenient.            | It focus on the individual errors (perhaps even victims of the deviation, as with non-zero contact factor functionally with unwanted energy) prevents / authorizes to avoid the observation of the context in which the errors occurred.  |
| On the system | Worker's errors are considered a consequence and not a cause of the deviation, deriving this, and often the same failures of individuals, free from defects upstream: in case of deviation must seek what went wrong in the system and organization, and who was wrong . | counter measures can be taken to prevent or mitigate the consequences of the causes of the individuals errors, properly structuring systems and organization. Correct information campaigns, training, drills are basic (Patrucco, 2003). |

### ***The evolution of interest in the accident***

Early theories of accidents emerged around the beginning of 900, when the accident at work was considered as an event dependent on supernatural forces against which no preventative measure could provide an effective solution, a divine action, a fatality.

Such theory, however, lost almost quickly foundation, in order to under consideration leave space to the interest and to the study in the analysis of accidents of injured worker most of the injury. Caught on a gradually increasing interest for the "Human Factor" (*Baudot de Nève, 1975; Surry,1971; Turbiaux, 1970/71*), which gave rise to the development of two major schools of thought:

- a) the individual predisposition (*CCHST, 1980; Hale & Grendon, 1987*): it is a definitive and stable predisposition – it means that the event is consequence of the human nature characteristics (its in the individual) that make in the course of life, the most vulnerable regardless of the work performed, as the sense of self-punishment <sup>(4)</sup>, unhappiness <sup>(5)</sup>, stress from adaptation <sup>(6)</sup> (*Kerr, 1950*), but also

3 in full agreement with the approaches "healthy" of Behaviour-Based Safety, namely those that refer to situations characterized by the level of expected frequency of occurrence

4 Psychoanalytic theories of Hale and Glendon 1987: "The injury was an unconscious act of self-punishment related to the worker's desire to escape from personal conflicts or even the need to escape from work or challenge the authority" - from which the injuries are the result of unconscious processes related to feelings of guilt, aggression, anxiety, ambition and conflict.

5 The hypothesis of the escape of Hill and Trist, "people unhappy at work have a tendency to get away from invoking different reasons" - the injury becomes a means for the individual to withdraw from their work situation as an escape.

the set of all these aspects considered like Cards of Domino <sup>(7)</sup>(Heinrich, 1931). The solution for the accident elimination involves a targeted selection to recognize and eliminate from the assumption susceptible individuals damaging event.

- b) the susceptibility to get injured is a predisposition linked to characteristics convertible with the experience and through the social environment - is based on the plasticity of human characteristics that need to be modelled through training; it focus on the traits, personality and individual attitudes that are acquired. Some members of this thinking are Hale & Hale <sup>(8)</sup>(Hale & Hale, 1980), according to which the choice of action to be influenced by several variables such as individual mental and physical abilities, the benefits (cost / benefit) of the different possible actions once they have been identified and the formation of individual attitudes. The worker and the situation interact at all stages of the process in such a way that the action taken as a result of the processing of information, in turn, change the job situation and the perception that the individual has. It also introduced a distinction between:
  - a. primary factor of injury: crack in one of the stages of the treatment process information;
  - b. secondary factors: they have the ability to influence one or more stages of the treatment process information; variables are associated with mental and physical, perceptual or coordination.

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6 Kerr, 1950: "Individuals who are unable to adapt to the work environment will tend to have more accidents than others to cause physical and psychological stress."

7 Industrial Accident Prevention of Heinrich, 1931/1980

8 Hale & Hale, 1970: the injury is a deficiency on the part of the individual to adequately meet the actual situation that presents itself. The reasons for this inadequacy are searchable in the individual, in his environment, or both components

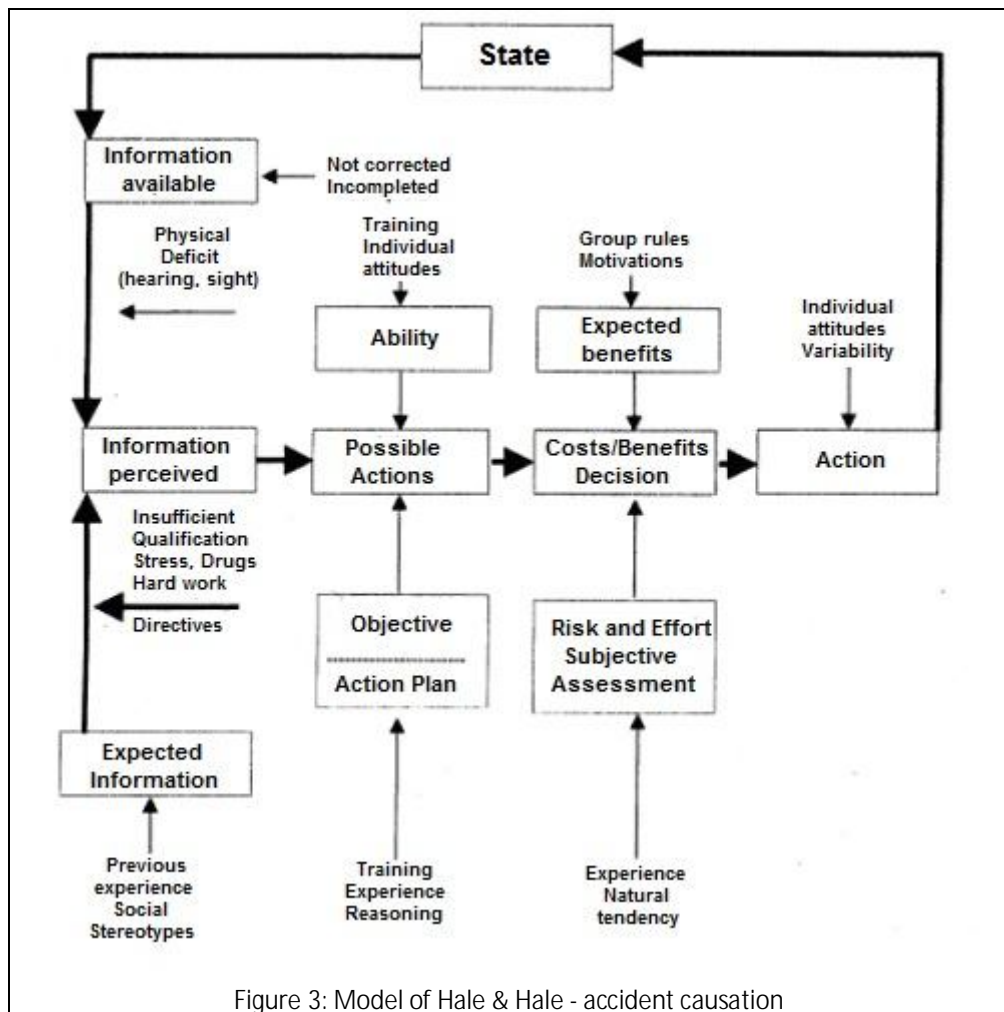


Figure 3: Model of Hale & Hale - accident causation

In developing this model Hale & Hale have pursued four objectives:

1. insert the idea of accident proneness in an analytical framework where all the factors that may contribute to the genesis of the accident find their place;
2. take into account that an injury can have multiple causes;
3. reconcile their theoretical approach to safety with the practical;introdurre la distinzione fra infortunio e lesione

According to the model's creators, it can come to the classification of the degree of injury depending to the stage of the process to the whose inside has happened the error and this would afford the formulation of clearer hypotheses for the resolution on the stage.

Other members are Corlett & Gilbank <sup>(9)</sup>(*Corlett & Gilbank, 1978*):

This model is based on the Hale and Hale thought further with the introduction of new variables such as stress and physical characteristics of the injured.

<sup>9</sup> Corlett & Gilbank, 1978 consider the Hale & Hale inadequacy and they rewrite it introducing the concept of the planning and accommodation of work place in order to pursue the two fold objective of the efficiency and the safety

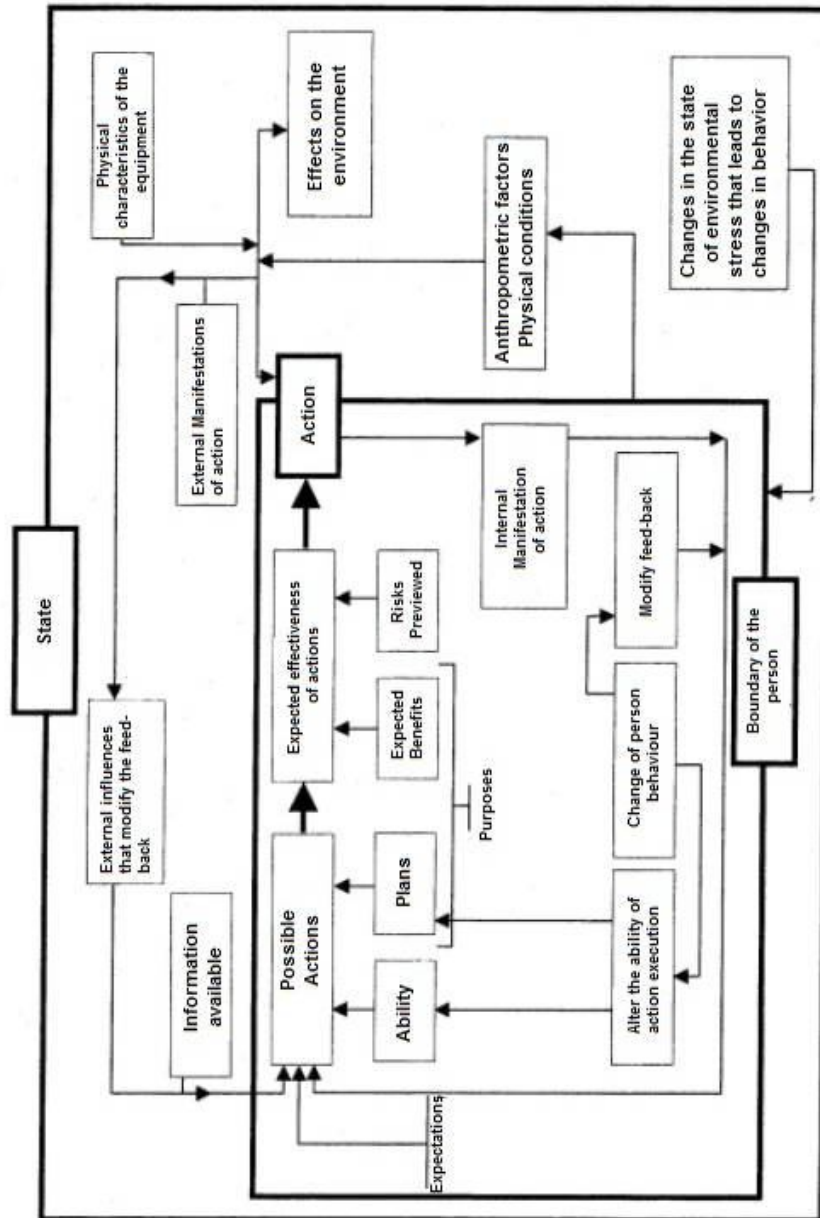


Figure 4: Schematic of analysis of Corlett Gilbank

To warning of the creators' thought, injury derives from an individual inadequate answer compared to the actual needs of a situation, such inadequacy can come gives:

- ❖ environmental layout;
- ❖ temporary individual factors (age, job experience, ...);
- ❖ the effects of the immediate situation.

Basically what all the supporters of these models propose is that the main emphasis come on unsafe acts and injury based on personal damages. People are seen like free acting, able to choose between safe and dangerous behaviours. The unsafe acts are generally intended like coming from the mental processes irregular: forgetfulness, inattention, distraction, worry, carelessness, low motivation, gross negligence or recklessness.

The main countermeasures adopted by these models had to correct the attitudinal and cognitive individual processes, which are considered the main causes of unsafe acts. These include campaigns aimed at appealing to fear, rewards and punishments, the unsafe acts verification, the writing of additional procedures, retraining, renaming and humiliation. In this case, in order to achieve the complete injury elimination, it can be run also on research focused on the social aspects of the environment.

### **The systematic approach**

The evolution and the practical one therefore are carried to consider incomplete and ineffective:

- ❖ theories of preparation that have never succeeded to demonstrate the direct connection of the liability related to the accident with the specific characteristics of people, but many other factors (*Saas e Cook, 1981*) probably mediate and influence the link between personality and propensity to commit accidents. They also make it impossible to draw up a perspective of global analysis of the injury, as well as not considering the possible interactions between human and machine;
- ❖ theories of susceptibility to get injured, which recognizes the distinction between the risk for the general framework within which the work is organized and carried out, and the risk to the individual operating within a specific work situation, but limited analysis in terms of presence / absence of an objective danger and essentially with respect to the specific work process.

Therefore is developed a new approach, which assumes that the operation of a system is the resulting from mutual interactions between man, machine and the environment, and not just the sum of its individual parts.

The man-machine system is an entity in its own right, the machine is associated with the workplace and, in combination with the man, form a single organized whole (*Cazamian e coll., 1974*). The natural elements, technical and human who compose this set are arranged mutually interconnected and interdependent, and the modification of one of them causes the reorganization of the whole and acts on all the elements present.

When one of system's elements stop to carry out the function that is attributed it, injury occurs. The injury is defined in this system as an index of dysfunction of the same, and every accident is similar to an injury, although not necessarily cause harm to people (*Faverge, 1974*). The essence of this approach is based on the fact that the front-line operators are not accident's activators, but rather become the heirs of latent conditions (or resident pathogens) that may have accumulated over a long time earlier, in these terms have been developed:

- ❖ sequential models on the accidents:
  - the Domino model the genesis of the accidents of Heinrich (*Heinrich, 1931*): it conceives the genesis of an accident as an event that ties him to the other in a linear scheme or it identifies more simply a chain of the accidents, in which the single rings tie him up to determine the adverse event. So in terms of prevention it is necessary to break the chain of errors (or of events) to avoid

to reach the injury. The limits of such model are to found on events defined in not objective way.

- o the model of the evolution and the barriers of the accident of Seveson (Seveson, 2001):

it is a method for analysis of incidents and accidents that models the evolution towards an incident/accident as a series of interactions between human and technical systems. The interaction consists of failures, malfunctions or errors that could lead to or have resulted in an accident. The method forces analysts to integrate human and technical systems simultaneously when performing an accident analysis starting with the simple flow chart technique of the method.

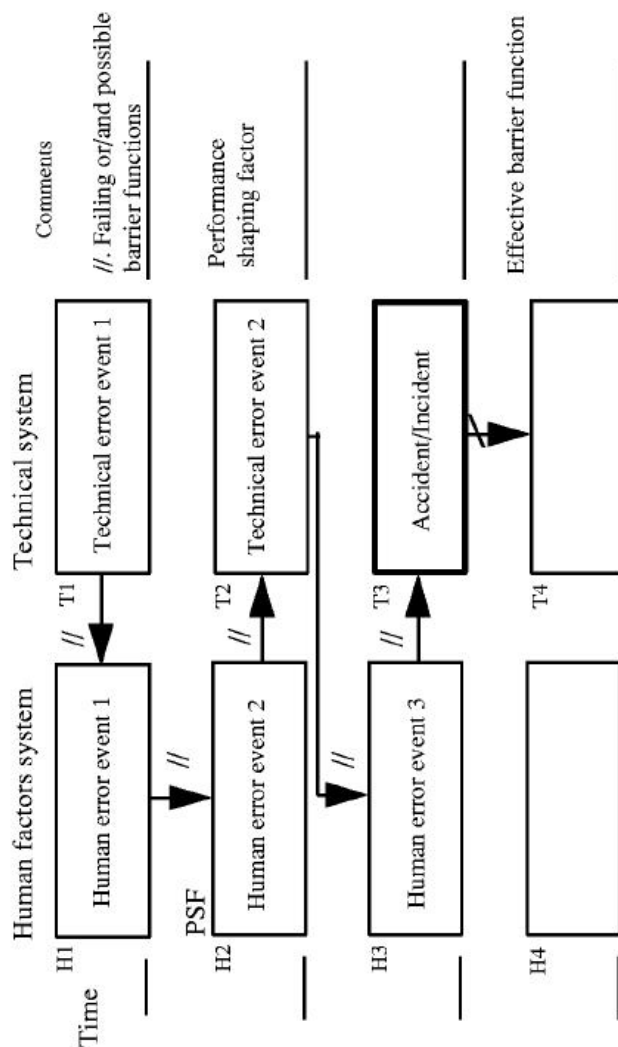


Figure 4: Scheme of AEB analysis (Accident analysis and barrier function)

In general, the sequence of error boxes in the diagram follows the time order of events. Between each pair of successive error boxes there is a possibility to arrest the evolution towards an incident/accident.

Barrier function systems (e.g., computer programs) that are activated can arrest the evolution through effective barrier



functions (e.g., the computer making an incorrect human intervention modeled in the next error box impossible through blocking a control).

An AEB analysis consists of two main phases:

1. Modeling of the accident evolution in a flow diagram based on a preprinted or computer based flow chart.
2. barrier function analysis: barrier functions are identified (ineffective and/or non existent), which could have arrested the unwanted evolution.

The AEB method provides a common theoretical framework that is useful for communication and improvements of complex systems. It is important to stress that it presupposes a simultaneous analysis of both human factors and technical systems by experts from both fields interacting when performing the analysis.

- the structure of the injury's anatomy of Green A.E. (*Green A.E., 1988*) : it involves a series of multiple sequences of events - diagram 3 leaks - in which individualizes the existence of some initial rootcause (every element of the chain of the events has his/her own precursors).

❖ Epidemiological models of injuries:

- The model of the "Swiss Cheese" (*Reason J., 1997*):

The analogy resides in the discourse of the problem as the yield of the interaction of various factors, some obvious potentially, other latent ones. In fact the model shows as the defenses can be bypassed from accidentally trajectories due to breakdowns and latent conditions of the system

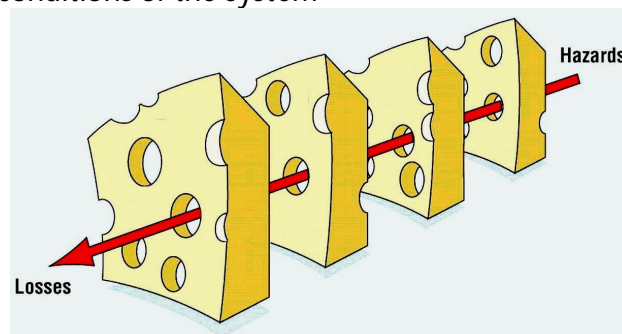


Figure 5: the model of the "Swiss Cheese" (Reason J.), 2000

Every slice - like Hemmental - has holes; but with the exception of the cheese, these holes are in continuous movement, moving themselves from one place to another, opening and closing themselves. Only when verification the alignment of a series of holes, and injury trajectory can pass through defenses and cause damage to the people, to resources and to the environment. The holes are generated by unsafe acts (usually short-lived windows of opportunity) and by latent factors (are created as the planners do not visualize possible accident scenarios).

- Analysis post-accident models based on FTA (Fault tree analysis<sup>(10)</sup>) aim to collect the information that afford for a structural analysis of the injury, or that they are considered the most likely causes, and many of them are placed inside the tree on several levels with logical connections and historical reports.

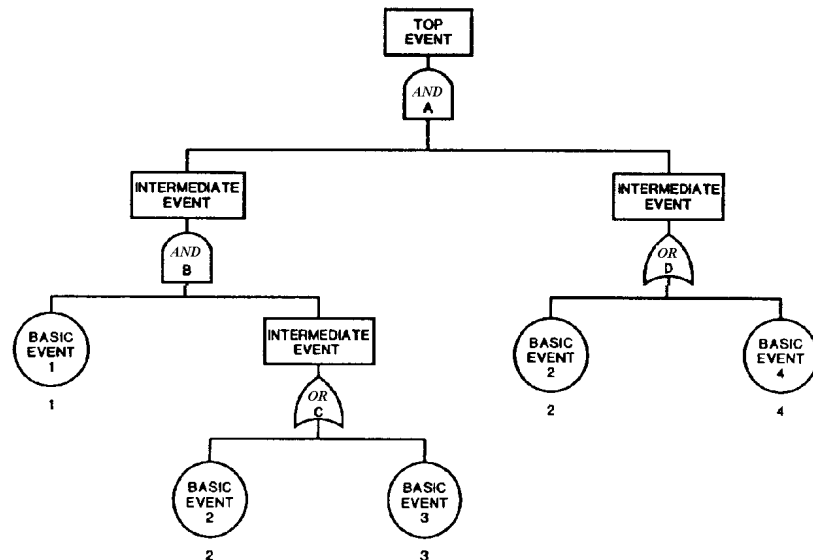


Figure 6: FTA analysis

The technique, commonly known as "fault tree", is founded on a graphical construction that provides the systematic description of the combinations of possible events that can produce an undesirable outcome. The tree is built with the identification of events that are necessary for the occurrence of the TOP EVENT and those necessary for the later levels, up to the basic events. The basic events can be identified failures that require the resolvable temporary breakdowns easily. In any case, faults can be divided into:

- primary, when the component is in operation within the limits (pressure, temperature, ...) declared by the manufacturer; these failures can be attributed to a defect of the component;
- secondary, when the component, for any reason, is operating outside of the limits of the design;
- of control, while the component can correctly work the control device is activated when it is not necessary or not active when it is. From the graphical representation the analysis' results are deduced, they are identified MCS (minimal cut sets), identifying their significance and recommendations on possible improvements.

Despite the systemic models, at first sight, represent the most appropriate way to consider the causality of accidents in terms of understanding the

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<sup>10</sup> Fault tree analysis (FTA) is a technique developed to determine the possible sources of error within a system and which provides a model in the form of graphic representation and logic of the possible combinations of events that they can happen inside system and lead to another undesirable event. In this thought the near misses, accidents and material damage they receive are considered and analyzed in the same way, they are considered as the products of man-machine system, or in a more general sense, the socio-technical system (Leplat 1982).

factors contributing and their corrective implications, also they have several disadvantages . In fact, systemic approach opens from a side new horizons to the studies and the accidents prevention at work, but on the other hand it involves disadvantages how the hierarchy of job rigidities or sources of perturbation in the determination of accident risks . They don't allow to specify how each of these, identified once and individually taken, contributes to the probability of the occurrence of a deviation and the interactions that such approaches put in evidence they are certainly useful to help to individualize suitable measures and means of prevention to different work situations but this is not enough to establish the priority choices of intervention founded on the severity of the risk factors associated with the observed (Tort, 1974; Leplat, 1984).

### The evolution of systematic approach towards today's energy and sequential models

Nowadays, injuries and their prevention have led to the development of different theories of analysis, each with a force point but none quite complete.

The process of analysis generally involves these steps:

1. In response to an injury, has started a complaint practice of INAIL, whose authority if it deems it necessary, open a practice where it authorizes documents and place, that are connected with the injury, inspection in order to arrive at a clear and complete in-depth analysis of the accident;
2. the analysis, which comes to the insurer, reaches this level of depth:

| Objective causes<br>[Causal Factor]: | Direct relationship injury-event: for example, "struck in the head by ..... ";   |                           |                |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
|--------------------------------------|--|---------------------------|----------------|----------------|----------------|------|------|------|------------------------|--------|-------|-------|---------------------|--------|--------|--------|---------------------|--------|-----------------|--------|---------------|--------|--------|--------|-------------------|---------|---------|--------|-----------|--------|-----------------|--------|----------|--------|--------|--------|----------------------------------|--------|--------|--------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| worker<br>age and experience         | <table border="1"> <thead> <tr> <th rowspan="2">Classe di età</th> <th colspan="5">Anno evento</th> </tr> <tr> <th>2007</th> <th>2008</th> <th>2009</th> <th>2010</th> <th>2011</th> </tr> </thead> <tbody> <tr> <td>fino a 17 anni</td> <td>1.056</td> <td>748</td> <td>364</td> <td>257</td> <td>234</td> </tr> <tr> <td>da 18 a 34 anni</td> <td>98.048</td> <td>87.970</td> <td>67.674</td> <td>60.601</td> <td>52.179</td> </tr> <tr> <td>da 35 a 49 anni</td> <td>109.862</td> <td>104.041</td> <td>89.173</td> <td>89.581</td> <td>81.790</td> </tr> <tr> <td>da 50 a 64 anni</td> <td>40.067</td> <td>38.635</td> <td>35.664</td> <td>35.897</td> <td>34.983</td> </tr> <tr> <td>65 anni e oltre</td> <td>641</td> <td>748</td> <td>608</td> <td>652</td> <td>670</td> </tr> <tr> <td><b>TOTALE</b></td> <td><b>249.674</b></td> <td><b>232.142</b></td> <td><b>193.483</b></td> <td><b>186.988</b></td> <td><b>169.856</b></td> </tr> </tbody> </table> <p>Table 2: Report on the seniority of the worker to the job (Statistics for the prevention, POS - <a href="http://www.inail.it">www.inail.it</a>)</p>  | Classe di età             | Anno evento    |                |                |      |      | 2007 | 2008                   | 2009   | 2010  | 2011  | fino a 17 anni      | 1.056  | 748    | 364    | 257                 | 234    | da 18 a 34 anni | 98.048 | 87.970        | 67.674 | 60.601 | 52.179 | da 35 a 49 anni   | 109.862 | 104.041 | 89.173 | 89.581    | 81.790 | da 50 a 64 anni | 40.067 | 38.635   | 35.664 | 35.897 | 34.983 | 65 anni e oltre                  | 641    | 748    | 608    | 652           | 670            | <b>TOTALE</b>  | <b>249.674</b> | <b>232.142</b> | <b>193.483</b> | <b>186.988</b> | <b>169.856</b> |
| Classe di età                        | Anno evento  |                           |                |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
|                                      | 2007   | 2008                      | 2009           | 2010           | 2011           |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| fino a 17 anni                       | 1.056  | 748                       | 364            | 257            | 234            |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| da 18 a 34 anni                      | 98.048   | 87.970                    | 67.674         | 60.601         | 52.179         |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| da 35 a 49 anni                      | 109.862  | 104.041                   | 89.173         | 89.581         | 81.790         |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| da 50 a 64 anni                      | 40.067   | 38.635                    | 35.664         | 35.897         | 34.983         |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| 65 anni e oltre                      | 641  | 748                       | 608            | 652            | 670            |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| <b>TOTALE</b>                        | <b>249.674</b>   | <b>232.142</b>            | <b>193.483</b> | <b>186.988</b> | <b>169.856</b> |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| job or workplace                     | <table border="1"> <thead> <tr> <th rowspan="2">Attività Fisica Specifica</th> <th colspan="3">Anno evento</th> </tr> <tr> <th>2009</th> <th>2010</th> <th>2011</th> </tr> </thead> <tbody> <tr> <td>Operazioni di macchina</td> <td>10.453</td> <td>9.585</td> <td>8.961</td> </tr> <tr> <td>Lavoro con utensili</td> <td>18.988</td> <td>16.510</td> <td>15.431</td> </tr> <tr> <td>Alla guida, a bordo</td> <td>24.859</td> <td>22.723</td> <td>20.558</td> </tr> <tr> <td>Manipolazione</td> <td>31.082</td> <td>28.263</td> <td>24.403</td> </tr> <tr> <td>Trasporto manuale</td> <td>12.264</td> <td>11.119</td> <td>10.074</td> </tr> <tr> <td>Movimenti</td> <td>35.846</td> <td>33.943</td> <td>29.235</td> </tr> <tr> <td>Presenza</td> <td>1.630</td> <td>1.397</td> <td>1.209</td> </tr> <tr> <td>Non determinato o non codificato</td> <td>31.031</td> <td>36.588</td> <td>32.478</td> </tr> <tr> <td><b>TOTALE</b></td> <td><b>166.133</b></td> <td><b>160.088</b></td> <td><b>142.349</b></td> </tr> </tbody> </table> <p>Table 3: Accidents at work occurred in the period 2009/2011 and compensated at all for 31/03/2011 type of physical activity and specific event year (Statistics for the prevention, POS-<a href="http://www.inail.it">www.inail.it</a>)</p> | Attività Fisica Specifica | Anno evento    |                |                | 2009 | 2010 | 2011 | Operazioni di macchina | 10.453 | 9.585 | 8.961 | Lavoro con utensili | 18.988 | 16.510 | 15.431 | Alla guida, a bordo | 24.859 | 22.723          | 20.558 | Manipolazione | 31.082 | 28.263 | 24.403 | Trasporto manuale | 12.264  | 11.119  | 10.074 | Movimenti | 35.846 | 33.943          | 29.235 | Presenza | 1.630  | 1.397  | 1.209  | Non determinato o non codificato | 31.031 | 36.588 | 32.478 | <b>TOTALE</b> | <b>166.133</b> | <b>160.088</b> | <b>142.349</b> |                |                |                |                |
| Attività Fisica Specifica            | Anno evento  |                           |                |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
|                                      | 2009   | 2010                      | 2011           |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| Operazioni di macchina               | 10.453   | 9.585                     | 8.961          |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| Lavoro con utensili                  | 18.988   | 16.510                    | 15.431         |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| Alla guida, a bordo                  | 24.859   | 22.723                    | 20.558         |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| Manipolazione                        | 31.082   | 28.263                    | 24.403         |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| Trasporto manuale                    | 12.264   | 11.119                    | 10.074         |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| Movimenti                            | 35.846   | 33.943                    | 29.235         |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| Presenza                             | 1.630  | 1.397                     | 1.209          |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| Non determinato o non codificato     | 31.031   | 36.588                    | 32.478         |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |
| <b>TOTALE</b>                        | <b>166.133</b>   | <b>160.088</b>            | <b>142.349</b> |                |                |      |      |      |                        |        |       |       |                     |        |        |        |                     |        |                 |        |               |        |        |        |                   |         |         |        |           |        |                 |        |          |        |        |        |                                  |        |        |        |               |                |                |                |                |                |                |                |

| Sede della lesione  | Temporanea     | Permanente in capitale | Permanente in rendita | Permanente totale | Morte      | TOTALE         | Durata media in gg | Indennizzo medio di un caso (Euro) |
|---------------------|----------------|------------------------|-----------------------|-------------------|------------|----------------|--------------------|------------------------------------|
| Cranio              | 5.799          | 217                    | 100                   | 317               | 104        | 6.220          | 18,0               | 1.068                              |
| Occhi               | 6.094          | 71                     | 73                    | 144               | —          | 6.238          | 7,6                | 425                                |
| Faccia              | 4.881          | 242                    | 54                    | 296               | 2          | 5.179          | 14,2               | 784                                |
| Colo                | 3.594          | 39                     | 6                     | 45                | 4          | 3.643          | 16,7               | 693                                |
| Cingolo braccia     | 5.574          | 469                    | 76                    | 625               | 3          | 6.152          | 33,9               | 2.910                              |
| Mano                | 5.604          | 288                    | 63                    | 331               | 54         | 5.989          | 24,1               | 1.380                              |
| Organi interni      | 241            | 40                     | 6                     | 46                | 34         | 321            | 21,8               | 1.365                              |
| Colonna vertebrale  | 17.900         | 450                    | 142                   | 592               | 12         | 18.504         | 19,9               | 1.099                              |
| Braccio avambraccio | 4.453          | 339                    | 70                    | 399               | 2          | 4.853          | 26,9               | 1.473                              |
| Genito              | 2.567          | 187                    | 30                    | 217               | —          | 2.784          | 28,5               | 1.586                              |
| Piada               | 4.889          | 454                    | 72                    | 526               | —          | 5.406          | 31,7               | 1.804                              |
| Mano                | 37.988         | 1.185                  | 148                   | 1.333             | —          | 39.321         | 23,7               | 1.276                              |
| Cingolo pelvico     | 851            | 56                     | 36                    | 92                | 2          | 945            | 31,5               | 2.152                              |
| Costa               | 1.745          | 113                    | 50                    | 163               | 1          | 1.909          | 31,4               | 2.126                              |
| Ginocchio           | 9.246          | 532                    | 52                    | 584               | —          | 9.830          | 32,9               | 1.863                              |
| Gamba               | 3.988          | 201                    | 73                    | 374               | 4          | 4.366          | 31,1               | 2.173                              |
| Caviglia            | 9.972          | 430                    | 55                    | 485               | —          | 10.356         | 28,1               | 1.504                              |
| Polso               | 6.195          | 337                    | 43                    | 380               | —          | 6.575          | 30,9               | 1.919                              |
| Alte                | 848            | 17                     | 1                     | 18                | —          | 866            | 28,6               | 1.483                              |
| Altre dita          | 656            | 14                     | 3                     | 17                | —          | 673            | 26,8               | 1.513                              |
| Non determinato     | 2.030          | 89                     | 35                    | 124               | 56         | 2.210          | 5,8                | 368                                |
| <b>TOTALE</b>       | <b>135.006</b> | <b>5.877</b>           | <b>1.188</b>          | <b>7.065</b>      | <b>278</b> | <b>142.349</b> | <b>23,0</b>        | <b>1.317</b>                       |

Table 4: Accidents at work occurred in the period 2011 and compensated at all for 31/03/2012 site of the lesion and the type of result (Statistics for the prevention, POS - www.inail.it)

| Natura lesione                            | Temporanea     | Permanente in capitale | Permanente in rendita | Permanente totale |
|---|----------------|------------------------|-----------------------|-------------------|
| Lesioni da sforzo                         | 2.444          | 33                     | 4                     |                   |
| Corpi estranei                            | 4.059          | 10                     | 14                    |                   |
| Lesioni da altri agenti                   | 3.550          | 90                     | 19                    |                   |
| Lesioni da agenti infettivi e parassitari | 94             | —                      | —                     |                   |
| Perdita anatomica                         | 668            | 288                    | 51                    |                   |
| Frattura                                  | 14.547         | 2.895                  | 659                   |                   |
| Lussazione, distorsione, distrazione      | 38.587         | 1.042                  | 110                   |                   |
| Contusione                                | 39.447         | 811                    | 193                   |                   |
| Fenta                                     | 29.580         | 619                    | 103                   |                   |
| Non determinato                           | 2.030          | 89                     | 35                    |                   |
| <b>TOTALE</b>                             | <b>135.006</b> | <b>5.877</b>           | <b>1.188</b>          |                   |

Table 5: Accidents at work occurred in the period 2011 and compensated at all for 31/03/2012 nature of the injury and the type of result (Statistics for the prevention, POS - www.inail.it)

| Classe di grado | Anno evento   |               |               |               |              |
|-----------------|---------------|---------------|---------------|---------------|--------------|
|                 | 2007          | 2008          | 2009          | 2010          | 2011         |
| 6-15            | 9.896         | 9.782         | 9.220         | 8.757         | 5.877        |
| 16-32           | 2.323         | 2.320         | 2.026         | 1.876         | 1.037        |
| 33-45           | 263           | 244           | 234           | 208           | 88           |
| 46-66           | 138           | 127           | 110           | 94            | 37           |
| 67-100          | 80            | 71            | 75            | 52            | 18           |
| Non determinato | 20            | 18            | 21            | 12            | 8            |
| <b>TOTALE</b>   | <b>12.720</b> | <b>12.562</b> | <b>11.686</b> | <b>10.999</b> | <b>7.065</b> |

Table 6: Infortuni sul lavoro avvenuti nel periodo 2007/2011 e indennizzati a tutto il 31/03/2012

| Mese          | Temporanea     | Permanente in capitale | Permanente in rendita | Permanente totale |
|---------------|----------------|------------------------|-----------------------|-------------------|
| Gennaio       | 9.751          | 645                    | 138                   | 783               |
| Febbraio      | 11.071         | 635                    | 148                   | 783               |
| Marzo         | 12.146         | 703                    | 159                   | 862               |
| Aprile        | 11.680         | 598                    | 124                   | 722               |
| Maggio        | 13.450         | 678                    | 157                   | 835               |
| Giugno        | 12.937         | 566                    | 111                   | 677               |
| Luglio        | 13.094         | 513                    | 105                   | 618               |
| Agosto        | 7.969          | 303                    | 60                    | 363               |
| Settembre     | 12.675         | 430                    | 76                    | 506               |
| Ottobre       | 11.449         | 353                    | 57                    | 410               |
| Novembre      | 10.905         | 281                    | 39                    | 320               |
| Dicembre      | 7.879          | 172                    | 14                    | 186               |
| <b>TOTALE</b> | <b>135.006</b> | <b>5.877</b>           | <b>1.188</b>          | <b>7.065</b>      |

Table 7: Accidents at work occurred in the period 2011 and compensated at all 31/03/2012

3. INAIL, in the case of judicial expertise, is accompanied by experts or technical consultants, who are asked by judges and lawyers to perform a thorough analysis of the case, highlighting reasons for which the event

occurred. In addition to these figures, the same analysis on behalf of the Employer can be carried out by specialists in the field to determine causes and intervention in order to avoid the recurrence of similar events. The first step in the analysis of post-injury is a comparison between the different databases, where you can find interesting information about the accident events. Some of the main databases are highlighted:

- ❖ INAIL - National Institute for Insurance against Accidents at Work which manages the Italian accident databases;
- ❖ NOHSC - National Occupational Health and Safety Commission, which manages the database of Australia (Safe Work Australia);
- ❖ OSHA - Occupational Safety and Health Administration that manages the database of the United States of America;
- ❖ MSHA - Mine Safety and Health Administration that manages the database of the United States of America with regard to mining activities;
- ❖ EU-OSHA - European Agency for Safety and Health at Work that manages the data of the European member states participating in the ESAW project (a project in which they are codified a number of variables to which all the countries of the Community should refer).

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## **THE BIRTH AND DEVELOPMENT OF A POST-EVENT INVESTIGATION PROTOCOL FOR RELATED ACCIDENTS**

All the techniques of injury's analysis, as well as the statistical analysis of accident data, are definitely an essential tool but obviously not enough to set up a correct work of prevention. This requires a deeper analysis of the dynamics that has carried to the event without to omit important news and connected details to it. A thorough accident analysis is used to define correctly the causes and at the same time it provides necessary information in order to avoid that the same event will happen again.

Principal difficulties are:

- ❖ To identify which information should be considered related to the event;
- ❖ To create a tool that allows to properly collect all the information;
- ❖ To make the instrument to enable a subsequent study for preventive purposes.

Before to proceed to in detail explain the structure of the analysis technique developed, it is necessary to explain one of the initially concepts: the analysis must be developed for preventive purposes and then not only it must use accident events, but also incidental situations that did not involve human consequences.

In fact, almost accidents or near miss, often overlooked, are to be closely monitored as indicators of an anomaly. Experience shows that the recurrence of abnormal situations, sooner or later, probably also leads to injury.

For this reason, if you were able to eliminate near-miss, you should also reduce the possibility of accidents occurrence, regardless of their severity (*Heinrich, 1931*).

## ***The development of the thoughts behind the in-depth analysis technique***

The objective previewed to get a impartial analysis of the causal chain of events that lead to accidents, so that a thorough knowledge of how and why it happened may provide suggestions in order to avoid repeating of similar situations. The basic purpose was to provide a formalized method to trace without subjective interpretations (<sup>11</sup>)(Reason, 1998) to the chain of events that led to the accident. Among the available techniques have been taken into consideration (see [Cigna C., Enrico M., Patrucco M., Scioldo G., 2004], [Palamara F., Demichela M., 2007], [Mure`S., Demichela M., Piccinini N., 2006], [Demichela M., Murè S., Cigna C., Monai L., Patrucco M., 2010]):

- CEA – Cause Effect Analysis (cause ad effect diagram or Ishikawa diagram);
- RCA – (Root cause analysis);
- CCA – Cause Consequence Analysis

Testing them on several cases, it was found that:

- CEA is applicable for very simple systems, because in those complexes it becomes extremely difficult to avoid to make the mistake of putting in multiple branches the same question (intermediate event), which no longer allows to solve completely the system;
- RCA method, designed for applications in very complex scenarios (such as operating rooms), lends itself to criticism referred to the note. itself automatically to criticism referred to the note.

Then the choice is addressed for the CCA approach, which has proven to be the most suitable for an objective analysis of the events dynamics that led to the accident, and due to the structural and formal similarity with ETA (Event Tree Analysis) and FTA techniques (fault Tree Analysis) lends itself to run a dual path:

injury → intermediate events → Root causes

useful for a correct and objective understanding of the causes of the accident and:

root causes →event tree →Top Event (injury)

---

<sup>11</sup> Too many times in the accidents analysis you are faced with interpretations forehead proposed by hasty analysts or based on a way of thinking that can be traced to the approach refers to the person of Reason:

### *Person approach*

*The longstanding and widespread tradition of the person approach focuses on the unsafe acts - errors and procedural violations - of people at the sharp end: nurses, physicians, surgeons, anaesthetists, pharmacists, and the like. It views these unsafe acts as arising primarily from aberrant mental processes such as forgetfulness, inattention, poor motivation, carelessness, negligence, and recklessness. Naturally enough, the associated countermeasures are directed mainly at reducing unwanted variability in human behaviour. These methods include poster campaigns that appeal to people's sense of fear, writing another procedure (or adding to existing ones), disciplinary measures, threat of litigation, retraining, naming, blaming, and shaming. Followers of this approach tend to treat errors as moral issues, assuming that bad things happen to bad people what psychologists have called the just world hypothesis.*

*The person approach remains the dominant tradition in medicine, as elsewhere. From some perspectives it has much to commend it. Blaming individuals is emotionally more satisfying than targeting institutions. People are viewed as free agents capable of choosing between safe and unsafe modes of behaviour. If something goes wrong, it seems obvious that an individual (or group of individuals) must have been responsible. Seeking as far as possible to uncouple a person's unsafe acts from any institutional responsibility is clearly in the interests of managers. It is also legally more convenient, at least in Britain.*

precious aid - through the application of Boolean operators - not only for the formulation of measures to prevent the Top Event, but especially for an efficient identification of critical paths (Cut Sets) on which to allocate the prevention efforts.

### ***Cause Consequence Analysis - CCA***

The CCA is a technique for identifying hazards and it represents both FTA (Fault Tree Analysis and Fault Tree Analysis) and ETA (Event Tree Analysis and Event Tree Analysis) (CCPS, 1992), where:

- FTA technique is characterized by the construction of a graphic model that shows the combinations of deviations that have for resulted a specific negative situation chosen as the object of analysis. This model is constituted by boxes containing failures and logical paths with AND / OR gates that connect them;
- ETA, formally similar to the FTA, it is, in terms of approach, the exact opposite: while FTA is a deductive process that starts from a result (TOP EVENT) to go up again to the causes of it, ETA considers an initial event and it follows with inductive method the different development paths and different final results that such event can have in the system.

Like any hazard assessment technique, the CCA is characterized by the following basic requirements:

|                  |  |
|------------------|--|
| 1. Systematic    | The analysis must be carried out according to a precise logical thread so as not to skip any point, that it can reveal then as weak element of the system.   |
| 2. Completeness  | It need to be certain that all variables able to produce critical situation are examined.  |
| 3. Formalization | The study must be conducted in a predetermined and repeatable way, so that to distance of time it can be reconstructed step by step by different people than the original version. It is also important that this formalization does not become a mere bureaucracy and that the documents produced are easy to understand. |

This technique is applied to the resolution of systems of faults whose logic is easy to identify the relationships between specific situations of damage and their root causes, but also the analysis of the accidents for the injuries prevention in any environments job. Its greatest peculiarity is in the type of graphic layout, that allows a quick understanding of the problem and the results from the users. On the other hand, the technique is particularly suited to the study of events not too complex as it ensures a good objectivity and results, under the graphic aspect, few bulky and effective.

The analysis is carried out according to the following steps:

1. selection of the event to be appraised, correspondent to what you would choose as initial event if you had to make an ETA;



2. protections identification and path tracking that conduct to the situation resulted, as in an ETA (it only changes the symbology used);

3. within every path ETA, development of the initial event and the logical functions at all levels to identify the root causes, according to the procedure of FTA [considering the initial event the TOP EVENTS (the negative situation to be implored) each of a fault tree];

4. evaluation of the MCS (MINIMAL CUT SET: shorter sequences of failure to reach the TOP EVENT) that they lead to the result of every path, intending for "paths" the sums of the horizontal paths typical of ETA with branches raised vertically from the analysis FTA applied the initial event and each branch, thus it departs from the root causes and it get to the final result;

The CCA, therefore, allows to go up to the indirect causes, even if:

- they are multiple;
- they are of Technological, organizational and behavioural type.

In fact it is possible to define the CCA as the ability to identify the root causes of backward deviation and to appraise the probability of event repetition in case of non-compliance.

If you analyze in depth an injury you discover that to occur the following conditions must be subsist:

- The presence of a danger factor or material agent such as the electric current, a hot surface, the altitude, etc..;
- The presence of a deviation (event, deviating from the norm, that leads to the accident and characterized by a probability of occurrence) that involves a contact with the danger factor.

The deviation and the contact with the danger factor are related by a precise dynamic of the harmful event in turn followed by a consequence (eg. burns, fracture, etc..), By damage characterized by its entity (light, severe , deadly).

The CCA allows just to set the attention and to investigate on the causes of deviation and to go back to the "root causes" of accidents.

### **The investigation protocol**

The structure of Cause Consequence Analysis (CCA), on which the protocol founds him,

The structure of cause-Consequence analysis, which is based on the protocol can be represented according to a scheme to tree in which the initiating events are gathered in categories of reference, the so-called root causes, such as:

- A. structural and plant internal / external characteristics;
- B. equipment (machines) and temporary works;
- C. physical, chemical, biological aspects of workplaces;
- D. interference of functional volumes;
- E. audit, supervision, operating procedures & IFT;
- F. revision and updating of the system, and maintenance;

G. physiological and ideological aspects of the subjects involved.

For all the categories of events that constitute the chain, until to reach the initiating events, it is established to use pre-identified groups of items (collected by the classifications ESAW (*Eurostat, 2012 edition*), as well as from databases or edited), so as to eliminate the possibility of confusion with synonyms by the analyst.

Table 8: Root Causes and Indirect Cause of II Level definition

|   |   |  |
|---|---|--|
| <b>STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS</b>   | <b>External criticality</b>   | <ul style="list-style-type: none"> <li>- General criticality [boundary conditions ( eg. topography, climate, availability of services, sociological context)]</li> <li>- Specific criticality (seismicity, area exposed to floods, avalanches, ...)</li> </ul>   |
|   | <b>Structure</b>  | <ul style="list-style-type: none"> <li>- General structural aspects (eg. general and local stability, allowable loads, materials, quality, efficiency, ...)</li> </ul>   |
|   |   | <ul style="list-style-type: none"> <li>- Specific structural Aspects [eg. Structural safety equipment, escape routes (eg fire escape) and safe places]</li> <li>- Consistency with the uses</li> </ul>   |
|   | <b>Common Plant</b>   | <ul style="list-style-type: none"> <li>- General Plants [eg. distribution systems (production) of energy, management systems of the general environmental conditions (eg. heating, cooling, air exchange, lighting,...), communication systems]</li> <li>- Specific Plants (systems of emergency management, detection, contrast and alarm)</li> </ul>   |
|   | <b>Structure maintenance</b>  | <ul style="list-style-type: none"> <li>- Conservation work</li> <li>- Participation of adaptation to the norms</li> </ul>  |
| <b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS</b>   | <b>Typology</b>   | <ul style="list-style-type: none"> <li>- Machine [tool, operator, auxiliary (eg. pollutant collection systems, cooling, heating, ...)]</li> <li>- Work Equipment [instrumentation, equipment, localized systems of transport energy (eg. power cables, ...)]</li> <li>- Machinery and transport equipment</li> <li>- Devices (command and control, signaling, security)</li> <li>- Works provisional (eg. scaffolding, ...)</li> </ul> |
|   | <b>Choice and conditions of use</b>                                       | <ul style="list-style-type: none"> <li>- Suitability to he development of specific operations in the context</li> <li>- Installation</li> <li>- How to use</li> <li>- Maintenance status</li> </ul>  |
| <b>PHYSICAL, CHEMICAL, BIOLOGICAL ASPECTS OF WORKPLACES</b>   | <b>Physical - chemical - biological critical of working environment</b>   | <ul style="list-style-type: none"> <li>- Raw materials and process products</li> <li>- Products resulting from process deviations</li> <li>- Chemical pollutants (solid, liquid, gaseous)</li> <li>- Physical pollutants (eg noise, vibration, electromagnetic fields and radiation, ...)</li> <li>- Biological agents (eg. viruses, bacteria, ...)</li> </ul>   |
|   | <b>Localized solutions for the management of environmental conditions</b> | <ul style="list-style-type: none"> <li>- Environmental treatment (eg. thermal insulation, acoustic, ...)</li> <li>- Lighting</li> <li>- Massing available</li> </ul>   |
| <b>INTERFERENCE OF FUNCTIONAL VOLUMES</b><br><input type="checkbox"/> Mechanical systems<br><input type="checkbox"/> Mec. sist...- operator<br><input type="checkbox"/> Operator - operator | <b>Use of functional volumes</b>  | <ul style="list-style-type: none"> <li>- Vehicles / machinery / plant / equipment in motion, controlled by operator</li> <li>- Vehicles / machinery / plant / equipment, automated motion (controlled by PLC)</li> <li>- Workers on the move</li> </ul>  |
| <b>AUDIT, SUPERVISION, OPERATING PROCEDURES &amp; IFT</b>   | <b>Procedure</b>  | <ul style="list-style-type: none"> <li>- Audit ;</li> <li>- Supervision;</li> <li>- Procedures for workers;</li> <li>- Procedures for machine operators;</li> <li>- Procedures for personnel systems;</li> <li>- Procedures for supervisors;</li> <li>- Procedures for special operations personnel;</li> <li>- Information, formation and Training</li> </ul>   |
| <b>REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE</b>   | <b>Operating conditions</b>   | <ul style="list-style-type: none"> <li>- Test</li> <li>- Verification functionality before to use</li> <li>- Types of maintenance applied</li> <li>- Revision</li> <li>- Updating systems</li> </ul>   |
| <b>PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED</b>   | <b>Ideological and subject aspects</b>                                    | <ul style="list-style-type: none"> <li>- Behaviour (available to any person to produce answers, determined from the environment, family regarding social situations, groups, and objects)</li> <li>- Position in relation to the duty cycle and the number of shifts</li> <li>- Relationships with supervisors and subordinates</li> <li>- Contract / employment</li> </ul>  |
|   | <b>physiological Aspects</b>  | <ul style="list-style-type: none"> <li>- Age</li> <li>- Work Experience</li> <li>- Conditions of health</li> <li>- Psycho-physical state (eg. depressed, sleepy, drunk, drugged, ...)</li> <li>- Attitude (predisposition for a particular mental or physical activity)</li> </ul>   |

The main areas of reference, however, are solved by the application of possible solutions in order to manage the risk associated with a particular occupation, identified as:

Table 9: Example of intervention type

|  |  |
|--|--|
| <p><b>TECHNICAL INTERVENTIONS</b></p>                      | <ul style="list-style-type: none"> <li>• <b>Structural, plant and technology solutions for the workplace management</b></li> <li>• <b>Plant / technologies solutions for the residual risks management of individual current operational situations (vs. the progress of technology and knowledge)</b></li> <li>• <b>Technological/Plant solutions for interference management: current operational situations</b></li> <li>• <b>Detection / signal / alarm deviations systems (emergencies) external or internal (from process deviations)</b></li> <li>• <b>Technological / plant solutions contrast deviations (emergencies) external or internal (from process deviations) and provided means intervention</b></li> </ul>  |
| <p><b>PROCEDURALE AND ORGANIZATIONAL INTERVENTIONS</b></p> | <ul style="list-style-type: none"> <li>• <b>Definition of the working phases and the contingent operations for the subjects (to the several levels)</b></li> <li>• <b>Procedures for checking presence</b></li> <li>• <b>Procedures of the action of the preplaces to the several levels</b></li> <li>• <b>Operational procedures for the current operating conditions (Signs of danger, prohibition and obligation: call procedure)</b></li> <li>• <b>Procedures of verification, control and detection / reporting / management of elementary functional anomalies</b></li> <li>• <b>Procedures for ordinary and extraordinary maintenance of sites / facilities / equipment including emergency management internal / external</b></li> <li>• <b>Procedures for the detection / warning / alarm emergencies external or internal (from process deviations)</b></li> <li>• <b>Operating procedures in emergency situations internal or external (uncontrollable evolution process) - Signs of Emergency (call procedure),</b></li> <li>• <b>Operating Procedures contrast of external (emergencies) or internal deviation (process deviations) - emergency intervention teams</b></li> </ul> |

As illustrated in the following figure, going back scheme beginning from the identification of the hazard, it is possible to define preventive measures in order to avoid the event under analysis, while going along this pattern as the entity of the lesion, and then identify the direct, indirect of I and II level, the root causes that led to the accident event.

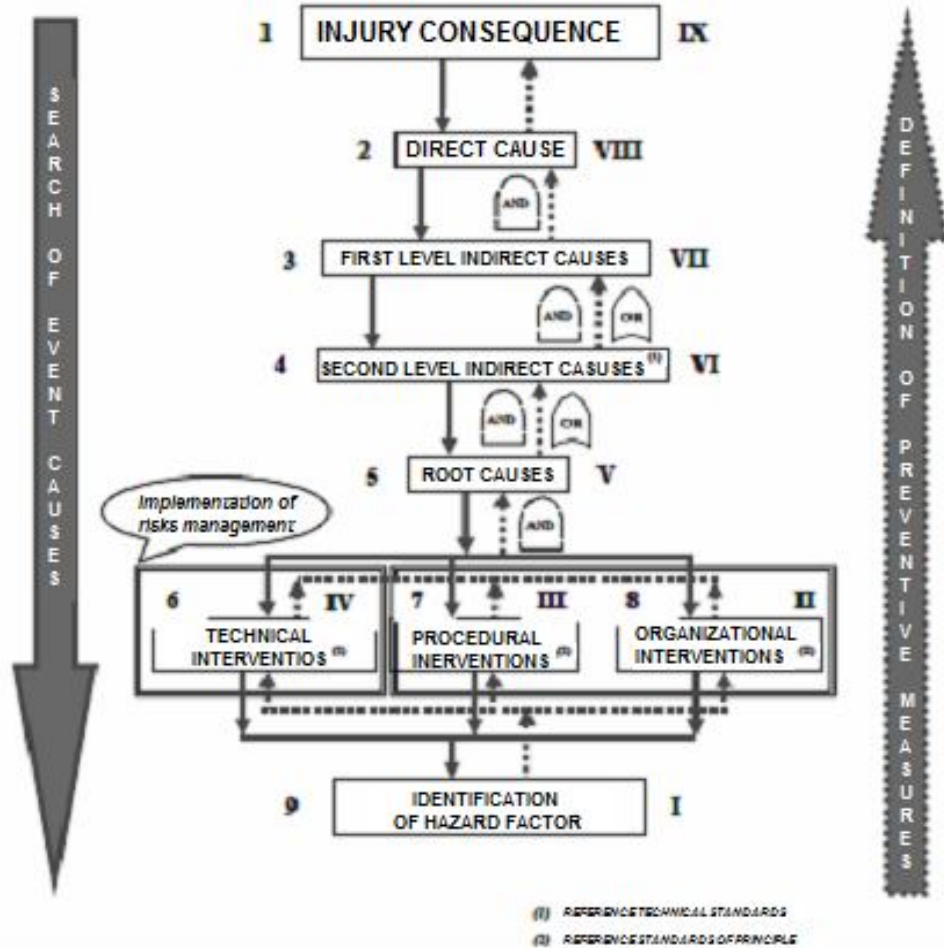


Figure 7: Logical Diagram of the investigation Protocol

It has been therefore possible to establish a logical connection between the principles of Management Occupational Risks assumed like macro-areas of reference and the various categories of initiating events where the intermediate events in the chain of causes can be attributed (see Table 10), reaching for a tree that goes back to the criteria, which refers to the criteria of Table 10.

Table 10: Macro-areas of reference and categories of events initiators

| Macro aree di riferimento   | Categorie cui ascrivere gli eventi iniziatori  |
|---|--|
| <ul style="list-style-type: none"> <li>□ A ÷ D Safety flaws at the work planning stage (poor PtD action)</li> <li>□ E ÷ G: Safety flaws at the work management stage</li> </ul> | <ul style="list-style-type: none"> <li><b>A.</b> structural and plant internal / external characteristics;</li> <li><b>B.</b> equipment (machines) and temporary works;</li> <li><b>C.</b> physical, chemical, biological aspects of workplaces;</li> <li><b>D.</b> interference of functional volumes;</li> <li><b>E.</b> audit, supervision, operating procedures &amp; IFT;</li> <li><b>F.</b> revision and updating of the system, and maintenance;;</li> <li><b>G.</b> audit, supervision, operating procedures &amp; IFT.</li> </ul> |

Table 11: Informing criteria of the investigation technique post-event elaborated

|  |
|--|
| <ul style="list-style-type: none"> <li>✓ inside of the tree every series of events, developed as a list of causal events, is grouped into categories of sequential reference, in order to proceed along the tree until the initiating events;</li> <li>✓ The number of categories of intermediate events adopted was defined through experimentations conducted on real cases: the proposed outline can provide sufficient completeness of reference for shipbuilding and industry events;</li> <li>✓ for the several categories of constituent events the chain, including initiators, refers to pre-identified groups of items, eliminating the possibility of arbitrary using of definition and synonyms by the analyst.</li> </ul> |
|--|

For the several categories have been taken in the lists compiled from an analysis of computerized systems cured from national agencies and organizations, European and non-European countries (see Table 11).

Such approach, although "bulky" in the paper version, is useful for implementation in computer assisted systems where the analyst can make unique choices on the drop down menu.

### Genesis of the levels

In the following table, for a better understanding of the protocol, it gives to illustrate the different levels of the scheme of the philosophical thought represented in Figure 7:

Table 12: Explanation of the different components of the accident consequences processing within the protocol developed

| Injury consequences     | Reference from which the list was drawn up  | In the software   |
|-------------------------|---|---|
| Severity<br>(Days lost) | <p>ESAW encoding phase 2 (1996) [Id]<br/>                     Definition: 'number of full calendar days' where the victim is unfit for work due to an accident at work. Are included only cases of accident involving an absence from work of more than 3 days<br/>                     As mentioned above only full calendar days of absence from work of the victim have to be considered, excluding the day of the accident.</p>   | <p>updated according to specific criteria for hospital emergency departments (introduction of codes of discharge) and simplification of the method ESAW</p> |
| Part of body injured    | <p>ESAW encoding phase 1 (1993)<br/>                     Definition: description of the part of the body injured.<br/>                     The ESAW methodology and data delivery allows only one choice, i.e. only one code can be chosen to describe the injured part(s) of the body. In cases where several parts of the body have been injured, the most serious injury should be chosen e.g. an amputation ranks above a bone fracture, which ranks above a wound etc. In other cases a code for multiple sites should be used at the appropriate level of the classification, e.g., broken hand and foot. In cases where larger parts of the body have been affected, e.g., injuries caused by burns or skalds, a code for multiple sites should be used as well.</p> | <p>updated according to specific criteria for hospital emergency departments</p>  |
| Type of injury          | <p>ESAW encoding phase 1 (1993)<br/>                     Definition: 'physical consequences for the victim' e.g. bone fracture, wounds etc.<br/>                     In case of multiple injuries suffered in one accident where one of the injuries is obviously more severe than the others, then this accident should be classified in the group corresponding to the nature of the more obviously severe injury. Only in cases where the victim has contracted two or more types of injuries and one of them cannot be said to be more serious than the other(s) the code 'multiple injuries' should be used.<br/>                     The current classification is used for the new data ESAW 1997, in accordance with the recommendation of the ILO</p>              |   |

Table 13: Categorie di eventi, loro derivazione e possibili associazioni

| EVENTS CATEGORIES   | Reference from which the causal events list has been drawn up for use in software  | Possible Associations   |
|---|--|---|
| <p><b>Objective cause</b><br/>events directly and univocally associated to the result of the event</p>                              | <p>ESAW encoding phase 3 (2001) - "Contact and mode of injury"</p> <p>Definition: the contact that injured the victim.<br/>This describes how the victim was hurt (physical or mental trauma) by the 'Material Agent' that caused the injury. If there are several 'Contacts -Modes of Injury', the one causing the most serious injury must be recorded.<br/>The classification follows the structure indicated below:<br/>10-29: The various injuries with non-mechanical sources (poison, temperature, electricity and asphyxiation);<br/>30-69: The various injuries with mechanical sources;<br/>70-79: The various injuries caused by physical or mental stress;<br/>80-89: The various injuries caused by animals or humans.</p>  | <p>1<br/>the medical report can determine which is the priority even in the presence of possible causes</p> |
| <p><b>Indirect cause of first level</b><br/>events associated to the category in which the identified objective cause re-enters</p> | <p>ESAW encoding phase 3 (2001) - "deviations"</p> <p>The proposed Deviation classification describes the abnormal event, such as totally or partially losing control of a machine or falling onto/off something.<br/>If there are several interlinked events, the last Deviation must be recorded (the Deviation closest in time to the Contact — Mode of Injury).<br/>The Deviation nomenclature has been organised into the following groups:<br/>Groups 10-30 The Deviation is normally out of the injured person's control and is mainly due to equipment problems.<br/>Groups 40-50 The victim totally or partially loses control of something (including falls).<br/>Groups 60-70 Body movements.<br/>Group 80 The victim, another person or an animal is an active party to the accident.<br/>The classification must be clear and unambiguous, for which reason codes like 'bulky, cumbersome, inadequate equipment' have been removed from the classification.</p> | <p>multiple<br/>often in part concurrent, select from case to case</p>                                      |



|  |   |   |  |
|--|---|---|--|
| <p><b>Indirect cause of second level</b></p> <p>events associated to the category in which the identified indirect causes of first level</p> | Original processing of criticality categories associated with the Root Causes   |   | <p>multiple<br/>often in part concurrent, select from case to case</p> |
| <p><b>Root causes</b></p>  | <p>Original processing obtained by repeat testing on a consistent series of events characterized by injury information detailed and comprehensive</p> | <ul style="list-style-type: none"> <li><b>A. External/internal structural and plant characteristics</b></li> <li><b>B. Machinery, equipment and provisional works</b></li> <li><b>C. Physical, chemical and biological aspects of the work environment</b></li> <li><b>D. Interference of functional volumes</b></li> <li><b>E. Audit, Supervision, Operating procedures &amp; IFT</b></li> <li><b>F. Revision, Updating and Maintenances</b></li> <li><b>A. Physiological, Subjective and ideological aspects</b></li> </ul> |  |
| <p>macro categories of cases in which the root causes are</p>  | <p>Derived directly from the principles of occupational risks management</p>  |   | <p>3<br/>also concomitant</p>  |

|  |   |   |
|--|---|---|
| grouped  |   |   |
| <b>CRITICALITIES TECHNICAL</b>   | <b>CRITICALITIES WORK PLANNING AND CRITICALITIES PROCEDURAL</b>   |   |
| <p><b>Structural, plant and technology solutions for the workplace management</b></p> <p><b>Plant / technologies solutions for the residual risks management of individual current operational situations (vs. the progress of technology and knowledge)</b></p> <p><b>Technological/Plant solutions for interference management: current operational situations</b></p> <p><b>Detection / signal / alarm deviations systems (emergencies) external or internal (from process deviations)</b></p> <p><b>Technological / plant solutions contrast deviations (emergencies) external or internal (from process deviations) and provided means intervention</b></p> | <p><b>Definition of the working phases and the contingent operations for the subjects (to the several levels)</b></p> | <p><b>Procedures for checking presence</b></p> <p><b>Procedures of the action of the preplaces to the several levels</b></p> <p><b>Operational procedures for the current operating conditions (Signs of danger, prohibition and obligation: call procedure)</b></p> <p><b>Procedures of verification, control and detection / reporting / management of elementary functional anomalies</b></p> <p><b>Procedures for ordinary and extraordinary maintenance of sites / facilities / equipment including emergency management internal / external</b></p> <p><b>Procedures for the detection / warning / alarm emergencies external or internal (from process deviations)</b></p> <p><b>Operating procedures in emergency situations internal or external (uncontrollable evolution process) - Signs of Emergency (call procedure),</b></p> <p><b>Operating Procedures contrast of external (emergencies) or internal deviation (process deviations) - emergency intervention teams</b></p> |

| TECHNICAL INTERVENTIONS  | WORK PLANNING AND PROCEDURAL INTERVENTIONS  |  |
|--|---|--|
| <p>Associated with the precedent for prevention scope<br/> <b>(backward path:</b><br/> interventions families needed to prevent the evolution of the causes chain with the control of root causes)</p> | <p>Original processing obtained by repeat testing on a consistent series of events characterized by injury information detailed and comprehensive and e from the adaptation of technical standards</p>  | <p>Multiple<br/> Concomitant for categories, and also in the same category</p> |
| <p><b>Hazard factor</b></p>  | <p>Original processing obtained by UNI EN ISO 12100:2010 (Safety of machinery -- General principles for design -- Risk assessment and risk reduction), that replaces EN 292, 1991, and supplemented by considerations relating to the structure and the working environment</p> | <p>Multiple also concomitant</p>   |
| <p><b>Hazard factors identification</b></p>  | <p>Reference to the list of H.I. Technique and selection criteria of them</p>   | <p>Multiple also concomitant</p>   |

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## **COMPUTER ASSISTED TECHNOLOGY: from the collection of the information on accidental and Near Miss events to the analysis for prevention purposes**

Safety is based on the prevention implementation and not on repairing action, so it is of primary importance to act before abnormal events occur and to anticipate, rather than check their results. But in order to apply this philosophy, it must make so that all the injury and/or near misses information, necessary of the preventive analysis, are collected in a clear, complete and objective way.

Then once available all the data are, it will be possible to apply the analysis and extrapolate the possible actions to ensure the hazardous situations elimination.

### ***The Data collection Approach***

The collection of injury information must involve different points to highlight all the fundamental slight to allow later an objective and effective analysis with the aims of prevention.

On the base of the principles that founds the investigation protocol, it has been developed, with the interaction and participation of Occupational Medicine graduates of the CTO, a questionnaire of collection information, that it was applied and tested in the reality of the Emergency Department of the same hospital (at the time of triage of the patient in case of not serious accidents and at the moment of discharge in case of serious injury).

The purpose of this document has been therefore to go from one side to complete the complaint accident module of INAIL , and on the other hand to offer a tool easy to use and that can speed up analysis, in order to help both the INAIL and analyst to trace clearly the causal chain of events, identifying responsibilities and application solutions.

The developed model is presented as a questionnaire composed of different sections of questions with multiple choice pre-identified answer. The questions were selected on the base of the INAIL original document and relevant to the investigation protocol aspects, only in the coding of the injury severity it has had to resort to two types of classification (in the acceptance module of hospital emergency departments it was used the code of discharge; in the protocol developed the indices of permanent, temporary disability, and death) because these documents are addressed at two different times of the injury analysis. The model is:

Model 1: Data collection model developed for the acceptance in hospital emergency department and to improve the complaint accident module of INAIL

QUESTIONARIO D'ANALISI DI INFORTUNIO

• *Inquadramento Anagrafico*

|                            |  |                                       |  |                                       |                                    |
|----------------------------|--|---------------------------------------|--|---------------------------------------|------------------------------------|
| Iniziali del Nome/Cognome: |  | Sesso/Genere                          |  | Maschio <input type="checkbox"/>      | Femmina <input type="checkbox"/>   |
| Età                        | <18 anni <input type="checkbox"/>          | 18 – 25 anni <input type="checkbox"/> | 25 – 35 anni <input type="checkbox"/>    | 35 – 45 anni <input type="checkbox"/> | > 45 anni <input type="checkbox"/> |
| Nazionalità                |  | Italiana <input type="checkbox"/>     | Straniera:                               |                                       |                                    |
| Grado di Istruzione        | Elementare <input type="checkbox"/>        |                                       | Media Inferiore <input type="checkbox"/> |                                       |                                    |
|                            | Diploma superiore <input type="checkbox"/> |                                       | Laurea e oltre <input type="checkbox"/>  |                                       |                                    |

• *Infortunio*

|  |   |   |   |   |  |
|--|---|---|---|---|--|
| Ora dell'evento :                                      |   | notturno (22.00 – 06.00) <input type="checkbox"/> |   | diurno (06.00 – 22.00) <input type="checkbox"/>             |  |
| Giorno della settimana :                               | lunedì <input type="checkbox"/>   | martedì <input type="checkbox"/>                  | mercoledì <input type="checkbox"/>  | giovedì <input type="checkbox"/>                            |  |
|  | venerdì <input type="checkbox"/>  | sabato <input type="checkbox"/>                   | domenica <input type="checkbox"/>   |   |  |
| Presenza di Calamità Naturali :                        |   | Si <input type="checkbox"/>                       |   | No <input type="checkbox"/>                                 |  |
| Tipologia Infortunio :                                 |   | in sede <input type="checkbox"/>                  |   | in itinere <input type="checkbox"/>                         |  |
| Luogo dell'accaduto :                                  |   | lungo il tragitto <input type="checkbox"/>        | Propria abitazione <input type="checkbox"/>   | Nell'area dell'attività lavorativa <input type="checkbox"/> |  |
| Natura della lesione                                   | non nota <input type="checkbox"/>   |   | Lesione dei tessuti molli <input type="checkbox"/>  |   |  |
|  | Sindrome commotiva e lesioni interne <input type="checkbox"/>   |   | Amputazioni traumatiche (perdita di segmenti del corpo) <input type="checkbox"/>  |   |  |
|  | Lesioni osteoarticolari <input type="checkbox"/>  |   | Ustioni <input type="checkbox"/>  |   |  |
|  | Avvelenamenti <input type="checkbox"/>  |   | Annegamento e asfissia <input type="checkbox"/>   |   |  |
|  | Effetti di suoni, vibrazioni e pressione<br><input type="checkbox"/> trauma acustico<br><input type="checkbox"/> barotrauma<br><input type="checkbox"/> effetti da vibrazioni |   | Effetti di condizioni di temperature estreme, della luce e delle radiazioni<br><input type="checkbox"/> insolazioni e ustioni solari<br><input type="checkbox"/> irradiazione acuta<br><input type="checkbox"/> shock ipotermico e congelamento |   |  |
|  | Rischio biologico<br><input type="checkbox"/> puntura con ago infetto<br><input type="checkbox"/> tagli<br><input type="checkbox"/> contatto con materiali biologici          |   | Shock post-traumatico da stress <input type="checkbox"/>  |   |  |
|  |   | Altro <input type="checkbox"/>                    |   |   |  |
| Sede della lesione                                     | Parte del corpo lesa non specificata <input type="checkbox"/>   |   | Capo <input type="checkbox"/>   | Arti superiori <input type="checkbox"/>                     |  |
|  | Colonna vertebrale <input type="checkbox"/>   | Tronco e organi interni <input type="checkbox"/>  |   | Arti inferiori <input type="checkbox"/>                     |  |
|  | Pluritrauma <input type="checkbox"/>  | Altro <input type="checkbox"/>                    |   |   |  |
| Gravità della lesione : codice di dimissione           |   |   |   |   |  |
| Prognosi   |   |   |   |   |  |
| Stato di salute prima dell'infortunio dell'infortunato |   | Normale <input type="checkbox"/>                  |   | .....   |  |

• *Infortunato e Ambiente di lavoro:*

|  |  |   |                                     |                                     |                                |
|--|--|---|-------------------------------------|-------------------------------------|--------------------------------|
| Distanza tra abitazione e sede lavorativa      |  | < 20 km <input type="checkbox"/>        | 20 – 40 km <input type="checkbox"/> | > 40 km <input type="checkbox"/>    |                                |
| Mezzo usato per raggiungere la sede lavorativa |  | Mezzi pubblici <input type="checkbox"/> | Piedi <input type="checkbox"/>      | Automobile <input type="checkbox"/> | Altro <input type="checkbox"/> |

|                                   |  |                                     |
|-----------------------------------|--|-------------------------------------|
| Status Professionale Infortunato: | Unico lavoro <input type="checkbox"/>  | Più lavori <input type="checkbox"/> |
|                                   | Nessun Lavoro <input type="checkbox"/> | .....                               |

|   |  |  |
|---|--|--|
| Status Professionale Infortunato, se in possesso di uno o più lavori: | Lavoratore autonomo <input type="checkbox"/>     | <b>Dipendente con</b><br><input type="checkbox"/> Occupazione stabile<br><input type="checkbox"/> Occupazione temporanea<br><input type="checkbox"/> tempo pieno/tempo parziale<br><input type="checkbox"/> tempo pieno<br><input type="checkbox"/> tempo parziale<br><input type="checkbox"/> contratto a tempo determinato<br><input type="checkbox"/> contratto a tempo indeterminato |
|   | Coadiuvante familiare <input type="checkbox"/>   |  |
|   | Tirocinante/Apprendista <input type="checkbox"/> | Altro <input type="checkbox"/>   |

|  |  |  |
|--|--|--|
| Attività economica dell'Azienda                | non nota   |  |
|  | Agricoltura, caccia e relativi servizi   |  |
|  | Pesca  |  |
|  | Estrazione di minerali   |  |
|  | Attività manifatturiere  |  |
|  | Produzione e distribuzione di energia elettrica, di gas, di vapore e acqua calda                               |  |
|  | Costruzioni  |  |
|  | Commercio all'ingrosso e al dettaglio; riparazione di autoveicoli, motocicli e di beni personali e per la casa |  |
|  | Alberghi e ristoranti  |  |
|  | Trasporti, magazzinaggio e comunicazioni   |  |
|  | Intermediazione monetaria e finanziaria  |  |
|  | Attività immobiliari, noleggio, informatica, ricerca, altre attività professionali e imprenditoriali           |  |
|  | Pubblica amministrazione e difesa; assicurazione sociale obbligatoria  |  |
|  | Istruzione   |  |
|  | Sanità e altri servizi sociali   |  |
| Altri servizi pubblici, sociali e personali    |  |  |
| Servizi domestici presso famiglie e convivenze |  |  |
| Organizzazioni ed organismi extraterritoriali  |  |  |

|                    |  |  |
|--------------------|--|--|
| Sede dell'Attività | Nessuna informazione <input type="checkbox"/>  | <b>Sito Industriale</b><br><input type="checkbox"/> Luogo di produzione, officina, laboratorio<br><input type="checkbox"/> Area destinata ad operazioni di manutenzione o riparazione<br><input type="checkbox"/> Luogo dedicato principalmente al magazzinaggio, al carico, allo scarico<br><input type="checkbox"/> Altro  |
|                    | <b>Cantiere di costruzione, cava, miniera a cielo aperto</b><br><input type="checkbox"/> edificio in demolizione, in restauro, manutenzione<br><input type="checkbox"/> Cava, miniera a cielo aperto, scavo, trincea (le miniere a cielo aperto, cave in esercizio)<br><input type="checkbox"/> Cantiere sotterraneo<br><input type="checkbox"/> Cantiere sull'acqua<br><input type="checkbox"/> Cantiere in ambiente iperbarico<br><input type="checkbox"/> Altro | <b>Luogo per l'agricoltura, l'allevamento, forestale, ittico</b><br><input type="checkbox"/> Luogo di allevamento<br><input type="checkbox"/> Luogo agricolo<br><input type="checkbox"/> Zona forestale<br><input type="checkbox"/> Zona ittica, pesca, acquacoltura (non a bordo di imbarcazione)<br><input type="checkbox"/> Giardino, parco, orto botanico, parco zoologico<br><input type="checkbox"/> Altro |
|                    | <b>Luogo di attività terziaria, ufficio, luogo di svago, varie</b><br><input type="checkbox"/> Ufficio, sala di riunione, biblioteca, ecc.<br><input type="checkbox"/> Istituto di insegnamento, scuola d'ogni ordine e grado<br><input type="checkbox"/> Luogo di vendita, piccolo o grande (vendita ambulante)   | <b>Luogo pubblico</b><br><input type="checkbox"/> Luogo aperto in permanenza al transito del pubblico (via d'accesso, di circolazione, zona di stazionamento, sala d'attesa in stazione/aerostazione, ecc.)<br><input type="checkbox"/> Mezzo di trasporto terrestre, strada/rotaia, privato o pubblico (treno, bus, automobile, ecc.)   |

|  |   |
|--|---|
| <input type="checkbox"/> Ristorante, albergo, pensione, luogo di svago (musei, luoghi di spettacolo, fiere, ecc)<br><input type="checkbox"/> Altro   | <input type="checkbox"/> Zona connessa ai luoghi pubblici ad accesso riservato al personale autorizzato: ferrovia, pista d'aeroporto, corsia d'emergenza d'autostrada<br><input type="checkbox"/> Altro   |
| <b>Luogo di cura</b> <input type="checkbox"/>  | <b>Domicilio</b><br><input type="checkbox"/> Domicilio privato<br><input type="checkbox"/> Parti comuni, locali di servizio, giardino attinente la proprietà privata<br><input type="checkbox"/> Altro tipo di luogo  |
| <b>Luogo di attività sportiva</b><br><input type="checkbox"/> All'interno<br><input type="checkbox"/> All'esterno<br><input type="checkbox"/> Altro  | <b>Luogo aperto, in alto (cantieri esclusi)</b><br><input type="checkbox"/> In alto - Su un piano fisso (tetto, terrazza)<br><input type="checkbox"/> In alto - Palo, pilone, piattaforma sospesa<br><input type="checkbox"/> Per aria - A bordo di un aeromobile, ecc.<br><input type="checkbox"/> Altro |
| <b>Ambiente sotterraneo (cantieri esclusi)</b><br><input type="checkbox"/> Tunnel<br><input type="checkbox"/> Miniera<br><input type="checkbox"/> Impianti fognari<br><input type="checkbox"/> Altro   | <b>Sull'acqua (cantieri esclusi)</b><br><input type="checkbox"/> Mare o oceano - A bordo di ogni tipo di imbarcazione<br><input type="checkbox"/> Lago, fiume, porto - A bordo di ogni tipo di imbarcazione<br><input type="checkbox"/> Altro   |
| <b>Ambiente iperbarico (cantieri esclusi)</b><br><input type="checkbox"/> Ambiente iperbarico - sott'acqua<br><input type="checkbox"/> Ambiente iperbarico - cassoni<br><input type="checkbox"/> Altro | <b>Altro tipo di luogo non indicato nella presente nomenclatura</b> <input type="checkbox"/>  |

|   |  |   |   |   |
|---|--|---|---|---|
| <b>Qualità ambientale, presenza di rischi fisici:</b> | particolati aerodispersi <input type="checkbox"/>    | Rumore <input type="checkbox"/>                             | Vibrazioni <input type="checkbox"/>         | Scarsa illuminazione <input type="checkbox"/> |
|   | radiazioni ionizzanti e non <input type="checkbox"/> | Scarsa ventilazione/ricambi d'aria <input type="checkbox"/> | discomfort termico <input type="checkbox"/> |   |

|  |                                |  |
|--|--------------------------------|--|
| <b>Suddivisione spazio lavorativo:</b> | unico <input type="checkbox"/> | Suddiviso in aree di lavoro comunicanti <input type="checkbox"/> |
|  |                                | Suddiviso in aree di lavoro separate <input type="checkbox"/>    |

|  |                             |                             |   |
|--|-----------------------------|-----------------------------|---|
| <b>Presenza di macchinari in movimento (interferenza):</b> | No <input type="checkbox"/> | Si <input type="checkbox"/> | <input type="checkbox"/> Muletti/ carrelli elevatori<br><input type="checkbox"/> parti di macchinari in movimento (bracci)<br><input type="checkbox"/> Mezzi di trasporto merci/persone<br><input type="checkbox"/> Altro |
|--|-----------------------------|-----------------------------|---|

|                                      |
|--------------------------------------|
| <b>Professione dell'Infortunato:</b> |
|--------------------------------------|

|                              |  |   |
|------------------------------|--|---|
| <b>Tipo di lavorazione :</b> | Tempistica predeterminata <input type="checkbox"/> | Tempistica autogestita <input type="checkbox"/> |
|------------------------------|--|---|

|                    |   |   |
|--------------------|---|---|
| <b>Turnazione:</b> | notturno (22.00 – 06.00) <input type="checkbox"/> | diurno (06.00 – 22.00) <input type="checkbox"/> |
|--------------------|---|---|

|                         |                                  |                                  |  |
|-------------------------|----------------------------------|----------------------------------|--|
| <b>Orari di lavoro:</b> | ≤ 8 ore <input type="checkbox"/> | > 8 ore <input type="checkbox"/> | <input type="checkbox"/> straordinario<br><input type="checkbox"/> Turno lavorativo ≥ 10 ore |
|-------------------------|----------------------------------|----------------------------------|--|

|  |                             |                             |   |
|--|-----------------------------|-----------------------------|---|
| <b>Compresenza di persone nel ciclo lavorativo :</b> | No <input type="checkbox"/> | Si <input type="checkbox"/> | <input type="checkbox"/> contribuiscono al ciclo<br><input type="checkbox"/> non contribuiscono |
|--|-----------------------------|-----------------------------|---|

|   |   |
|---|---|
| <b>Ha seguito corsi di Formazione/Informazione ed addestramento: (procedure operative di sicurezza sul macchinario usato)</b> | No <input type="checkbox"/>                                       |
|   | Si <input type="checkbox"/><br>Quando l'ultimo?.....<br>Che cosa? |

|  |  |   |  |
|--|--|---|--|
| <b>Utilizzo di DPI nel ciclo lavorativo:</b> | Guanti <input type="checkbox"/>                    | Casco <input type="checkbox"/>                    | Protettori acustici <input type="checkbox"/> |
|  | Tute particolari <input type="checkbox"/>          | Occhiali/Maschere visive <input type="checkbox"/> |  |
|  | Scarpe antinfortunistiche <input type="checkbox"/> | Maschere antipolvere <input type="checkbox"/>     |  |



### Infortunio In Itinere

|                          |       |
|--------------------------|-------|
| Dinamica dell'accaduto : | ..... |
|--------------------------|-------|

### • Infortunio In Sede

|  |   |   |
|--|---|---|
| <b>Attività lavorativa svolta al momento dell'infortunio</b> | Nessuna informazione <input type="checkbox"/>   | <b>Produzione, trasformazione, trattamento, magazzino:</b><br><input type="checkbox"/> Produzione, trasformazione, trattamento<br><input type="checkbox"/> Magazzinaggio<br><input type="checkbox"/> Altro tipo di lavoro   |
|  | <b>Sterro, costruzione, manutenzione e demolizione edili:</b><br><input type="checkbox"/> Sterro<br><input type="checkbox"/> Edilizia (Costruzione)<br><input type="checkbox"/> Genio civile, infrastrutture, strade, ponti, dighe, porti (Costruzione)<br><input type="checkbox"/> Restauro, riparazione, ampliamento<br><input type="checkbox"/> Demolizione<br><input type="checkbox"/> Altro tipo di lavoro   | <b>Attività di tipo agricolo, forestale, ittico, con l'uso di animali vivi:</b><br><input type="checkbox"/> agricolo, trattamento del terreno<br><input type="checkbox"/> agricolo, coltura dei vegetali<br><input type="checkbox"/> agricolo che comporti l'allevamento o l'uso di animali vivi<br><input type="checkbox"/> forestale<br><input type="checkbox"/> ittico, pesca<br><input type="checkbox"/> Altro tipo di lavoro   |
|  | <b>Attività di servizio all'impresa e/o alla persona umana; lavoro intellettuale:</b><br><input type="checkbox"/> Attività di servizio, cura, assistenza alla persona umana<br><input type="checkbox"/> Attività intellettuale - insegnamento, formazione, trattamento dell'informazione, lavoro d'ufficio, attività di organizzazione, di gestione<br><input type="checkbox"/> Attività commerciale: acquisto, vendita, attività ad esse complementari<br><input type="checkbox"/> Altro | <b>Attività complementari a quelle espresse dai precedenti gruppi:</b><br><input type="checkbox"/> Installazione, preparazione, montaggio, smontaggio<br><input type="checkbox"/> Manutenzione, riparazione, registrazione, messa a punto<br><input type="checkbox"/> Pulizia di locali, di macchine - industriale o manuale<br><input type="checkbox"/> Gestione dei rifiuti, raccolta e trattamento dei rifiuti di ogni tipo<br><input type="checkbox"/> Sorveglianza, ispezione - di processi di fabbricazione, di locali, di mezzi di trasporto, di attrezzature - con o senza materiale di controllo<br><input type="checkbox"/> Altro |
|  | <b>Circolazione, attività sportiva, attività artistica:</b><br><input type="checkbox"/> Circolazione, con o senza mezzi di trasporto<br><input type="checkbox"/> Attività sportiva, attività artistica<br><input type="checkbox"/> Altro tipo di lavoro   | Altro tipo di lavoro <input type="checkbox"/>   |

|                             |                                    |  |  |
|-----------------------------|------------------------------------|--|--|
| <b>Attività lavorativa:</b> | ordinaria <input type="checkbox"/> | Straordinaria <input type="checkbox"/> | <input type="checkbox"/> saltuaria<br><input type="checkbox"/> prima volta |
|-----------------------------|------------------------------------|--|--|

|                                   |  |   |
|-----------------------------------|--|---|
| <b>Attività fisica specifica:</b> | <b>Operazioni di macchina</b><br><input type="checkbox"/> Avviare la macchina, arrestare la macchina<br><input type="checkbox"/> Alimentare/Disalimentare la macchina<br><input type="checkbox"/> Sorvegliare, fare funzionare la macchina<br><input type="checkbox"/> Altro   | <b>Trasporti manuali</b><br><input type="checkbox"/> verticale: sollevare, alzare, portare in basso un oggetto<br><input type="checkbox"/> orizzontale: tirare, spingere, rotolare un oggetto<br><input type="checkbox"/> trasporto a mano di carichi<br><input type="checkbox"/> Altro   |
|                                   | <b>Movimenti</b><br><input type="checkbox"/> Camminare, correre, salire, scendere, ecc.<br><input type="checkbox"/> Entrare, uscire<br><input type="checkbox"/> Saltare, slanciarsi, ecc.<br><input type="checkbox"/> Strisciare, arrampicarsi<br><input type="checkbox"/> Alzarsi in piedi, sedersi<br><input type="checkbox"/> Nuotare, tuffarsi | <b>Manipolazione oggetti</b><br><input type="checkbox"/> prendere in mano, afferrare, strappare, tenere in mano, deporre - su piano orizzontale<br><input type="checkbox"/> legare, allacciare, sciogliere, disfare, stringere, avvitare, svitare, girare<br><input type="checkbox"/> fissare a, appendere, alzare, installare - su un piano verticale<br><input type="checkbox"/> Lanciare, proiettare lontano |

|  |   |  |
|--|---|--|
|  | <input type="checkbox"/> Movimenti sul posto<br><input type="checkbox"/> Altro  | <input type="checkbox"/> Aprire, chiudere (cassa, imballaggio, pacco)<br><input type="checkbox"/> Spargere, versare in, riempire, annaffiare, vuotare, prosciugare<br><input type="checkbox"/> Tirare (es. cassetto), spingere (es. porta di un capannone, armadio)<br><input type="checkbox"/> Altro                                    |
|  | <b>Lavoro con utensili a mano</b><br><input type="checkbox"/> utensili a mano manuali<br><input type="checkbox"/> utensili a mano motorizzati<br><input type="checkbox"/> Altro | <b>Alla guida, a bordo di una attrezzatura di movimentazione</b><br><input type="checkbox"/> condurre un' attrezzatura di movimentazione mobile e motorizzato<br><input type="checkbox"/> condurre un' attrezzatura di movimentazione mobile e non motorizzato<br><input type="checkbox"/> Altro   |
|  | <b>Presenza</b> <input type="checkbox"/>  | <b>Alla guida, a bordo di un mezzo di trasporto</b><br><input type="checkbox"/> condurre un mezzo di trasporto mobile e motorizzato<br><input type="checkbox"/> condurre un mezzo di trasporto mobile e non motorizzato<br><input type="checkbox"/> essere passeggero a bordo di un mezzo di trasporto<br><input type="checkbox"/> Altro |
|  | Altro..... <input type="checkbox"/>   |  |

|  |   |   |
|--|---|---|
| <b>Macchinari utilizzati nell'attività al momento dell'infortunio:</b> | <b>Si</b><br><input type="checkbox"/> Componente di macchina/utensile<br><input type="checkbox"/> Dispositivo di segnalazione, regolazione, comando<br><input type="checkbox"/> Mezzo di trasporto materiali<br><input type="checkbox"/> Componente di mezzo di trasporto materiali<br><input type="checkbox"/> Mezzi di produzione, stoccaggio e fiato | <input type="checkbox"/> Componente di mezzi di trasporto persone<br><input type="checkbox"/> Macchina utensile<br><input type="checkbox"/> Macchina operatrice<br><input type="checkbox"/> Componente di macchina operatrice<br><input type="checkbox"/> Organo di macchina operatrice<br><input type="checkbox"/> Componente di macchina<br><input type="checkbox"/> Mezzi di trasporto materiale/persone<br><input type="checkbox"/> Mezzi di trasporto di persone<br><input type="checkbox"/> Componente di mezzi di produzione, stoccaggio e sfianto |
|  | <b>No</b> <input type="checkbox"/>  |   |

|  |                                    |           |
|--|------------------------------------|-----------|
| <b>Sicurezze installate sulle macchine usate</b> | <b>No</b> <input type="checkbox"/> | <b>Si</b> |
|--|------------------------------------|-----------|

|  |                                    |  |
|--|------------------------------------|--|
| <b>Attrezzature utilizzate nell'attività al momento dell'infortunio:</b> | <b>No</b> <input type="checkbox"/> | <b>Si</b> <input type="checkbox"/> Attrezzatura non legata alla produzione presente<br><input type="checkbox"/> Attrezzatura da lavoro<br><input type="checkbox"/> Organo attrezzatura di lavoro |
|--|------------------------------------|--|

|  |                                    |                 |
|--|------------------------------------|-----------------|
| <b>Sicurezze installate sulle attrezzature usate</b> | <b>No</b> <input type="checkbox"/> | <b>Si</b> ..... |
|--|------------------------------------|-----------------|

|   |                                    |   |
|---|------------------------------------|---|
| <b>Il macchinario/attrezzatura usato ha subito delle modifiche dopo la formazione dell'infortunato:</b> | <b>No</b> <input type="checkbox"/> | <b>Si</b> <input type="checkbox"/> sicurezze<br><input type="checkbox"/> tecniche proprie del macchinario<br><input type="checkbox"/> organizzative/procedurali |
|---|------------------------------------|---|

Essentially the module is composed of four sections:

1. First section: basic identifying information are requested (the initial name, sex, age, nationality, level of education);
2. Injury section: is framed in terms of the day, hour and place the event, by pointing out even if there were the presence of natural disasters; is analyzed the type of injury (on-site or in transit), location and nature of the injury, gravity (for simplicity identified with the codes of discharge of the emergency room), prognosis, and finally the health of the injured before the accident.
3. Relationship between the worker and the work environment: distance from the worker's house to the work place, the means used to reach work place, type of employment status of the worker, type of economic activity of work environment, workplace, the environmental quality of the working reality, subdivision of the working space, the presence of other machinery and persons moving in the injury place and finally the specific work of the injured, illustrating his profession, the type carried out working and the respective training, PPE, working hours performed;

4. accident in transit: it is left open field for the explanation of what happened.
5. accident on-site: it is gone to pay attention to what happened at the time of the accident like the working activity of the victim, even if it was a routine activity, the specific activity or what exactly was the victim and if used machines / equipment for the operation.

### ***The computer assisted technique for the in-depth analysis of Work related Accidents***

The software is developed with Microsoft Visual Basic 6.0 Professional. The user (analysts, business and court consultants, technicians of supervisors, etc.) interacts easy with the program: he is driven in the compilation of a series of tabs for collecting data through windows, fields and drop-down menu that reduce the possibility of errors, that afford to obtain an adequate schematic leaving little space for subjective interpretation of the facts and avoid that important information about the event are left out.

The structure of the program is realized thanks to the collaboration of the Turin computer science study Geo & Soft of Eng. George Scioldo.

#### **The structure of the software**



The software is structured according to twelve different sections listed below:

1. Identifying Details of the event
2. Data injured
3. Enterprise of Injured
4. Risk Analysis of injured enterprise
5. Host Enterprise (possible card)
6. Accident consequences
7. Boundary data
8. Injury information
9. Analysis of corporate risk
10. Causes Analysis and Prevention

- a. Direct Cause
- b. Indirect Causes of the First Level
- c. Causes indirect Second Level
- d. Association of the causes
- e. Analysis of the causes
- f. Interventions
- g. Association of interventions
- h. Analysis of the interventions

11. Solutions

12. Final data

The sections, each composed of one or more cards where the different variables are linked logically, following a kind of guided tour that permits a rapid data collection, and allows, if it can't be possible to compile them immediately, to temporarily skip some fields; in fact, it is not said that the user, who collects the accident data just happened, has the possibility to know instantaneously all the information of which he needs.

Besides the fields where this is not possible (thinking to the injured name and the surname), the compilation of the other is based on the choice among the various options, presented by drop – down menu and by predefined voices of every variable, reducing minimizing the possibilities of compilation error.

Many of the predefined voices have been drafts from the ESAW classification (*Eurostat, 2012*) (Appendix A contains a list), but some are revisited or integrated in accordance with what found in other databases and especially thanks to the experience matured from direct tests with the lists on real cases.

The section of the causes analysis and prevention allows the connection to other eight cards, that are designed specifically to go back, through different levels, to accident Root Causes and to obtain important information for the prevention.

| <b>RICERCA CAUSE – criterio generale per la compilazione del programma</b>   |  |
|--|--|
| 1. Direct Cause  | <b>A.</b> Injury consequence (severity, type of injury and part of body injured)<br>[selected by the ESAW encodings Phase 1 and 2, revised and reworked on the selection in Accident Consequences] |
|  | <b>B.</b> Only and obligatory selection of the injury Direct/Objective Cause (selected by the ESAW encodings Phase 3 " Contact and mode of injury")  |
| 2. Multiple selection of indirect causes of first level<br>(selected by the ESAW encodings Phase 3 " deviations")  |  |
| 3. Multiple selection of indirect causes of second level of event and a root causes identification<br>(selected by original processing of categories associated to Root Causes)  |  |
| 4. Association of the causes - It is associated to each Indirect Cause of II Level, chosen during the CCA, a letter of the alphabet in according to the principle of cause - effect applicable in the reverse path among the levels identified: the causes of the upper level are the causes, while those of the |  |

|   |   |
|---|---|
| <i>lower level, closely related, are the effects.</i>   |   |
| 5. <i>Analysis of the Causes:</i> it is visualized the graphical layout that illustrates links among the various causes previously selected and also by selection of the shortest path carries in passages short to the incident                      |   |
| 6. <i>Interventions : Application of the risks management implemetation of event (grouped into macro categories of intervention selectable derived from the principles of management - original processing) :</i>                                     | <i>technical criticalities</i>                                  |
| <ul style="list-style-type: none"> <li>❖ <i>Safety flaws at the worl planning stage (poor PtD action)</i></li> <li>❖ <i>Safety flaws at the work management stage</i></li> </ul>  | <i>procedural criticalities and work planning criticalities</i> |
| 7. <i>Association of interventions:</i> it is associated with each intervention, chosen during the CCA, a letter of the alphabet in according to the cause - effect principle applicable in the reverse path among the levels identified..            |   |
| 8. <i>Analysis of interventions:</i> it is visualized the graphical layout that illustrates links among the various interventions and causes previously selected and also by selection of the shortest path carries in passages short to the incident |   |

### Identifying Details of the event

This first section includes all the necessary information to describe the event, to individualize of the people that occupy and that they have intervened.

The screenshot shows a software window titled "Infortuni sul lavoro" with a tabbed interface. The active tab is "Dati Identificativi Evento". The form contains the following fields and options:

- Numero/Codifica Evento:** prova 1
- Data Infortunio:** gg, mm, aa
- Ora Infortunio:** hh, mm
- Numero Registro Infortuni:** [Empty]
- Luogo Infortunio:** presso altra ditta
- ASL Competente:** Selezionare
- 1° Intervento Ispettivo:** gg, mm, aa
- Nome Ispettore ASL:** < 5, > 5
- Figure esterne intervenute:** SI (selected), NO
- Interventi:** Vigili del Fuoco (CF, LF), Polizia (CF, LF), Vigili Urbani (CF, LF), Carabinieri (CF, LF), Ispettor. Lavoro (CF, LF), Altri (CF, LF)
- Data Apertura Caso (Magistratura):** gg, mm, aa
- Date Sopralluoghi (0):** gg, mm, aa
- Alterazione dello Stato di fatto nell'immediatezza:** SI (selected), NO
- Interventi:** per soccorso (CF, LF), per messa in sicurezza (CF, LF)

Buttons at the bottom include "Nuovo", "Leggi dati", "Annulla", "Successivo >", and a help icon.

Figure 8: Identifying details of the events card

In this card it focus on some fundamental aspect, such as "Accident Place": it defines if the accident is happened in head office or in a branch

office of work, or in other enterprise or in transit. According to the chosen case there will be various way to operate and to take part.

### Data Injured

The second section regards the data, both personal type that professional type, which relate to the injured person.

The screenshot shows a software window titled "Infortunati sul lavoro" with a tabbed interface. The active tab is "Dati Parte offesa". The form contains the following fields and controls:

- Nome Cognome P.O.: (Inserire) (Inserire)
- Gender:  M  F
- Data di Nascita: gg mm aa (dropdowns)
- Nazione di Nascita: (Selezionare) (dropdown)
- Comune di Domicilio: (dropdown)
- Indirizzo di Domicilio: (text input)
- Recapito Telefonico: (text input)
- Codice ASL appartenenza: (dropdown)
- Codice ISTAT: (dropdown)
- Grado Istruzione P.O.: Nessuno (dropdown)
- Lingua Madre: <seleziona> (dropdown)
- Status Professionale P.O.:  Lavoratore Autonomo  Altro (dropdown)
- Stato Civile:  Celibe/Nubile  Vedovo/a  Separato/a  Divorziato/a  Tutelato/a  Coniugato/a
- Numero Persone a Carico: 0 (text input)
- Importo Retributivo Infortunato: €/anno (text input)
- Calcola il Codice Fiscale: (button)
- Buttons: Nuovo, Leggi dati, Annulla, Precedente, Successivo >, ?

Figure 9: Data injured card

This section, besides to include the necessary data for identification of the worker, requires information about the contractual and working position of the injured. In Italy, INAIL in case of an accident is the responsible institution for protecting the worker economically and to cover any costs of treatment and recovery in hospital.

Among the voices also appears the "preferred language by the injured." Some indications about these data are contained in Legislative Decree n.. 81/2008 Title I, Chapter III, Section IV, Art. 36 (information to the workers).

More specifically, in paragraph 4 it is provided that "the content of the worker information must be easily understandable and must enable them to acquire the relevant knowledge.

Where the information relates to foreign workers, it is done after checking the understanding of the language used in the "information path".

A linguistic misunderstanding may therefore contribute to the occurrence of an accident.

### Firm of employee

This section requires the information on organization for which the injured works. It can regard both the private and public sector.

Figure 10: Firm of employee of injured card

The variables required are used to frame the economic - productive environment - in which operate the injured activity (Public Sector, Private or Third Parties present at Legitimate Title).

In this card it specifies where exactly the PO has working, which in head office or in a branch office.

Furthermore, once identified the type of affiliation economic/private of PO it is specified the essential characteristics of this sector by introducing the "company documents security", as the Legislative Decree no. 81/08 requires risks analysis for all activities that are not at major accident risk, which falling instead in the DPR 175/88 and modify better known as "Seveso Directive".

Art. 17 of the Legislative Decree n. 81/08 provides that the employer can not delegate the evaluation of safety and health risks of workers, and let alone the development of the document to be drawn up at the end of the evaluation.

It is important to note that as reported by art. 29 the employer carries out the evaluation and processes the document in collaboration with the responsible of preventions and protection service, and the competent doctor, after consultation with the representative of the workers' safety. This appraisal must be immediately revised in the event of changes in the production process or in the organization of work for the health and safety of workers, or in relation to the degree of technical evolution, for prevention or protection as a result of injuries or when the results of health surveillance show that it is necessary.

The existence of the safety documentation (of which the date of preparation and last update is always required) is therefore very

important, since, in addition to meeting the requirements from the law, it allows to get more quickly to the identification of injury causes.

### Risks Analysis of injured enterprise

The screenshot shows the 'Analisi di Rischio Aziendale' card in the 'Infortuni sul lavoro' software. The interface is organized into several sections:

- Analisi di Rischio Esistente:** Includes radio buttons for 'SI' and 'NO', a 'Data Ultimo Aggiornamento' field with dropdowns for 'gg', 'm', and 'aa', and 'CF' and 'LF' buttons.
- MOTODOLOGIA VALUTAZIONE DEL RISCHIO:** Contains checkboxes for 'Check List', 'Job Safety', 'HAZOP', 'FTA', 'What If', 'FMEA', and 'Altro'.
- Metodiche di calcolo del rischio:** Includes radio buttons for 'Stima Soggettiva' and 'Statistica Dati Secondo il Worst Credible Case', and checkboxes for 'Valutazione Condivisa' and 'Livello Frequenza Attesa di Accadimento'.
- La Valutazione del Rischio comprende:** Contains radio buttons for 'NO' and 'SI', and checkboxes for 'Tecniche', 'Organizzative', 'Procedurali', and 'DPI'.
- ASPETTI SPECIFICI DELLA V.R. RELATIVI ALL'EVENTO INFORTUNISTICO:** Includes radio buttons for 'SI' and 'NO', a 'Da Quanto Tempo lo Svolgeva' dropdown menu, and checkboxes for 'Periodico' and 'Su richiesta del Lavoratore'.

At the bottom, there are navigation buttons: 'Nuovo', 'Leggi dati', 'Annulla', 'Precedente', and 'Successivo >', along with a red question mark icon.

Figure 11: Risks analysis of injured enterprise card

This section includes data regarding the essential characteristics of the present safety documentation in the company at the time of the accident, in particular the modalities of execution and elaboration, like the methodology used for the Risk Assessment. Particular attention is given on how it is processed the risk assessment in the company, identifying first of all which techniques were used for the Hazard identification. Then the attention is placed on the methods of risk calculation, where depending on the selection of the type of ED (severity), FC (contact factor) and P (probability of occurrence) is evaluated "Objective" or "Subjective" the risk assessment prepared (L.Faina et al., 1996-97).

At last, the relationship between risk assessment and place where the accident occurred is evaluated, or if the employee had been the subject of training with respect to the process under investigation, and to the possible presence of Protective Clothing and / or DPI .

### Host Enterprise

This card is optional, it is activated only if the card "Identification Details of Event" to the question " Injury Place " is chosen "at another company":



| Dati Identificativi Caso                          |  | Dati Parte offesa                      | Ditta Infortunato  | Analisi di Rischio Aziendale                          | Ditta Ospitante  | Conseguenze Infortunio         |
|---|--|--|--|---|--|--------------------------------|
| Dati al Contorno                                  | Informazioni Infortunio                                      | Analisi Cause e Prevenzione            | Soluzioni  | Dati finali   |  |                                |
| Settore Pubblico                                  | <input checked="" type="radio"/> SI <input type="radio"/> NO | Sede Centrale                          | <input checked="" type="radio"/> SI <input type="radio"/> NO | Sede distaccata con autonomia in materia di sicurezza | <input checked="" type="radio"/> SI <input type="radio"/> NO |                                |
| Codice Ministero                                  |  | Numero Dipendenti                      | Non Conosciuto   |   |  |                                |
| Indirizzo   | Via - n° civico  |  | C.A.P.   | Località  |  |                                |
| Codice Ditta                                      |  | Indirizzo Sede distaccata              | (Inserire)   |   |  |                                |
| Codice Fiscale / Parità IVA                       |  | Tipo Attività Economica                | (Selezionare Voce)   |   |  |                                |
| Tipo Polizza Assicurativa                         |  |  |  |   |  |                                |
| Numero Polizza Assicurativa                       |  |  |  |   |  |                                |
| Esente DUVRI                                      | <input checked="" type="radio"/> SI <input type="radio"/> NO | CF                                     | LF   |   |  |                                |
| Data Redazione                                    | gg   | mm                                     | aa   |   |  |                                |
| Firme Figure Preposte                             | Azienda Ospitante  | <input type="checkbox"/> Datore Lavoro | <input type="checkbox"/> R.S.P.P.                            | <input type="checkbox"/> Medico Competente            | <input type="checkbox"/> R.L.S.                              | <input type="checkbox"/> Altro |
|   | Ditta della P.O.   | <input type="checkbox"/> Datore Lavoro | <input type="checkbox"/> R.S.P.P.                            | <input type="checkbox"/> Medico Competente            | <input type="checkbox"/> R.L.S.                              | <input type="checkbox"/> Altro |
| Previsi indumenti di lavoro speciali nel contesto | <input checked="" type="radio"/> SI <input type="radio"/> NO | CF                                     | LF   |   |  |                                |
| Interventi ispettivi antecedenti infortunio       | <input checked="" type="radio"/> SI <input type="radio"/> NO | Prescrizioni da adempiere              | <input checked="" type="radio"/> SI <input type="radio"/> NO | CF  | LF   |                                |

Nuovo Leggi dati Annulla Precedente Successivo > ?

Figure 12: Host enterprise card

The card is analogous to that of the "Enterprise of injured", but simplified in a description of the sector of affiliation and in the address of the head office.

Even here the focus is on the safety documentation, in this case the "DUVRI", and the safety figures in the branch office.

### Injury consequences

It goes on to analyze what has occurred when the event happened:

Figure 13: Injury consequences card

- ❖ the type of relief that took place immediately after the incident to the injured;
- ❖ Type of injury;
- ❖ Part of body injured;
- ❖ Severity (days lost) of the accident.

The severity identified before with days of prognosis and then in definitive days is a list of pre-identified choices starting from the ESAW encoding Phase 2 (1996) - lost days, which means the number of calendar days in which the victim has been absent from work due to an accident at work, which is updated according to specific criteria for hospital emergency departments (introduction of codes of discharge) and so a simplification of the ESAW method.

While the part of body injured and type of injury have been drafted from ESAW encoding Phase 1 (1993), updated in accordance with specific criteria for hospital emergency departments (introduction of codes of discharge) and simplification of the method ESAW.

### Boundary data

This section applies to those data that surround the accident but that are important in order to define greater detail the context in which it occurred.

The screenshot shows a software window titled "Infortuni sul lavoro" with a tabbed interface. The active tab is "Dati al Contorno". The form contains the following fields and controls:

- Infotunio all'aperto:** Radio buttons for "SI" (selected) and "NO".
- Condizioni Meteo / Strade:** Two dropdown menus.
- Dati Riguardanti il Luogo:** Checkboxes for Rumoroso, Buio, Ventilato, Caldo, Freddo, Polveroso, and Umido.
- Stato Infortunato Inizio Turno:** Checkboxes for Normale, Sonnol., Depresso, Ubbriaco, and Altro.
- Data Conoscenza Infort. Dat. Lav.:** Three dropdown menus (gg, mm, aa) and **Ora Conoscenza Infort. Dat. Lav.:** Two dropdown menus (hh, gg).
- Data Segnalazione del Dat. Lav.:** Three dropdown menus (gg, mm, aa) and **Dichiarazioni del Dat. Lav.:** CF and LF buttons.
- Presenza Altre Persone:** Radio buttons for "SI" (selected) and "NO".
- Pres. Dat.Lav./Resp.Sic./Sorvegli.:** Radio buttons for "SI" (selected) and "NO".
- Le Altre persone Stavano:** Checkboxes for Lavorando, Spostandosi, In Pausa, and Assenti.
- Possono Testimoniare:** Radio buttons for "SI" (selected) and "NO".
- Testimoni Diretti (0):** Radio buttons for "SI" (selected) and "NO", followed by dropdown menus for Titolo, NOME, and COGNOME, and CF/LF buttons.
- Avallo Descrizione Dat. Lav.:** Radio buttons for "SI" (selected) and "NO".
- Testimoni Indiretti:** Radio buttons for "SI" (selected) and "NO".
- Testimoni Indiretti (0):** Radio buttons for "SI" (selected) and "NO", followed by dropdown menus for Titolo, NOME, and COGNOME, and CF/LF buttons.
- Eventuali Danni a Terzi:** A text input field.

At the bottom, there are buttons for "Nuovo", "Leggi dati", "Salva dati", "Precedente", "Successivo >", and a help icon (red circle with a question mark).

Figure 14: Boundary Data card

The first field allows to indicate if the accident has happened outside or in an enclosed space and the related environmental parameters: it is understandable as adverse weather conditions or environments with non-optimal microclimate (noise, darkness, humidity, etc..) increase the likelihood of injury.

Another interesting data regards the worker's physical or mental condition, before to take the service: it is clear that a impaired person is mainly subject to a possible accident at work.

The focus then shifted to the communication modalities of the accident and to witnesses people who have unwittingly participated to the event.

### Injury Informations

This section contains important variables that allow to go back with greater precision to the dynamics of the event.

The screenshot shows a software window titled "Infortuni sul lavoro" with a menu bar and several tabs. The "Informazioni Infortunio" tab is selected. The form contains the following fields and controls:

- Attività Specifica:** A dropdown menu labeled "(selezionare voce)".
- Fattore di Pericolo associato all'attività specifica al momento dell'infortunio:** A dropdown menu labeled "(selezionare voce)".
- Fattore di pericolo secondario:** A dropdown menu labeled "(selezionare voce)".
- L'attività specifica svolta è propria della P.O.:** Radio buttons for "SI" and "NO", with "NO" selected.
- Praticata da (giorni):** A dropdown menu showing "gg".
- La P.O. è informata, formata e addestrata per tale attività?:** Radio buttons for "SI" and "NO", with "SI" selected.
- Disegno / Foto Scenario Infortunio:** Checkboxes for "CF" and "LF".
- Attrezzi/Macchine ecc. adoperate dalla P.O.:** Checkboxes for "Attrezzi", "Macchine", "Opere Provvisionali", and "Altro", each with "CF" and "LF" sub-options.
- Attrezzi/Macchine ecc. presenti nell'area dell'infortunio:** Checkboxes for "Attrezzi", "Macchine", "Opere provvisionali", and "Altro", each with "CF" and "LF" sub-options.
- Norme Violate (10):** A row of 10 radio buttons, with the 3rd one selected. To the right are fields for "Norma" (0), "Titolo", and "Articolo".
- Prescrizioni fornite da U.P.G.:** Checkboxes for "CF" and "LF".
- Eventuale Sequestro:** Radio buttons for "SI" and "NO", with "NO" selected.
- Ammenda Iniziale:** A text input field.
- Data per Eventuali Ricorsi:** Three dropdown menus for "gg", "mm", and "aa".

At the bottom, there are buttons for "Nuovo", "Leggi dati", "Salva dati", "Precedente", "Successivo >", and a help icon.

Figure 15: Injury Informations card

A description of the moment when something of anomalous has occurred is importance for the description of the injury, such as what the victim was making at the time of the accident.

The causes and circumstances include 3 levels of data:

- ❖ The description of the circumstances before the injury occurrence
  - workstation, working environment, working process, specific physical activity;
- ❖ The deviation;
- ❖ The Contact and mode of injury.

It is, therefore, of fundamental importance the material agent, something (materials, machinery or equipment, methods and activity) that has the potential to cause a damage; it is the responsible agent for the accident and also it is closely linked to the injury event.

It needs to know every aspect about its equipment involved, both the principals characteristics, both the state and the type of maintenance performed and the conformity or not with national legislation.

According to the material agent involved it can execute statistics search.

The card moreover allows the possibility to insert a schematic drawing or a photograph of the accident occurred; this is important, as well as to better understand the dynamics of the accident, but also the violations that have occurred up to the time of the accident and in what ways the company has answered.

### Causes Analysis and Prevention

This is the section that affords the connection to the cards in which CCA(Cause - Consequence Analysis, which analyzes the causes - consequences) to the accident is applied, and in which prevention speech

is thorough. Leaving from the severity and the type of injury, it is possible to reach the Root Causes, and from these, through a backtracking, it is possible to derive useful indications in order to effect the interventions implementation with the aim to avoid that event is retabled.

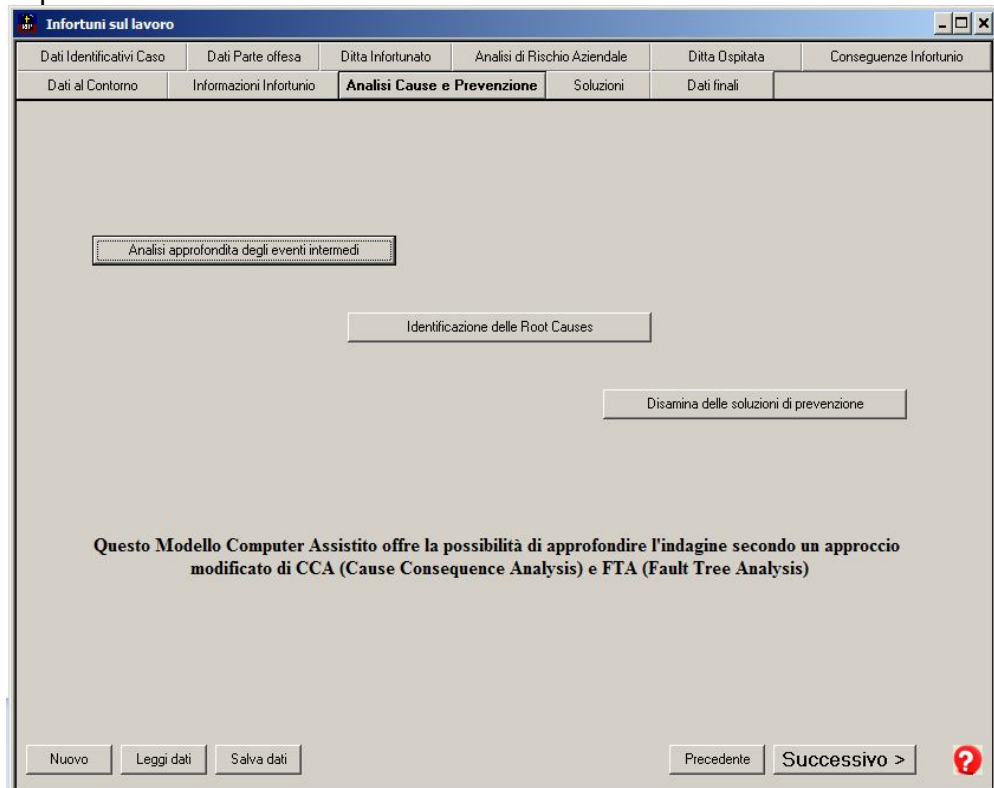


Figure 16: Cause analysis and prevention card

### ***DIRECT CAUSE***

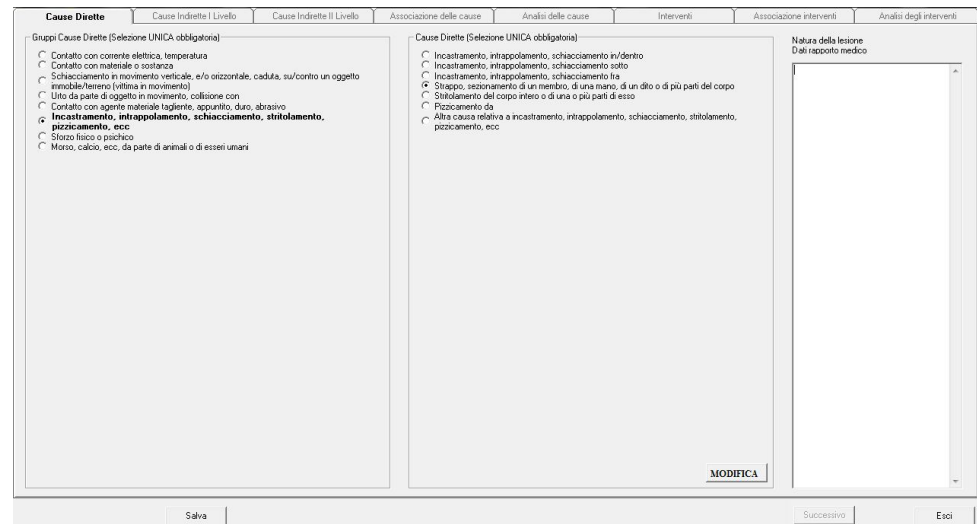


Figure 17: Direct Cause card

In this card, the type of injury is taken again from the selection in the "Accident Consequences" card, moreover it can be integrated with the data obtainable from the medical report.

So on the base of type of injury, the direct cause of the accident can be chosen. Initially groups of causes are proposed and selected one of these, the subgroups associated with it appear.

The choice regards a single cause, in fact an injury happens according to a precise direct cause.

The MODIFY button allows to enable the modification of the selection.

Once the group and the direct cause are selected, the choice can't be changed except by selecting such command.

Then after the selection it will have to push NEXT button to proceed to the next card.

### INDIRECT CAUSES OF FIRST AND SECOND LEVEL

Figure 18: Indirect causes of first level card

On the card of indirect cause of 1st and 2nd level with the aid of a selectable field, the user has the option to choose one or more indirect causes of first and second level. Also it can make multiple choices on the subgroups of indirect causes previously selected.

### ASSOCIATION OF CAUSES

Figure 19: Association of causes card

In this card, according to as it is decided to take action to prevent the damage recurrence, a letter of the alphabet with each indirect cause of second level, chosen during the CCA, is associated according to the cause - effect principle applicable in reverse path among the levels

identified: causes of higher level are the causes while those of lower level, closely linked, are the effects.

### INTERVENTIONS

Figure 20: Interventions card

The last level of the chain concerns technique, work planning and procedural interventions:

Table 14: List of the possible interventions

|                         |   |
|-------------------------|---|
| Technique Interventions | <ul style="list-style-type: none"> <li>• <b>Structural, plant and technology solutions for the workplace management</b></li> <li>• <b>Plant / technologies solutions for the residual risks management of individual current operational situations (vs. the progress of technology and knowledge)</b></li> <li>• <b>Technological/Plant solutions for interference management: current operational situations</b></li> <li>• <b>Detection / signal / alarm deviations systems (emergencies) external or internal (from process deviations)</b></li> <li>• <b>Technological / plant solutions contrast deviations (emergencies) external or internal (from process deviations) and provided means intervention</b></li> </ul> |
|-------------------------|---|

|  |  |
|--|--|
| Work planning and procedural interventions | <ul style="list-style-type: none"> <li>• <b>Definition of the working phases and the contingent operations for the subjects (to the several levels)</b></li> <li>• <b>Procedures for checking presence</b></li> <li>• <b>Procedures of the action of the preplaces to the several levels</b></li> <li>• <b>Operational procedures for the current operating conditions (Signs of danger, prohibition and obligation: call procedure)</b></li> <li>• <b>Procedures of verification, control and detection / reporting / management of elementary functional anomalies</b></li> <li>• <b>Procedures for ordinary and extraordinary maintenance of sites / facilities / equipment including emergency management internal / external</b></li> <li>• <b>Procedures for the detection / warning / alarm emergencies external or internal (from process deviations)</b></li> <li>• <b>Operating procedures in emergency situations internal or external (uncontrollable evolution process) - Signs of Emergency (call procedure),</b></li> <li>• <b>Operating Procedures contrast of external (emergencies) or internal deviation (process deviations) - emergency intervention teams</b></li> </ul> |
|--|--|

In this case, interventions are seen as the causes while the causes of the second level, closely associated with the Root Causes, are effects. The association of one or more letters is fundamental to be able to go backwards in the diagram according to Boolean logic based on logical operators AND / OR.

Practically it is looked for understanding which combinations of interventions are able to cancel indirect causes of second level. If it is considered that all technical/procedural solutions identified are necessary must be assigned to each of them the same letter so that we can proceed according to a logical AND, while if it exists the possibility to have independent solutions but all valid purposes for prevention, it must associate to them different letters in order to proceed with a logical OR.

These are substantially the two extreme cases, but there are several possible combinations managed from Boolean algebra.

### ***ANALYSIS OF CAUSES AND INTERVENTIONS***

Graphical layouts, that illustrate from a side links existing among the various causes previously selected, from the other the links among the various interventions and the various causes previously selected, are shown. In both cases, by the selection of buttons:



- RESOLVE it is evidenced the shortest path that on one side leads to the accident in a few passages and from the other it interrupts the causes chain of injury;
- RESET it is returned to the initially graph and it can play by removing some interventions in order to see what of different can be made.

## Solutions

Figure 21: Solution card

This is a summary card of what reported by the software, it start with a short description of the injury where it is brought in the foreground the causes path identified by the software, until to highlight hazards not identified with the related interventions to apply to resolve situations. Finally, in the card it is given the opportunity to look for similar cases in the Internal Database, in other important Databases, which are previously mentioned, and also the analyst can have the possibility to search in a general way on the internet through the use of keywords.

## Final Data

The screenshot shows a software window titled "Infortuni sul lavoro". The window has a menu bar with options: "Dati Identificativi Caso", "Dati Parte offesa", "Ditta Infortunato", "Analisi di Rischio Aziendale", "Ditta Ospitata", and "Conseguenze Infortunio". Below the menu bar is a toolbar with icons for "Dati al Contorno", "Informazioni Infortunio", "Analisi Cause e Prevenzione", "Soluzioni", and "Dati finali" (which is currently selected). The main area contains several data entry fields: "Costi Totali per Infortunato" (highlighted in red), "Inotemp. Prescriz. Periodo Previsto" (highlighted in red), "Sanzioni Disciplinari" (highlighted in red), "Ammende Finali" (highlighted in red), "Data Chiusura Ispezione" (with dropdowns for gg, mm, aa), "Data Chiusura Caso" (with dropdowns for gg, mm, aa), "Parola chiave" (with a search button "Cerca nel catalogo LNI"), and "Valutazione Violazione Normativa (10)" (with a row of 10 radio buttons and fields for "Norma", "Titolo", and "Articolo"). At the bottom, there are buttons for "Nuovo", "Leggi dati", "Salva dati", and "Precedente", along with a red question mark icon.

Figure 22: Final Data card

The last card contains data relating to the closure of the case from the bureaucratic and disciplinary point of view.

Costs, that are originated with the occurrence of the injury, are highlighted.

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## APPLICATION OF THE COMPUTER ASSISTED TECHNIQUE

At the end of software processing it is proceeded to the test of the policy adopted. The injury events investigated, analyzed and used for the evolution of software, are 33 (see Appendix B) and they have been filed according to a summary table created to contain the most significant data of event. The various cards have been organized in this way:

- ⇒ from n° 1 to n° 3 are contained accident related to "Extraction mineral from quarries and mines" filed;
- ⇒ from n° 4 to n° 9 are contained accident related to "Manufacturing activities" field;
- ⇒ from n° 10 to n°14 are contained accident related to "Construction" field;
- ⇒ from n° 15 is contained an accident related to "Transport and storage" field;
- ⇒ from n° 16 to n°30 are contained accident related to "Iron working" field;
- ⇒ from n°31 is contained an injury related to agricultural field;

### ***Analysis of accident in the quarry and mining extraction sector***

**Deadly injury** for crushing of whole body; the victim presented the results of mechanical activity (rotor bar and impact plate of the crusher) with a politraumatisme of right lower limb and of his skull which appeared non-existent.

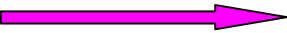
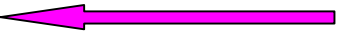


Figure 23: Bar Mill



Figure 24: Crush equipments

Table 15: Technique of analysis applied to the event

|   | RESEARCH CAUSES   | ADOPTION PREVENTIVE MEASURES   |   |
|---|---|--|---|
|   |    |   |   |
|   | <p><i>ED: 7500 Id (death)</i><br/>                     Part of body injured: totally of the body and internal organs<br/>                     Type of injury: Other types of concussion and internal injuries</p>   | <p><i>ev. sist. protective passive / active (in the case given the severity of the accident – constriction by the movement of the rod / crank - PPE protection would not solve the problem</i></p> |   |
| 1 | <p><b>STRUCK BY MOVING OBJECT, COLLISIONS WITH – Struck by object in rotation, motion, movement –movement of the impact bars and plates of crusher</b></p>  | <p><i>At the time of deviation operator intervenes with the machine stopped</i></p>  | 7 |
| 2 | <p><b>BREAKAGE, BURSTING, SPLITTING, SLIPPING, FALL, COLLAPSE OF MATERIAL AGENT - Breakage, bursting - causing splinters (wood, glass, metal, stone, plastic, others - chalks blocks</b><br/> <b>LOSS OF CONTROL (TOTAL OR PARTIAL) OF MACHINE, MEANS OF TRANSPORT OR HANDLING EQUIPMENT, HAND-HELD TOOL, OBJECT, ANIMAL - Loss of control (total or partial) - of machine (including unwanted start-up) or of the material being worked by the machine –linked to the fact that crushing was blocked and then resumed</b><br/> <b>SLIPPING - STUMBLING AND FALLING - FALL OF PERSONS - Fall of person - to a lower level – related to the fact that the person is precipitated in the mill bar following the unblocking</b><br/> <b>BODY MOVEMENT UNDER OR WITH PHYSICAL STRESS (GENERALLY LEADING TO AN INTERNAL INJURY) - Pushing, pulling –linked to the fact that the injured pushing the chalk block with force</b></p> | <p><i>Installing the device to stop functioning equipment at the time of the door opening</i></p> <p><i>Operator training in case of anomaly in the operation of the mill bar</i></p>              | 6 |
| 3 | <p><b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Tipology - Work</b></p>  | <p><i>Evaluation of the choice of the solutions adopted</i></p>  | 5 |

|   |  |   |   |
|---|--|---|---|
|   | <p><b>Equipment [instrumentation, equipment, localized systems of transport energy (eg. power cables, ...)] - related to the unblocking of the material in the feeding of the mill</b></p> <p><b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Tipology - Devices (command and control, signaling, security) - related to the unblocking of the material in the feeding of the mill and to the block of the machine at the time of the opening of the intervention window</b></p> <p><b>AUDIT, SUPERVISION, OPERATING PROCEDURES &amp; IFT - Procedure - Procedures for workers, Procedures for machine operators, Procedures - related to the fact that he was not present any specific control problems procedure</b></p> <p><b>REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE – operating condition – Verification functionality before to use – related to the fact that the grind is interrupted and then resumed without permission</b></p> |   |   |
| 4 | <p><b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS – related to equipments and control devices of bar mill;</b></p> <p><b>AUDIT, SUPERVISION, OPERATING PROCEDURES &amp; IFT – related to the absence of procedures for different levels of emercy situation</b></p> <p><b>REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE – related to verify functionality before to use</b></p>  | <p><b>MACHINERY, EQUIPMENT AND PROVISIONAL WORKS – equipments used and control devices of machine used for the work</b></p> <p><b>AUDIT, SUPERVISION AND OPERATING PROCEDURES &amp; IFT - information, education and training of every level of worker; behavioural and operational procedure; supervision of the worker</b></p> <p><b>REVISION, UPDATING AND MAINTENANCES – verification of functionality before to use and upgrade of procedure and formation</b></p> | 4 |

|     |   |   |   |
|-----|---|---|---|
| 5.1 | <p><i>Failure block of the mill to the opening of the intervention door - failure of safety equipment systems for any deviation</i></p> <p><i>Equipment not suitable for the task of unblocking the mill</i></p>                                      | <p><b>Plant / technologies solutions for the residual risks management of individual current operational situations (vs. the progress of technology and knowledge) – related to the adjustment of the control device of interruption operation of the mill when the interventions door opens and definition of the equipment to be used for the unblocking</b></p> <p><b>Detection / signal / alarm deviations systems (emergencies) external or internal (from process deviations) – related to the inclusion of the breaking device operating</b></p> | 3 |
| 5.2 | <p><i>no specific procedures for operators at different levels on the activities to be carried out</i></p> <p><i>No information, education and training</i></p> <p><i>no supervision and procedures both operational and behavioral deficient</i></p> | <p><b>A. Definition of the working phases and the contingent operations for the subjects (to the several levels)</b><br/><i>(establishment of procedures for the use and maintenance of the mill bar and supervisor control)</i></p> <p><b>B. Operational procedures for the current operating conditions (Signs of danger, prohibition and obligation: call procedure)</b><br/><i>(danger signalling of moving machine and illustration of an intervention procedure in the case of filling of the mill bar)</i></p>                                   | 2 |
| 6   | <p><b>Hazard factor not identified</b> <i>(choice of H.I. technique not appropriate for the context)</i></p>  | <p><i>Definition of the applicable updates to the situation and any subsequent actions</i></p>  | 1 |

## Insertion of the data input


| Dati Identificativi Evento   | Dati Parte Offesa   | Azienda P.D.                    | Analisi di Rischio Aziendale               | Diitta Ospitata   | Conseguenze Infortunio |
|--|---|---------------------------------|--|---|------------------------|
| Dati al Contorno   | Informazioni Infortunio   | Analisi Cause e Prevenzione     | Soluzioni                                  | Dati finali   |                        |
| Numero Codifica Evento   |   |                                 |  |   |                        |
| Data Infortunio  | 05   10   2001  | Giorno Settimanale Infortunio   |  | venerdì   |                        |
| Ora Infortunio   | 19   50   | Ora Progr. Infortunio nel turno |  | IX  |                        |
| Numero Registro Infortuni  |   |                                 | Classe di età Infortunato                  |   | da 35 a 49 anni        |
| Luogo Infortunio   | sede della ditta della P.D.   |                                 | Luogo Fisico Infortunio                    |   |                        |
| ASL Competente   | <selezionare>   |                                 | Luogo di produzione, officina, laboratorio |   |                        |
| 1° Intervento Ispettivo  | giorno mese anno<br>gg   mm   aa  |                                 |  |   |                        |
| Nome Ispettore ASL   | ◀ <5   CF   LF   ▶ >=5  |                                 | Ispezione U.P.G. a seguito di evento       |   |                        |
| Figure esterne intervenute   | <input checked="" type="radio"/> SI <input type="radio"/> NO<br><input checked="" type="checkbox"/> Vigili del Fuoco   CF   LF   <input type="checkbox"/> Polizia   CF   LF   <input type="checkbox"/> Vigili Urbani   CF   LF  <br><input checked="" type="checkbox"/> Carabinieri   CF   LF   <input checked="" type="checkbox"/> Ispettor. Lavoro   CF   LF   <input type="checkbox"/> Altri   CF   LF |                                 |  |   |                        |
| Data Apertura Caso (Magistratura)  | giorno mese anno<br>05   10   2001  |                                 |  |   |                        |
| Date Sopralluoghi (0)  | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/>   |                                 |  |   |                        |
| Alterazione dello Stato di fatto nell'immediatezza   | <input type="radio"/> SI <input checked="" type="radio"/> NO  |                                 |  |   |                        |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/> |   |                                 |  | <input type="button" value="Successivo &gt;"/>  |                        |

Figure 25: Identifying details of the events


| Dati Identificativi Evento   | Dati Parte Offesa   | Azienda P.D.                | Analisi di Rischio Aziendale  | Diitta Ospitata  | Conseguenze Infortunio   |
|--|---|-----------------------------|---|--|--|
| Dati al Contorno   | Informazioni Infortunio   | Analisi Cause e Prevenzione | Soluzioni   | Dati finali  |  |
| Nome Cognome P.D.  | Mario Rossi   |                             | <input checked="" type="radio"/> M <input type="radio"/> F  |  |  |
| Data di Nascita  | 06   04   1953  | Comune di Nascita           |   | Torino (TO)  |  |
| Nazione di Nascita   | Italia  |                             | Comune Residenza  |  | Torino (TO)  |
| Comune Domicilio   | Torino (TO)   |                             | Indirizzo residenza   |  |  |
| Indirizzo Domicilio  |   |                             |   |  |  |
| Recapito Telefonico  |   |                             |   |  |  |
| Codice ASL appartenenza  | Torino 3 (0103)   |                             |   |  |  |
| Codice ISTAT   |   |                             |   |  |  |
| Grado Istruzione P.D.  | Sup. Scientifica  |                             |   |  |  |
| Lingua Madre P.D.  | italiano  |                             |   |  |  |
| Status Professionale P.D.  | <input type="radio"/> Lavoratore autonomo <input checked="" type="radio"/> Altro  |                             | <input type="checkbox"/> Dipendente con un'occupazione stabile o temporanea (tempo indeterminato/determinato) |  |  |
| Qualifica formale  | Operaio specializzato   |                             | Data Inizio rapporto di lavoro  |  | 04   01   1998   |
| Parente Datore Lavoro  | <input type="radio"/> SI <input type="radio"/> NO   |                             | Libretto di lavoro  |  | CF   LF  |
| Mansione svolta al mom. infortunio   | Spostamento a piedi   |                             | Numero Matricola  |  |  |
| Stato Civile   | <input type="radio"/> Celibe/Nubile <input type="radio"/> Vedovo/a <input type="radio"/> Separato/a<br><input type="radio"/> Divorziato/a <input type="radio"/> Tutelato/a <input checked="" type="radio"/> Coniugato/a |                             | Appartenenza Sindacato  |  | <input type="radio"/> SI <input checked="" type="radio"/> NO   |
| Numero Persone a Carico  | 0   |                             | Tipo Contratto Collettivo Nazionale   |  | <input checked="" type="radio"/> Metalmeccanico <input type="radio"/> Chimico<br><input type="radio"/> Commerciale <input type="radio"/> Altro |
| Importo Retributivo Infortunato  |   |                             | Numero Contratto Coll. Naz.   |  |  |
| Calcola il Codice Fiscale  | RSSMRA53D06L219E  |                             | Data Stipul. Contratto Coll. Naz.   |  | gg   mm   aa   |
| Recapito Somma Indenn. Infort.   |   |                             | Data Scad. Contratto Coll. Naz.   |  | gg   mm   aa   |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/> |   |                             |   | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>  |  |

Figure 26: Injured Data


| Dati Identificativi Evento   | Dati Parte Offesa       | Azienda P.O.   | Analisi di Rischio Aziendale | Ditta Ospitata  | Conseguenze Infortunio |
|--|-------------------------|--|------------------------------|---|------------------------|
| Dati al Contorno   | Informazioni Infortunio | Analisi Cause e Prevenzione  | Soluzioni                    | Dati finali   |                        |
| Settore Pubblico <input type="radio"/> Settore privato <input checked="" type="radio"/> Terzi presenti a titolo legittimo <input type="radio"/>            |                         | P.O. in forza alla sede centrale <input checked="" type="radio"/>  |                              |   |                        |
| Ragione Sociale <input type="text" value="FONDERIA S.P.A."/>   |                         | P.O. in forza alla sede distaccata <input type="radio"/>   |                              |   |                        |
| Visura Camerale <input type="text" value="CF"/> <input type="text" value="LF"/>  |                         | Numero Dipendenti <input type="text" value="101-200"/>   |                              |   |                        |
| Indirizzo <input type="text" value="Via - n° civico"/>   |                         | C.A.P. <input type="text" value=""/>   |                              | Località <input type="text" value="TORINO"/>  |                        |
| Codice Azienda <input type="text"/>  |                         | Docum. Aziendale Sicurezza <input checked="" type="radio"/> SI <input type="radio"/> NO  |                              |   |                        |
| Tipo Attività Economica <input type="text" value="Produzione di metalli e loro leghe"/>  |                         | Data Redazione <input type="text" value="18"/> <input type="text" value="02"/> <input type="text" value="1999"/>                                     |                              |   |                        |
| Codice Fiscale / Partita IVA <input type="text"/>  |                         | Ultimo Aggiornamento <input type="text" value="18"/> <input type="text" value="02"/> <input type="text" value="1999"/>                               |                              |   |                        |
| Tipo Polizza Assicurativa <input type="text"/>   |                         | Addetti Pronto Soccorso <input checked="" type="radio"/> SI <input type="radio"/> NO <input type="text" value="CF"/> <input type="text" value="LF"/> |                              |   |                        |
| Numero Polizza Assicurativa <input type="text"/>   |                         | Addetti Antincendio <input checked="" type="radio"/> SI <input type="radio"/> NO <input type="text" value="CF"/> <input type="text" value="LF"/>     |                              |   |                        |
| Data Stipulazione <input type="text" value="gg"/> <input type="text" value="mm"/> <input type="text" value="aa"/>  |                         | Firme Figure Preposte <input type="checkbox"/> Datore Lavoro <input checked="" type="checkbox"/> R.S.P.P.  |                              |   |                        |
| Data Scadenza <input type="text" value="gg"/> <input type="text" value="mm"/> <input type="text" value="aa"/>  |                         | <input type="checkbox"/> Medico Competente <input checked="" type="checkbox"/> R.L.S.  |                              |   |                        |
| Figure Sicurezza Azienda (0) <input checked="" type="radio"/> >5 <input type="text" value="CF"/> <input type="text" value="LF"/> <input type="radio"/> <=5 |                         | <input type="checkbox"/> Altro   |                              |   |                        |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/>                                   |                         | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>   |                              |  |                        |

Figure 27: Enterprise of injured


| Dati Identificativi Evento  | Dati Parte Offesa       | Azienda P.O.  | Analisi di Rischio Aziendale | Ditta Ospitata  | Conseguenze Infortunio |
|---|-------------------------|---|------------------------------|---|------------------------|
| Dati al Contorno  | Informazioni Infortunio | Analisi Cause e Prevenzione   | Soluzioni                    | Dati finali   |                        |
| Analisi di Rischio Esistente <input checked="" type="radio"/> SI <input type="radio"/> NO   |                         | Data Ultimo Aggiornamento <input type="text" value="18"/> <input type="text" value="02"/> <input type="text" value="1994"/> |                              |   |                        |
| SGS Certificato Esistente <input type="radio"/> SI <input checked="" type="radio"/> NO  |                         |   |                              |   |                        |
| <b>METODOLOGIA VALUTAZIONE DEL RISCHIO</b>  |                         |   |                              |   |                        |
| Tecniche Hazard Identification <input type="checkbox"/> Check List <input type="checkbox"/> Job Safety <input type="checkbox"/> HAZOP <input type="checkbox"/> FTA <input type="checkbox"/> <input checked="" type="checkbox"/> What If <input type="checkbox"/> FMEA <input type="checkbox"/> Altro <input type="checkbox"/> |                         |   |                              |   |                        |
| <b>Metodiche di calcolo del rischio</b>   |                         |   |                              |   |                        |
| ED (Entità del Danno) <input checked="" type="radio"/> Stima Soggettiva <input type="radio"/> Statistica Dati Secondo il Worst Credible Case  |                         | <b>VALUTAZIONE SOGGETTIVA</b>   |                              |   |                        |
| FC (Fattore di Contatto) <input type="radio"/> Stima Soggettiva <input checked="" type="radio"/> Valutazione Condivisa  |                         |   |                              |   |                        |
| P (Probabilità di Accadimento) <input checked="" type="radio"/> Stima Soggettiva <input type="radio"/> Livello Frequenza Attesa di Accadimento  |                         |   |                              |   |                        |
| <b>La Valutazione del Rischio comprende:</b>  |                         |   |                              |   |                        |
| 1. Soluzioni di eliminazione/gestione rischio residuo <input type="radio"/> NO <input checked="" type="radio"/> SI <input type="checkbox"/> Tecniche <input type="checkbox"/> Organizzative <input type="checkbox"/> Procedurali <input checked="" type="checkbox"/> DPI  |                         |   |                              |   |                        |
| 2. La caratterizzazione dei modelli espositivi dei lavoratori <input checked="" type="radio"/> NO <input type="radio"/> SI  |                         | Date riunioni periodiche ultimo anno <input type="text" value="CF"/> <input type="text" value="LF"/>                        |                              |   |                        |
| <b>ASPETTI SPECIFICI DELLA V.R. RELATIVI ALL'EVENTO INFORTUNISTICO</b>  |                         |   |                              |   |                        |
| Lavoro di Propria Competenza <input checked="" type="radio"/> SI <input type="radio"/> NO   |                         | Da Quanto Tempo lo Svolgeva <input type="text" value="&gt; 1 anno"/>  |                              |   |                        |
| Infortunato Formato/Informato A.R. <input type="radio"/> SI <input checked="" type="radio"/> NO   |                         |   |                              |   |                        |
| Eventuale riunione periodica in cui si è trattato l'argomento afferente alla dinamica inf. <input type="radio"/> SI <input checked="" type="radio"/> NO   |                         |   |                              |   |                        |
| Previsti Indum. di Lavoro Speciali <input type="radio"/> SI <input checked="" type="radio"/> NO   |                         |   |                              |   |                        |
| Previsti e Forniti DPI <input checked="" type="radio"/> SI <input type="radio"/> NO   |                         | Sono stati selezionati dei DPI - Fare click per visualizzarli   |                              |   |                        |
|   |                         | Organizzazione sostituzioni <input type="text"/>  |                              |   |                        |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/>  |                         | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>                                    |                              |  |                        |

Figure 28: Risks analysis of injured enterprise



| Dati Identificativi Evento  | Dati Parte Offesa       | Azienda P.O.  | Analisi di Rischio Aziendale | Ditta Ospitata | Conseguenze Infortunio  |    |
|---|-------------------------|---|------------------------------|----------------|---|----|
| Dati al Contorno  | Informazioni Infortunio | Analisi Cause e Prevenzione   | Soluzioni                    | Dati finali    |   |    |
| Abbandono Lavoro <input type="radio"/> SI <input checked="" type="radio"/> NO |                         |   |                              |                |   |    |
| Prime Cure Prestate da:   |                         | Colleghi nelle vicinanze  |                              |                |   |    |
| Prime Cure Prestate dove:   |                         | Luogo dell'incidente  |                              |                |   |    |
| Prime Cure Prestate quando:   |                         | una volta che è stata ripulita l'area   |                              |                |   |    |
| Natura Lesione  |                         | Ustioni e scottature (termiche)   |                              |                |   |    |
| Sede Lesione  |                         | Lesioni multiple  |                              |                |   |    |
| Data 1° Certif. Medico al Dat. Lav.   |                         | 15  | 10                           | 2001           | Interruzione dell'attività produttiva associata all'infortunio <input type="radio"/> NO <input checked="" type="radio"/> SI |    |
| Giorni di Prognosi  |                         | 0   |                              |                | Giorni di Interruzione  | 60 |
| Giorni Definitivi   |                         | <input type="radio"/> Inabilità Temp. gg. 0<br><input type="radio"/> Inabilità Permanente<br><input checked="" type="radio"/> Morte |                              |                |   |    |
| Nuovo   |                         | Leggi dati  |                              | Salva dati     |   |    |
|   |                         |   |                              | Precedente     |   |    |
|   |                         |   |                              | Successivo >   |   |    |

Figure 29: Injury consequence

| Dati Identificativi Evento  | Dati Parte Offesa       | Azienda P.O.   | Analisi di Rischio Aziendale | Ditta Ospitata  | Conseguenze Infortunio |
|---|-------------------------|--|------------------------------|---|------------------------|
| Dati al Contorno  | Informazioni Infortunio | Analisi Cause e Prevenzione  | Soluzioni                    | Dati finali   |                        |
| Fattore di Pericolo associato all'attività specifica al momento dell'infortunio |                         | Dispositivi di stoccaggio, imballaggio, contenitori (silo, serbatoi) - fissi - cisterne, bacini, serbatoi, ecc.  |                              |   |                        |
| Fattore di pericolo secondario  |                         | Carichi - sospesi a dispositivi di messa a livello, gru  |                              |   |                        |
| Attrezzi/Macchine ecc. adoperate dalla P.O.                                     |                         | <input type="checkbox"/> Attrezzi <input type="button" value="CF"/> <input type="button" value="LF"/><br><input checked="" type="checkbox"/> Macchine <input type="button" value="CF"/> <input type="button" value="LF"/>  |                              | <input type="checkbox"/> Opere Provvisoriali <input type="button" value="CF"/> <input type="button" value="LF"/><br><input type="checkbox"/> Altro <input type="button" value="CF"/> <input type="button" value="LF"/>            |                        |
| Attrezzi/Macchine ecc. presenti nell'area dell'infortunio                       |                         | <input type="checkbox"/> Attrezzi <input type="button" value="CF"/> <input type="button" value="LF"/><br><input type="checkbox"/> Macchine <input type="button" value="CF"/> <input type="button" value="LF"/>   |                              | <input checked="" type="checkbox"/> Opere provvisoriali <input type="button" value="CF"/> <input type="button" value="LF"/><br><input type="checkbox"/> Altro <input type="button" value="CF"/> <input type="button" value="LF"/> |                        |
| Attività Specifica  |                         | Camminare, correre, salire, scendere, ecc.   |                              | Disegno / Foto Scenario Infortunio <input type="button" value="CF"/> <input type="button" value="LF"/>  |                        |
| Violazione evidenziate nel rapporto UPG (10)                                    |                         | <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |                              |   |                        |
| Prescrizioni fornite da U.P.G.  |                         | <input type="button" value="CF"/> <input type="button" value="LF"/>  |                              | Eventuale Sequestro <input type="radio"/> SI <input type="radio"/> NO   |                        |
| Ammenda Iniziale  |                         |  |                              |   |                        |
| Data per Eventuali Ricorsi  |                         | gg   | mm                           | aa  |                        |
| Nuovo   |                         | Leggi dati   |                              | Salva dati  |                        |
|   |                         |  |                              | Precedente  |                        |
|   |                         |  |                              | Successivo >  |                        |

Figure 30: Injury Informations

Also for this case it have not been able to completely fill all the cards, due to incomplete information, and moreover to respect the privacy lot of data have been made unreadable and for the people have been insert fantasy name

### Selection of the Causes and of the Interventions

By analyzing thoroughly the material available, they have been obtained important information that allows to identify the accident causes and interventions closely linked. In summary:

**SEVERITY AND TYPE OF INJURY:** Death for crushing of whole body; the victim presented the results of mechanical activity (rotor bar and impact plate of the crusher) with a politraumatisme of right lower limb and of his skull which appeared non-existent.

**DIRECT CAUSE:** Struck by object in rotation, motion, movement –movement of the impact bars and plates of crusher

**INDIRECT CAUSES OF FIRST LEVEL:**

- ⇒ BREAKAGE, BURSTING, SPLITTING, SLIPPING, FALL, COLLAPSE OF MATERIAL AGENT - Breakage, bursting - causing splinters (wood, glass, metal, stone, plastic, others - chinks blocks.
- ⇒ LOSS OF CONTROL (TOTAL OR PARTIAL) OF MACHINE, MEANS OF TRANSPORT OR HANDLING EQUIPMENT, HAND-HELD TOOL, OBJECT, ANIMAL - Loss of control (total or partial) - of machine (including unwanted start-up) or of the material being worked by the machine –linked to the fact that crushing was blocked and then resumed;
- ⇒ SLIPPING - STUMBLING AND FALLING - FALL OF PERSONS - Fall of person - to a lower level – related to the fact that the person is precipitated in the mill bar following the unblocking
- ⇒ BODY MOVEMENT UNDER OR WITH PHYSICAL STRESS (GENERALLY LEADING TO AN INTERNAL INJURY) - Pushing, pulling –linked to the fact that the injured pushing the chalk block with force

**INDIRECT CAUSES OF SECOOND LEVEL:**

- ❑ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Tipology - Work Equipment [instrumentation, equipment, localized systems of transport energy (eg. power cables, ...)] - related to the unblocking of the material in the feeding of the mill
- ❑ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Tipology - Devices (command and control, signaling, security) - related to the unblocking of the material in the feeding of the mill and to the block of the machine at the time of the opening of the intervention window
- ❑ AUDIT, SUPERVISION, OPERATING PROCEDURES & IFT - Procedure - Procedures for workers, Procedures for machine operators, Procedures - related to the fact that he was not present any specific control problems procedure
- ❑ REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE – operating condition – Verification functionality before to use – related to the fact that the grind is interrupted and then resumed without permission

**ROOT CAUSES:**

- ✓ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – related to equipments and control devices of bar mill;
- ✓ AUDIT, SUPERVISION, OPERATING PROCEDURES & IFT – related to the absence of procedures for different levels of emergency situation
- ✓ REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE – related to verify functionality before to use



Figure 31: Causes Analysis

### **TECHNIQUE INTERVENTIONS:**

- ✓ Plant / technologies solutions for the residual risks management of individual current operational situations (vs. the progress of technology and knowledge) – related to the adjustment of the control device of interruption operation of the mill when the interventions door opens and definition of the equipment to be used for the unblocking
- ✓ Detection / signal / alarm deviations systems (emergencies) external or internal (from process deviations) – related to the inclusion of the breaking device operating

### **WORK PLANNING AND PROCEDURE INTERVENTIONS:**

- ❑ Definition of the working phases and the contingent operations for the subjects (to the several levels) (establishment of procedures for the use and maintenance of the mill bar and supervisor control)
- ❑ Operational procedures for the current operating conditions (Signs of danger, prohibition and obligation: call procedure) (danger signalling of moving machine and illustration of an intervention procedure in the case of filling of the mill bar)

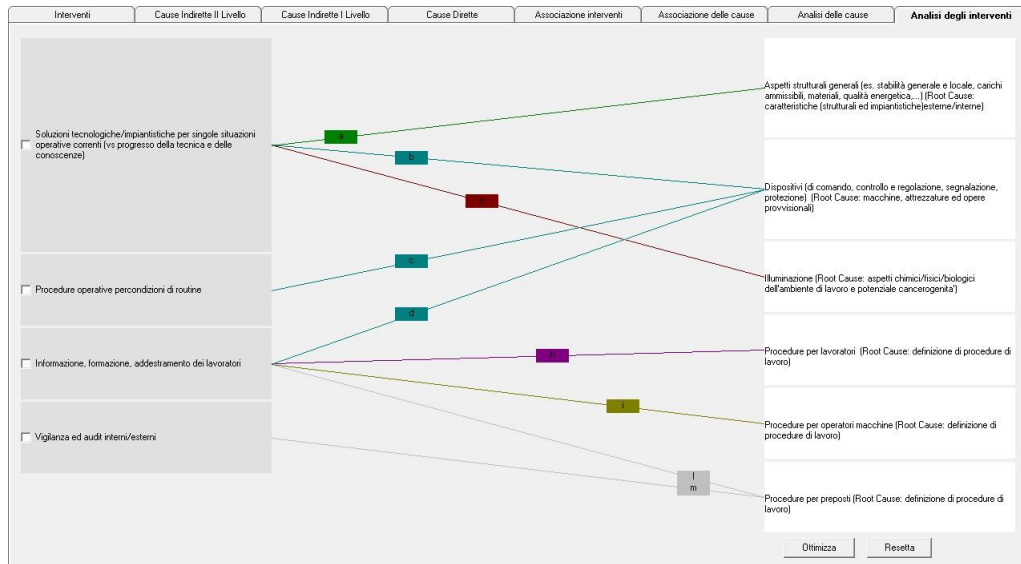


Figure 32: Interventions analysis

Also in this case all the intervention solutions should not be applied but only technological/ plant solutions for operating current situation (technological upgrading for the handling loads) and the information, education and training of the worker (associated with updating procedures following control systems changes).

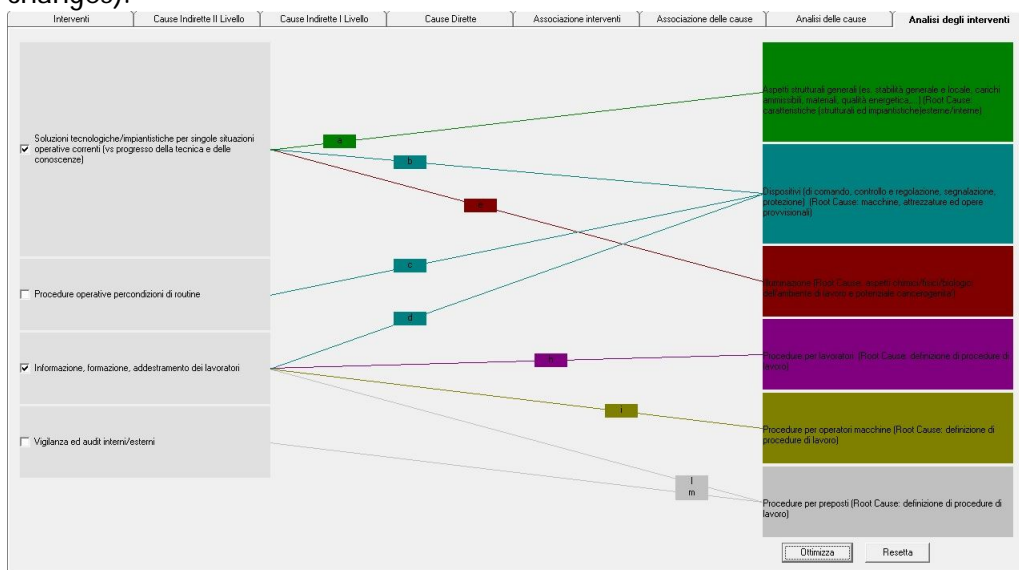
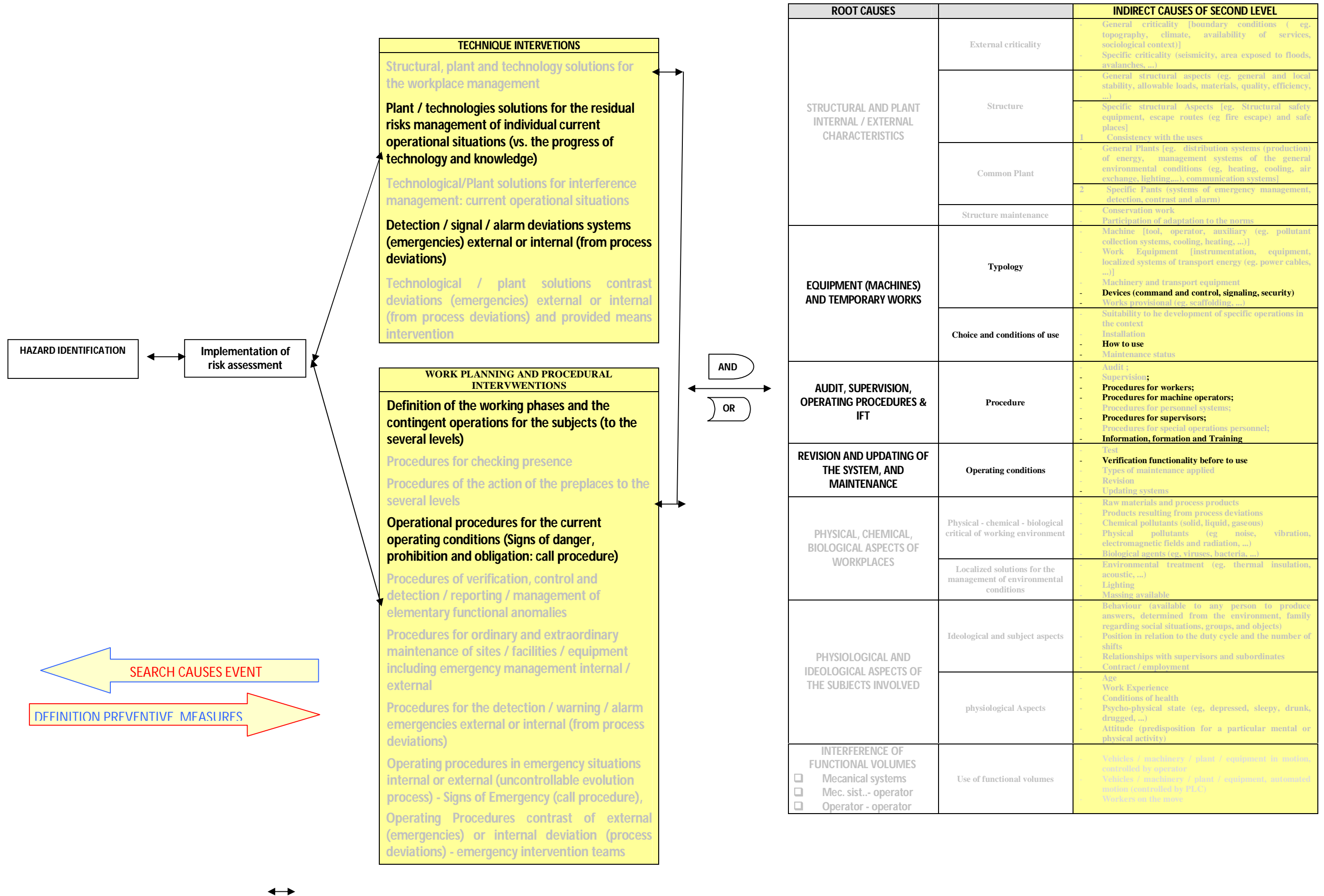
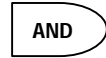
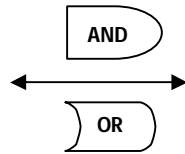


Figure 33: Interventions analysis resolved

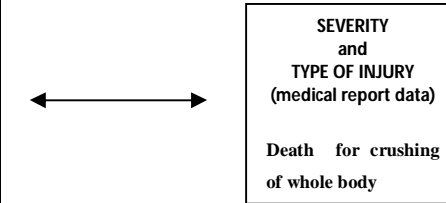
Figure 34: Graphic visualization of the analyzed event



| INDIRECT CAUSES OF FIRST LEVEL   |   |
|--|---|
| Deviation due to electrical problems, explosion, fire  | <ul style="list-style-type: none"> <li>- Electrical problem caused by a plant failure</li> <li>- Electrical problem caused by static electricity</li> <li>- Electrical problem caused by missing insulation</li> <li>- Electrical problem caused by external radiation / lightning</li> <li>- Explosion</li> <li>- Fire</li> <li>- Another case relating to electrical problems, explosion, fire</li> </ul>   |
| overflow, overturn, leak, flow, vaporisation, emission   | <ul style="list-style-type: none"> <li>- Solid state - overflowing, overturning</li> <li>- Liquid state - leaking, oozing, flowing, splashing, spraying</li> <li>- Gaseous state - vaporisation, aerosol formation, gas formation</li> <li>- Pulverulent material - smoke generation, dust/particles in suspension/emission of</li> <li>- Another case relating to overflow, overturn, leak, flow, vaporisation, emission</li> </ul>  |
| <b>Breakage, bursting, splitting, slipping, fall, collapse of Material Agent</b>   | <ul style="list-style-type: none"> <li>- Break of material, at junctions, connections, material agent</li> <li>- Break / release of personal protective equipment</li> <li>- <b>Break with explosion of splinters (wood, glass, metal, stone, plastic, etc.) agent material</b></li> <li>- Another case involving rupture, fracture, rupture violent, sudden and loud agent material</li> </ul>   |
| Slipping, falling, loss of stability, collapse agent material  | <ul style="list-style-type: none"> <li>- Slip, fall, loss of stability, collapse of Material Agent placed above (which falls on the victim)</li> <li>- Sliding, fall, loss of stability, collapse of agent material placed below (which drags the victim)</li> <li>- Slip, fall, loss of stability, the collapse of a material agent - at the same level</li> <li>- Another case relating to slipping, falling, loss of stability, collapse agent material</li> </ul>   |
| <b>Loss of control (total or partial) of machine, means of transport or handling equipment, hand-held tool, object, animal</b> | <ul style="list-style-type: none"> <li>- <b>Problems of total or partial control of the machine (including the unintended equipment) as well as the processed material</b></li> <li>- Problems of total or partial control of the means of transport / equipment material handling and / or substance (motorized or not)</li> <li>- Problems of total or partial control of a means of transport / handling of people and / or animals</li> <li>- Problems of total or partial control of hand tool (motorized or not) as well as the material machined by</li> <li>- Problems of total or partial control of object (led, moved, moved, etc.).</li> <li>- Problems of total or partial control of animal</li> <li>- Another cause of problems related to total or partial control of machinery, transportation / handling equipment, hand tools or objects, animals</li> </ul> |
| <b>Slipping - Stumbling and falling - Fall of persons</b>  | <ul style="list-style-type: none"> <li>- Fall of person from the top through the opening</li> <li>- Slipping or tripping - with the fall of man - from</li> <li>- Slipping or tripping - with the fall of person - at the same level</li> <li>- Loss of balance - with the fall of man - from</li> <li>- <b>Loss of balance - with the fall of person - at the same level</b></li> <li>- Slipping or tripping on machinery</li> <li>- Another case involving slipping or tripping, loss of balance - with the fall of person</li> </ul>   |
| Body movement without any physical stress  | <ul style="list-style-type: none"> <li>- Walking on a sharp object</li> <li>- Kneel, sit, lean against</li> <li>- Being grabbed, dragged, or moved by something from their momentum</li> <li>- Uncoordinated movements, gestures, inopportune, inappropriate</li> <li>- Another cause relative movement of the body without physical exertion (which usually leads to an external injury)</li> </ul>  |
| <b>Body movement under or with physical stress</b>   | <ul style="list-style-type: none"> <li>- Lifting, carrying or standing</li> <li>- <b>Pushing, pulling, pulling</b></li> <li>- Depositing, dropping</li> <li>- Twisting, turning, turning</li> <li>- Step false twisting of the leg or ankle, slipping without falling</li> <li>- Another cause relative movement of the body during physical exertion (which usually leads to an internal injury)</li> </ul>  |
| Shock, fright, violence, aggression, threat, presence  | <ul style="list-style-type: none"> <li>- Surprise, fear</li> <li>- Violence, aggression, threat - including employees of the company to the victims in the context of their function (bank robbery, assaulting bus drivers, etc.).</li> <li>- Aggression, mobs, violence by animals</li> <li>- Presence of the victim or a third party that creates in itself a danger to the victim / for himself and if any other</li> <li>- Another case involving surprise, fright, violence, aggression, threat, presence</li> </ul>   |



| DIRECT CAUSE  |  |
|---|--|
| Contact with electric current, temperature  | <ul style="list-style-type: none"> <li>- Indirect contact with the electrical circuit, lightning (passive)</li> <li>- Direct contact with electricity, suffer an electric discharge in the body</li> <li>- Contact with flame or object / warm or red-hot</li> <li>- Contact with object or cold or frozen</li> <li>- Another case involving contact with electric current, temperature</li> </ul>   |
| Contact with other material or substance  | <ul style="list-style-type: none"> <li>- Contact with hazardous substances for nasal, oral, inhalation</li> <li>- Contact with hazardous substances through the skin or eyes</li> <li>- Contact with hazardous substances through the digestive system, swallowing or eating</li> <li>- Drowning in a liquid</li> <li>- Burial under a solid</li> <li>- Immersion in a gas, in a suspension of particles</li> <li>- Another case involving contact with material or substance</li> </ul> |
| Crushing vertically and / or horizontally moving, fall on / against an immovable object / ground (victim in motion) | <ul style="list-style-type: none"> <li>- Vertical motion, crash on / against (the result of a fall)</li> <li>- Horizontal motion, crash on / against</li> <li>- Another case involving crushing vertical and / or horizontal moving, fall on / against an immovable object / ground (victim in motion)</li> </ul>  |
| <b>Struck by moving object, collisions with</b>   | <ul style="list-style-type: none"> <li>- Struck by object projected</li> <li>- Struck by falling object</li> <li>- Struck by object that oscillates</li> <li>- <b>Struck by object in rotation, motion, displacement, including vehicles</b></li> <li>- Collision with a moving object, including vehicles - a collision with a person (the victim is moving)</li> <li>- Another case involving a collision by moving object, collision with</li> </ul>                                  |
| contact with sharp material agent, pointed, hard, abrasive  | <ul style="list-style-type: none"> <li>- Contact with a sharp Material Agent (knife / blade)</li> <li>- Contact with a sharp Material Agent (nail / sharp tool)</li> <li>- Contact agent with hard or abrasive material</li> <li>- Another case concerning materials in contact with agent edgy, sharp, hard, abrasive</li> </ul>  |
| Nesting, trapping, crushing, crushing, pinching, etc..  | <ul style="list-style-type: none"> <li>- Nesting, trapping, crushing in / inside</li> <li>- Nesting, trapping, crushing under</li> <li>- Nesting, trapping, crushing between</li> <li>- Tearing, cutting of a member, a hand, a finger or more parts of the body</li> <li>- Constrict of whole body or of one or more parts of it</li> <li>- By pinching</li> <li>- Another case involving nesting, trapping, crushing, crushing, pinching, etc..</li> </ul>                             |
| Physical or mental effort   | <ul style="list-style-type: none"> <li>- Physical effort at the expense of the musculoskeletal system</li> <li>- Physical exertion caused by radiation, noise, light, pressure</li> <li>- Effort psychic, mental shock</li> <li>- Another case involving mental or physical effort</li> </ul>  |
| Bite, calcium, etc., by animals or humans   | <ul style="list-style-type: none"> <li>- Bite</li> <li>- Puncture by insects or fish</li> <li>- Shot, football, head, strangulation</li> <li>- Another case relating to bite, kick, etc., by animals or humans</li> </ul>  |



## ***Analysis of accidents in the paper manufacturing sector***

Fatal injury for mechanical asphyxia mixed ("strangulation and immobilization chest")



Figure: 35 Central "Sietta" affected by the event of accidents



Figure 36: Boardwalk in the area siette (see the bag containing the remains of clothing which 'was released the PO)





Figure 37: geared motor assembly rod moved into the area suitable for a number of preliminary visual analysis



Figure 38 evident traces of the original placement of the connecting rod - crank axis of the gearbox bolted into place with tilt and less eccentric crank

Table 16: Technique of analysis applied to the event

|          | RESEARCH CAUSES   | ADOPTION PREVENTIVE MEASURES  |          |
|----------|---|---|----------|
|          |    |    |          |
|          | <p><i>ED: 7500 Id (death)</i><br/>                     Part of body injured: trunk and internal organs<br/>                     Type of injury: mixed mechanical asphyxia</p>   | <p><i>ev. sist. protective passive / active (in the case given the severity of the accident) - to constrict the movement of the rod / crank - PPE protection would not solve the problem</i></p>              |          |
| <b>1</b> | <p><b>NESTING, TRAPPING, CRUSHING, CRUSHING, PINCHING, ETC.– Constrict of whole body or of one or more parts of it – neck and chest crushing</b></p>  | <p><i>The P.O. at the time of emergency is limited to support his colleague, and to carry out the order him to him</i></p>  | <b>7</b> |
| <b>2</b> | <p><b>BREAKAGE, BURSTING, SPLITTING, SLIPPING, FALL, COLLAPSE OF MATERIAL AGENT - Break of material, at junctions, connections, material agent - destruction of the bearing collar</b></p> <p><b>LOSS OF CONTROL (TOTAL OR PARTIAL) OF MACHINE, MEANS OF TRANSPORT OR HANDLING EQUIPMENT, HAND-HELD TOOL, OBJECT, ANIMAL - Problems of total or partial control of the means of transport / equipment material handling and / or substance (motorized or not) - crank mechanism that transmits the reciprocating motion to the system horizontal oscillating multi sprayer nozzle</b></p> <p><b>BODY MOVEMENT UNDER OR WITH PHYSICAL STRESS – Pushing, pulling - Share of P.O. to try to remedy the malfunction of the transmission of the reciprocating sietta</b></p> | <p><i>Control action on the safety of the plant installation and maintenance</i></p> <p><i>Vigilance on the part of those in charge and information, training of PO recently inserted in the activity</i></p> | <b>6</b> |
| <b>3</b> | <p><b>STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS - External criticality - General criticality [boundary conditions ( eg. topography, climate, availability of services, sociological context)]- related to the climatic conditions of the work environment in which it operated Part abuse</b></p> <p><b>STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS – Common Plant - Specific Pants (systems of emergency management,</b></p>   | <p><i>Evaluation of the choice of the solutions adopted</i></p>   | <b>5</b> |



**detection, contrast and alarm)** - *related to the fact that the emergency stop button was not easily accessible and not blocked the progress of the whole machine, but only some parts of it;*

**STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS –**

**Structure maintenance – Conservation work** - *related to the fact that pieces have been recovered from the existing system, like the engine crank-connecting rod system, which had many flaws, and the gear that was in terms of improper maintenance*

**STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS –**

**Structure maintenance – Participation of adaptation to the norms** - *related to the fact that the gear had been recovered without consideration of its seal that contained asbestos, and that the bearing crank was in poor condition*

**EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Tipology -**

**Devices (command and control, signaling, security)** - *related to the fact that the emergency stop button was not easily accessible and not blocked the progress of the whole machine, but only some parts of it*

**EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Choice and**

**condition of use – Maintenance status** - *related to the fact that the gearbox was in a state of improper service, and that the bearing crank was in poor condition*

**PHYSICAL, CHEMICAL, BIOLOGICAL ASPECTS OF WORKPLACES -**

**Localized solutions for the management of environmental conditions – lighting** - *related to visibility problems in the operational area of the continuous line*

**PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS**

**INVOLVED - physiological Aspects – work experience** - *linked to the fact that the P.O. had been included recently in the activity with the task of "guiding the chief engineer" for the purpose of learning the conduct of the paper machine*

|   |   |   |   |
|---|---|---|---|
|   | <p><b>AUDIT, SUPERVISION, OPERATING PROCEDURES &amp; IFT - Procedure - Procedures for workers, procedures for machine operators, Procedures for supervisors</b> - <i>related to the fact that it was not present no procedure for interventions in case of emergency on the continuous line</i></p> <p><b>REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE – Operating conditions – Types of maintenance applied –</b> <i>related to lack of maintenance both in the workplace and the equipment</i></p>  |   |   |
| 4 | <p><b>STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS –</b> <i>related to general criticality, to the consistency with the uses and to actions to norms adaptation and specific systems for emergency management</i></p> <p><b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS –</b> <i>related to the maintenance type and status of continuous line and its equipments;</i></p> <p><b>PHYSICAL, CHEMICAL AND BIOLOGICAL ASPECTS OF THE WORK ENVIRONMENT -</b> <i>related to the lighting of the environment work</i></p> <p><b>PHYSIOLOGICAL, SUBJECTIVE AND IDEOLOGICAL ASPECTS –</b> <i>related to the work experience of the injured;</i></p> <p><b>AUDIT, SUPERVISION AND OPERATING PROCEDURES &amp; IFT -</b> <i>related to the fact that it was not present no procedure</i></p> <p><b>REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE –</b> <i>related to maintenance</i></p> | <p><b>EXTERNAL/INTERNAL STRUCTURAL AND PLANT CHARACTERISTICS –</b>work environment</p> <p><b>MACHINERY, EQUIPMENT AND PROVISIONAL WORKS -</b> equipment used for processing</p> <p><b>PHYSICAL, CHEMICAL AND BIOLOGICAL ASPECTS OF THE WORK ENVIRONMENT –</b> related to working conditions in the workplace</p> <p><b>PHYSIOLOGICAL, SUBJECTIVE AND IDEOLOGICAL ASPECTS –</b> Type of employment contract, choice of workers, work experience</p> <p><b>AUDIT, SUPERVISION AND OPERATING PROCEDURES &amp; IFT -</b> information, training and operator training at various levels, both operational and behavioral procedures, supervision of the worker by the Head</p> | 4 |

|     |   |   |   |
|-----|---|---|---|
| 5.1 | <p><i>poor maintenance of the workplace</i></p> <p><i>lack of maintenance of the equipment</i></p> <p><i>failure of safety equipment systems for maintenance activities</i></p>   | <p><b>A. Plant / technologies solutions for the residual risks management of individual current operational situations (vs. the progress of technology and knowledge)</b> <i>(related to all Root Causes identified);</i></p> <p><b>B. Detection / signal / alarm deviations systems (emergencies) external or internal (from process deviations)</b> - <i>(related to the difficulties of finding a PO and linked to the external and internal structural characteristics of the continuous line);</i></p>   | 3 |
| 5.2 | <p><i>no procedures for the operators at different levels on the activities to be carried out in case of emergency</i></p> <p><i>failure to provide information, education and training</i></p> <p><i>no supervision / operational and behavioural procedures deficient</i></p> <p><i>operation not provided and not analyzed</i></p> | <p><b>A. Definition of operational procedures for emergency conditions</b> <i>(related to machinery, equipment and temporary works);</i></p> <p><b>B. Procedures for ordinary and extraordinary maintenance of sites / facilities / equipment including emergency management internal / external</b> <i>(related to machinery, equipment and temporary works);</i></p> <p><b>C. Procedures of verification, control and detection / reporting / management of elementary functional anomalies</b> <i>(related to the definition of working procedures and consequent information, education and training)</i></p> | 2 |
| 6   | <p><b>Hazard factor not identified</b> <i>(choice of H.I. technique not appropriate for the context)</i></p>  | <p><i>Definition of the technical maintenance of equipment and the organization of society at various levels</i></p>  | 1 |

## Insertion of the data input

| Dati Identificativi Evento                         |   | Dati Parte Offesa       |   | Azienda P.O.   |  | Analisi di Rischio Aziendale         |                            | Ditta Ospitata |  | Conseguenze Infortunio |  |
|--|---|-------------------------|---|--|--|--------------------------------------|----------------------------|----------------|--|------------------------|--|
| Dati al Contorno                                   |   | Informazioni Infortunio |   | Analisi Cause e Prevenzione  |  | Soluzioni                            |                            | Dati finali    |  |                        |  |
| Numero Codifica Evento                             |   |                         |   |  |  |                                      |                            |                |  |                        |  |
| Data Infortunio                                    | 19  | 02                      | 2010                                      | Giorno Settimanale Infortunio  |  | venerdi                              |                            |                |  |                        |  |
| Ora Infortunio                                     | 10  | 15                      | Ora Progr. Infortunio nel turno           |  | II   |                                      |                            |                |  |                        |  |
| Numero Registro Infortuni                          |   |                         |   |  |  |                                      |                            |                |  |                        |  |
| Luogo Infortunio                                   | sede della ditta della P.O.   |                         | Classe di età Infortunato                 |  | da 18 a 34 anni                            |                                      |                            |                |  |                        |  |
| ASL Competente                                     | Mondovì (0116)  |                         | Luogo Fisico Infortunio                   |  | Luogo di produzione, officina, laboratorio |                                      |                            |                |  |                        |  |
| 1° Intervento Ispettivo                            | giorno  | mese                    | anno                                      | Nome Ispettore ASL   |  | Ispezione U.P.G. a seguito di evento |                            |                |  |                        |  |
|  | 24  | 02                      | 2010                                      | <input checked="" type="radio"/> <5 <input type="radio"/> >=5  |  |                                      |                            |                |  |                        |  |
| Figure esterne intervenute                         | <input checked="" type="radio"/> SI <input type="radio"/> NO  |                         |   |  |  |                                      |                            |                |  |                        |  |
|  | <input type="checkbox"/> Vigili del Fuoco   |                         | <input type="checkbox"/> Polizia          |  | <input type="checkbox"/> Vigili Urbani     |                                      |                            |                |  |                        |  |
|  | <input checked="" type="checkbox"/> Carabinieri   |                         | <input type="checkbox"/> Ispettor. Lavoro |  | <input type="checkbox"/> Altri             |                                      |                            |                |  |                        |  |
| Data Apertura Caso (Magistratura)                  | giorno  | mese                    | anno                                      | Date Sopralluoghi (1)  |  |                                      |                            |                |  |                        |  |
|  | 19  | 02                      | 2010                                      | <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |  |                                      |                            |                |  |                        |  |
|  | giorno  |                         | mese                                      |  | anno                                       |                                      |                            |                |  |                        |  |
|  | 24  |                         | 02  |  | 2010                                       |                                      |                            |                |  |                        |  |
|  | Titolo  |                         | NOME                                      |  | COGNOME                                    |                                      | Incarico                   |                |  |                        |  |
|  | Laurea Mag. Ingegneria  |                         | Mario                                     |  | Rossi                                      |                                      | di consulenza tecnica P.M. |                |  |                        |  |
| Alterazione dello Stato di fatto nell'immediatezza | <input checked="" type="radio"/> SI <input type="radio"/> NO <input checked="" type="checkbox"/> per soccorso <input type="checkbox"/> per messa in sicurezza <input type="checkbox"/> CF <input type="checkbox"/> LF |                         |   |  |  |                                      |                            |                |  |                        |  |
| Nuovo  |   | Leggi dati              |   | Salva dati   |  | Successivo >                         |                            |                |  |                        |  |

Figure 39: Identifying details of the events

| Dati Identificativi Evento         |  | Dati Parte Offesa       |                                     | Azienda P.O.                |  | Analisi di Rischio Aziendale |                             | Ditta Ospitata |      | Conseguenze Infortunio |  |
|------------------------------------|--|-------------------------|-------------------------------------|-----------------------------|--|------------------------------|-----------------------------|----------------|------|------------------------|--|
| Dati al Contorno                   |  | Informazioni Infortunio |                                     | Analisi Cause e Prevenzione |  | Soluzioni                    |                             | Dati finali    |      |                        |  |
| Nome Cognome P.O.                  | Pippo  |                         | Baudo                               |                             | <input checked="" type="radio"/> M <input type="radio"/> F   |                              |                             |                |      |                        |  |
| Data di Nascita                    | 08   | 06                      | 1979                                | Comune di Nascita           |  | Cuneo (CN)                   |                             |                |      |                        |  |
| Nazione di Nascita                 | Italia   |                         | Comune di Residenza                 |                             | Cuneo (CN)   |                              |                             |                |      |                        |  |
| Comune Domicilio                   | Cuneo (CN)   |                         | Indirizzo residenza                 |                             |  |                              |                             |                |      |                        |  |
| Indirizzo Domicilio                |  |                         |                                     |                             |  |                              |                             |                |      |                        |  |
| Recapito Telefonico                |  |                         |                                     |                             |  |                              |                             |                |      |                        |  |
| Codice ASL appartenenza            | Cuneo (0115)   |                         | Status Professionale P.O.           |                             | <input type="radio"/> Lavoratore autonomo <input checked="" type="radio"/> Altro <input type="checkbox"/> Dipendente con un'occupazione stabile o temporanea (tempo indeterminato/determinato) |                              |                             |                |      |                        |  |
| Codice ISTAT                       |  |                         |                                     |                             |  |                              |                             |                |      |                        |  |
| Grado Istruzione P.O.              | Medie  |                         | Data Inizio rapporto di lavoro      |                             | 01   |                              | 09                          |                | 2009 |                        |  |
| Lingua Madre P.O.                  | italiano   |                         | Libretto di lavoro                  |                             | <input type="checkbox"/> CF  |                              | <input type="checkbox"/> LF |                |      |                        |  |
| Status Professionale P.O.          |  |                         |                                     |                             |  |                              |                             |                |      |                        |  |
| Qualifica formale                  | Operaio comune   |                         | Numero Matricola                    |                             |  |                              |                             |                |      |                        |  |
| Parente Datore Lavoro              | <input type="radio"/> SI <input checked="" type="radio"/> NO   |                         |                                     |                             |  |                              |                             |                |      |                        |  |
| Mansione svolta al mom. infortunio | apprendista per la conduzione della macchina cor   |                         | Appartenenza Sindacato              |                             | <input type="radio"/> SI <input checked="" type="radio"/> NO   |                              |                             |                |      |                        |  |
| Stato Civile                       | <input type="radio"/> Celibe/Nubile <input type="radio"/> Vedovo/a <input type="radio"/> Separato/a <input type="radio"/> Divorziato/a <input type="radio"/> Tutelato/a <input checked="" type="radio"/> Coniugato/a |                         |                                     |                             |  |                              |                             |                |      |                        |  |
| Numero Persone a Carico            | 3  |                         | Tipo Contratto Collettivo Nazionale |                             | <input checked="" type="radio"/> Metalmeccanico <input type="radio"/> Chimico <input type="radio"/> Commerciale <input type="radio"/> Altro  |                              |                             |                |      |                        |  |
| Importo Retributivo Infortunato    |  |                         |                                     |                             |  |                              |                             |                |      |                        |  |
| Calcola il Codice Fiscale          | BDAPPP79H08D205Q   |                         | Numero Contratto Coll. Naz.         |                             |  |                              |                             |                |      |                        |  |
| Recapito Somma Indenn. Infort.     |  |                         |                                     |                             |  |                              |                             |                |      |                        |  |
|                                    | Data Stipul. Contratto Coll. Naz.  |                         | 01                                  |                             | 09   |                              | 2009                        |                |      |                        |  |
|                                    | Data Scad. Contratto Coll. Naz.  |                         | 01                                  |                             | 09   |                              | 2010                        |                |      |                        |  |
| Nuovo                              |  | Leggi dati              |                                     | Salva dati                  |  | Precedente                   |                             | Successivo >   |      |                        |  |

Figure 40: Injured Data


| Dati Identificativi Evento   | Dati Parte Offesa   | Azienda P.O.  | Analisi di Rischio Aziendale   | Ditta Ospitata                     | Conseguenze Infortunio |
|--|---|---|--|------------------------------------|------------------------|
| Dati al Contorno   | Informazioni Infortunio   | Analisi Cause e Prevenzione                             | Soluzioni  | Dati finali                        |                        |
| Settore Pubblico <input type="radio"/>   | Settore privato <input checked="" type="radio"/>                        | Terzi presenti a titolo legittimo <input type="radio"/> |  |                                    |                        |
| Ragione Sociale  | CARTIERA S.P.A.   | P.O. in forza alla sede centrale                        | <input checked="" type="radio"/>   | P.O. in forza alla sede distaccata | <input type="radio"/>  |
| Visura Camerale  | CF   LF   | Numero Dipendenti                                       | 6-10   |                                    |                        |
| Indirizzo  | tal dei tali - 2568   | Via - n° civico   | C.A.P.   | Località                           | Mondovi                |
| Codice Azienda   |   |   |  |                                    |                        |
| Tipo Attività Economica  | Fabbricazione della pasta da carta, della carta e dei prodotti di carta | Docum. Aziendale Sicurezza                              | <input type="radio"/> SI <input type="radio"/> NO  |                                    |                        |
| Codice Fiscale / Partita IVA   |   | Addetti Pronto Soccorso                                 | <input type="radio"/> SI <input type="radio"/> NO  |                                    |                        |
| Tipo Polizza Assicurativa  |   | Addetti Antincendio                                     | <input type="radio"/> SI <input type="radio"/> NO  |                                    |                        |
| Numero Polizza Assicurativa  |   |   |  |                                    |                        |
| Data Stipulazione  | gg   mm   aa  |   |  |                                    |                        |
| Data Scadenza  | gg   mm   aa  |   |  |                                    |                        |
| Figure Sicurezza Azienda (0)   | <input type="radio"/> >5 <input type="radio"/> <=5                      |   |  |                                    |                        |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/> |   |   | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>  |                                    |                        |

Figure 41: Enterprise of injured


| Dati Identificativi Evento   | Dati Parte Offesa  | Azienda P.O.  | Analisi di Rischio Aziendale   | Ditta Ospitata | Conseguenze Infortunio |
|--|--|---|--|----------------|------------------------|
| Dati al Contorno   | Informazioni Infortunio  | Analisi Cause e Prevenzione                                   | Soluzioni  | Dati finali    |                        |
| Analisi di Rischio Esistente   | <input checked="" type="radio"/> SI <input type="radio"/> NO   | Data Ultimo Aggiornamento                                     | 28   07   2009   |                |                        |
| SGS Certificato Esistente  | <input type="radio"/> SI <input checked="" type="radio"/> NO   |   |  |                |                        |
| <b>METODOLOGIA VALUTAZIONE DEL RISCHIO</b>   |  |   |  |                |                        |
| Tecniche Hazard Identification   | <input type="checkbox"/> Check List <input type="checkbox"/> Job Safety <input type="checkbox"/> HAZOP <input type="checkbox"/> FTA <input type="checkbox"/> What If <input checked="" type="checkbox"/> FMEA <input type="checkbox"/> Altro |   |  |                |                        |
| <b>Metodiche di calcolo del rischio</b>  |  |   |  |                |                        |
| ED (Erità del Danno)   | <input checked="" type="radio"/> Stima Soggettiva <input type="radio"/> Statistica Dati Secondo il Worst Credible Case   | <b>VALUTAZIONE SOGGETTIVA</b>                                 |  |                |                        |
| FC (Fattore di Contatto)   | <input checked="" type="radio"/> Stima Soggettiva <input type="radio"/> Valutazione Condivisa  |   |  |                |                        |
| P (Probabilità di Accadimento)   | <input checked="" type="radio"/> Stima Soggettiva <input type="radio"/> Livello Frequenza Attesa di Accadimento  |   |  |                |                        |
| <b>La Valutazione del Rischio comprende:</b>   |  |   |  |                |                        |
| 1. Soluzioni di eliminazione/gestione rischio residuo  | <input checked="" type="radio"/> NO <input type="radio"/> SI   |   |  |                |                        |
| 2. La caratterizzazione dei modelli espositivi dei lavoratori  | <input checked="" type="radio"/> NO <input type="radio"/> SI   | Date riunioni periodiche ultimo anno                          | CF   LF  |                |                        |
| <b>ASPETTI SPECIFICI DELLA V.R. RELATIVI ALL'EVENTO INFORTUNISTICO</b>   |  |   |  |                |                        |
| Lavoro di Propria Competenza   | <input checked="" type="radio"/> SI <input type="radio"/> NO   | Da Quanto Tempo lo Svolgeva                                   | > 1 mese   |                |                        |
| Infortunato Formato/Informato A.R.   | <input checked="" type="radio"/> SI <input type="radio"/> NO   | CF   LF   |  |                |                        |
| Eventuale riunione periodica in cui si è trattato l'argomento afferente alla dinamica inf.                               | <input type="radio"/> SI <input checked="" type="radio"/> NO   |   |  |                |                        |
| Previsti Indum. di Lavoro Speciali   | <input checked="" type="radio"/> SI <input type="radio"/> NO   | (Specificare)   |  |                |                        |
| Previsti e Forniti DPI   | <input checked="" type="radio"/> SI <input type="radio"/> NO   | Organizzazione sostituzioni                                   |  |                |                        |
|  |  | Sono stati selezionati dei DPI - Fare click per visualizzarli |  |                |                        |
|  |  | Organizzazione sostituzioni                                   |  |                |                        |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/> |  |   | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>  |                |                        |

Figure 42: Risks analysis of injured enterprise


| Dati Identificativi Evento   | Dati Parte Offesa       | Azienda P.O.  | Analisi di Rischio Aziendale   | Ditta Ospitata  | Conseguenze Infortunio  |
|--|-------------------------|---|--|---|---|
| Dati al Contorno   | Informazioni Infortunio | Analisi Cause e Prevenzione   | Soluzioni  | Dati finali   |   |
| Abbandono Lavoro <input type="radio"/> SI <input checked="" type="radio"/> NO  |                         |   |  |   |   |
| Prime Cure Prestate da:  |                         | Colleghi  |  |   |   |
| Prime Cure Prestate dove:  |                         | Sgo dell'infortunio, nei pressi del lava feltro - 1° pressa superiore macchina continua - passerella superiore lato comando |  |   |   |
| Prime Cure Prestate quando:  |                         | Immediatamente dopo l'evento  |  |   |   |
| Natura Lesione   |                         | Asfissia  |  |   |   |
| Sede Lesione   |                         | Collo, altre parti non specificate sopra  |  |   |   |
| Data 1° Certif. Medico al Dat. Lav.  |                         | gg <input type="text"/>   | mm <input type="text"/>  | aa <input type="text"/>                                 | Interruzione dell'attività produttiva associata all'infortunio <input type="radio"/> NO <input checked="" type="radio"/> SI |
| Giorni di Prognosi   |                         | <input type="text" value="0"/>  |  |   |   |
| Giorni Definitivi  |                         | <input type="radio"/> Inabilità Temp. gg. <input type="text" value="0"/>  |  | Giorni di Interruzione <input type="text" value="180"/> |   |
|  |                         | <input type="radio"/> Inabilità Permanente  |  |   |   |
|  |                         | <input checked="" type="radio"/> Morte  |  |   |   |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/> |                         |   | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>  |   |   |

Figure 43: Injury consequences


| Dati Identificativi Evento   | Dati Parte Offesa       | Azienda P.O.  | Analisi di Rischio Aziendale   | Ditta Ospitata   | Conseguenze Infortunio |
|--|-------------------------|---|--|--|------------------------|
| Dati al Contorno   | Informazioni Infortunio | Analisi Cause e Prevenzione   | Soluzioni  | Dati finali  |                        |
| Fattore di Pericolo associato all'attività specifica al momento dell'infortunio  |                         | Dispositivi di trasmissione e stoccaggio di energia (meccanica, pneumatica, idraulica, elettrica, compresi gli accessori e le testate)  |  |  |                        |
| Fattore di pericolo secondario   |                         | Macchine per trattare le superfici - pulire, lavare, asciugare, pitturare, stampare   |  |  |                        |
| Attrezzi/Macchine ecc. adoperate dalla P.O.  |                         | <input type="checkbox"/> Attrezzi <input type="text" value="CF"/> <input type="text" value="LF"/>   |  | <input type="checkbox"/> Opere Provvisoriali <input type="text" value="CF"/> <input type="text" value="LF"/>                                     |                        |
|  |                         | <input type="checkbox"/> Macchine <input type="text" value="CF"/> <input type="text" value="LF"/>   |  | <input checked="" type="checkbox"/> Altro <input type="text" value="CF"/> <input type="text" value="LF"/>  |                        |
| Attrezzi/Macchine ecc. presenti nell'area dell'infortunio  |                         | <input type="checkbox"/> Attrezzi <input type="text" value="CF"/> <input type="text" value="LF"/>   |  | <input type="checkbox"/> Opere provvisoriali <input type="text" value="CF"/> <input type="text" value="LF"/>                                     |                        |
|  |                         | <input type="checkbox"/> Macchine <input type="text" value="CF"/> <input type="text" value="LF"/>   |  | <input type="checkbox"/> Altro <input type="text" value="CF"/> <input type="text" value="LF"/>   |                        |
| Attività Specifica   |                         | <input type="text" value="Lavorare con utensili a mano manuali"/>   |  | Disegno / Foto Scenario Infortunio <input type="text" value="CF"/> <input type="text" value="LF"/>   |                        |
| Violazioni evidenziate nel rapporto di U.P.G. (10)   |                         | <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |  |  |                        |
| Prescrizioni fornite da U.P.G.   |                         | <input type="text" value="CF"/> <input type="text" value="LF"/>   |  | Eventuale Sequestro <input checked="" type="radio"/> SI <input type="radio"/> NO <input type="text" value="CF"/> <input type="text" value="LF"/> |                        |
| Ammenda Iniziale   |                         | <input type="text"/>  |  |  |                        |
| Data per Eventuali Ricorsi   |                         | gg <input type="text"/>   | mm <input type="text"/>  | aa <input type="text"/>  |                        |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/> |                         |   | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>  |  |                        |

Figure 44: Injury informations

Also for this case it have not been able to completely fill all the cards, due to incomplete information, and moreover to respect the privacy lot of data have been made unreadable and for the people have been insert fantasy name

### Selection of the Causes and of the Interventions

To summarize:

**SEVERITY AND TYPE OF INJURY:** mechanical asphyxia mixed ("strangulation and immobilization chest").

**DIRECT CAUSES:** nesting, trapping, crushing, crushing, pinching, etc.– Constrict of whole body or of one or more parts of it – neck and chest crushing.

**INDIRECT CAUSES OF FIRST LEVEL:**

- ⇒ BREAKAGE, BURSTING, SPLITTING, SLIPPING, FALL, COLLAPSE OF MATERIAL AGENT - Break of material, at junctions, connections, material agent - destruction of the bearing collar
- ⇒ LOSS OF CONTROL (TOTAL OR PARTIAL) OF MACHINE, MEANS OF TRANSPORT OR HANDLING EQUIPMENT, HAND-HELD TOOL, OBJECT, ANIMAL - Problems of total or partial control of the means of transport / equipment material handling and / or substance (motorized or not) - crank mechanism that transmits the reciprocating motion to the system horizontal oscillating multi sprayer nozzle
- ⇒ BODY MOVEMENT UNDER OR WITH PHYSICAL STRESS – Pushing, pulling - Share of P.O. to try to remedy the malfunction of the transmission of the reciprocating sietta

**INDIRECT CAUSES OF SECOOND LEVEL:**

- ❑ STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS - External criticality - General criticality [boundary conditions ( eg. topography, climate, availability of services, sociological context)]- related to the climatic conditions of the work environment in which it operated Part abuse
- ❑ STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS – Common Plant - Specific Pants (systems of emergency management, detection, contrast and alarm) - related to the fact that the emergency stop button was not easily accessible and not blocked the progress of the whole machine, but only some parts of it;
- ❑ STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS – Structure maintenance – Conservation work - related to the fact that pieces have been recovered from the existing system, like the engine crank-connecting rod system, which had many flaws, and the gear that was in terms of improper maintenance
- ❑ STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS – Structure maintenance – Participation of adaptation to the norms - related to the fact that the gear had been recovered without consideration of its seal that contained asbestos, and that the bearing crank was in poor condition
- ❑ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Tipology - Devices (command and control, signaling, security) - related to the fact that the emergency stop button was not easily

accessible and not blocked the progress of the whole machine, but only some parts of it

- ❑ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Choice and condition of use – Maintenance status - related to the fact that the gearbox was in a state of improper service, and that the bearing crank was in poor condition
- ❑ PHYSICAL, CHEMICAL, BIOLOGICAL ASPECTS OF WORKPLACES - Localized solutions for the management of environmental conditions – lighting - related to visibility problems in the operational area of the continuous line
- ❑ PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED - physiological Aspects – work experience - linked to the fact that the P.O. had been included recently in the activity with the task of "guiding the chief engineer" for the purpose of learning the conduct of the paper machine
- ❑ AUDIT, SUPERVISION, OPERATING PROCEDURES & IFT - Procedure - Procedures for workers, procedures for machine operators, Procedures for supervisors - related to the fact that it was not present no procedure for interventions in case of emergency on the continuous line
- ❑ REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE – Operating conditions – Types of maintenance applied – related to lack of maintenance both in the workplace and the equipment

### **ROOT CAUSES:**

- ✓ STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS – related to general criticality, to the consistency with the uses and to actions to norms adaptation and specific systems for emergency management
- ✓ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – related to the maintenance type and status of continuous line and its equipments;
- ✓ PHYSICAL, CHEMICAL AND BIOLOGICAL ASPECTS OF THE WORK ENVIRONMENT - related to the lighting of the environment work
- ✓ PHYSIOLOGICAL, SUBJECTIVE AND IDEOLOGICAL ASPECTS – related to the work experience of the injured;
- ✓ AUDIT, SUPERVISION AND OPERATING PROCEDURES & IFT - related to the fact that it was not present no procedure
- ✓ REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE – related to maintenance



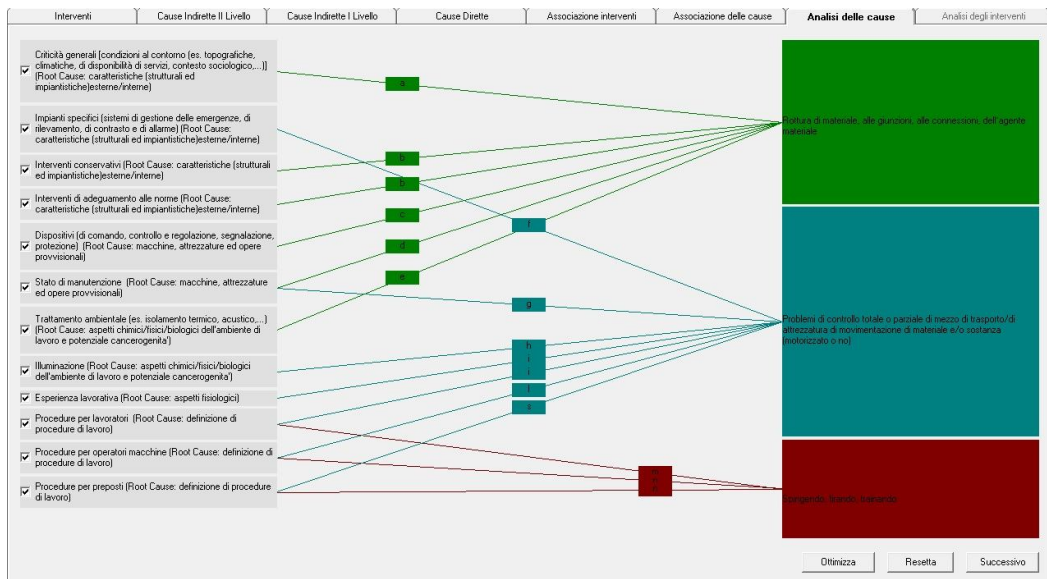


Figure 45: Cause analysis

### **TECHNIQUE INTERVENTIONS:**

- ✓ Plant / technologies solutions for the residual risks management of individual current operational situations (vs. the progress of technology and knowledge) (related to all Root Causes identified);
- ✓ Detection / signal / alarm deviations systems (emergencies) external or internal (from process deviations) - (related to the difficulties of finding a PO and linked to the external and internal structural characteristics of the continuous line);

### **WORK PLANNING AND PROCEDURE INTERVENTIONS:**

- ❑ Definition of operational procedures for emergency conditions (related to machinery, equipment and temporary works);
- ❑ Procedures for ordinary and extraordinary maintenance of sites / facilities / equipment including emergency management internal / external (related to machinery, equipment and temporary works);
- ❑ Procedures of verification, control and detection / reporting / management of elementary functional anomalies (related to the definition of working procedures and consequent information, education and training)
- ❑ Operational procedures for the current operating conditions (Signs of danger, prohibition and obligation: call procedure) (danger signalling of moving machine and illustration of an intervention procedure in the case of filling of the mill bar)

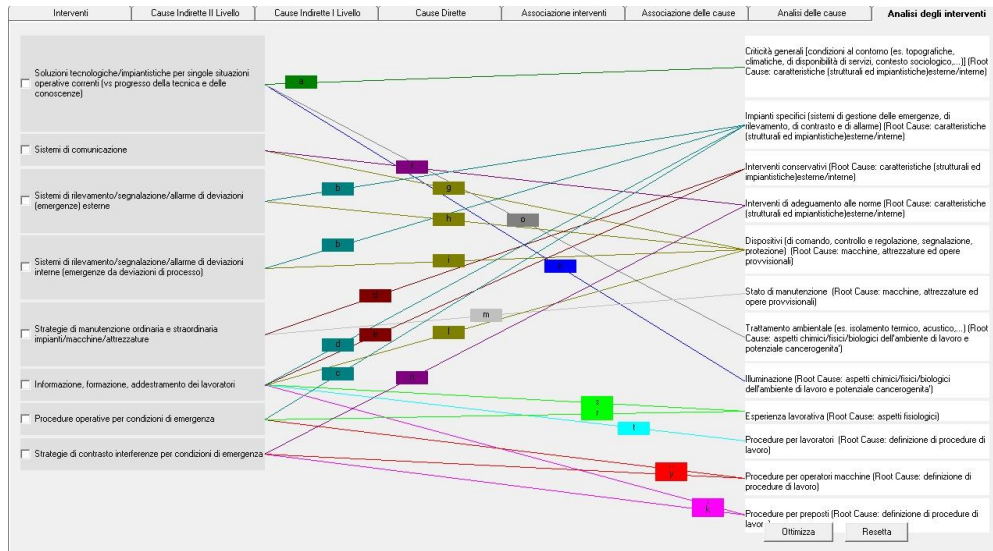


Figure 46: Interventions analysis

From the graph it also gets the optimal solution of intervention, which includes:

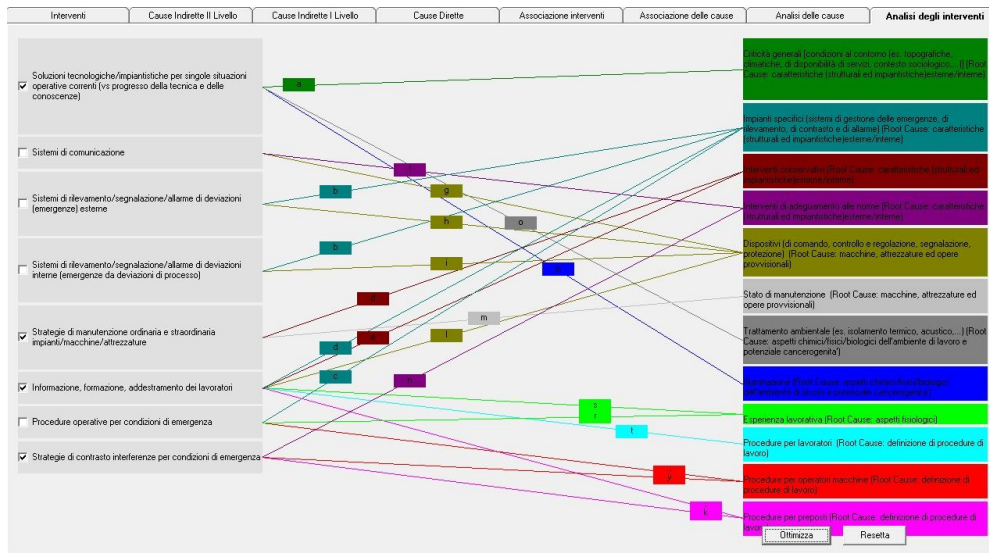
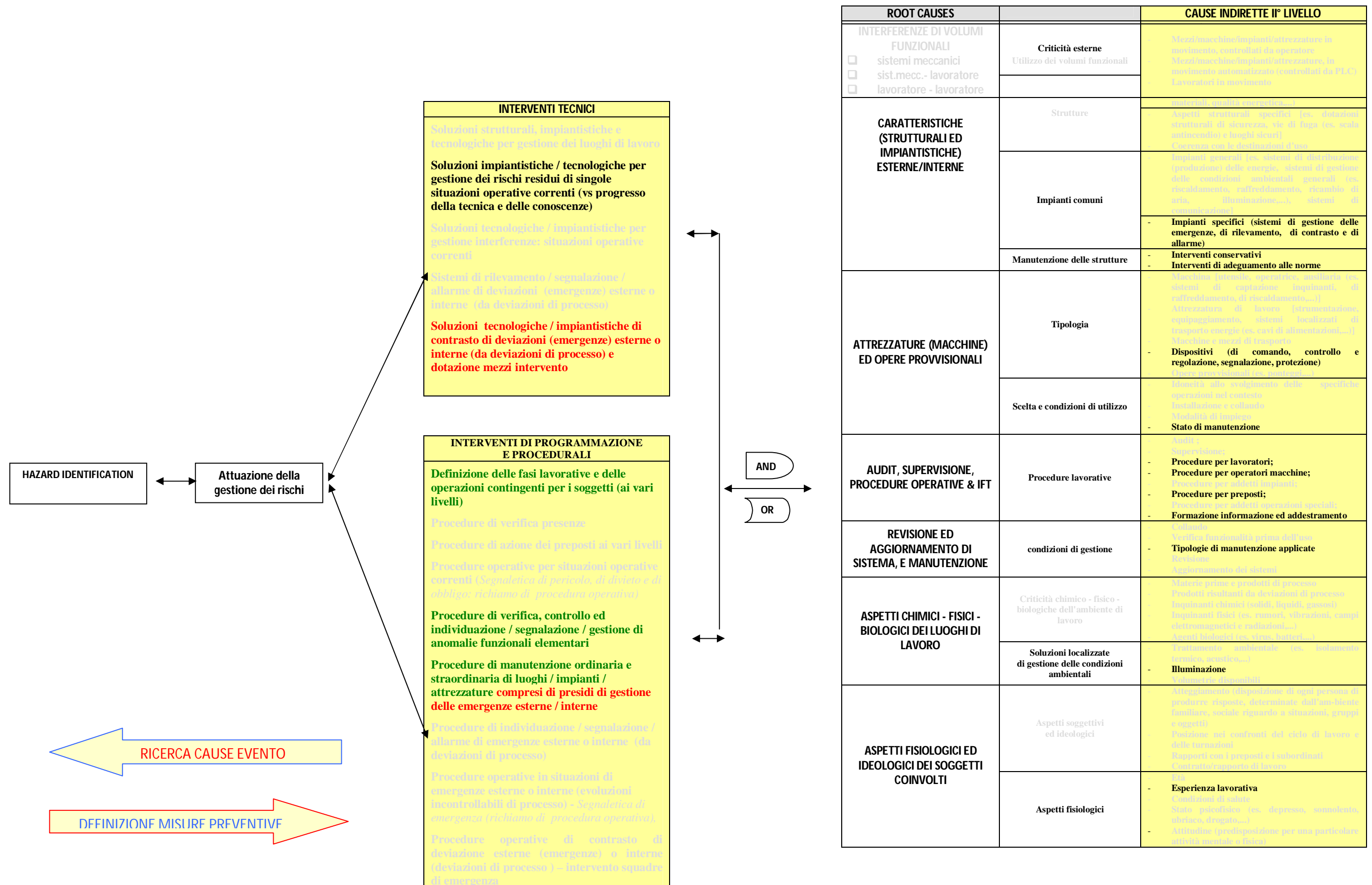


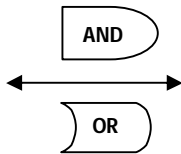
Figure 47: Interventions analysis resolved

Figure 48: Graphic visualization of the analyzed event



| CAUSE INDIRETTE 1° LIVELLO   |   |
|--|---|
| Problema elettrico, esplosione, incendio   | <ul style="list-style-type: none"> <li>- Problema elettrico causato da un guasto all'impianto</li> <li>- Problema elettrico causato da elettricità statica</li> <li>- Problema elettrico causato da mancato isolamento</li> <li>- Problema elettrico causato da radiazioni esterne/fulmine</li> <li>- Esplosione</li> <li>- Incendio</li> <li>- Altra causa relativa a problema elettrico, esplosione, incendio</li> </ul>  |
| Traboccamento, rovesciamento, perdita, scorrimento, vaporizzazione, emanazione   | <ul style="list-style-type: none"> <li>- Allo stato solido – rovesciamento, scorrimento</li> <li>- Allo stato liquido – perdita, trasudo, fuoriuscita, rovesciamento, traboccamento, spruzzo, asperione</li> <li>- Allo stato gassoso – vaporizzazione, formazione di aerosol, formazione di gas, emanazione</li> <li>- Polverosità – generazione di fumi, emissione di polveri, particelle</li> <li>- Altra causa relativa a traboccamento, rovesciamento, perdita, scorrimento, vaporizzazione, emanazione</li> </ul>   |
| <b>Rottura, frattura, rottura violenta, improvvisa e fragorosa dell'agente materiale</b>   | <ul style="list-style-type: none"> <li>- <b>Rottura di materiale, alle giunzioni, alle connessioni, dell'agente materiale</b></li> <li>- Rottura/sganciamento del dispositivo di protezione individuale</li> <li>- Rottura con esplosione di schegge (legno, vetro, metallo, pietra, plastica, altro) dell'agente materiale</li> <li>- Altra causa relativa a rottura, frattura, rottura violenta, improvvisa e fragorosa dell'agente materiale</li> </ul>  |
| Scivolamento, caduta, perdita di stabilità, crollo dell'agente materiale   | <ul style="list-style-type: none"> <li>- Scivolamento, caduta, perdita di stabilità, crollo di agente materiale posto al di sopra (che cade sulla vittima)</li> <li>- Scivolamento, caduta, perdita di stabilità, crollo di agente materiale posto al di sotto (che trascina la vittima)</li> <li>- Scivolamento, caduta, perdita di stabilità, crollo di un agente materiale – allo stesso livello</li> <li>- Altra causa relativa a scivolamento, caduta, perdita di stabilità, crollo dell'agente materiale</li> </ul>   |
| <b>Problemi di controllo totale o parziale di macchine, mezzi di trasporto /attrezzature di movimentazione, utensili a mano o oggetti, animali</b> | <ul style="list-style-type: none"> <li>- Problemi di controllo totale o parziale di macchina (ivi compreso l'avviamento intempestivo) nonché del materiale lavorato</li> <li>- <b>Problemi di controllo totale o parziale di mezzo di trasporto/di attrezzatura di movimentazione di materiale e/o sostanza (motorizzato o no)</b></li> <li>- Problemi di controllo totale o parziale di un mezzo di trasporto/di movimentazione di persone e/o di animali</li> <li>- Problemi di controllo totale o parziale di utensile a mano (motorizzato o no) nonché del materiale lavorato dall'utensile</li> <li>- Problemi di controllo totale o parziale di oggetto (portato, spostato, movimentato, ecc.)</li> <li>- Problemi di controllo totale o parziale di animale</li> <li>- Altra causa relativa a problemi di controllo totale o parziale di macchine, mezzi di trasporto /attrezzature di movimentazione, utensili a mano o oggetti, animali</li> </ul> |
| Scivolamento o inciampamento, perdita dell'equilibrio - con caduta di persona  | <ul style="list-style-type: none"> <li>- Caduta di persona dall'alto attraverso apertura</li> <li>- Scivolamento o inciampamento - con caduta di persona - dall'alto</li> <li>- Scivolamento o inciampamento - con caduta di persona - allo stesso livello</li> <li>- Perdita dell'equilibrio - con caduta di persona - dall'alto</li> <li>- Perdita dell'equilibrio - con caduta di persona - allo stesso livello</li> <li>- Scivolamento o inciampamento sul macchinario</li> <li>- Altra causa relativa a scivolamento o inciampamento, perdita dell'equilibrio - con caduta di persona</li> </ul>   |
| Movimento del corpo senza sforzo fisico (che porta generalmente ad una lesione esterna)  | <ul style="list-style-type: none"> <li>- Camminare su un oggetto tagliente</li> <li>- Inginocchiarsi, sedersi, poggarsi contro</li> <li>- Essere afferrato, trascinato, spostato da qualcosa o dal proprio slancio</li> <li>- Movimenti scoordinati, gesti intempestivi, inopportuni</li> <li>- Altra causa relativa a movimento del corpo senza sforzo fisico (che porta generalmente ad una lesione esterna)</li> </ul>   |
| <b>Movimento del corpo sotto sforzo fisico (che porta generalmente ad una lesione interna)</b>   | <ul style="list-style-type: none"> <li>- Sollevando, portando o alzandosi</li> <li>- <b>Spingendo, tirando, trainando</b></li> <li>- Depositando, abbassandosi</li> <li>- Torsione, rotazione, girandosi</li> <li>- Passo falso, torsione di gamba o caviglia, scivolamento senza caduta</li> <li>- Altra causa relativa a movimento del corpo sotto sforzo fisico (che porta generalmente ad una lesione interna)</li> </ul>   |
| Sorpresa, spavento, violenza, aggressione, minaccia, presenza  | <ul style="list-style-type: none"> <li>- Sorpresa, spavento</li> <li>- Violenza, aggressione, minaccia – tra dipendenti dell'impresa</li> <li>- Violenza, aggressione, minaccia – proveniente da persone esterne all'impresa verso le vittime nel quadro della loro funzione (rapina in banca, aggressione ad autisti di autobus, ecc.)</li> <li>- Aggressione, calca, violenza da parte di animali</li> <li>- Presenza della vittima o di un terzo che crea di per sé stesso un pericolo per la vittima/per sé stesso e se del caso per altri</li> <li>- Altra causa relativa a sorpresa, spavento, violenza, aggressione, minaccia, presenza</li> </ul>   |

| CAUSE DIRETTE  |   |
|--|---|
| Contatto con corrente elettrica, temperatura   | <ul style="list-style-type: none"> <li>- Contatto indiretto con circuito elettrico, fulmine (passivo)</li> <li>- Contatto diretto con elettricità, subire una scarica elettrica nel corpo</li> <li>- Contatto con fiamma viva o con oggetto/ambiente caldo o arroventato</li> <li>- Contatto con oggetto o ambiente freddo o ghiacciato</li> <li>- Altra causa relativa a contatto con corrente elettrica, temperatura</li> </ul>   |
| Contatto con materiale o sostanza  | <ul style="list-style-type: none"> <li>- Contatto con sostanze pericolose per via nasale, orale, per inalazione</li> <li>- Contatto con sostanze pericolose attraverso pelle o occhi</li> <li>- Contatto con sostanze pericolose attraverso il sistema digerente, inghiottendo o mangiando</li> <li>- Annegamento in un liquido</li> <li>- Seppellimento sotto un solido</li> <li>- Immersione in un gas, in una sospensione di particelle</li> <li>- Altra causa relativa a contatto con materiale o sostanza</li> </ul>   |
| Schiacciamento in movimento verticale, e/o orizzontale, caduta, su/contro un oggetto immobile/terreno (vittima in movimento) | <ul style="list-style-type: none"> <li>- Movimento verticale, schiacciamento su/contro (risultato di caduta)</li> <li>- Movimento orizzontale, schiacciamento su/contro</li> <li>- Altra causa relativa a schiacciamento in movimento verticale, e/o orizzontale, caduta, su/contro un oggetto immobile/terreno (vittima in movimento)</li> </ul>   |
| Urto da parte di oggetto in movimento, collisione con  | <ul style="list-style-type: none"> <li>- Urto da parte di oggetto proiettato</li> <li>- Urto da parte di oggetto in caduta</li> <li>- Urto da parte di oggetto che oscilla</li> <li>- Urto da parte di oggetto in rotazione, movimento, spostamento, ivi inclusi i veicoli</li> <li>- Collisione con un oggetto in movimento, ivi inclusi i veicoli - collisione con una persona (la vittima è in movimento)</li> <li>- Altra causa relativa a urto da parte di oggetto in movimento, collisione con</li> </ul>   |
| Contatto con agente materiale tagliente, appuntito, duro, abrasivo   | <ul style="list-style-type: none"> <li>- Contatto con un agente materiale tagliente (coltello/lama)</li> <li>- Contatto con un agente materiale appuntito (chiodo/utensile acuminato)</li> <li>- Contatto con agente materiale duro o abrasivo</li> <li>- Altra causa relativa a contatto con agente materiale tagliente, appuntito, duro, abrasivo</li> </ul>  |
| <b>Incastramento, intrappolamento, schiacciamento, stritolamento, pizzicamento, ecc.</b>                                     | <ul style="list-style-type: none"> <li>- Incastramento, intrappolamento, schiacciamento in/dentro</li> <li>- Incastramento, intrappolamento, schiacciamento sotto</li> <li>- Incastramento, intrappolamento, schiacciamento fra</li> <li>- Strappo, sezionamento di un membro, di una mano, di un dito o di più parti del corpo</li> <li>- <b>Stritolamento del corpo intero o di una o più parti di esso</b></li> <li>- Pizzicamento da</li> <li>- Altra causa relativa a incastramento, intrappolamento, schiacciamento, stritolamento, pizzicamento, ecc.</li> </ul> |
| Sforzo fisico o psichico   | <ul style="list-style-type: none"> <li>- Sforzo fisico a carico del sistema muscolo-scheletrico</li> <li>- Sforzo fisico causato da radiazioni, rumore, luce, pressione</li> <li>- Sforzo psichico, shock mentale</li> <li>- Altra causa relativa a sforzo fisico o psichico</li> </ul>   |
| Morso, calcio, ecc. da parte di animali o di esseri umani  | <ul style="list-style-type: none"> <li>- Morso</li> <li>- Puntura da insetti o pesci</li> <li>- Colpo, calcio, testata, strangolamento</li> <li>- Altra causa relativa a morso, calcio, ecc. da parte di animali o di esseri umani</li> </ul>   |



ENTITA' e NATURA DELLA LESIONE (dati referto medico)

Decesso per asfissia meccanica di tipo misto.

## ***Analysis of accidents in the agricultural activity sector***

Fatal accident occurred during a routine maintenance of a shovel excavator

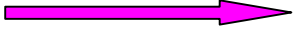
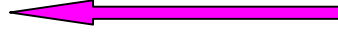


Figure 49: Front view of the blade material agent of the event



Figure 50: Side view of the machinery of the injury

Table 17: Technique of analysis applied to the event

|          | RESEARCH CAUSES  | ADOPTION PREVENTIVE MEASURES  |          |
|----------|--|---|----------|
|          |   |    |          |
|          | <p><i>ED: 7500 Id (death)</i><br/>                     Part of body injured: trunk and internal organs<br/>                     Type of injury: multiple trauma</p>  | <p><i>ev. sist. protective passive / active (in the case given the severity of the accident) - Fall Bucket - PPE protection would not solve the problem</i></p> |          |
| <b>1</b> | <p><b>STRUCK BY MOVING OBJECT, COLLISIONS WITH – Struck by falling object – crushed by the shovel excavator fall</b></p>   | <p><i>The worker to the detection of a deviation of the functionality of equipment called the technical expertise and not using the failure equipment</i></p>   | <b>7</b> |
| <b>2</b> | <p><b>OVERFLOW, OVERTURN, LEAK, FLOW, VAPORISATION, EMISSION – Liquid state - leaking, oozing, flowing, splashing, spraying - linked to the fact that the excavator bucket has undergone a release of oil from the installation of lifting of the blade;</b></p> <p><b>SLIPPING, FALLING, LOSS OF STABILITY, COLLAPSE AGENT MATERIAL - Slip, fall, loss of stability, collapse of Material Agent placed above (which falls on the victim) - linked to the fall of the blade on the victim.</b></p> | <p><i>Inclusion of a system for the maintenance of equipment;</i></p>   | <b>6</b> |

|   |   |   |   |
|---|---|---|---|
| 3 | <p><b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Tipology - Devices (command and control, signaling, security</b> - related to the fact that the loss of oil in the lifting of the blade was not signaled by a light and there was not a lock command of the blade and related to the fact that there is a safety device to operate the maintenance;</p> <p><b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Choice and condition of use – How to use</b> - related to the fact that the operator, because of the lack of clarity of the instructions and there was no sufficient training, had no idea of what actions were correct and which are not;</p> <p><b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Choice and condition of use – Maintenance status</b> - linked to the maintenance of the excavator bucket;</p> <p><b>PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED – Ideological and subject Aspects – employment contractor</b> - linked to the type of contract that the operator had at the time of the accident;</p> <p><b>PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED - physiological Aspects – work experience</b> - linked to the experience of the operator deficient for the maintenance operations;</p> <p><b>AUDIT, SUPERVISION, OPERATING PROCEDURES &amp; IFT - Procedure - Procedures for workers</b> - related to non-existent procedures for routine work for every single operator for all its activities</p> | <p><i>Evaluation of the choice of the solutions adopted</i></p> | 5 |
|---|---|---|---|

|     |   |   |   |
|-----|---|---|---|
| 4   | <p><b>EQUIPMENT (MACHINES) AND TEMPORARY WORKS</b> - related to machinery and transport equipment, devices, operating instructions, maintenance status;</p> <p><b>PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED</b> - related to the type of employment contract and to the work experience of the worker;</p> <p><b>AUDIT, SUPERVISION, OPERATING PROCEDURES &amp; IFT</b> - related to the workers procedures.</p> | <p><b>MACHINERY, EQUIPMENT AND PROVISIONAL WORKS</b> - equipment used for processing</p> <p><b>PHYSIOLOGICAL, SUBJECTIVE AND IDEOLOGICAL ASPECTS</b> – Type of employment contract, choice of workers, work experience</p> <p><b>AUDIT, SUPERVISION AND OPERATING PROCEDURES &amp; IFT</b> - information, training and operator training at various levels, operational and behavioural procedures, supervision of the worker</p>   | 4 |
| 5.1 | <p><i>lack of maintenance of the equipment</i></p> <p><i>failure of safety equipment systems for maintenance activities</i></p>   | <p><b>A. Technological / plant solutions contrast deviations (emergencies) external or internal (from process deviations) and provided means intervention</b> (related to the fact that it needs a signaling system of the bucket excavator deviations and consequently a intervention means to remedy the deviations);</p>   | 3 |
| 5.2 | <p><i>no operators procedures for the equipment maintenance (bucket excavator)</i></p> <p><i>no information, education and training</i></p> <p><i>no supervision / operational and behavioural procedures deficient</i></p> <p><i>operation not provided and not analyzed</i></p>   | <p><b>A. Procedures for ordinary and extraordinary maintenance of sites / facilities / equipment including emergency management internal / external</b> - in the case of the maintenance degree and the lines to be followed for the machine in question</p> <p><b>B. Definition of the working phases and the contingent operations for the subjects (to the several levels)</b> (related work experience of P.O. and the definition of working procedures);</p> <p><b>C. Definition of the working phases and the contingent operations for the subjects (to the several levels)</b> – definition of operator / supervisors tasks and related information, education and training</p> | 2 |



|   |  |  |   |
|---|--|--|---|
| 6 | <b>Hazard factor not identified</b> (choice of H.I. technique not appropriate for the context) | Definition of the technical maintenance of equipment and the organization of society at various levels | 1 |
|---|--|--|---|

## Insertion of the data input


| Dati Identificativi Evento                         | Dati Parte Offesa   | Azienda P.O.                | Analisi di Rischio Aziendale | Ditta Ospitante  | Conseguenze Infortunio             |
|--|---|-----------------------------|------------------------------|--|------------------------------------|
| Dati al Contorno                                   | Informazioni Infortunio   | Analisi Cause e Prevenzione | Sugg. Prevenzione            | Soluzioni  | Dati finali                        |
| Numero Codifica Evento                             | <input type="text" value="&lt;inserire&gt;"/>   |                             |                              |  |                                    |
| Data Infortunio                                    | 07  | 05                          | 2011                         | Giorno Settimanale Infortunio  | sabato                             |
| Ora Infortunio                                     | 11  | 00                          |                              | Ora Progr. Infortunio nel turno  | III                                |
| Numero Registro Infortuni                          | <input type="text" value="&lt;inserire&gt;"/>   |                             |                              |  |                                    |
| Luogo Infortunio                                   | sede della ditta della P.O.   |                             |                              |  |                                    |
| ASL Competente                                     | Savonese (0702)   |                             |                              |  |                                    |
| 1° Intervento Ispettivo                            | 07  | 05                          | 2011                         | Luogo Fisico Infortunio  | Luogo agricolo - coltura del suolo |
| Nome Ispettore ASL                                 | <input checked="" type="radio"/> <5 <input type="radio"/> >=5    Ispezione U.P.G. a seguito di evento   |                             |                              |  |                                    |
| Figure esterne intervenute                         | <input checked="" type="radio"/> SI <input type="radio"/> NO<br><input type="checkbox"/> Vigili del Fuoco    CF    LF <input type="checkbox"/> Polizia    CF    LF <input type="checkbox"/> Vigili Urbani    CF    LF<br><input checked="" type="checkbox"/> Carabinieri    CF    LF <input type="checkbox"/> Ispettor. Lavoro    CF    LF <input type="checkbox"/> Altri    CF    LF |                             |                              |  |                                    |
| Data Apertura Caso (Magistratura)                  | 12  | 05                          | 2011                         |  |                                    |
| Date Sopralluoghi (1)                              | <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> 14    02    2013   |                             |                              |  |                                    |
| Alterazione dello Stato di fatto nell'immediatezza | <input type="radio"/> SI <input checked="" type="radio"/> NO  |                             |                              |  |                                    |
|  | <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/>  |                             |                              | <input type="button" value="Successivo &gt;"/>  |                                    |

Figure 51: identifying details of the events


| Dati Identificativi Evento         | Dati Parte Offesa  | Azienda P.O.                | Analisi di Rischio Aziendale | Ditta Ospitante  | Conseguenze Infortunio |
|------------------------------------|--|-----------------------------|------------------------------|--|------------------------|
| Dati al Contorno                   | Informazioni Infortunio  | Analisi Cause e Prevenzione | Sugg. Prevenzione            | Soluzioni  | Dati finali            |
| Nome Cognome P.O.                  | Pippo    paolo <input type="radio"/> M <input type="radio"/> F   |                             |                              |  |                        |
| Data di Nascita                    | 18   | 01                          | 1976                         | Comune di Nascita  | Genova (GE)            |
| Nazione di Nascita                 | Italia   |                             |                              |  |                        |
| Comune Domicilio                   | Savona (SV)  |                             |                              |  |                        |
| Indirizzo Domicilio                | <input type="text" value="&lt;inserire&gt;"/>  |                             |                              |  |                        |
| Recapito Telefonico                | <input type="text" value="&lt;inserire&gt;"/>  |                             |                              |  |                        |
| Codice ASL appartenenza            | Savonese (0702)  |                             |                              |  |                        |
| Codice ISTAT                       | <input type="text" value="&lt;inserire&gt;"/>  |                             |                              |  |                        |
| Grado Istruzione P.O.              | Medie  |                             |                              |  |                        |
| Lingua Madre P.O.                  | italiano   |                             |                              |  |                        |
| Status Professionale P.O.          | <input type="radio"/> Lavoratore autonomo <input checked="" type="radio"/> Altro    Dipendente con un'occupazione temporanea (contratto a tempo determinato) - tempo   |                             |                              |  |                        |
| Qualifica formale                  | Operatore  |                             |                              |  |                        |
| Parente Datore Lavoro              | <input type="radio"/> SI <input checked="" type="radio"/> NO   |                             |                              |  |                        |
| Mansione svolta al mom. infortunio | Manutenzione macchinario di lavoro   |                             |                              |  |                        |
| Stato Civile                       | <input type="radio"/> Celibe/Nubile <input type="radio"/> Vedovo/a <input type="radio"/> Separato/a <input type="radio"/> Divorziato/a <input type="radio"/> Tutelato/a <input checked="" type="radio"/> Coniugato/a |                             |                              |  |                        |
| Numero Persone a Carico            | 2  |                             |                              |  |                        |
| Importo Retributivo Infortunato    | <input type="text" value="&lt;inserire&gt;"/>  |                             |                              |  |                        |
| Calcola il Codice Fiscale          | PLAPPP65H05D969T   |                             |                              |  |                        |
| Recapito Somma Indenn. Infort.     | <input type="text" value="&lt;inserire&gt;"/>  |                             |                              |  |                        |
|                                    | <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/>   |                             |                              | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>  |                        |

Figure 52: Injured data

| Dati Identificativi Evento             | Dati Parte Offesa   | Azienda P.O.  | Analisi di Rischio Aziendale   | Ditta Ospitante | Conseguenze Infortunio |
|--|---|---|--|-----------------|------------------------|
| Dati al Contorno                       | Informazioni Infortunio                                       | Analisi Cause e Prevenzione                                       | Sugg. Prevenzione  | Soluzioni       | Dati finali            |
| Settore Pubblico <input type="radio"/> | Settore privato <input checked="" type="radio"/>              | Terzi presenti a titolo legittimo <input type="radio"/>           |  |                 |                        |
| Codice Ministero                       | Ambiente, Tutela del Territorio e del Ma                      | P.O. in forza alla sede centrale <input checked="" type="radio"/> |  |                 |                        |
|  |   | P.O. in forza alla sede distaccata <input type="radio"/>          |  |                 |                        |
|  |   | Numero Dipendenti   | 3-5  |                 |                        |
| Indirizzo                              | Via - n° civico   | C.A.P.  | Località   |                 |                        |
| Codice Azienda                         |   | Docum. Aziendale Sicurezza  | SI <input checked="" type="radio"/> NO <input type="radio"/>   |                 |                        |
| Tipo Attività Economica                | (selezionare voce)  | Data Redazione  | 02 01 2009   |                 |                        |
| Codice Fiscale / Partita IVA           |   | Ultimo Aggiornamento  | 19 09 2009   |                 |                        |
| Tipo Polizza Assicurativa              |   | Addetti Pronto Soccorso   | SI <input checked="" type="radio"/> NO <input type="radio"/> CF LF   |                 |                        |
| Numero Polizza Assicurativa            |   | Addetti Antincendio   | SI <input type="radio"/> NO <input checked="" type="radio"/>   |                 |                        |
| Data Stipulazione                      | gg mm aa  | Firme Figure Preposte   | <input checked="" type="checkbox"/> Datore Lavoro <input checked="" type="checkbox"/> R.S.P.P. <input type="checkbox"/> R.L.S. |                 |                        |
| Data Scadenza                          | gg mm aa  |   | <input type="checkbox"/> Medico Competente <input type="checkbox"/> Altro  |                 |                        |
| Figure Sicurezza Azienda (5)           | >5 <input type="radio"/> <=5 <input checked="" type="radio"/> | Formazione  | Nome   | Cognome         |                        |
|  |   | Laurea  | caio   | plinio          |                        |
|  |   | Tipo  | Dipendenza   |                 |                        |
|  |   | RSPP  | Interna  |                 |                        |
| Nuovo                                  |   | Leggi dati  |  | Salva dati      |                        |
|  |   | Precedente  |  | Successivo >    |                        |

Figure 53: Enterprise of injured

| Dati Identificativi Evento   | Dati Parte Offesa  | Azienda P.O.  | Analisi di Rischio Aziendale                       | Ditta Ospitante                                   | Conseguenze Infortunio |
|--|--|---|--|---|------------------------|
| Dati al Contorno   | Informazioni Infortunio  | Analisi Cause e Prevenzione   | Sugg. Prevenzione                                  | Soluzioni   | Dati finali            |
| Analisi di Rischio Esistente   | SI <input checked="" type="radio"/> NO <input type="radio"/>   | Data Ultimo Aggiornamento   | 19 09 2004   |   |                        |
| SGS Certificato Esistente  | SI <input type="radio"/> NO <input checked="" type="radio"/>   |   |  |   |                        |
| <b>METODOLOGIA VALUTAZIONE DEL RISCHIO</b>   |  |   |  |   |                        |
| Tecniche Hazard Identification   | <input type="checkbox"/> Check List <input type="checkbox"/> Job Safety <input type="checkbox"/> HAZOP <input type="checkbox"/> FTA <input type="checkbox"/> What If <input type="checkbox"/> FMEA <input checked="" type="checkbox"/> Altro | <input type="text" value="inserire"/>   |  |   |                        |
| <b>Metodiche di calcolo del rischio</b>  |  |   |  |   |                        |
| ED (Entità del Danno)  | Stima Soggettiva <input checked="" type="radio"/> Statistica Dati Secondo il Worst Credible Case <input type="radio"/>   | <b>VALUTAZIONE SOGGETTIVA</b>   |  |   |                        |
| FC (Fattore di Contatto)   | Stima Soggettiva <input checked="" type="radio"/> Valutazione Condivisa <input type="radio"/>  |   |  |   |                        |
| P (Probabilità di Accadimento)   | Stima Soggettiva <input checked="" type="radio"/> Livello Frequenza Attesa di Accadimento <input type="radio"/>  |   |  |   |                        |
| <b>La Valutazione del Rischio comprende:</b>   |  |   |  |   |                        |
| 1. Soluzioni di eliminazione/gestione rischio residuo                                      | NO <input type="radio"/> SI <input checked="" type="radio"/>   | <input type="checkbox"/> Tecniche <input type="checkbox"/> Organizzative <input type="checkbox"/> Procedurali <input checked="" type="checkbox"/> DPI |  |   |                        |
| 2. La caratterizzazione dei modelli espositivi dei lavoratori                              | NO <input checked="" type="radio"/> SI <input type="radio"/>   | Date riunioni periodiche ultimo anno  | CF LF  |   |                        |
| <b>ASPETTI SPECIFICI DELLA V.R. RELATIVI ALL'EVENTO INFORTUNISTICO</b>                     |  |   |  |   |                        |
| Lavoro di Propria Competenza   | SI <input type="radio"/> NO <input checked="" type="radio"/>   |   |  |   |                        |
| Infortunato Formato/Informato A.R.   | SI <input checked="" type="radio"/> NO <input type="radio"/> CF LF   |   |  |   |                        |
| Eventuale riunione periodica in cui si è trattato l'argomento afferente alla dinamica inf. | SI <input type="radio"/> NO <input checked="" type="radio"/>   |   |  |   |                        |
| Previsti Indum. di Lavoro Speciali   | SI <input type="radio"/> NO <input checked="" type="radio"/>   |   |  |   |                        |
| Previsti e Forniti DPI   | SI <input checked="" type="radio"/> NO <input type="radio"/>   | Sono stati selezionati dei DPI - Fare click per visualizzarli   |  |   |                        |
|  |  | Organizzazione sostituzioni   | Periodica (sett.) <input checked="" type="radio"/> | Su richiesta del lavoratore <input type="radio"/> |                        |
| Nuovo  |  | Leggi dati  |  | Salva dati  |                        |
|  |  | Precedente  |  | Successivo >                                      |                        |

Figure 54: Risks analysis of injured enterprise


| Dati Identificativi Evento   | Dati Parte Offesa       | Azienda P.O.                | Analisi di Rischio Aziendale   | Ditta Ospitante | Conseguenze Infortunio |  |
|--|-------------------------|-----------------------------|--|-----------------|------------------------|--|
| Dati al Contorno   | Informazioni Infortunio | Analisi Cause e Prevenzione | Sugg. Prevenzione  | Soluzioni       | Dati finali            |  |
| Abbandono Lavoro <input type="radio"/> SI <input checked="" type="radio"/> NO  |                         |                             |  |                 |                        |  |
| Prime Cure Prestate da: <input type="text" value="Collega Parte Offesa"/>  |                         |                             |  |                 |                        |  |
| Prime Cure Prestate dove: <input type="text" value="sul piazzale dove si è verificato l'incidente"/>   |                         |                             |  |                 |                        |  |
| Prime Cure Prestate quando: <input type="text" value="immediatamente dopo l'incidente"/>   |                         |                             |  |                 |                        |  |
| Natura Lesione: <input type="text" value="b. Lesioni interne"/>  |                         |                             |  |                 |                        |  |
| Sede Lesione: <input type="text" value="a. Corpo intero (effetti sistemici)"/>   |                         |                             |  |                 |                        |  |
| Data 1° Certif. Medico al Dat. Lav.: <input type="text" value="09"/> <input type="text" value="05"/> <input type="text" value="2011"/>   |                         |                             |  |                 |                        |  |
| Giorni di Prognosi: <input type="text" value="0"/>   |                         |                             |  |                 |                        |  |
| Giorni Definitivi:<br><input type="radio"/> Inabilità Temp. gg. <input type="text" value="0"/><br><input type="radio"/> Inabilità Permanente % <input type="text" value="&lt;inserire&gt;"/><br><input checked="" type="radio"/> Morte |                         |                             |  |                 |                        |  |
| Interruzione dell'attività produttiva associata all'infortunio: <input type="radio"/> NO <input checked="" type="radio"/> SI   |                         |                             |  |                 |                        |  |
| Giorni di Interruzione: <input type="text" value="18"/>  |                         |                             |  |                 |                        |  |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/>   |                         |                             | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>  |                 |                        |  |

Figure 55: Injury consequences


| Dati Identificativi Evento   | Dati Parte Offesa       | Azienda P.O.                | Analisi di Rischio Aziendale   | Ditta Ospitante | Conseguenze Infortunio |  |
|--|-------------------------|-----------------------------|--|-----------------|------------------------|--|
| Dati al Contorno   | Informazioni Infortunio | Analisi Cause e Prevenzione | Sugg. Prevenzione  | Soluzioni       | Dati finali            |  |
| Attività Specifica: <input type="text" value="Sorvegliare, far funzionare la macchina"/>   |                         |                             |  |                 |                        |  |
| L'attività specifica svolta è propria della P.O.: <input type="radio"/> SI <input checked="" type="radio"/> NO   |                         |                             |  |                 |                        |  |
| Fattore di Pericolo associato all'attività specifica al momento dell'infortunio: <input type="text" value="Dispositivi mobili di movimentazione, carrelli di movimentazione (con o senza motore) - carriola, carrello a forche, ecc."/>  |                         |                             |  |                 |                        |  |
| Praticata da?: <input type="text" value="1"/>  |                         |                             |  |                 |                        |  |
| La P.O. è formata, informata e addestrata per tale attività?: <input type="radio"/> SI <input checked="" type="radio"/> NO   |                         |                             |  |                 |                        |  |
| Fattore di pericolo secondario: <input type="text" value="Dispositivi di trasmissione e stoccaggio di energia (meccanica, pneumatica, idraulica, elettrica, compresi di"/>   |                         |                             |  |                 |                        |  |
| Disegno / Foto Scenario Infortunio: <input type="text" value="CF"/> <input type="text" value="LF"/>  |                         |                             |  |                 |                        |  |
| Attrezzi/Macchine ecc. adoperate dalla P.O.:<br><input type="checkbox"/> Attrezzi <input type="text" value="CF"/> <input type="text" value="LF"/><br><input checked="" type="checkbox"/> Macchine <input type="text" value="CF"/> <input type="text" value="LF"/><br><input type="checkbox"/> Opere Provvisoriali <input type="text" value="CF"/> <input type="text" value="LF"/><br><input type="checkbox"/> Altro <input type="text" value="CF"/> <input type="text" value="LF"/>  |                         |                             |  |                 |                        |  |
| Attrezzi/Macchine ecc. presenti nell'area dell'infortunio:<br><input type="checkbox"/> Attrezzi <input type="text" value="CF"/> <input type="text" value="LF"/><br><input type="checkbox"/> Macchine <input type="text" value="CF"/> <input type="text" value="LF"/><br><input type="checkbox"/> Opere provvisoriali <input type="text" value="CF"/> <input type="text" value="LF"/><br><input checked="" type="checkbox"/> Altro <input type="text" value="CF"/> <input type="text" value="LF"/>                                |                         |                             |  |                 |                        |  |
| Violazioni evidenziate nel rapporto di U.P.G. (1): <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> |                         |                             |  |                 |                        |  |
| Prescrizioni fornite da U.P.G.: <input type="text" value="CF"/> <input type="text" value="LF"/>  |                         |                             |  |                 |                        |  |
| Eventuale Sequestro: <input checked="" type="radio"/> SI <input type="radio"/> NO <input type="text" value="CF"/> <input type="text" value="LF"/>  |                         |                             |  |                 |                        |  |
| Ammenda Iniziale: <input type="text" value="&lt;inserire&gt;"/>  |                         |                             |  |                 |                        |  |
| Data per Eventuali Ricorsi: <input type="text" value="gg"/> <input type="text" value="mm"/> <input type="text" value="aa"/>  |                         |                             |  |                 |                        |  |
| <input type="button" value="Nuovo"/> <input type="button" value="Leggi dati"/> <input type="button" value="Salva dati"/>   |                         |                             | <input type="button" value="Precedente"/> <input type="button" value="Successivo &gt;"/>  |                 |                        |  |

Figure 56: Injured informations

Also for this case it have not been able to completely fill all the cards, due to incomplete information, and moreover to respect the privacy lot of data have been made unreadable and for the people have been insert fantasy name

## Selection of the Causes and of the Interventions

To summarize:

**SEVERITY AND TYPE OF INJURY:** death as a result of internal injuries on the whole body (systemic effects) that resulted in a violent mechanical asphyxia from being crushed

**DIRECT CAUSES:** STRUCK BY MOVING OBJECT, COLLISIONS WITH – Struck by falling object – crushed by the shovel excavator fall

**INDIRECT CAUSES OF FIRST LEVEL:**

- ⇒ OVERFLOW, OVERTURN, LEAK, FLOW, VAPORISATION, EMISSION – Liquid state - leaking, oozing, flowing, splashing, spraying - linked to the fact that the excavator bucket has undergone a release of oil from the installation of lifting of the blade;
- ⇒ SLIPPING, FALLING, LOSS OF STABILITY, COLLAPSE AGENT MATERIAL - Slip, fall, loss of stability, collapse of Material Agent placed above (which falls on the victim) - linked to the fall of the blade on the victim.

**INDIRECT CAUSES OF SECOOND LEVEL:**

- ❑ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Tipology - Devices (command and control, signaling, security - related to the fact that the loss of oil in the lifting of the blade was not signaled by a light and there was not a lock command of the blade and related to the fact that there is a safety device to operate the maintenance;
- ❑ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Choice and condition of use – How to use - related to the fact that the operator, because of the lack of clarity of the instructions and there was no sufficient training, had no idea of what actions were correct and which are not;
- ❑ EQUIPMENT (MACHINES) AND TEMPORARY WORKS – Choice and condition of use – Maintenance status - linked to the maintenance of the excavator bucket;
- ❑ PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED – Ideological and subject Aspects – employment contractor - linked to the type of contract that the operator had at the time of the accident;
- ❑ PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED - physiological Aspects – work experience - linked to the experience of the operator deficient for the maintenance operations;
- ❑ AUDIT, SUPERVISION, OPERATING PROCEDURES & IFT - Procedure - Procedures for workers - related to non-existent procedures for routine work for every single operator for all its activities

**ROOT CAUSES:**

- ✓ EQUIPMENT (MACHINES) AND TEMPORARY WORKS - related to machinery and transport equipment, devices, operating instructions, maintenance status;

- ✓ PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED - related to the type of employment contract and to the work experience of the worker;
- ✓ AUDIT, SUPERVISION, OPERATING PROCEDURES & IFT - related to the workers procedures.

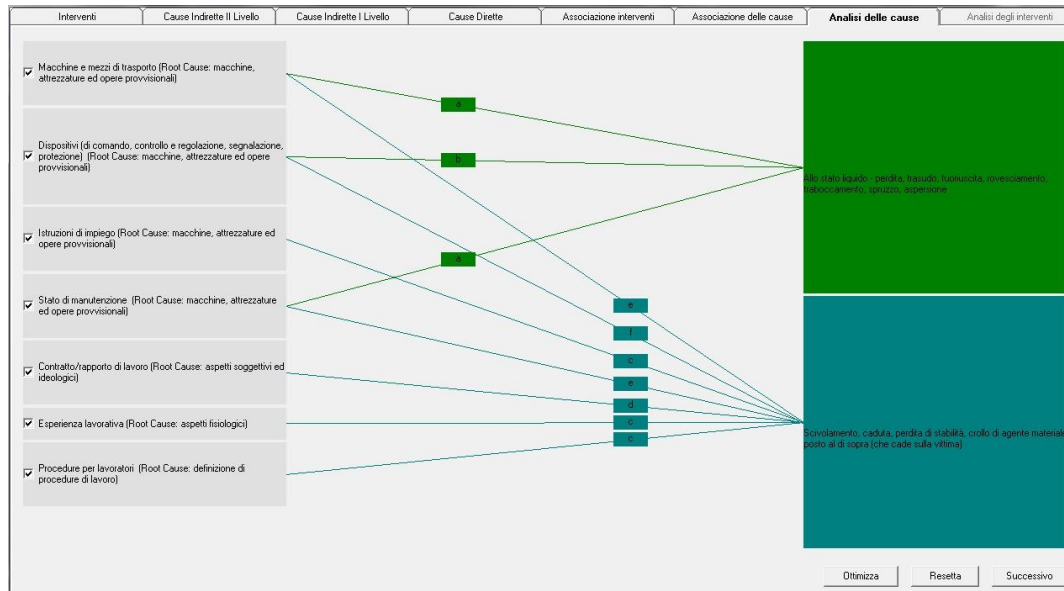


Figure 57: Causes analysis

### **TECHNIQUE INTERVENTIONS:**

- ✓ Technological / plant solutions contrast deviations (emergencies) external or internal (from process deviations) and provided means intervention (related to the fact that it needs a signaling system of the bucket excavator deviations and consequently a intervention means to remedy the deviations);

### **WORK PLANNING AND PROCEDURE INTERVENTIONS:**

- ❑ Procedures for ordinary and extraordinary maintenance of sites / facilities / equipment including emergency management internal / external - in the case of the maintenance degree and the lines to be followed for the machine in question
- ❑ Definition of the working phases and the contingent operations for the subjects (to the several levels) (related work experience of P.O. and the definition of working procedures);
- ❑ Definition of the working phases and the contingent operations for the subjects (to the several levels) – definition of operator / supervisors tasks and related information, education and training

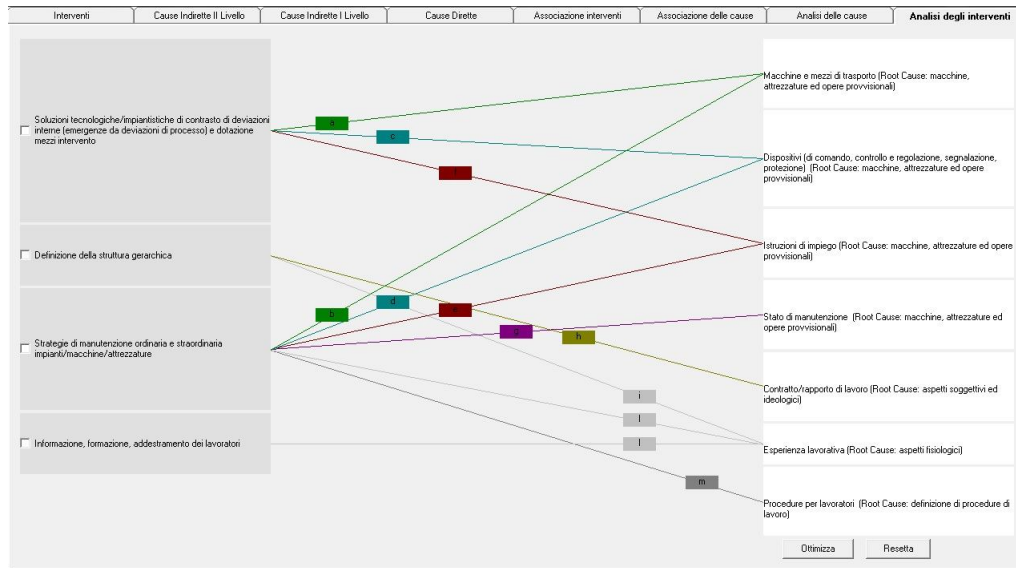
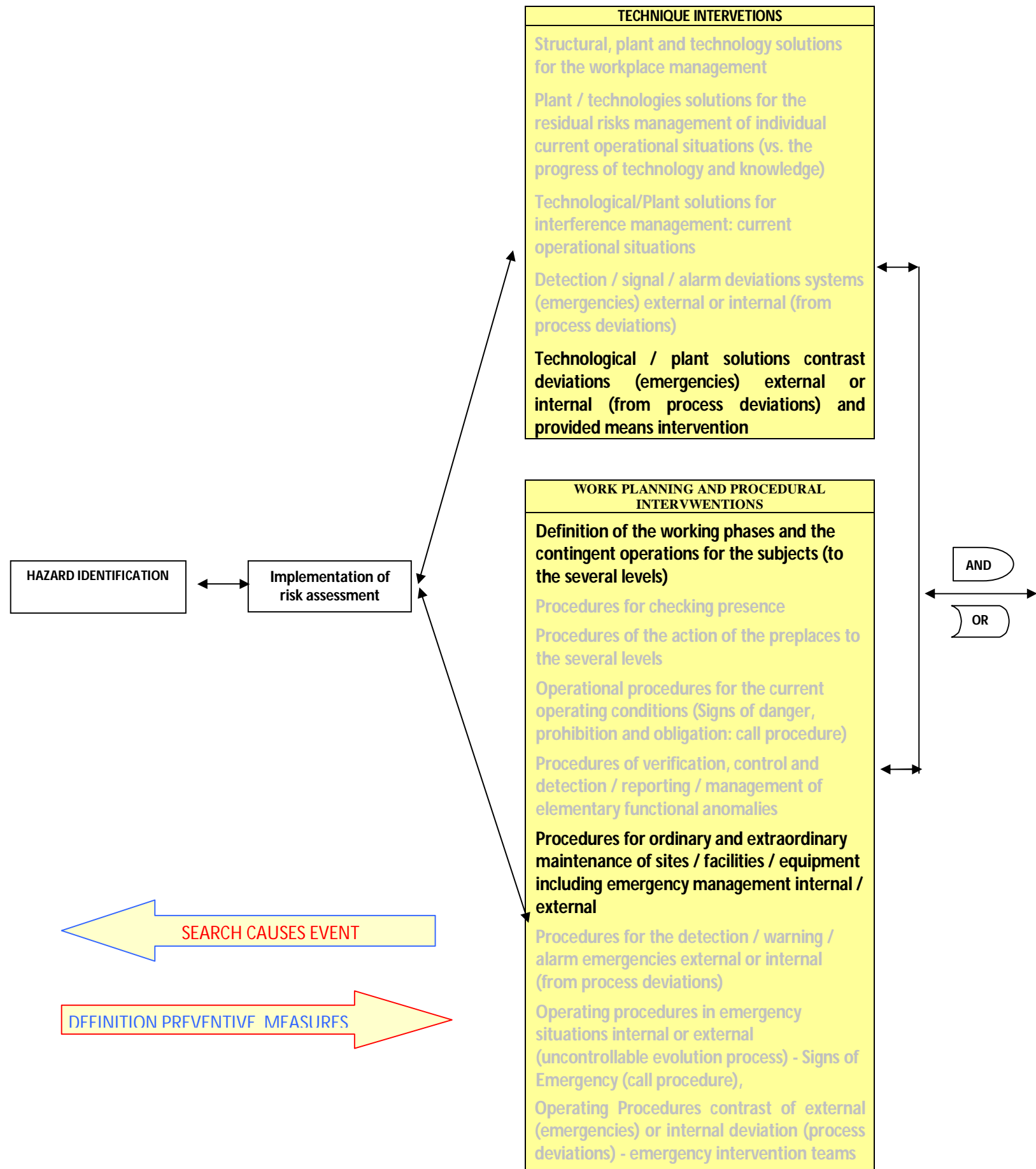


Figure 58: Interventions analysis

Even in this case should not be applied all the intervention solutions, but only some of those proposals to eliminate the possibility to occur the chain of causes.

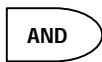
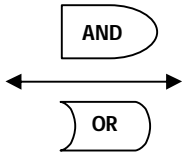
Figure 59: Graphic visualization of the analyzed event



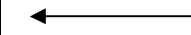
| ROOT CAUSES  |  | INDIRECT CAUSES OF SECOND LEVEL  |
|--|--|--|
| STRUCTURAL AND PLANT INTERNAL / EXTERNAL CHARACTERISTICS       | External criticality   | <ul style="list-style-type: none"> <li>- General criticality (boundary conditions ( eg. topography, climate, availability of services, sociological context))</li> <li>- Specific criticality (seismicity, area exposed to floods, avalanches, ...)</li> </ul>   |
|  | Structure  | <ul style="list-style-type: none"> <li>- General structural aspects (eg. general and local stability, allowable loads, materials, quality, efficiency, ...)</li> <li>- Specific structural Aspects [eg. Structural safety equipment, escape routes (eg fire escape) and safe places]</li> <li>- Consistency with the uses</li> </ul>   |
|  | Common Plant   | <ul style="list-style-type: none"> <li>- General Plants [eg. distribution systems (production) of energy, management systems of the general environmental conditions (eg. heating, cooling, air exchange, lighting,...), communication systems]</li> <li>- Specific Plants (systems of emergency management, detection, contrast and alarm)</li> </ul>   |
|  | Structure maintenance  | <ul style="list-style-type: none"> <li>- Conservation work</li> <li>- Participation of adaptation to the norms</li> </ul>  |
| EQUIPMENT (MACHINES) AND TEMPORARY WORKS                       | Typology   | <ul style="list-style-type: none"> <li>- Machine [tool, operator, auxiliary (eg. pollutant collection systems, cooling, heating, ...)]</li> <li>- Work Equipment [instrumentation, equipment, localized systems of transport energy (eg. power cables, ...)]</li> <li>- Machinery and transport equipment</li> <li>- Devices (command and control, signaling, security)</li> <li>- Works provisional (eg. scaffolding, ...)</li> </ul> |
|  | Choice and conditions of use   | <ul style="list-style-type: none"> <li>- Suitability to the development of specific operations in the context</li> <li>- Installation</li> <li>- How to use</li> <li>- Maintenance status</li> </ul>   |
| AUDIT, SUPERVISION, OPERATING PROCEDURES & IFT                 | Procedure  | <ul style="list-style-type: none"> <li>- Audit ;</li> <li>- Supervision;</li> <li>- Procedures for workers;</li> <li>- Procedures for machine operators;</li> <li>- Procedures for personnel systems;</li> <li>- Procedures for supervisors;</li> <li>- Procedures for special operations personnel;</li> <li>- Information, formation and Training</li> </ul>   |
| REVISION AND UPDATING OF THE SYSTEM, AND MAINTENANCE           | Operating conditions   | <ul style="list-style-type: none"> <li>- Test</li> <li>- Verification functionality before to use</li> <li>- Types of maintenance applied</li> <li>- Revision</li> <li>- Updating systems</li> </ul>   |
| PHYSICAL, CHEMICAL, BIOLOGICAL ASPECTS OF WORKPLACES           | Physical - chemical - biological critical of working environment   | <ul style="list-style-type: none"> <li>- Raw materials and process products</li> <li>- Products resulting from process deviations</li> <li>- Chemical pollutants (solid, liquid, gaseous)</li> <li>- Physical pollutants (eg noise, vibration, electromagnetic fields and radiation, ...)</li> <li>- Biological agents (eg. viruses, bacteria, ...)</li> </ul>   |
|  | Localized solutions for the management of environmental conditions   | <ul style="list-style-type: none"> <li>- Environmental treatment (eg. thermal insulation, acoustic, ...)</li> <li>- Lighting</li> <li>- Massing available</li> </ul>   |
| PHYSIOLOGICAL AND IDEOLOGICAL ASPECTS OF THE SUBJECTS INVOLVED | Ideological and subject aspects  | <ul style="list-style-type: none"> <li>- Behaviour (available to any person to produce answers, determined from the environment, family regarding social situations, groups, and objects)</li> <li>- Position in relation to the duty cycle and the number of shifts</li> <li>- Relationships with supervisors and subordinates</li> <li>- Contract / employment</li> </ul>  |
|  | physiological Aspects  | <ul style="list-style-type: none"> <li>- Age</li> <li>- Work Experience</li> <li>- Conditions of health</li> <li>- Psycho-physical state (eg. depressed, sleepy, drunk, drugged, ...)</li> <li>- Attitude (predisposition for a particular mental or physical activity)</li> </ul>   |
| INTERFERENCE OF FUNCTIONAL VOLUMES                             | Use of functional volumes  | <ul style="list-style-type: none"> <li>- Vehicles / machinery / plant / equipment in motion, controlled by operator</li> <li>- Vehicles / machinery / plant / equipment, automated motion (controlled by PLC)</li> <li>- Workers on the move</li> </ul>  |
|  | <input type="checkbox"/> Mechanical systems<br><input type="checkbox"/> Mec. sist.- operator<br><input type="checkbox"/> Operator - operator |  |



| INDIRECT CAUSES OF FIRST LEVEL  |  |
|---|--|
| Deviation due to electrical problems, explosion, fire   | <ul style="list-style-type: none"> <li>- Electrical problem caused by a plant failure</li> <li>- Electrical problem caused by static electricity</li> <li>- Electrical problem caused by missing insulation</li> <li>- Electrical problem caused by external radiation / lightning</li> <li>- Explosion</li> <li>- Fire</li> <li>- Another case relating to electrical problems, explosion, fire</li> </ul>  |
| <b>overflow, overturn, leak, flow, vaporisation, emission</b>   | <ul style="list-style-type: none"> <li>- Solid state - overflowing, overturning</li> <li>- <b>Liquid state - leaking, oozing, flowing, splashing, spraying</b></li> <li>- Gaseous state - vaporisation, aerosol formation, gas formation</li> <li>- Pulverulent material - smoke generation, dust/particles in suspension/emission of</li> <li>- Another case relating to overflow, overturn, leak, flow, vaporisation, emission</li> </ul>  |
| Breakage, bursting, splitting, slipping, fall, collapse of Material Agent   | <ul style="list-style-type: none"> <li>- Break of material, at junctions, connections, material agent</li> <li>- Break / release of personal protective equipment</li> <li>- Break with explosion of splinters (wood, glass, metal, stone, plastic, etc.) agent material</li> <li>- Another case involving rupture, fracture, rupture violent, sudden and loud agent material</li> </ul>   |
| <b>Slipping, falling, loss of stability, collapse agent material</b>  | <ul style="list-style-type: none"> <li>- <b>Slip, fall, loss of stability, collapse of Material Agent placed above (which falls on the victim)</b></li> <li>- Sliding, fall, loss of stability, collapse of agent material placed below (which drags the victim)</li> <li>- Slip, fall, loss of stability, the collapse of a material agent - at the same level</li> <li>- Another case relating to slipping, falling, loss of stability, collapse agent material</li> </ul>   |
| Loss of control (total or partial) of machine, means of transport or handling equipment, hand-held tool, object, animal | <ul style="list-style-type: none"> <li>- Problems of total or partial control of the machine (including the unintended equipment) as well as the processed material</li> <li>- Problems of total or partial control of the means of transport / equipment material handling and / or substance (motorized or not)</li> <li>- Problems of total or partial control of a means of transport / handling of people and / or animals</li> <li>- Problems of total or partial control of hand tool (motorized or not) as well as the material machined by</li> <li>- Problems of total or partial control of object (led, moved, moved, etc.).</li> <li>- Problems of total or partial control of animal</li> <li>- Another cause of problems related to total or partial control of machinery, transportation / handling equipment, hand tools or objects, animals</li> </ul> |
| Slipping - Stumbling and falling - Fall of persons  | <ul style="list-style-type: none"> <li>- Fall of person from the top through the opening</li> <li>- Slipping or tripping - with the fall of man - from</li> <li>- Slipping or tripping - with the fall of person - at the same level</li> <li>- Loss of balance - with the fall of man - from</li> <li>- Loss of balance - with the fall of person - at the same level</li> <li>- Slipping or tripping on machinery</li> <li>- Another case involving slipping or tripping, loss of balance - with the fall of person</li> </ul>   |
| Body movement without any physical stress   | <ul style="list-style-type: none"> <li>- Walking on a sharp object</li> <li>- Kneel, sit, lean against</li> <li>- Being grabbed, dragged, or moved by something from their momentum</li> <li>- Uncoordinated movements, gestures, inopportune, inappropriate</li> <li>- Another cause relative movement of the body without physical exertion (which usually leads to an external injury)</li> </ul>   |
| Body movement under or with physical stress   | <ul style="list-style-type: none"> <li>- Lifting, carrying or standing</li> <li>- Pushing, pulling, pulling</li> <li>- Depositing, dropping</li> <li>- Twisting, turning, turning</li> <li>- Step false twisting of the leg or ankle, slipping without falling</li> <li>- Another cause relative movement of the body during physical exertion (which usually leads to an internal injury)</li> </ul>  |
| Shock, fright, violence, aggression, threat, presence   | <ul style="list-style-type: none"> <li>- Surprise, fear</li> <li>- Violence, aggression, threat - including employees of the</li> <li>- Violence, aggression, threat-from people external to the company to the victims in the context of their function (bank robbery, assaulting bus drivers, etc.).</li> <li>- Aggression, mobs, violence by animals</li> <li>- Presence of the victim or a third party that creates in itself a danger to the victim / for himself and if any other</li> <li>- Another case involving surprise, fright, violence, aggression, threat, presence</li> </ul>  |



| DIRECT CAUSE  |  |
|---|--|
| Contact with electric current, temperature  | <ul style="list-style-type: none"> <li>- Indirect contact with the electrical circuit, lightning (passive)</li> <li>- Direct contact with electricity, suffer an electric discharge in the body</li> <li>- Contact with flame or object / warm or red-hot</li> <li>- Contact with object or cold or frozen</li> <li>- Another case involving contact with electric current, temperature</li> </ul>   |
| Contact with other material or substance  | <ul style="list-style-type: none"> <li>- Contact with hazardous substances for nasal, oral, inhalation</li> <li>- Contact with hazardous substances through the skin or eyes</li> <li>- Contact with hazardous substances through the digestive system, swallowing or eating</li> <li>- Drowning in a liquid</li> <li>- Burial under a solid</li> <li>- Immersion in a gas, in a suspension of particles</li> <li>- Another case involving contact with material or substance</li> </ul> |
| Crushing vertically and / or horizontally moving, fall on / against an immovable object / ground (victim in motion) | <ul style="list-style-type: none"> <li>- Vertical motion, crash on / against (the result of a fall)</li> <li>- Horizontal motion, crash on / against</li> <li>- Another case involving crushing vertically and / or horizontal moving, fall on / against an immovable object / ground (victim in motion)</li> </ul>  |
| <b>Struck by moving object, collisions with</b>   | <ul style="list-style-type: none"> <li>- Struck by object projected</li> <li>- <b>Struck by falling object</b></li> <li>- Struck by object that oscillates</li> <li>- Struck by object in rotation, motion, displacement, including vehicles</li> <li>- Collision with a moving object, including vehicles - a collision with a person (the victim is moving)</li> <li>- Another case involving a collision by moving object, collision with</li> </ul>                                  |
| contact with sharp material agent, pointed, hard, abrasive  | <ul style="list-style-type: none"> <li>- Contact with a sharp Material Agent (knife / blade)</li> <li>- Contact with a sharp Material Agent (nail / sharp tool)</li> <li>- Contact agent with hard or abrasive material</li> <li>- Another case concerning materials in contact with agent edgy, sharp, hard, abrasive</li> </ul>  |
| Nesting, trapping, crushing, crushing, pinching, etc..  | <ul style="list-style-type: none"> <li>- Nesting, trapping, crushing in / inside</li> <li>- Nesting, trapping, crushing under</li> <li>- Nesting, trapping, crushing between</li> <li>- Tearing, cutting of a member, a hand, a finger or more parts of the body</li> <li>- Constrict of whole body or of one or more parts of it</li> <li>- By pinching</li> <li>- Another case involving nesting, trapping, crushing, crushing, pinching, etc..</li> </ul>                             |
| Physical or mental effort   | <ul style="list-style-type: none"> <li>- Physical effort at the expense of the musculoskeletal system</li> <li>- Physical exertion caused by radiation, noise, light, pressure</li> <li>- Effort psychic, mental shock</li> <li>- Another case involving mental or physical effort</li> </ul>  |
| Bite, calcium, etc., by animals or humans   | <ul style="list-style-type: none"> <li>- Bite</li> <li>- Puncture by insects or fish</li> <li>- Shot, football, head, strangulation</li> <li>- Another case relating to bite, kick, etc., by animals or humans</li> </ul>  |



**SEVERITY**  
and  
**TYPE OF INJURY**  
(medical report data)

**Death for crushing of whole body**

## REFERENCES

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- [2] Perizia e Consulenza C.T.P.M., 2010: *"Attività manifatturiere (fabbricazione di carta e di prodotti di carta) - morte dell'infortunato in asfissia meccanica di tipo misto (strangolamento ed immobilizzazione toracica)"*
- [3] Perizia e Consulenza C.T.P.M., 2011: *"Attività agricole - Infortunio mortale occorso durante una manutenzione straordinaria di una pala con benna escavatrice"*
- [4] Patrucco M., *"Sicurezza e ambiente di lavoro"*, Torino, Trauben, 1997

## CONCLUSIONS

This work has made it possible to create valid instruments for the analysis and prevention of accidents. These instruments include:

- A data collection questionnaire, which has allowed all the information necessary for the subsequent analysis of the chain of events to be obtained;
- A logical scheme that has led to knowledge on the chain of events responsible for an accident, but which, if followed backwards, can offer useful information for the prevention of such accidents;
- A software program that allows the logical analysis scheme to be applied, thus simplifying the search for the causes and solutions that are necessary to interrupt the chain of events that trigger the accidental event.

Although it is here important to reconfirm the concept that it is of utmost importance to act before anomalous events occur, rather than controlling their results, it is also true that an in-depth study, speeded up by a specific collection of information on the dynamics of an accident, is a useful source of indications of a technical, organizational and procedural nature which can be used to eliminate risks or, once the impossibility of doing so has been established, to reduce these risks.

The subsequent introduction of such an instrument into the real working environment has made it possible to set up a suitable, efficacious and more rapid method than the one that is presently being used for the study of accidents, which is necessary for the protection of the safety and security of the working force.

Remarkable efforts were necessary to reach this objective, first because the questionnaire required several revisions that were determined, now and again, on the basis of suggestions made after its use in the real situation of an emergency room, and then due to the difficulties involved in collecting the data because of the limited objective participation of the victims of accidents (who were in a difficult situation because of their not perfectly safe working environment). Finally, since the analysis of the accidents that occurred was particularly detailed, so that the results could offer useful information, particular efforts were again required. However, having detailed information on accidental events has surely made it possible to find the ideal format for the reporting of accidents and to establish precise indications on the dynamics that had led to the

damaging event, in other words, to be able to acquire information that would otherwise be difficult to find in other documents.

After the data had been collected, the next step was that of "processing" the thought behind the analysis, which can be illustrated through a logical diagram, into a real software program, which has allowed a suitable and efficacious tool to be created for the study of accidental events, which is necessary to guarantee the safety and security of workers.

It has in fact been the preventive aspect that has been given just relevance in this work. In fact, a meticulous prevention activity cannot be fully efficacious if attention is only focused on the last rings of the production chain; it is only by having the possibility of intervening on the real causes of an accident that the problem is resolved, but it is also necessary to investigate what has happened to find the correct remedies.

The instruments proposed through this thesis, for example, the data collection questionnaire, as far as the accident report model is concerned, is obviously meant for all users, while both the questionnaire, once filled in, and the investigation protocol are meant for competent users, such as UPG inspectors, INAIL or technical experts/consultants, in that the two complement each other, and the latter in particular requires the knowledge of "AND/OR" Boolean algebra, above all during the identification of the preventive measures, in order to obtain the best results.

Finally, the application of such powerful tools makes it possible to assert that a further step towards the safeguarding of the health and safety of workers is surely possible, even in those countries, such as in Italy, where the technological and industrialized level is extremely high and complex.

# **ATTACHMENT B**

**Appraisals and Consulting of C.T. P.M.  
Summary of accident events analyzed in detail**