Occupational accidents and occupational risk prevention

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Abstract
The phenomenon of workplace accidents is a global relevance issue in terms of its social and economic impact on the working population and on businesses. Although the number of occupational injuries is still very high today, it is worth noting that in recent years a downward trend is taking place. Occupational risk prevention is mainly aimed at ensuring a better understanding of the problem so as to be fully aware of the best and most effective safety measures to adopt in workplace environments.

Introduction

An occupational accident is a traumatic event caused by a violent occurrence, arising out of or in connection with work, which results in the inability to perform work for more than three days. The phenomenon of workplace accidents is a global relevance issue in terms of its social and economic impact on the working population and on businesses. According to ILO data (1) 317 million accidents occur on the job annually, 2.3 million out of which with a fatal outcome. These figures are even more alarming considering that, according to available data, 6,300 people die in the world every day from occupational injuries, i.e. one every 15 seconds and that such data do not reflect the actual extent of the problem since a large number of work accidents fail to be reported to authorities or that in some countries these estimates do not exist. Although the number of occupational injuries is still very high today, it is worth noting that in recent years a downward trend is taking place; these data are also consistent with the results of recent European statistics (2) which reported a significant decrease in the number of occupational injuries from 2009 to 2012, particularly with regard to the number of nonfatal injuries which declined by about 313,000 units. The interpretation of these figures requires some caution in the light of the decrease in the total number of employees observed in recent years in the Euro area labour market as a result of the economic crisis. Nonetheless the incidence rate (number of events per 100,000 workers) confirms the actual reduction of occupational injuries (2). There are obviously some differences between the various E.U. member states: the highest incidence rate for fatal injuries is observed in Malta (8.1), followed by Lithuania and Luxembourg. At the other extreme we find the Netherlands, Greece, Sweden, the United Kingdom, Germany and Finland while Italy ranks in the middle of the list. As instead concerns nonfatal injuries, the highest rates are found in Portugal, France and Spain and the lowest in Romania and Bulgaria; even in this case Italy is in line with the average European values (2).

European statistics also point out that men are more likely to be victims of accidents (either fatal or nonfa-
tal) than are women and not merely as a result of the higher percentage of men employed as compared to women, but mainly because of the type of work activities typically reserved to male labour force: the healthcare, manufacturing, construction, transport, agriculture, fisheries and trade sectors are reported as having the highest percentage of injuries and as the areas where male workers are much more numerous than their female counterparts (2).

Finally it is worth highlighting how wounds and superficial injuries (29.7%) are the most frequent type of injury in Europe, followed by sprains, dislocations and strains (25.5%), concussion and internal injuries (15.9%) and bone fractures (11.3%) (2).

In Italy, according to data by the National Institute for Insurance against Accidents at Work (INAIL), the total number of workplace injuries in 2015 was 632,665, including 1,172 deaths. Despite the drop highlighted by these data compared to the previous year (-3.92% as concerns total injuries), the count of fatal occupational injuries is higher than in 2014 (+16.15%) thus showing how this problem still remains dramatically relevant today (3,4). The construction, transport and manufacturing sectors are the most affected and the male gender is reported as having the highest incidence rate. These data appear almost identical to those observed in the rest of Europe, thus underlining the increasingly urgent need to take all the necessary measures to contain and reduce this phenomenon as much as possible.

Given the importance of this issue, great attention is reserved by the scientific community to occupational accidents and various studies can be found in the literature. Nonetheless, due to the current complexity of the labour market and the substantial differences observed in the country and the productive sector under exam, data often fail to be unique and unambiguous.

In Turkey, for example, the mortality rate and the total number of occupational injuries decreased between 1988 and 2011 as opposed to the injury incidence rate which increased from 8.6 to 25.5% (5). The reverse situation applies instead to Peru where, despite the adoption of stricter workplace safety regulations recently enacted, the number of workplace accidents continues to show an upward trend (6). As previously mentioned, the work domain probably has the greatest impact when it comes to analyzing the accident rate and type of injury. In the healthcare sector, for example, an American study confirms the growing number of needlestick injuries despite the introduction of new regulations establishing a maximum limit of 80 hours per week for hospital doctors (7): 1,200 neurosurgery doctors were interviewed through a questionnaire administered before and after the entry into force of the new regulations. What immediately stands out is that almost 90% of the sample (89.33%) say they have witnessed a needlestick injury at least once during their career. The results also show an increase in the percentage of percutaneous injuries (21.77 vs 8.9%) and accidental blood exposure (51.94 vs 40.94%). A study conducted in Poland between 2008 and 2012 on a sample of emergency medical technicians and paramedics employed in emergency medical services showed instead a significant reduction in the number of workplace injuries, especially with regard to traffic accidents involving male workers under 30 (8). Road accidents are the most common workplace accident even in a group of employees working with a Spanish financial institution (9): 1,517 occupational accidents were registered between 2007 and 2013 and 27% were traffic accidents, 1.3% out of which with a fatal outcome. Gender differences are significant: while fatal injuries and fractures are more likely to occur in the male population, commuting and passenger injuries, sprains and dislocations tend to recur more frequently in the female population.

In the Philippines, a group of researchers has shown that among Manila drivers gruelling working hours (at least 16/day) and risky driving behaviours lead to increased risks in road traffic accidents (10). Rear end collisions with other vehicles caused by inattention, fatigue and drowsiness are the most frequently recurring accidents, as well as their effects on the cervical, thoracic and lumbar spine. The risk of a road accident is twice as high among drivers suffering from sleep apnea syndrome (11).

In the primary sector a distinction must instead be drawn between agriculture and animal breeding with the former showing a higher percentage of fatal accidents (15.9 vs 10.8 per 100,000 workers) whereas animals assaults, falls and acute accidental exposure to chemicals appear to be more common in the latter (12).

As for the secondary sector literature data are almost overlapping: the risk factors are not adequately assessed and verified, personal protective equipment is only rarely used and its proper use often fails to be adequately controlled. Moreover, it should be noted that workers employed in the industrial sector are exposed to a larger number of health and safety risks which, by their nature, are more dangerous than in other sectors. For example, 231 workplace accidents were registered in a Turkish mining industry between 2006 and 2011: as made evident by a retrospective analysis of data, open-cast mines and surface facilities are associated to serious injuries (with a prognosis of more than 3 days) with manual handling of loads and heavy vehicle driving reported as being the risk factors most frequently associated to the above mentioned evidence (13).

In Iran 500 occupational accidents (14) were instead reported between 2009 and 2013 in the construction industry. The conditions below are often associated with more serious injuries: workers under 30s, with less than five years of seniority or a low level of education and working as simple manual labourers rather than qualified technicians. In accordance with the above, only half of the injured had received adequate training and only 22% had received regular updated information.

The use of PPE is inversely related to occupational accidents and only 21% of the sample makes a proper use of PPE. In addition, as shown by other studies, the poor hygiene standards and inadequate risk as-
As for the health and safety manager, the possibility to adopt Guidelines on accident prevention in the workplace will make it possible to understand its criticalities and specific deficiencies in the various economic sectors and businesses, so as to develop ad hoc accident prevention measures aimed at minimizing the impact of the conditions most frequently related to accident and injury occurrences. In this respect, it is worth mentioning that apart from structural, managerial and organizational deficiencies, even inappropriate employee behaviours may play a major role and that a critical evaluation of this factor will make it possible to counter its effects by setting up valuable training courses effectively informing about the specific working environments. It will be just as important to follow the latest scientific literature on accident analysis and prevention. The scientific community considers workplace accidents and their prevention as a matter of the utmost importance and research in this area can help not only to identify the leading causes of accidents (also in relation to different working environment at the international level), and to postulate possible preventive strategies, but also to analyze the various statistical methods applied to quantify accidents in view of identifying the most viable (21-23). When considering the overall impact of accident prevention policies over a long period of time no clear evidence can be found in scientific literature nor are data on the causes adequate and sufficient (24-29). Many confounding technical aspects must be taken into account before drawing general conclusions based on workplace hazards, thus creating a more appropriate environment in terms of safety and health. As for the health and safety manager, the possibility to rely on an instrument effectively promoting greater awareness can help this figure to identify the best standards and practices for a safer and healthier workplace environment and one in which penalties for breaches of health and safety regulations are less likely to occur.

Last, but not least, employees working in a safe environment and properly trained and informed will feel more personally involved and committed to keeping a safe and healthy workplace.

Scope and objectives of occupational risk prevention

Introduction

As mentioned above, occupational risk prevention has much broader implications than we might expect at first. The enforcement of a viable accident prevention strategy does not only imply the adoption of all necessary measures for effectively reducing the number of accidents but also a general improvement of business conditions in structural, organizational but also human terms, resulting in increased productivity in combination with optimal safety standards. Occupational risk prevention is mainly aimed at ensuring a better understanding of the problem so as to be fully aware of the best and most effective safety measures to adopt in workplace environments. A proper understanding of this phenomenon requires a critical analysis of statistics on workplace accidents; at national level, they can be freely accessed on the National Institute for Insurance against Accidents at Work - INAIL website (4), where statistics exploring trends in workplace accidents over the last few years are analyzed based on various characteristics. Being aware of the main characteristics of the accident will make it possible to understand its criticalities and specific deficiencies in the various economic sectors and businesses, so as to develop ad hoc accident prevention measures aimed at minimizing the impact of the conditions most frequently related to accident and injury occurrences.

In the light of the above, we deem it useful and appropriate to recommend employers, occupational health physicians, health and safety managers, workers’ health and safety representatives and employees the adoption of Guidelines on accident prevention in the workplace.

This instrument is intended as a support for all stakeholders so that, by becoming aware of injury risks and their consequences in the national context, they might be encouraged to take a proactive approach in terms of measures and actions to be implemented, with a special focus on risk prevention. The benefits for employers, occupational health physicians, health and safety managers, workers’ health and safety representatives and employees can be manifold.

Advantages for the employer could be measured in terms of:

- reduced absence rates from work-related injuries, resulting in lower economic costs and higher productivity;
- improved corporate reputation and credibility, resulting in increased community involvement and confidence;
- lower risk of incurring penalties in case of inspections by public authorities.

As for the occupational health physician, it will also prove easier for him/her to provide guidance in risk assessment and health surveillance processes not to mention the benefits in terms of improved interactions with employees, better informed and properly trained on workplace hazards, thus creating a more appropriate environment in terms of safety and health. As for the health and safety manager, the possibility to rely on an instrument effectively promoting greater awareness can help this figure to identify the best standards and practices for a safer and healthier workplace environment and one in which penalties for breaches of health and safety regulations are less likely to occur.

As for the health and safety manager, the possibility to identify the most viable (21-23). When considering the overall impact of accident prevention policies over a long period of time no clear evidence can be found in scientific literature nor are data on the causes adequate and sufficient (24-29). Many confounding technical aspects must be taken into account before drawing general conclusions based on accident statistics, but also a general improvement of business conditions in structural, organizational but also human terms, resulting in increased productivity in combination with optimal safety standards.
on this partial or not convergent information: methods to quantify and report the effects of prevention programs, methods to quantify and report injury rates, time interval used to assess the effects of prevention programs, the role that an upward or downward economic trend could have on density of hours worked, and therefore on the likelihood of accidents occurring. 

As mentioned above, the heterogeneity of the methods used worldwide by the various organizations plays a crucial role which must be taken into account before comparing such information.

Even when referring to preventive measures required to reduce injury rates, a number of studies are available in scientific literature (30-33) but once again data fail to be reliable and unique. Therefore, even in the scientific community accident and injury prevention remains an open question and it is hoped that further studies based on standardized methodologies and mutually comparable assessment systems will be developed.

**Accident prevention: a legislative overview**

Knowledge of current legislation concerning workplace safety and prevention is of prime importance both for Employers and for all figures involved in workplace safety. In recent years the legislative framework for the prevention of occupational accidents and diseases has gone through substantial changes, especially from an organizational and cultural point of view.

The Consolidated Law on Workplace Health and Safety and the totality of rules contained in Legislative Decree no. 81 9th April 2008 brought together all the various provisions and rules on occupational health and safety, even in the light of technology and work organization developments, with the aim of generating a consolidated and harmonized document. The main regulatory measures on health and safety at work are listed below:

- the Italian Constitution (1 January 1948) (34) emphasizes the need to protect the health of citizens as a fundamental ethical and social value: “The Republic protects health as a fundamental right of the individual and collective interest” (Art. 32); “The Republic protects work in all its forms and applications. It provides for the training and professional advancement of workers. It promotes and encourages international agreements and organizations whose aim is to assert and regulate labor rights” (Art. 35); “Private-sector economic initiative is freely exercised. It cannot be conducted in conflict with social usefulness or in such a manner that could damage safety, liberty, and human dignity” (Art. 41);  
- art. 2087 of the Civil Code (1942) (35) draws attention to physical and moral integrity of workers: “Protection of working conditions. The entrepreneur shall adopt measures for the operation of the enterprise which, according to the particularity of the work, experience and technique are necessary to protect the physical and moral integrity of employees”;  
- various Presidential Decrees dating back to the 1950s were published to cover all production activities performed by employees, except those with specific characteristics and requirements. This is the first time the State sets out extensive and general nature provisions on hygiene and safety at work introducing a number of obligations and identifying their recipients (employers, managers, supervisors, workers). Moreover, not only is their application ensured thanks to the supervision of specific public inspection bodies but specific sanctions are also applied should obligations fail to be complied with.

Below is a list of the main P.D. referred to above:

- presidential Decree no. 547/55 (36) “Regulations for accident prevention in the workplace”, which contains provisions on the maintenance of equipment, the protection of working environments exposing workers to hazardous or noxious products, the personal protective equipment and first aid procedures (repealed by the entry into force of the new Consolidated Law on Workplace Health and Safety);
- presidential Decree no. 164/56 (37) “Regulations for accident prevention on construction sites” (repealed by the entry into force of the new Consolidated Law on Workplace Health and Safety);
- presidential Decree no. 303/56 (38) “General principles on hygiene standards in the workplace” including a range of preventive measures aimed at protecting workers’ health through the removal of the main environmental health risk factors (repealed by the entry into force of the new Consolidated Law on Workplace Health and Safety, with the exception of Article 64);
- law 300/70 (39), better known as the Workers’ Statute, which contains provisions protecting the health and safety of workers (art. 9): “Employees have the right to control, through their representatives, the application of rules for the prevention of occupational accidents and diseases and to promote research, development and implementation of all measures necessary to safeguard their health and their physical integrity”;  
- a number of decrees aimed at reducing the risk of occupational accidents and diseases in specific processes (for example, 1979: aromatic amines; Presidential Decree 175/78: major industrial hazards, DPR 962/82: vinyl chloride monomer; Decree 277/81: asbestos, lead and noise; Presidential Decree 459/96: machinery Directive; Presidential Decree 494/96: construction sites Directive);  
- legislative Decree no. 626/94 (40) aimed at improving health and safety in the workplace.

In the light of the above, the decision was made to generate from this variety of provisions and rules a harmonized document containing updated information about the main obligations and requirements on health and safety matters: the above mentioned Consolidated Law on Health and Safety at Work - Legislative Decree 9th April 2008 no. 81 and s.m.s. (41). With reference to the part covering the protection of
health and safety in the workplace, the decree, under art. 15.1, specifies the general measures of protection and in particular:

a) assessment of all relevant risk factors;
b) identification and setting up of an adequate prevention programme, encompassing in an integrated and coherent way the production and technical conditions of the enterprise as well as the environmental and work organization factors likely to affect it;
c) elimination of risks or, should this not be possible, their substantial reduction in the light of the technical progress and experience gained;
d) compliance with ergonomic principles in the organization of work [...];
e) reduction of risks at source;
f) replacement of a dangerous substance or process with a safer alternative;
g) reduction of the number of workers exposed or likely to be exposed to such risks;
h) limited use of chemical, physical and biological agents in the workplace;
i) priority accorded to collective protection measures over individual protective measures;
j) medical surveillance of workers;
m) withdrawal of the worker from all exposure to risk on health grounds and assignment, where possible, to a different task;
n) adequate information and training for workers;
o) adequate information and training for managers and supervisors;
p) adequate information and training for workers' safety representatives;
q) appropriate instructions to workers;
r) participation and consultation of workers;
s) participation and consultation of workers' safety representatives;
t) planned adoption of the measures deemed necessary to ensure improved safety levels over time, including through codes of conduct and good practices;
u) emergency measures to be implemented in case of first aid and fire-fighting procedures, evacuation of workers and serious and imminent danger;
v) use of warning and safety signs;
w) regular maintenance of premises, equipment, systems, with particular attention to safety devices in compliance with the manufacturers’ instructions.

**Parties involved**

The parties below are identified by Legislative Decree no. 81/08 as key players for the implementation of the current regulatory requirements for safety and health in the workplace. Their specific duties and functions are also set forth by Legislative Decree no. 81/08.

**The Employer**

*Art. 17 and 18*: he/she is the main responsible for what occurs in the enterprise. He/she is vested with many functions aimed at ensuring workplace safety, starting from the assessment of all risks and the designation of the prevention and protection service manager (tasks which cannot be delegated), through the designation of workers to positions in emergency management, the provision of the necessary and appropriate personal protective equipment, the adoption of suitable measures to control risk situations, the provision of appropriate training and information to workers, and anything else set forth in art.18. With regard to the specific issue of workplace injuries, art.18 paragraph 1, letter b) states that the employer (or the manager he/she designated) is obliged to appoint workers to positions in fire prevention and fire-fighting, evacuation in the case of serious and imminent danger, first-aid and emergency management; in accordance with letters e) and f), the employer must take appropriate measures to ensure that only workers who have received adequate instructions and specific training have access to areas exposing them to serious and specific danger; he/she has the authority to require individual workers to comply with the existing laws and with the company regulations on safety and hygiene standards and the use of personal and collective protective equipment made available to them. Under letters h) and i) it is the employer’s responsibility to ensure that suitable measures are taken to keep risk situations under control in case of an emergency and give instructions enabling workers to leave the worksite or the dangerous area in the event of a serious, imminent and unavoidable danger. He/she must inform as soon as possible workers exposed to the risk of serious and imminent danger of the risks involved and of the steps taken or to be taken for their protection. Further, the employer shall communicate electronically to competent authorities (INAIL and IPSEMMA), and through them, to the National Information System for Prevention in the Workplace within 48 hours from the reception of the medical certificate. For statistical purposes and information, the employer shall provide data and information concerning the occupational accidents involving absence from work of at least one day (not including the day of the event). And, for insurance purposes, the employer shall notify occupational accidents involving absence at work of more than three days.

**The Manager**: the Manager is the figure tasked with organizing/supervising the same activities carried by the Employer, within the limits of the powers delegated, and the same obligations and responsibilities for which the employer is liable under art.18 shall apply to him/her.

**Supervisor**: as specified under art.19, supervisors must, among other things, supervise and ensure compliance with the safety measures set up by the employer and managers, as well as to report any deficiencies on the equipment or any other dangerous situation.

**Workers**: every worker has to take reasonable steps to protect his/her own health and safety and that of other people at workplace, under the obligations set forth by art. 20. Amongst the workers the Workers’
safety representative (WSR), whose specific duties are set out in Art. 50, definitely plays a key role. In addition to receiving appropriate training and information and having access to risk assessment documents and associated prevention measures, taking part in the annual meeting with the Employer (or his/her representative), the Head of the Protection and Prevention Service and the Occupational Physician and be consulted on risk assessment procedures, he/she has the right to put forward proposals on prevention activities, inform the employer of any identified risks, have recourse to the competent authorities if the prevention and control measures adopted by the employer and/or the managers and their implementation do not appear to ensure a safe and healthy workplace.

Occupational physician: the major role of this figure, whose duties and responsibilities are set forth in art. 25, is associated to health rather than safety issues, but letter a) specifies that “he/she collaborates with the Employer and the Protection and Prevention Service in assessing risks, including for health surveillance planning purposes, in the preparation of measures for the protection of the health and psycho-physical integrity of workers […]” and letter l) “he/she visits each workplace at least once a year or at different intervals based on his/her risk assessment evaluation […]”.

Protection and Prevention Service: articles 31-35 of the Decree describe the Protection and Prevention Service formed by a Manager and one or more Supervisors. The Service, whose tasks are specifically listed in art. 33, is committed to identify and assess the relevant risk factors, to identify and draw up the relevant prevention and protection measures, to put forward proposals on information and training programs for workers, to take part in consultation arrangements on health and safety protection and to participate to the periodical meeting.

In the light of the above, the employer and all the figures involved in prevention should focus on specific objectives in view of planning a viable risk prevention strategy.

According to the International Labour Organization (ILO), the current global crisis and associated economic instability could lead to a deterioration in safety standards in terms of increased job insecurity, longer work times, greater presence of irregular employment and less effective controls. This is why one of the employer’s top priorities should be the adoption of all necessary contractual and working arrangements and practices so as to minimize the risk of accidents connected to and dependent on poor organizational standards. In this respect, the employer, assisted by the PPSM, must ensure that all employees are properly informed about the working environment and working procedures, not only through the provision of specific and properly organized training courses but also through a follow-up strategy evaluating their ability to apply the knowledge and skills learned in their daily work.

Nor should be forgotten, in this context, the impact induced by foreign workers in Italy, whose numbers continue to grow and who are often employed in sectors with a statistically higher risk for injuries, such as construction and agriculture. Moreover, it is well known that this category of workers is particularly vulnerable in terms of totally or partially off-the-books work which, for safety and insurance matters, is a major obstacle to the reduction of injuries (42-44). Hence, ensuring regular contractual positions for all employees must be the employer’s main objective. It is likewise worth mentioning that foreign workers may have difficulties in developing awareness as to safety measures and how to apply them, because of language but also cultural, ethnic and social reasons. This is why employers should be thoroughly informed about their foreign labor force so as to properly evaluate their distinguishing characteristics and the difficulties stemming therefrom and thereby acquiring the tools necessary to organize ad hoc training and information. Indeed, courses reserved to foreign employees should be organized even more carefully and could also include the possibility of: educational pathways for improving language skills, considering that communication and comprehension difficulties are the first and most difficult barrier to overcome on the way to active participation to the enterprise’s safety policies; courses providing an introduction to the basic principles of labor law and citizenship right, which concepts are “taken for granted” by those who have always lived in a given reality whereas people from other countries, with different cultures, customs and costumes, may not share the same feeling. Only after these basics have been introduced and workers’ awareness verified, training courses providing more specific information and practical guidance as to the practices and behaviours to cope with occupational risk factors should be organized.

Proper attention should also be paid to the workers’ thorough knowledge of the main road safety rules and regulations in the light of the growing number of commuting accidents whose impact on enterprises is comparable to that of “traditional” accidents (9).

The Employer must be fully informed about the workforce employed in his/her enterprise in terms of age, sex, geographical origin, etc. and be aware of accident statistics not only with respect to injury rate for each category but also to the type of injury, the circumstances leading to injury, the most affected anatomic sites, etc. By cross-referencing these data he/she will be in a condition to set up the most appropriate safety measures (with the support of all figures involved) tailored to the characteristics of the workforce.

Even more important, in the same respect, is access to information about the enterprise accident rate trend over the previous years. First of all the Employer, as well as all the other figures involved in safety issues, should be familiar with the characteristics of the tasks performed by workers so that safety task assessment sheets can be properly prepared. This is an important tool as it provides an overview of all the risks incurred by workers when performing a task, including accident risks: each task will embody, by reason of its inherent peculiarities, specific circumstances leading to poten-
tial accidents. These indications may be a good starting point for the adoption of the most suitable safety measures taking due account of the work activity being carried out.

It is also very important to refer to the total number of accidents reported by the enterprise over the previous year. Indeed, thanks to such data the weakest points in the company safety system can be identified and properly modified with the adoption of more suitable measures. The same remarks could, of course, also apply to workers’ training and information.

Even the Occupational Physician must be thoroughly informed about the safety task assessment sheets describing the various tasks performed by the workers since this will raise his/her awareness as to safety matters, grow his/her competence in the preparation of the risk assessment document, provide an adequate overview of the activities carried out by each worker undergoing health surveillance and help him/her make specific medical visits for each worker.

All members of the Prevention and Protection Services, beginning with the Manager, must share the same objectives as the Employer’s and in particular:

- awareness of enterprise risks and of the risks associated with each task;
- definition, in collaboration with the Employer, of the measures to be taken;
- review on an yearly basis of injury statistics in view of modifying, updating, replacing any of the existing measures or adopting new ones;
- supervision of employees to ensure they comply with the safety measures and procedures applicable to their area of work, in particular by checking they have followed the training courses provided and are fully aware of the information received.

As to employees, they are obviously called upon to adopt a safety-oriented behaviour.

Therefore, they are required to attend all training delivered with a critical approach and take all safety measures concerning their own health (e. g., in terms of Personal Protective Equipment). Each worker is also called upon to collaborate as they are considered as entities actively engaged not only in safeguarding his/her own health but also in encouraging all workers to have a more safety-oriented approach. In this light each employee should not just stand idly when his/her fellow co-workers commit a negligent act, error or omission but rather take appropriate steps to ensure that everybody complies with safety measures. Indeed, employees are the main protagonists of business activities and as such they should also commit themselves to another shared goal by cooperating with all figures involved in safety prevention issues. In other words, far from being passive entities receiving instructions by the Employer and the Prevention and Protection Service, they should promptly inform the Employer or PPSM of any deficiencies or failures in the working environment and formulate observations aimed at improving the safety management system.

**Risk prevention and business productivity**

**Introduction**

Risk prevention is the set of measures implemented in view of minimizing work-related health risks. The term “business productivity” refers to an average measure of direct labor used in the production turnover process. Adequate risk prevention resulting in the reduction of workplace injury rates enables businesses to optimize their workforce productivity. This is why careful consideration should be given to the need of implementing an effective risk prevention management system for its beneficial effects on employees’ psychological well-being and on the company’s economic growth. Business productivity can be quantified through the performance evaluation process or “performance management” as it is commonly referred to. Performance management involves defining which tools and procedures are necessary to ensure that goals and objectives are being reached efficiently and effectively. Effectiveness relates to the capability of producing a desired result whereas efficiency relates to the capability of obtaining it with the minimum allocation of resources. Therefore, a drastic reduction of accident occurrences will contribute to make better use of human resources thus promoting business efficiency.

It is not always clear for a business which costs are to be associated to diseases and accidents in the workplace, partly because the potential benefits of a good health and safety management system often fail to be recognized. In this light, the best way to investigate costs and effects of occupational accidents is through an economic evaluation clarifying costs and benefits from the implementation of a health and safety management system at a national and company level so as to identify any critical areas as well as areas for potential improvement. However, the real benefits of economic evaluation can be measured in terms of the impact it may have on the decisions taken at managerial level. In practice, evaluation can be interpreted in two ways here:

a) evaluation of the cost per single accident or injury over a given period of time, which is typically called an ex-post evaluation;

b) evaluation of the economic effects of preventive actions or accident prevention (cost-benefit analysis). This type of evaluation is often used to assess the feasibility of an investment or to choose between a number of alternatives.

On the other hand improved working conditions and the implementation of preventive actions do not only reduce health risks and the number of accidents but they also prove beneficial in terms of:

- improved motivation, collaboration and morale of the workforce;
- increased worker productivity and more efficient working methods;
- reduced rates of unplanned costs through an effective business continuity plan;
• well-structured and high-quality recruitment and retention policies;
• reduced insurance premiums and reduced exposure to criminal or civil litigation.

Prevention, often perceived only as a cost, is instead an asset for the enterprise because it could eliminate the additional costs for workers and their families, for insurance companies and public funds due to poor prevention strategies.

The model of performance evaluation has evolved over the years. In the 1970s the focus was on behaviours explored through evaluation scales expressed in degrees (report cards). In the 1980s Peter F. Drucker developed the concept of “management by objectives”, a systematic and organized approach which emphasized the achievement of goals. In the 1990s, instead, even as a result of the application of total quality management concepts, the focus was not only on results but also on how they could be reached, thus obtaining a more complete model evaluating both results and behaviours.

In recent years we have been witnessing a further evolution of the performance management system which is increasingly considered as a strong lever for development and organizational management of the great processes of change typical of many enterprises. There are two types of performance evaluation models with respect to the time dimension, not necessarily alternative to each other:
1. short-term model, mainly centered on evaluating goals achieved versus objectives assigned; in this case the focus is on placed on “what” and the system is directly linked to incentive mechanisms;
2. long-term model, mainly centered on evaluating actual behaviours versus expected behaviours; in this case the emphasis is on “how” and the system appears to be more correlated to development systems.

As already pointed out, the key to optimizing business resides in the implementation of an adequate workplace risk prevention strategy based on risk assessment, which is the cornerstone of the European approach in the field of health and safety in the workplace.

**Today’s debate on safety and productivity**

A central EU commitment from the Lisbon Strategy (45) is to give equal importance to increased employment and productivity. According to 2007 European data, the cost of injuries at work and occupational diseases in the EU-15 ranges from 2.6 to 3.8% of GDP (46).

Today more than ever before, occupational safety is based on prevention, protection, information, education, training and organization, thereby intending the evolutionary process that should shape the entire business structure in view of minimizing and removing all workplace-specific hazards. Every enterprise can enjoy significant benefits by investing in an occupational safety system since its implementation provides an effective framework both in terms of accidents /ill health prevention and also in terms of increased productivity/profitability. This simple axiom results from the creation of a safety organizational chart which, combined with simple and effective measures, shall protect the physical integrity and moral personality of workers.

The establishment of occupational risk prevention strategies requires specific economic resources, which a business is expected to deploy for the implementation of appropriate measures in terms of structures, materials, machinery and for the development of training and information courses. The application of viable preventive strategies, far from being a waste of economic resources, is an essential part of a successful business in terms of cost reduction and increased business productivity.

As specified by the European Agency for Safety and Health in the workplace, every enterprise can enjoy significant benefits by investing in occupational safety because (47):
• it helps demonstrate that a business is socially responsible;
• it protects and enhances brand image and brand value;
• it maximizes the productivity of workers;
• it enhances employees’ commitment to the business;
• it builds a more competent, healthier workforce;
• it reduces business costs and disruption;
• it encourages the workforce to stay longer in active life.

Both large and small/medium-sized enterprises can benefit from a well-designed safety system in terms of increased business productivity. Large organizations have realized the productivity benefits of a good safety strategy. These are most noticeable in terms of:
• reduced rates of accidents, incidents and ill health;
• enhanced levels of motivation, cooperation and morale in the workforce;
• increased workers’ productivity and more efficient working methods;
• minimised unplanned costs through effective business continuity planning;
• improved quality of employee recruitment and retention;
• reduced insurance premiums;
• reduced exposure to criminal or civil litigation.

Many small and medium-sized enterprises are also beginning to recognize the benefits of good occupational safety performance. These are most noticeable in terms of:
• avoiding business disruption and loss of key staff;
• motivating staff and retaining their commitment;
• adopting safer working methods that also allow work to be done quicker and with fewer people;
• reducing rates of accidents, incidents and ill health;
• maximizing levels of recruitment, motivation and retention of skilled staff.

Business productivity is improved through a good accident prevention strategy based on a careful exami-
nation of what in the workplace could cause harm to people. This is why risk assessment appears to be one of the pillars of Directive 89/391/EEC (Framework Directive) (48) and the other EU directives on safety and health at work, first transposed into Italian law by Decree 626/94 (40), which mark a ground-breaking step towards a new accident prevention philosophy. It is the Employer’s obligation to evaluate all the risks to the workers’ health and safety in the workplace, which responsibility cannot be delegated (Legislative Decree 81/08, art. 17) (41). The Employer shall draw up the risk assessment document in collaboration with the Occupational Physician and the Manager of the Prevention and Protection Service. The Occupational Physician shall implement a prevention strategy aimed at protecting the workers’ health and safety and his/her presence is essential to support the economic growth of the enterprise.

Behaviour-based safety

An innovative accident prevention approach, which is recently catching on in the field of occupational safety, is the Behaviour-based Safety (o Behavioural Safety) approach. Behaviour-based safety is a broad term used to describe a comprehensive safety management system designed to change a company’s safety culture through the identification of practices (behaviours) critical to reducing the risk of injury (49,50). This approach refers to the use of applied behaviour analysis models to achieve continuous improvement in safety performance and was successfully experimented in the 1990s in the Anglo-Saxon world and has also had several significant applications in Italy since the early 2000s (51-53). The conceptual foundations of this behaviour-based safety tool were developed by H.W. Heinrich in the 1930s. After reviewing thousands of accidents reports, Heinrich came to the conclusion that most of all workplace accidents, illnesses and injuries were caused by “man-failures” i.e. errors made by employees while carrying out their duties (50, 53). The term “behaviour-based safety” (BBS) came into being as the result of three distinct currents of work:

• in 1978 the applied behaviour analysis work of psychologist Judi Komaki. Komaki was one of a small group of academic applied behavioural analysts working on industrial performance;

• in 1979 Dr. John Hidley was asked by an offshore oil-drilling company in California to help them find innovative ways of improving safety performance. Based on their preliminary analysis, Dr. Hidley recommended the use of applied behaviour analysis as an improvement methodology. During this same period he learnt that Gene Earnest and Jim Palmer, safety managers at Proctor and Gamble, were developing a methodology drawn from the behavioural sciences which they called “behaviour-based safety”. Earnest and Palmer were reportedly the first to use the phrase “behaviour-based safety”;

• in 1979 Dr. E. Scott Gelleger, Psychology Professor at Virginia Tech Department of Psychology – USA – and Director of Safety Performance Solutions Inc., a consulting firm specializing in Behaviour-Based Safety, initially adopted this procedure in industrial settings and later also in offices/laboratories and in intensive care units.

The evolution of BBS models most largely used between 1980 and 1985 was management-driven from the top down: effective training was provided to supervisors with the information and tools they needed to apply the method focusing on frontline personnel. A wide array of behaviours, in some cases as many as 80 or 100, were observed. The emphasis in this period was mainly on the worker’s individual behaviour and on how to modify it through specific reinforcements. In the period between 1986 and 1996, even as a result of the popularity of Total Quality Management principles in the petrochemical industry, the model was changed to one that was employee-driven. Businesses which pioneered behaviour-based strategies saw strong commitment of the employees who in fact asked to reformulate the method in view of ensuring large employee involvement. This is why businesses integrated TQM and organisation development principles with those of applied behaviour analysis and also developed software to store and analyze data generated during behavioural observations, and emphasized feedback as an improvement mechanism and as a type of reinforcement.

Since 1997 the BBS model has evolved to include more completely the engagement of all employees. This occurred in response to the need to address more directly the contradiction that some organisations perceived between an employee-driven process and management accountability.

The first model (1980/1985), guided by a supervisor from the top down, can be easily implemented, since lower training is required and no cultural contextualization, which limits its functionality, is envisaged. The second model (1986/1996) made it possible to switch to a more thorough and active involvement of employees; however, in spite of warnings to the contrary, some companies implementing BBS leave out the manager and the supervisor. The model presently adopted sees the active participation of the entire personnel, including managers, supervisors and employees: in this model management behaviour is as important as employee behaviour and great emphasis is placed on the use of data gathered during behavioural observations for problem-solving purposes (54).

In 2015, 632,665 workers fell victims to a workplace injury in Italy (3); these grim statistics justify the growing attention given by government organizations, employers, trade unions and society to a problem that appears to be a very serious social alarm. Accidents occurring in hundreds of organizations have been analyzed over the past 10 years in order to develop accident prevention checklists and clear evidence has emerged that most of all workplace accidents are caused by human behaviour. In this perspective, the Behaviour-Based Safety has proved an effective workplace prevention tool (50, 55-59). This strategy is
evidence-based, which is the reason behind its success and widespread implementation, since it is a scientifically validated system founded on principles inductively derived from experimental research, published and replicated by scholars around the world through a protocol analysing performance in terms of frequency, latency, duration and intensity: the BBS protocol measures the occurrence of outcomes mainly as an indicator of the effectiveness of induced behavioural changes. There is now general agreement among scientific experts that human factors are a major component of the causes of accidents in the workplace (50, 55), much more than poor structural or organizational standards.

Oftentimes accidents are not due, for example, to a lack of PPE but simply to not wearing it. Encouraging safety-oriented behaviours has a positive impact in terms of reduced accident rates. Observation of workers’ actions and workplace safety conditions, elimination of structural risks, recognition and reward of good behaviour, these are the activities found in a Behaviour-Based Safety process (50, 53). This scientific method intends to promote a culture of safety within a business organization whose main focus is not on punishing wrong behaviours but rather on rewarding, hence reinforcing over time, sometimes with verbal exhortations, sometimes with tangible rewards, all behaviours that contribute to limit the risks (50, 53). The inspiring principle underlying such behavioural-based scientific methods comes from the paradigm first developed by Dr. B.F. Skinner, Professor of Psychology at Harvard University, chief promoter of radical behaviourism which considers human behaviours as evoked by the environmental conditions in the workplace, i.e. the stimuli that occur right before a behaviour (antecedents) and are maintained, increased or decreased by the stimuli occurring right after that behaviour (consequences). The Antecedents-Behaviour-Consequences Triad is therefore the main paradigm of safety behaviour used to develop all intervention techniques.

The A-B-C (Antecedents-Behaviour-Consequences) or interactionist model, draws a clear distinction between the effects of antecedents, which only permit to display behaviours, and the effect of consequences, which affect the future behaviour (reinforcement + or -). Skinner’s paradigm has shown that for properly understanding, predicting and controlling behaviour it is necessary to:
1) measure (not judge) safety behaviours;
2) associate correct behaviours to positive, immediate and certain consequences;
3) reduce or (almost) remove any consequences, both positive and negative, related to “errors” or dangerous behaviours in the workplace.

A good BBS program should consist of:
• common goals processed in the executive management process;
• definition of specific behavioural expectations and consequent evaluation of safety processes;
• data collection and observation;
• use of data-based tools to adopt appropriate behavioural procedures;
• frequent feedback on the effectiveness of workers’ safety behaviours;
• review of reports on workplace behaviours.

At its very core BBS is based on reinforcement + (positive reinforcement R+), which promotes the repetition of the safe behaviour. Hence, BBS shifts the emphasis away from the consequences of incorrect behaviours, i.e. not complying to safety rules and procedures (accidents), and focuses instead on causes by directly addressing them.

A further contribution of Behaviour Analysis and behavioural sciences refers to the adoption of reinforcement systems + for verbal and motor behaviours: in the light of the close correlation between cognitive (thinking), emotional (feelings) and motor (actions) responses, most behaviour-based safety strategies tend to create a social environment formed by colleagues, supervisors, union representatives, managers and sometimes even the workers’ families in view of strengthening, not just behaviours, but also safety-related verbal statements (50, 53) (Table 1).

BBS has also made significant contributions to safety culture and values: the term safety culture refers to a behaviour, these are the activities found in a Behaviour-Based Safety process (50, 53). The inspiring principle underlying such behavioural-based scientific methods comes from the paradigm first developed by Dr. B.F. Skinner, Professor of Psychology at Harvard University, chief promoter of radical behaviourism which considers human behaviours as evoked by the environmental conditions in the workplace, i.e. the stimuli that occur right before a behaviour (antecedents) and are maintained, increased or decreased by the stimuli occurring right after that behaviour (consequences). The Antecedents-Behaviour-Consequences Triad is therefore the main paradigm of safety behaviour used to develop all intervention techniques.

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<table>
<thead>
<tr>
<th>Without BBS</th>
<th>With BBS</th>
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<tbody>
<tr>
<td>Unsafe behaviours are detected to punish them (P+). Employees are rewarded only when their behaviour complies with the standards.</td>
<td>Safe behaviours are reinforced to reward them (R+). Employees are rewarded as soon as their behaviour improves.</td>
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<tr>
<td>Employees are rewarded depending on the judgment made by supervisors (performance appraisal).</td>
<td>Employees are rewarded depending on objective measures (performance management).</td>
</tr>
<tr>
<td>Employees are rewarded only after they achieve results (e.g. injury-free periods).</td>
<td>Employees are reinforced for their safe behaviours regardless of the results (safety actions).</td>
</tr>
<tr>
<td>Commands are reinforced and reiterated to obtain “obedience” (placement of antecedents).</td>
<td>Reinforcements are delivered to obtain “voluntary” performance (delivery of consequences).</td>
</tr>
</tbody>
</table>
port with approval, positive feedback and social or material reinforcers. The term safety values includes a complex repertoire of verbal statements used by workers when referring to safety and PPE, expressing their anxieties, praising colleagues having a safety-oriented behaviour on the workplace, etc. Such positive verbal behaviours, or safety values, are thereby characterized by the content of the collective and verbal statements and practices ignoring or neglecting safety are punished or simply extinguished for lack of attention from colleagues and supervisors: the rule-governed behaviour or "verbal behaviour governed by rules" is able to produce extremely resistant safety behaviours even in the absence of an immediate external control (60).

BBS interventions produce viable results if implemented by competent persons: far from simply being an effective method to promote safety behaviours, BBS is also a winning strategy to develop successful quality and production policies suitable to meet the company needs and costs. A poorly planned intervention implemented without the necessary technical and scientific knowledge is devoid of the contents and resources required for a correct and proper promotion of safety and prevention behaviours.

The implementation of a behaviour-based safety process is translated into corporate behaviours and is divided into separate and subsequent steps:

- analysis of previous injuries and identification of behaviours and/or conditions surrounding and accompanying the event;
- creation of a questionnaire and data collection through interviews on accident occurrences and safety practices in the workplace;
- formation of a steering and a project group within the enterprise, made up from a cross-section of different (management, safety, production, union, frontline) functions;
- training on behaviour-based safety for the project team;
- presentation of the behaviour-based safety project to all involved personnel (production executives, middle managers, technicians and workers);
- identification (pinpointing) of behaviours associated to the most frequent and most severe injuries;
- construction of ad hoc lists (checklists) for the different departments and/or types of work to use in the behavioural safety process which is being set up;
- creation of an implementation group in charge of supervising and monitoring the behaviour-based safety process;
- creation of observer groups, usually made up on a voluntary basis, mainly by the workers themselves;
- training on observation/assessment techniques reserved to all observers;
- training on leadership/feedback techniques reserved to all observers;
- field assessment (observation and behavioural adjustment) of safety behaviours, usually carried out through time sampling;
- functional analysis of safety behaviours detected (detection of antecedents and consequences of safe/at-risk behaviours);
- determination of reinforcement schemes to develop and maintain safe behaviours;
- analysis of results and development of observation lists and reinforcement schemes, meetings and feedback;
- implementation of intermittent reinforcement patterns of behaviours and strategies for the maintenance of the behavioural safety process over time.

Research conducted over thirty years of application of BBS techniques have demonstrated the superiority of the method for its ability to promote safe behaviour and to reduce accidents associated with undesirable behaviour (50, 53, 55-60).

Furthermore, from the viewpoint of costs, the adoption of BBS strategies produces positive effects in terms of:

- reduced or zero hours lost due to accidents;
- reduced damage to equipment or to third parties involved in the occurrence;
- reduced rate of work processes suspended or only partially carried out because of safety deficiencies identified when the work was already in progress;
- reduced insurance premiums, though not so easy to get in the Italian context;
- reduced impact of legal disputes between the enterprise and the workers about workplace injuries;
- improved workplace climate and relations between management and workforce, thanks to widespread use of positive feedback techniques and social praise with minimal sanctions;
- increased productivity (50, 53, 60).

The positive effect on productivity is presumably because BBS implementation requires middle managers to gain a good knowledge of behavioural control and performance management techniques which, given their positive impact in terms of increased safety-promoting behaviours, are partly used by supervisors and managers to improve quality and production behaviours (61-63).

Even workers, according to a study published by Cooper et al., appear to show a remarkable propensity for BBS: the survey, conducted on a sample of 247 companies implementing BBS strategies, showed that 92% of workers interviewed preferred to work in an enterprise using this system rather than one not having it, hence confirming its effectiveness and usefulness (64).

Despite its many positive aspects, the popularity of BBS was far from being easy for a number of reasons:

- it is a rigorous discipline, whose implementation must be guided by qualified personnel in the field of behaviour analysis methodologies. The BBS process should not be set up without proper involvement of human resource managers;
- it presents a cultural obstacle: in Anglo-Saxon countries the adoption of a new behaviour analysis methodology is free from emotional or cultural identity connotations, but is related to its functionality and effectiveness; in EU countries instead,
especially in Italian enterprises, it is not unusual to find human resources managers with an explicit culture-oriented professional preparation and training;

• it is inherent in the business system implementing behaviour-based safety procedures to leave out certain professional figures even in the latest operating models: if a BBS initiative is carried out without involving the management nor consulting the unions or if PPSM are not in a position to take an active and significant role in the safety process, the chances of a change in behavioural accident prevention processes are unlikely to occur. A behaviour-based safety process should always be supported by strong interaction and cooperation among all actors involved, especially frontline personnel, but this is not always the case and it is often developed ad hoc;

• BBS is commonly believed to be applicable only for major businesses and, in any case, not for contractors, subcontractors or temporary workers (50).

The precautions to be taken when implementing a BBS process include:

• analysis of past accidents, for the purposes of benchmarking, i.e. an examination of the methods, processes, procedures, products and service performance of the enterprise against those of other enterprises;

• the BBS project is expected to integrate the safety prevention system of the company that decides to apply it;

• union representatives will have to be informed through an effective and convincing presentation of the behaviour-based safety analysis project;

• all workers will have to be informed through a “sales” presentation of the initiative before being observers or simple observes;

• management will have to be regularly informed of progress and improvements obtained through linear diagrams and specific presentations: failure to regularly inform management deprives the process of an important source of feedback;

• the workers’ representatives will have to be involved in the project, together with employers and safety managers. Careful leadership and a well-designed system produce a great influence in terms of commitment by the entire environmental analysis team;

• the workers involved in the observation and feedback process should initially be volunteers and only at a later stage include other workers;

• no information or news obtained through the BBS system will have to be used to sanction the worker;

• the daily positive reinforcement and weekly feedback should always be calibrated to ensure they are perceived as positive events from all workers involved;

• specific initiatives will have to be put in place for behaviours (load handling, use of helmets, etc.) with their own system of feedback and incentives in order to achieve specific improvements and focus on each safety-related point (50).

Various types of questionnaires have been developed to assess the effectiveness of BBS strategies, such as the Ready Made Questionnaire, which is based on some thematic areas:

• demography

• risk assessment identifying the potential hazards in the workplace

• involvement in safety activities

• intercompany solidarity system

• observation of employees on safety practices covering:
  - top management commitment
  - job-induced stress
  - feedback
  - managerial actions
  - safety communication
  - safe behaviours
  - personal involvement
  - emergency procedures
  - risk perception
  - safety training
  - expected pattern of work
  - personal safety
  - opinions on the causes of accidents
  - safe systems in the workplace.

Other questionnaires are divided into different sections:

Part 1 - What is an unsafe act?

1. Briefly describe a dangerous act

2. Is a slippery floor an unsafe act or an unsafe condition?
   Unsafe act
   Unsafe condition

3. Why are some unsafe acts so difficult to keep under control?

4. List three factors which can contribute to unsafe acts.
   1. ____________________________
   2. ____________________________
   3. ____________________________

Part 2 - What is behavioural safety?

5. Behavioural safety is based on the theories of:
   Cause and Effect
   Behaviour Change
   Self-Actualization
   All of the above

6. Positive reinforcement uses feedback and discussion to establish positive consequences for safe behaviour.
   True
   False

7. A person is likely to behave differently depending on the consequences of such behaviour.
   True
   False
**Part 3 - What is a behaviour-based safety programme?**

8. A behaviour-based safety programme consists of 5 components.
   True
   False

9. Which is the first step in a behaviour-based safety observation?
   Identification of specific at-risk behaviours
   Inform employees that they are going to be observed in the performance of their tasks
   Discuss people’s behaviours taking note of the name of employees who are going to be observed

10. How many steps are there in a behaviour-based safety observation?
    3
    4
    5

11. Which is the purpose of a behaviour-based safety observation?

12. Which is the final step of a behaviour-based safety observation?

A variety of studies is available in literature about the root causes of accidents which confirm the benefits of enterprise-wide BBS strategies. These studies show that 80% of all workplace injuries are directly attributable to unsafe behaviour (65). The BBS philosophy is not punishment/sanctions-oriented, but rather based on a predictive criterion, placing emphasis on pragmatic approach to effective upstream risk control; unsafe behaviours must be discouraged and not through ex-post interventions. Major/fatal accidents or serious injuries are only the visible tip of the iceberg; any intervention at the top of the pyramid will not alter in any way the base of the pyramid itself. This particular methodology wants instead to modify the steps immediately before the accidents for reducing the likelihood that they will occur (65).

**An example of BBS**

In 2003 BBS was applied in an organization formed by six manufacturing sites for the production of sacks of a leading industrial group and, in subsequent years, the injury rate trend was monitored in the six plants (66). The activities were grouped into two main phases:
- a “PRE-OPERATIONAL” phase (preliminary to the implementation of the system) over a six-month period, to identify critical behaviours;
- a “FULLY-OPERATIONAL” phase, where unsafe acts are observed, analyzed and improved (BBS becomes a real management system).

The pre-operational phase starts with intensive training of plant personnel (management, supervisors and employees), whose purpose is to explain the objectives and phases of the project, and with the establishment of a central coordination body headed by an environmental health and safety manager. This structure is responsible for the project and identifies the operational managers of single activities. A list of critical safe and at-risk behaviors is developed through an injury records analysis and based on inputs from the other European sites of the group involved in similar work processes. Specific workgroups are finally created in each department tasked with providing information to the central coordination body and where, following a short training period, employees shall join workshop sessions providing them guidelines to identify risks and critical behaviours in their activity. These groups are headed and managed by workers’ supervisors (with the same leadership role they have in the workplace); the presence of the PPSM or the external advisor may also be possible (as facilitators). Table 2 contains an example of critical behaviours. Once the list of critical behaviours has been drawn up, observational tools are developed (e.g. observation data collection form) and observers are properly trained: specific meetings are clearly planned in view of instructing and informing workers on the proper operating procedures.

The fully-operational phase starts with observations (on samples) of critical behaviours in the workplace, generally conducted by management and supervisors. By carefully analyzing the results it is possible to establish which critical acts need improvements (which may differ from one site to the other, depending on observation data collected). The root causes of a specific critical act are then analyzed and the proper correc-

<table>
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<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td>Lock-out tag-out</td>
<td>Switchboard doors and cabins locked out</td>
</tr>
<tr>
<td></td>
<td>Power sources always locked out</td>
</tr>
<tr>
<td></td>
<td>Work in progress- do not start or move vehicle sign</td>
</tr>
<tr>
<td></td>
<td>Disconnector padlocked when out of sight/control operator</td>
</tr>
<tr>
<td>Falls protection</td>
<td>Railings, gates and chains locked when working at elevations</td>
</tr>
<tr>
<td></td>
<td>Use of PPE for protection against falls</td>
</tr>
<tr>
<td>Ascending/descending ladder</td>
<td>Proper ladder placement and stability</td>
</tr>
<tr>
<td></td>
<td>Ladders properly secured during use</td>
</tr>
<tr>
<td></td>
<td>Safely and properly climb a movable or fixed ladder</td>
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tive actions are approved and applied in the workplace. The results in terms of injuries reduction at the end of the second year are extremely positive. Although the context described above is very specific (sacks production), the results of this experience can be extended to other manufacturing companies, even in the light of available literature data that further confirm the validity of behavior-based safety methods (54).

**Latest updates**

The Cefic/ECTA /FECC guidelines introduced in 2007 were reviewed and replaced in 2014; the new guidelines promote best industry practices aimed at continuously improving the safety performance of chemical road transport activities from a technical, behavioral and organizational point of view. The scope of the current guidelines includes the safe loading/unloading of chemical products by operators and drivers at production sites, storage terminals, warehouses and customers, and covers the loading/unloading of bulk as well as packaged goods. The guidelines are implemented through a four-step process; the first two steps are a base level while the third consists of data collection and analysis even in the light of the previous statistic results: • “collect, record and analyze observation data”; • “look for trends”; • “communicate, on a regular basis, the observation results to all employees and all involved parties”. The fourth and last step refers to behaviour analysis in terms of antecedents and consequences: • “use a system to analyze unsafe behaviours. Example: the ABC analysis”, in conjunction with safety culture measurement and improvement; • “there is an active BBS policy towards customers and suppliers”.

Compared to the previous versions, the 2014 guidelines place therefore greater emphasis on behaviour assessment and “ABC” analysis (67).

**The costs of occupational injuries**

Occupational injuries have profound negative effects not only on workers’ health, but also in terms of economic costs. Data from the INAIL national database show that the total cost of workplace injuries accounts for about 45 billion euro per year. In spite of warnings to the contrary, documented by several studies, enterprises seem to underestimate the economic impact of an injury occurrence (68). Although some scholars have attempted to quantify these costs (69), no universally validated instruments are currently available for a realistic calculation of economic costs associated to different types of injuries. Indeed, such a calculation would require a careful analysis of multiple and heterogeneous factors (circumstances of occurrence - equipment and tools eventually involved, lost profits, legal fees, loss of production, ...) In conclusion, even though it is difficult to draw an a priori and generalized calculation of economic costs related to a workplace injury, it is nonetheless certain today that every euro spent on prevention provides an economic return (Return On Prevention, ROP) equivalent to EUR 2.2 (70), calculated by comparing the economic and non economic benefits deriving from prevention activities to the economic costs incurred to implement the same initiatives.

**Conclusions**

The phenomenon of workplace injuries is a global relevance issue because of the social and economic impact that its consequences may have on the working population as well as on enterprises. Indeed, even though the total number of accidents has diminished, many interventions have yet to be put in place to limit this phenomenon, whose consequences are not only economic but also, and above all, human.

**References**


