



ELSEVIER

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/safety

The evolution of health-, safety- and environment-related competencies in Italy: From HSE technicians, to HSE professionals and, eventually, to HSE managers



Simone Colombo^{a,*}, Luigi Enrico Golzio^{b,c}, Giancarlo Bianchi^d

^a Department of Chemistry, Materials and Chemical Engineering “Giulio Natta”, Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

^b Università di Modena e Reggio Emilia, Dipartimento di Economia “Marco Biagi”, Viale Berengario, 51, 41123 Modena, Italy

^c System Logik Srl, Via Bigli, 2, 20121 Milan, Italy

^d Associazione Italiana Ambiente e Sicurezza (AIAS), Via Fara, 35, 20124 Milan, Italy

ABSTRACT

After a short introduction of cultural models underlying the prevention policies of business risks, the manuscript explains, through an unconventional reading filtered by the systemic, socio-technical theoretical approach, how the competencies, as well as the role, of Italy’s HSE professionals evolved over years and what were the challenges that were faced and the opportunities caught.

Starting from the description of the different cultural backgrounds owned by Italy’s Health, Safety, and Environment professionals, the paper explains how the HSE profiles evolved according to both the legislative and the societal evolution. Further, it explains how the HSE professionals, thanks to the contribution of the unions, the (industrial and practitioners) associations and the national (as well as regional) policies, evolved from the simple role of technicians to that of professionals and, finally, will (hopefully) evolve into that of HSE managers.

1. Introduction

The HSE competencies composing the theoretical and experiential background of Italy’s Health, Safety and Environment professionals has evolved over years under a twofold influence, namely: the technological and the societal evolution. Aim of this paper is to propose an unconventional reading of this evolution filtered by the systemic, socio-technical theoretical approach (which is considered, by the authors, as being the most advanced conceptual thinking to date).

The analysis of cultural models underlying prevention policies of business risks is based on the theoretical assumption that the organization is a cultural construct, i.e., a dynamic entity made up of the cognitive constructs of the individuals composing the company fabric, in which people are not only producers of actions, but also of (organisational and learning) change through the learning process (Argyris and Schön, 1978; Smircich, 1983).

Cultural models, through which one might interpret the organisational behaviour, have followed, on the one hand, the technological advancements, and, on the other hand, the socio-cultural development. These models can be (coarsely) grouped into 5 main typologies, namely: the blaming (or fatalistic) culture, the technological determinism culture, the ergonomic culture (or that of the human factors), the socio-technical (or integrated) culture, and, finally, the High

Reliability Organisation (HRO) culture, this last being an evolution of the socio-technical culture (Weick and Sutcliffe, 2001). Fig. 1 summarises their principal traits.

In the fatalistic culture accidents are due either to fate (Acts of God) or inability of someone (who is the one to blame) to perform his/her duty. From a risk prevention perspective this culture might be seen as a non-culture as it contributes neither to the prevention activity nor to the company maturity growth. The fatalistic culture, born at the beginning of the industrial revolution, was followed by the technological determinism culture. For it the technology is the centre of gravity of everything and, as such, it has to impose the organisation of work. Frederick Winslow Taylor (a mechanical engineer), founder of the School of Scientific Management, in his book “*The Principles of Scientific Management*” (Taylor, 1911), formulated the thesis both at the micro level, in the relationship between the human and the machine (i.e., exasperation of the fragmentation of the work and its subordination to the machine’s constraints), and at the macro level of the organization of work, in the organisational functions (i.e., work division), which primary criteria was that of the technical specialisation.

The most radical criticism to this model (originated by the many industrial disasters the history has recorded) was formulated by Charles Perrow in his book “*Normal Accidents*” (Perrow, 1984). In the technological determinism culture, the accidents are due to the unexpected

* Corresponding author.

E-mail address: simone.colombo@polimi.it (S. Colombo).

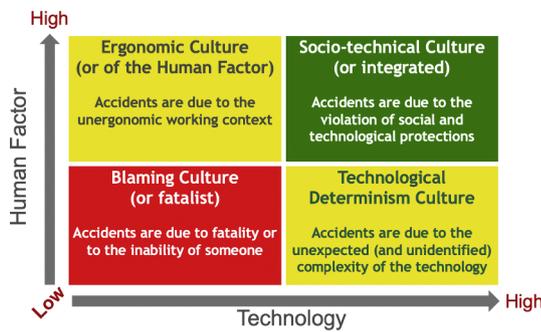


Fig. 1. Summary of the 5 cultural models of risk prevention.

(and unidentified) complexity of the adopted technology. Perrow argued that the conventional engineering approach to ensuring safety, i.e., building in more warnings and safeguards, fails because the (too) high complexity of systems makes failures inevitable. He further argues that the typical precautions, that add to an already high complexity, may help creating new categories of accidents, thus increasing the difficulty in preventing accidents. At Chernobyl, the tests (reckless, one might add) of a new safety system helped to produce the meltdown of the reactor (and subsequent fire and release of radioactive material).

The technological determinism culture has dominated for decades up until the social aversion towards the industrial accidents and disasters prevailed and forced a new paradigm to emerge. The importance of the centrality of human beings in the (risk) performance of organisations then started to take shape (in the 1970s). The organisation of work soon started to be influenced by two distinctive and emerging cultures: the ergonomic culture (primarily influenced by sociologists and psychologists) and the socio-technical culture (primarily influenced by organisation’s experts). The former concentrated on the ergonomic aspects of work meant as “optimal” human-machine interaction, while the latter assumed the equal relationship between the technology and the behaviour of individuals (and groups). The ergonomic culture unbalanced the centre of gravity towards the human being (in opposition to the technology determinism culture where the technology was at the centre). Yet, the ergonomic culture initially failed to account for the organisational environment and dimension (and its importance) in the risk prevention activity.

On the ergonomic side, the first cognitive theory on the “human functioning” was formulated by Jens Rasmussen in his book “*Information Processing and Human-Machine Interface – An Approach to Cognitive Engineering*”, (Rasmussen, 1986). Rasmussen theory was soon followed by that of Reason in his book “*Human Errors*” (Reason, 1990), and that of Hollnagel in his book “*Human reliability analysis: Context and Control*” (Hollnagel, 1993). In the ergonomic culture accidents occur because of the poor ergonomic design of working environments. The (limited) perspective offered by the ergonomic culture was theoretically extended by Reason in his book “*Managing the Risks of Organisational Accidents*” (Reason, 1997), in which Reason has included even the organisational dimension of risk prevention.

On the socio-technical side, the first theoretical foundation was given by Burns and Stalker (1961) in their book “*The management of innovation*”, in which they explained how the mechanistic and the

organic organizational forms can fit the stable and the dynamic environment respectively. The contribution of Burns and Stalker was subsequently perfected by Emery and Trist with their manuscript “The causal texture of organizational environment” (Emery and Trist, 1963), transforming the two organisational forms proposed by Burns and Stalker into four forms, thus offering an even more complete approach. Trist some 20 years later proposed “*The Evolution of socio-technical systems as a Conceptual Framework and an Action Research Program*” (Trist, 1981). The strength of the socio-technical culture (that has allowed the organisational approach associated to it of surviving till today) lies in the consideration of the organization as a socio-technical system that adapts to environmental pressures and takes advantage of the opportunities offered in a contingent logic. In the socio-technical culture accidents are due to the (more or less conscious and intentional) violation of both social and technological protections.

The contribution of sociologists and psychologists in analysing high-risk organisations allowed them to extend the socio-technical culture beyond the limitations imposed by the underlying organisational approach proposed by Lawrence and Lorsch (1969) in their book “*Organisation and environment*”, i.e., the contingent adaptation of the organization to the environment, thus giving rise to the culture of the high reliability organisations. The first sound theory of the High Reliability Organisation (HRO) culture saw its light with Weick and Sutcliffe in their book “*Managing the Unexpected: Assuring High Performance in an Age of Complexity*” (Weick and Sutcliffe, 2001). To facilitate the understanding of the socio-technical perspective (system thinking) of working environments, the terms Human, Technology and Organisation (HTO) model has been introduced to refer to the three interrelated elements and their effects on efficiency and performance, as well as on safety (Rollenhagen, 2000; Karltonet al., 2014).

The aforementioned 5 cultural models, being a “reading tool” to interpret companies’ prevention behaviour and not a tool themselves, can be conveniently used to interpret the behaviour of both large and SMEs companies. In the hereinafter, bearing in mind the 5 cultural models and adopting as a reading filter the systemic, socio-technical perspective, i.e., the fourth (and fifth) model, the manuscript explains how the competencies, as well as the role, of Italy’s HSE professionals evolved over years and what were the challenges that were faced and the opportunities taken.

2. The health, safety and environment professionals: The Italian perspective

In the Italian perspective, the Health, Safety & Environment (HSE) professionals are certified specialists of different scientific disciplines that deal with the prevention of different types of risks stemming from the production of goods and services by private companies and public institutions. More specifically, the HSE professionals are certified professionals according to Law “Accordo Stato-Regioni” (State-Regions Agreement – see Section 4) in the sense they have to go through an educational program at the end of which they get a certificate (after passing an exam).

Table 1 shortly summarises the cultural background typically owned by Italy’s HSE professionals in relation to the type of risk(s) they are required to prevent.

In terms of risk identification/recognition and prevention, each HSE

Table1 Safety professional roles in Italian private companies and public institutions.

Types of risks	Professionals
Hygiene and occupational diseases	Medical doctors and hygienists
Occupational accidents & injuries	Safety professionals (engineers, ergonomists, lawyers, chemists...)
Psycho-social risks (work-related stress & wellbeing)	Medical doctors, psychologists, psychiatrists
Environmental pollution and disasters risks	Environment professionals (engineers, chemists, biologists, physics, geologists, computer scientists, statisticians, environment prevention professionals)

professional deals with both aspects from their own perspective. This approach, despite it allows to capitalise all the competencies hold by the different professionalisms, might create coordination inefficiencies as what might be a good choice for one type of professional, might turn out not to be good for another. Clearly, (operational) problems and inefficiencies might arise when both professional opinions are (legally) important. For example, should a Personal Protective Equipment (PPE) need to be chosen, what might happen is that the same PPE might be a good choice for the safety professional, for example for mechanical reasons (because assessed by an HSE professional holding an engineering background), but a bad choice for the competent medical doctor because of its health-related implications. The ultimate decision is in charge to the HSE professional that might either decide to substitute the PPE (if already bought – with an increase of costs) or keep using them exposing the company to a potential administrative and/or criminal sanction.

Today, in the Health, Safety and Environment (HSE) areas of expertise, people are either employed as HSE professionals in private companies and public institutions (as researchers, operating staff or inspectors/auditors) or they practice the profession as practitioners at the service of entrepreneurs and private companies. Yet, in Italy, the specific competences of risk prevention developed over years, primarily under the *stimuli* of scientific research, political decisions and labour legislation. As far as the scientific *stimulus* is concerned, Italy profoundly influenced the international (scientific and professional) community of hygiene and occupational diseases. According to Gochfeld (2005), Bernardino Ramazzini (1713), with his world's first book on occupational diseases titled “*De Morbis Artificum Diatriba*” (i.e., literally “Diseases of Workers”), can be considered the father of occupational diseases. His book outlined the health hazards associated with chemicals, metals, dust, repetitive or abrupt and sudden motions, odd postures, and other disease-causative agents encountered by workers in more than fifty occupations. On the other hand, and as far as the political (and subsequently even the scientific) decisions are concerned, Italy provided its significant contribution in the City of Milan (historically the place of production for “heavy industry”) starting from the beginning the of the last century (1902), the “*Clinica del lavoro*” (The Work Clinic) founded by Luigi Devoto, which is the oldest medical structure worldwide. The goal of “The Work Clinic” (in the mind of those who conceived it) was to study and prevent hygiene and occupational diseases. Over years “The Work Clinic” has evolved and today is the Department of Health Sciences of the “*Università degli Studi di Milano*” (University of Milan). The Work Clinic, jointly with the trade unions’ fights for occupational health and safety (see “*Gruppo Omogeneo*” later on in the text), other than influencing the specialisation in occupational medicine has also influenced that of psychology, stimulating the strand of risk prevention and safety behaviour. As far as the other scientific disciplines involved in HSE prevention are concerned, they were primarily influenced by the legislative framework. The Law

no. 300/1970 (see Table 4) represented a milestone as it has influenced the legal disciplines to develop in favour of the HSE prevention. After that the Law no. 186/1989 suppressed the previous degree in mining engineering and introduced the “*laurea in ingegneria per l'ambiente e il territorio*” (master degree in engineering for the environment and the territory), thus putting the emphasis on (the protection of) the environment and the territory. Eventually, the Law no. 626/1994 stimulated the organisational and sociological disciplines that introduced the scientific strand of organisational safety (the former) and that of work sociology (the latter). Finally, in 2004, under the initiative of a fistful of professors (stemming primarily from the process industry domain – chemical and nuclear), the Politecnico di Milano activated Italy's first master's degree in prevention and safety engineering in the process industry (still active today), thus concentrating the research knowledge and experience, previously fragmented within the institution, under one scientific strand.

As far as the labour legislation influence is concerned, Italy has a long HSE tradition that finds its origin at the end of the 19th century and that deserves a proper historical explanation (described in the section below) to provide a better understanding of its influence on Italy's HSE professional evolution.

The weak point of the Italian tradition is the absence of an interdisciplinary perspective either by the different scientific disciplines or by the empirical risk prevention approach within companies. On the education side, universities masters are specialized courses, based on a single scientific discipline. There is only one Master level course in safety management offered by the University of Modena and Reggio Emilia. On the practical risk prevention side, the medical doctor, specialized in occupational diseases (the so-called “*medico competente*” – competent medical doctor) that might be either an external consultant or an internal function (at company discretion), provides health services to workers typically without (a proper) coordination with the company HSE professional (that, similarly, might be either an internal or an external consultant at company discretion).

3. The evolution of the Italian HSE legislation

Italy has begun to regulate the risk prevention market and the HSE practice since the end of the 19th century. Table 2 summarises the main labour-related Laws that influenced the HSE area of business in the Italian enterprises during the Italian kingdom. These Laws were sufficiently far-sighted to the point that their effects are still influencing today's practice.

As far as the voluntary insurance of workers is concerned, the first company that insured its workers dates back to the end of the 19th century, to be precise in 1881. To strengthen the increasing awareness of Italian enterprises towards the importance of taking care of their own workers, in April 1892 the Italian Association of Industrialists was created in Milan with the specific and declared goal of preventing

Table 2
Main health, safety & environment laws during the kingdom of Italy.

Year	Law number	Content
1883		The creation of the “ <i>Cassa Nazionale di Assicurazione per gli Infortuni degli Operai sul Lavoro</i> ” (National Insurance Fund for Workers' Accidents at Work) for insuring workers against occupational accidents on a voluntary basis (a public body)
1898	80	The imposition of the compulsory insurance for the occupational accidents to all industrial enterprises (initially limited to male workers and subsequently extended to women and young workers)
1906	380	The creation of the “ <i>Ispettorato del Lavoro (IL)</i> ” (Inspectorate of Labour), a public body of labour inspectors, under the direction of the Ministry of Labour
1927	530	The creation of the “ <i>Medico di Fabbrica</i> ” (Factory Doctor), i.e., the company medical doctor, and the compulsory periodic medical examination for each worker to ensure the protection against hygiene risks – compulsory for all companies
1933		The merge of the “ <i>Cassa Nazionale di Assicurazione per gli Infortuni degli Operai sul Lavoro</i> ” with some private insurance companies into the “ <i>Istituto Nazionale per l'Assicurazione degli Infortuni sul Lavoro (INAIL)</i> ” (National Institute for Occupational Accident Insurance – a public body) – compulsory for all workers
1942	262 Civil Code, art.2089	The imposition to the entrepreneur “to prevent workers from occupational health diseases and accidents and protect their physical integrity and the moral personality”

accidents at work. Insurance for occupational accidents and diseases became compulsory for all companies on 1898 with the introduction of Law no. 80. This insurance from the 1898 till 1932 was stipulated with the “*Cassa Nazionale di Assicurazione per gli Infortuni degli Operai sul Lavoro*” (National Insurance Fund for Workers’ Accidents at Work), and from 1933 onwards (up until today) with the “*Istituto Nazionale per l’Assicurazione degli Infortuni sul Lavoro (INAIL)*” (National Institute for Occupational Accident Insurance), which is a public body.

In 1927 it became compulsory for all companies to create a competent medical doctor function (either internal or external, at the company’s discretion) which was charged with the periodic medical examination of each worker to prevent hygiene risks.

As far as the knowledge, skills and competences are concerned, throughout the entire Italian economic development and up until the end of World War II, the HSE technicians, working both in the private and public sector, were primarily focused on the prevention of major accidents¹ and diseases, and trained to do so. Their knowledge, skills and competences were then almost exclusively of a technical nature and primarily focused to prevent mechanical, electrical, fire and explosion and health-related risks. Of the HTO-related knowledge and skills they primarily developed the technological- and human-related aspects, limiting their approach to the organisational side of the risk to a tacit, heuristically-based approach (informally handed on and learnt on-the-job over years). More specifically, the health-related knowledge and skills were limited to the occupational hygiene part and both the ergonomic (cognitive and anthropometric) and psycho-social aspects (i.e., stress and wellbeing) were completely ignored. Further, the skills in applying HTO knowledge and skills, as well as in using the available tools, were specific and limited to the extent necessary to solve the problems of the company where the single technician was employed as the mobility was very low (i.e., the labour market of HSE professionals was substantially absent). Factory doctors in this respect made an exception as, since from the beginning, they have met almost all of the elements that characterise a profession, namely:

- The possession of a Master Diploma (of 2 years);
- Success at the compulsory state examination for professional qualification;
- Registration in the national professional register (subject to the acceptance of deontological rules).

The professional register simplified and fostered the sharing of experiences and innovations, thus allowing them to be specialists with a deep, wide-ranging and up to date technical knowledge. Their status of experts in the prevention and treatment of hygiene and occupational diseases was widely recognized in private companies as well as in public institutions.

In 1946 Italy transformed from a kingdom into a republic and that change, thanks to the precepts introduced by the constitution, benefited (at least from a legislative standpoint) even the quality of workplaces.

Table 3 summarises the main labour-related Laws that were introduced in Italy after the transformation of Italy from a kingdom into a republic.

The practical effect of the legislation on the prevention of health-related risks was extremely disappointing. In the twenty years after the World War II Italy experienced an economic boom. And in that same period, Italian companies recorded some 23 million injuries and 82.000 deaths, namely 4.000 deaths per year, which translates into an average of more than 18 deaths per day (on a 220 working days/year basis of

calculation).

With hindsight, the main limit of the legislation has been the lack of inclusion of workers’ rights in the prevention of risks. In addition, the activity of the public inspectors in the three HSE areas was weak as:

- The number of field inspectors and the financial resources to control systematically Italian companies were inadequate to cope efficiently with the negative health and safety situation of Italian companies;
- The inspection approach was repressive as the non-compliances were filed as criminal penalties and a criminal trial automatically activated (inspectors were, and still are, judicial policemen).

The increase of sanctions did not cause immediate criminal trials, due to the bureaucracy of the Italian justice system. Sanctions, especially those of mild severity, were “parked” in a limbo of the Criminal Court and, in many cases, the criminal trials exceeded the expiration time specified for that type of offence and consequently the occupational crimes went unpunished.

As a result, the behaviour of companies was to concentrate their own efforts on the formal (paperwork) demonstration that all HSE aspects were appropriately dealt with and compliant with the Law(s) (i.e., hiding their HSE problems behind formally impeccable HSE reports instead of requiring help and support to the authorities to correct them). In short, the repressive approach contributed only in a (very) limited way to the prevention of risks (of all types) in Italian companies.

Besides, despite the fact that the legislative framework was sufficiently developed to induce companies to devote part of their attention and efforts to the prevention of risks, a prevention culture was anything but flourishing at the time, as was demonstrated by the fact that entrepreneurs and top managers made risk prevention subordinate to the production imperative. To demonstrate this approach, the policy widely adopted by companies was to monetize workers’ health: their salary was proportional to the workers’ risk exposure level (i.e., the job held). This policy was enshrined by national collective contracts of employment that explicitly mentioned the amount of the salary meant to cover the risk faced by the worker (Onofri, 1955; Addaria, 1976). Point 1 of Italy’s national collective workers’ labour agreement operating in the chemical industry provides an example: “workers assigned to harmful, dangerous and burdensome works will be paid with a special allowance, proportionate to the harmfulness, dangerousness and burdenomeness of working conditions” (Contratto nazione di lavoro dei chimici, 1947). The concrete application of the monetization of workers’ health resulted in dividing chemical workers into three groups, each of them paid with a specific risk-related allowance, namely: 12 Italian lira per hour for group 1; 7 Italian liras for group 2; 5 Italian liras for group 3. In this context, the role and importance of HSE technicians and factory doctors were undervalued and they were underemployed. Their business function was limited by entrepreneurs and managers to the formal (paperwork) demonstration that all HSE aspects were dealt with in compliance with the Law(s). For this reason, the HSE professionals played their roles by emphasising a technical approach and secondary prevention,² i.e., they used their safety and occupational medicine competencies as social control tools of the work environment.³

While the aforementioned approach was preferred by the vast majority of companies (especially SMEs), in the same period a counter-trend was about to start up by a restricted number of large Italian companies that set up voluntary health and safety services operated by full time technicians whose activity was, primarily, to check both the safety of machines and the health and hygiene of workplaces (albeit

¹By “major accidents” is meant those industrial accidents involving dangerous chemicals and posing a significant threat to humans and the environment, causing huge economic losses and disrupting sustainable growth. Put differently, the major accidents are those meant to be prevented by the European Directive 82/501/EEC.

²Please refer to the distinction between the primary and the secondary prevention in the definition explained later on in the manuscript.

³By “social control tools of the work environment” is meant the use of occupational data (produced by the safety technician and the factory doctor) to influence company decisions and behavior to improve the working conditions.

Table 3

Main safety & health laws of the Italian republic: 1946–1966.

Year	Law number	Content
1947	The Italian Constitution Art. 41	“The business activity can't be managed in contrast with the social values and security, or to cause damage to the human health, safety, freedom and dignity”
1955	547	Technical standards to protect machines and Personal Protective Equipment (PPE)
1964	185	The first Law transposing the European Directive 96/29, and ruling the protection of the health of workers and the general public against the dangers arising from ionizing radiation and defining the duties of the “competent medical doctor”

strictly in compliance with the Law).

At the time these technicians held a medium level of qualification⁴ (and remuneration) and their role was in the staff line, under the hierarchical authority of either the Production or the Human Resources Director.

The reaction of workers to the aforementioned unsafe working conditions was tough and the trade unions struggled to face the requests of workers to have healthier and safer working conditions, as well as to refuse the monetisation policy of paying for risk exposure. The result of the social conflict was the disruption of the previous, traditional approach towards risk prevention that favoured the technical perspective and the unilateral intervention of company's HSE experts, excluding any contribution of the workers.

The rationalisation of the workers' experiences is summarized in the following four “principles”:

- (1) Health is not for sale, namely: the production technologies and processes are to be designed and operated with respect for workers' health and safety;
- (2) Primary risk prevention (proactive), based on direct observations by workers about the dangers and harmfulness of their work environment, is to be preferred to secondary risk prevention (reactive)⁵; the primary risk prevention is managed by “*Gruppi Omogenei*” (Homogeneous Groups) of workers exposed to the same risks in the work environment;
- (3) Workers cannot delegate risk prevention unrestrictedly to HSE professionals (i.e., the RSPP), to the competent medical doctors and, more generally, to any experts;
- (4) Health and safety are not only individual but also collective rights. The risk analysis must favour the group of workers exposed to same risk(s), the so-called “*Gruppo Omogeneo*”⁶ (Homogeneous Group).

The application of these principles allowed the approach to risk analysis to change and to include workers' viewpoints and experience (“direct observation”), thus enriching and widening the perspective and stimulating the creation of new research approaches and tools.

Direct observation was based on four homogeneous groups of workers, namely:

- Group 1 was monitored according to the general harmfulness of the working environment: temperature (too hot, too cold), light, humidity, noise, and ventilation exposure;
- Group 2 was monitored according to the specific harmfulness of the working environment: gas, dust, vapour, vibration and radiation exposure;
- Group 3 recorded the muscle-related fatigue required by the work

activity;

- Group 4 recorded the “*fatica industriale*” (industrial fatigue), i.e., the work-related stress, required by the working activity⁷;

Data obtained through direct observation by the homogenous groups were recorded in:

- “*il registro dei dati ambientali*” (the register of environment data) which reported all data for each working area and harmful factor;
- “*il registro dei dati biostatistici*” (the register of biostatistical data) which reported all data on workers' health, included those recorded by the “*medico competente*” (competent medical doctor) (Righi, 1992).

The objective, factual approach was integrated by the worker-centred, subjective approach in analysing injuries and work-related stress and wellbeing. Amongst the new tools created by competent medical doctors from workers' experience to satisfy workers' requests were toxicological sheets, environmental investigations, and targeted health checks. Their application led to the standardization of the methodologies for risk investigation amongst competent medical doctors.

Workers claimed their right to participate both in analysing and inspecting the production processes and the labour organization to identify embedded and cross functional risks. The results of the risk analyses were required to be submitted to the discussion and to the so-called “*validazione consensuale*” (consensual validation) of the assembly of all company workers (Berlinguer, 1973).

Experiences of the fights of workers for their health were reflected in the law no. 300/1970 (see Table 4). Thanks to that law the monetization of risks was eliminated, and health and safety became matters to be negotiated in the national labour agreement by trade unions with entrepreneurs (Briante, 1977).

The company was forced by Law to keep, for each employee, both the “*libretto individuale di rischio*” (individual risk book) and the “*libretto sanitario individuale*” (individual health book).

The HSE principles, rationalised by workers to protect their health and safety, were in line with the European Directive 89/39/EEC on “*The introduction of measures to encourage improvements in the safety and health of workers at work*”. The introduction of this Directive was justified as the numbers of occupational accidents and diseases were still too high and their social and economic costs were too high to be accepted both by European society and the enterprises at large (as their competitiveness would have been put at risk).

The two main objectives to pursue set by the European Commission's action framework, for the period 1994–2000, were as follows:

- Ensuring that workers were protected from risks of occupational accidents and diseases;

⁴ By “medium level of qualification” is meant the possession of a high school diploma.

⁵ By “primary risk prevention” is meant a proactive approach, whose action (i.e., the definition and implementation of preventive measures) is guided by weak signals, i.e., by leading indicators, and not by negative, factual results (i.e., accidents and injuries) as is the “secondary (reactive) risk prevention” approach.

⁶ The “*Gruppo Omogeneo*” (Homogeneous Group) is the group of workers exposed to the same risk(s), although they cover different jobs in the company.

⁷ A vivid example of the “*fatica industriale*” (industrial fatigue) is reported in the diary of Simon Weil (1965), during his work experience at the Renault Factory, where the work was organised on the basis of Taylor's scientific management principles.

Table 4
Main safety and health laws of the Italian republic: 1970–2018.

Year	Law number	Content	Dealt with by
1970	300, art.9	<i>“Worker have the right to control the application of norms for the risk prevention of occupational injuries and diseases through their labour union representatives. Workers have the right to promote applied research and tools to protect their health and physical integrity”</i>	● Unions' Representative (not yet the RLS – see table 5)
1978	833	The health care reform establishes that health is a fundamental social right of each citizen. The reform assigns to each Italian Region the occupational injuries and illnesses prevention and the control of the compliance to norms by enterprises through its <i>“Azienda Sanitaria Locale (ASL)”</i> (Local Health Authority) and its <i>“Servizio per la Prevenzione e la Sicurezza negli Ambienti di Lavoro (SPSAL)”</i> (Service for the Prevention of Occupational Health and Safety).	
1988	175	The Law transposes the European Directive 82/501/CEE (known as Seveso Directive) on relevant human and environmental risks (i.e., known as major accidents)	● HSE technician (who, in contrast with the HSE professional – i.e., the RSPP profile, had direct civil and criminal liability)
1990	142	The Law establishes the <i>“Agenzia Regionale per la Prevenzione Ambientale (ARPA)”</i> (Regional Agency for Environmental Protection), the Regional Agency (one for each of the 19 Italian Regions ¹) for the prevention and control of environmental risks	
1991	277	The Law transposes a set of European Directives and revises the medical doctor role (i.e., the Factory Doctor) and requiring a 4 years specialisation on Occupational medicine, thus transforming the Factory Doctor into the <i>“Medico Competente”</i> (Competent Medical Doctor)	
1994	626	The Law transposes a set of European Directives that establishes the fundamental criteria to organize the risk prevention in private companies. The Law established the new role of HSE technician, the so-called <i>“Responsabile del Servizio di Prevenzione e Protezione (RSPP)”</i> (Head of the Prevention and Protection Service)	
1995		The voluntary Eco-Management and audit Scheme (EMAS) of the European regulation n. 1836/1993 entered definitely into force	● HSE Professional (i.e., the RSPP)
2006	152	The (reorganizational) Law complying with all the European Directives on environment regulation from 1975 to date and reorganising Italy's environmental legislation	● HSE Professional (i.e., the RSPP)
2008	81	The Law improves and strengthens the previous 626 norm and the organization of HSE prevention. It defines clearly the roles of all actors involved in the company, including the HSE professional (i.e., the RSPP) and the competent medical doctor	● HSE Professional (i.e., the RSPP) ● Competent Medical Doctor
2008	133	The Law establishes the <i>“Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)”</i> (Higher Institute for Environmental Protection and Research). The aim of ISPRA is: to coordinate the action of all 19 regional ARPA; to be the Italian link of the European Environment Agency (EEA) and to support the <i>“Ministero dell'Ambiente e della tutela del Territorio e del Mare”</i> (Italian Ministry of the Environment, Soil and Sea Protection), with its research and monitoring activities.	
2011	231	The Law establishes the new independent collective role of the <i>“Organismo di vigilanza”</i> (Surveillance Body), an independent body internal to the company, responsible to audit the company organization of risks prevention and its compliance with the HSE legislation	● Surveillance Body

¹ The Italian Regions are 20 but when it comes to the HSE aspects the Trentino-Alto Adige Region is substituted by the two autonomous provinces of Trento and Bolzano.

- Preventing that the health and safety of workers be jeopardized by the free movement of goods and people.

The transposition of the European Directive 39391/89/EEC was formalized into the two Laws no. 626/1994 and no. 81/2008 (Table 4).

The Law no. 626 introduced a paradigm shift (it was a shock for entrepreneurs and employers), to the role and, above all, the associated responsibilities of the HSE technician. Actually, before the introduction of the Law no. 626 the HSE technician was, as head of the HSE aspects, responsible for all HSE-related (negative) effects the production system would have had on the workers, the society and the environment (i.e., for all the effects of non-market risks). With the introduction of the Law no. 626, the HSE technician transformed into the RSPP (Head of the Prevention and Protection Service), i.e., an HSE professional, that, contrary to its misleading title, was not responsible anymore for the HSE-related (negative) effects of the company as the responsibilities were transferred (with possibility of delegation) directly to the entrepreneur and/or the employer (today it is still so). Thus, looking at the HSE profile from the ENSHPO perspective, both the HSE technician and the HSE professional (meant as RSPP) were head of the HSE function, with the significant difference that the former was liable for the HSE-related (negative) effects on workers, society and the

environment and the latter was not anymore (despite preserving its role as head of the function).⁸ As will be explained later on in this manuscript, Law no. 626 transformed the HSE technician into an HSE professional in the sense it transformed the HSE expert from a role of responsibility to that of consultancy (still compulsory). The legislator made this choice to stop the opportunistic behaviour (i.e., the bad practice) of bad entrepreneurs and employers to resort to the scapegoat model (Bonazzi, 1983), assigning the responsibility of HSE aspects to HSE technicians without giving them a sufficient budget to prevent HSE risks, thus transforming the role of the HSE technician into that of a scapegoat for the company's HSE inefficiencies, behaviour that resulted in criminal convictions of some HSE experts instead of those who had real responsibility (i.e., entrepreneurs/employers and top managers).

Table 5 summarises the legislative norms that reflect the heritage of trade unions' struggles on the health and safety risk prevention.

The tough reaction of workers' trade unions towards the risk prevention approach has had a relevant impact on HSE technicians.

⁸ More precisely the liability of the HSE professional (i.e., the RSPP) still hold but only for negligent behaviour.

Table 5
Workers' health and safety rights granted by the Italian legislation.

Law No.	Rights gained
– 626: art. 19 – 81: art. 47–48–49–50	The right to be represented: the new role of the “ <i>Rappresentante dei Lavoratori per la Sicurezza (RLS)</i> ” (Workers Representative for Health and Safety) Workers are entitled to elect their health and safety representatives (RLS) (their number varies according to the size and nature of the company). The RLS performs two functions: <ul style="list-style-type: none"> • Cooperates with the entrepreneur regarding the risk evaluation, the safety plan, the training courses, the choice of the HSE professional(s); • Monitors health and safety conditions of workplaces and the health surveillance plan.
– 626: art. 21 – 81: art. 36	The right to be informed about health and safety aspects. The entrepreneur/employer is obliged to inform employees about: <ul style="list-style-type: none"> • General and specific risks of the workplace; • Procedures regarding first aid, firefighting, and evacuation from workplaces; • The organization of the safety unit and health surveillance.
– 626: art. 22; – 81: art. 2, 37, and 51	The communication of the data required by the Law (i.e., health and safety statistics and relevant risk data) must be provided by the entrepreneur and shared with the RLS in the “ <i>Riunione Periodica</i> ” (Periodical Health and Safety Meeting), at least once a year. The right to be trained on health and safety aspects. The entrepreneur/employer must ensure a sufficient and adequate health and safety training to each employee (including the RLS) when s/he is hired or required to change role, as well as when new technologies are introduced. The health and safety training must be regularly updated according to the State-Regions agreement (see Table 6). A new joint body, the so-called “ <i>organismo paritetico</i> ” (Joint Body), made up of trade unions and entrepreneurs' associations representatives (at regional level) is to be created. The Joint Body is entitled to: <ul style="list-style-type: none"> • Design and deliver health and safety training courses; • Collect the best health and safety practices and disseminate them within the companies; • Solve controversies regarding the correct application and protection of health and safety information and training rights.

4. The influence of the legislation on the organisation of risk prevention

In 1970 they founded in Milan, on a voluntary basis, the first Italian association named “*Associazione Italiana fra Addetti alla Sicurezza (AIAS)*” (Italian Association of Safety Employees), which lately changed its name to “*Associazione professionale Italiana Ambiente e Sicurezza (AIAS)*” (Italian Professional Association for Environment and Safety). Its statutory model was derived from the existing professional associations in countries with a long and advanced industrial tradition such as the United States and the United Kingdom. The mission of the Association was (and it still is today) to improve the HSE competencies required by the complexities of business and so to turn technicians into HSE professionals. AIAS is aware that professionalism is the essential source of organizational identity and the independence of its associates in the enterprises.

The technological innovation required to broaden the technical HSE competencies from the knowledge and skills concerning the interaction between machines and the individual behaviour of workers to a much broader understanding of the risks associated with the technological processes and their potential social and environmental consequences both within the company perimeter and outside the company perimeter (so-called major accidents).

The increase in the Italian HSE legislation, influenced by the increasingly frequent regulations created by the European Commission, has required technicians/professionals to have a complete knowledge and a continuous update of the legislative framework, as well as the adaptation of the skills necessary to apply the precepts stemming from the new regulations, and then to interpret their application to the specific working environment of the company.

Since the beginning the main activity of the AIAS association has been the technical and legal education and training of its members, the majority of whom still hold only a high school diploma. AIAS's approach has initially neglected the behavioural and organisational aspects.

Laws no. 626, 81 and 231 defined the latest competency requirements by HSE professionals (i.e., the RSPP). Currently, they are expected to be made up of the knowledge and skills necessary to design and manage a “*Sistema di Gestione della Sicurezza sul Lavoro (SGSL)*” (Occupational Safety Management System) in order to make it compliant with the prevention principles and organizational requirements of Laws no. 81 and 231.

The prevention principles in the mind of the legislator and underlying these two Laws are as follows:

- The improvement of workers' health improves the economics of enterprises and the public finance;
- The protection of workers' health must be a value of all company cultures;
- Risk prevention must be on a professional dimension and be an organizational responsibility of managers and supervisors;
- Risks must be identified and evaluated technically and economically; their elimination must be planned jointly with the planning and designing of the business activities;
- Risk prevention is a both a multidisciplinary and interdisciplinary process that must be shared with the participation of workers.

According to the aforementioned Laws the SGSL must define and formalize:

- The responsibilities of all role- and function-holders who form the structure of the company, namely: entrepreneurs, managers, supervisors, workers and their HSE representatives;
- The procedures that rule the working activities in such a way that the HSE precepts are respected;
- The identification and evaluation of risks and the plan to eliminate them, formally called “*Documento di Valutazione dei Rischi (DVR)*” (Risk Evaluation Report);
- The analysis of the HSE training needs of employees and the associated training plan to satisfy them.

For HSE professionals (i.e., the RSPP) designing the SGSL means:

- To integrate HSE responsibilities into the existing job descriptions managed by the HR manager;
- To formalize HSE procedures, adopting the ISO 45001:2018 standard (or the Italian UNI-INAIL guidelines, which are based on it) and the ISO 14001:2015 standard, and supporting the integration of the existing procedure into the quality control process (as required by the UNI EN ISO 9001:2015).

This organizational knowledge and the related skills should be used by the HSE professionals (i.e., the RSPP) to advise the entrepreneur and his first line of managers. As anticipated earlier in the manuscript, the

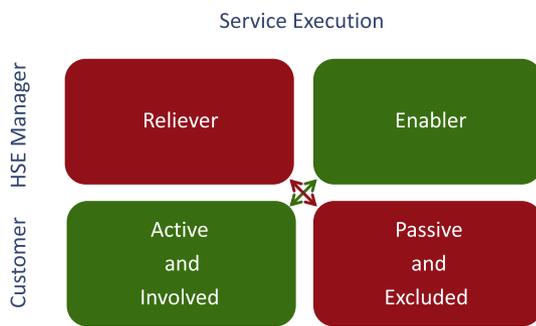


Fig. 2. The reliever vs. enabler profile as per Normann (1984).

role of the RSPP is defined by the Law no. 81 as a consultant and not as the responsible person (as it was before, with the previous Law(s)). The new role of the HSE professional underlines that his authority is based only on his multidisciplinary/interdisciplinary professionalism that can be improved thanks to the existence of an adequate “market” and offer of HSE education and training.

More specifically, as far as the organisational dimension is concerned, Law no. 81 defines the HSE professional as a consultant to the entrepreneur, his managers and supervisors. Yet, it leaves discretion to decide:

- Where to place the HSE unit and its professionals in the organizational structure;
- How to design the RSPP role and, consequently, to define competencies required of the role’s holder(s).

Italian companies have mostly chosen to design a staff unit, the Health, Safety and Environment (HSE) Service to advise on the prevention and management of HSE-related risks. This organizational choice is in line with the one adopted by the majority of European companies that, in some cases, include in the unit even the quality activities and, in some exceptional cases, even the security activities (the QHSSE area). Indeed, the integration of the QHSSE model, given that QHSSE activities all have the same objective, i.e., preventing non-market risks and their social costs, might turn out to be significantly more efficient as it benefits from (potentially significant) economies of scale. Furthermore, QHSSE prevention processes are cross functional, involving all company activities, and potentially conflicting with them, if dealt with in isolation from one another (as might easily happen for safety and security aspects).

The most crucial problem in designing the (Q)HS(S)E prevention system to cash in on the benefit from the desired economies of scope associated with the reduction of costs) lies in its integration within other existing operating systems. Particularly, this is true for:

- The performance appraisal system to include (Q)HS(S)E responsibilities for all roles’ holders;
- The budgeting system to allocate financial resources to plan technical-economic activities to eliminate and prevent risks;
- The training system to include prevention risks and (Q)HS(S)E courses for all relevant employees.

The integration is a challenging activity because the aforementioned operating systems are managed and under the responsibility of the HR manager and the Controller. These roles have demonstrated in the past their managerial nature and their importance for the business. Yet, according to the research experience of the authors (Casai et al., 2018), they have demonstrated their reluctance to modify their operating systems and to share their responsibilities with the (Q)HS(S)E professional(s).

Law no. 81/2008 forces the entrepreneur to organize the internal HSE unit by hiring an HSE professional as a full time RSPP with a

permanent labour contract, if the enterprise runs specified risks (listed in art.31) or it is above a certain size (i.e., more than 200 employees). In all other cases, the Law offers three alternatives to organize the HSE units. The first one is the same as the compulsory one, i.e., hiring an HSE professional as permanent staff, but as a voluntary action of the entrepreneur. The second alternative is to buy HSE consultancy services from an external HSE professional who must be appointed as an external part time RSPP. This choice is compulsory when the entrepreneur doesn’t hold HSE skills and competencies (which is a typical situation for SMEs). This second alternative can be achieved also by a pool of enterprises that agree to externalise their HSE competencies to an external professional; in this case each company has to sign its own independent contract with the chosen HSE professional. The third alternative is devoted to SMEs with less than 5 employees: in this case the entrepreneur can be the job holder of the RSPP role and, in doing so, he is forced to attend the compulsory training courses designed for the role.

As far as the consultancy dimension of the HSE role is concerned, and with respect for the service management literature (Gronroos, 2000), the HSE professional/manager role can be designed in two radically different ways, namely: the reliever or the enabler consultant for HSE services (Normann, 1984) (see Fig. 2).

The HSE professionals are reliever consultants when they provide specialized HSE solutions and services to their internal clients based on their expertise. The professional behaviour and attitude in the provision of the service to these internal clients can either be proactive or “on demand”. The strong point in favour of the reliever approach is the provision of efficient solutions by deeper experts. The weak point is the minimal involvement and participation of its internal clients that lead to two consequences:

- The lack of HSE learning by those who are exposed to the risks and, as a consequence, their (unconscious) dependence on the HSE reliever for all their HSE duties. The dependency causes the rapid fall of in requests for support, because managers, supervisors and operators do not develop the knowledge and skills to identify risks, thus rapidly tending to behave in a non-HSE-oriented way;
- The delay both in building a sound and common HSE culture at company level and in the mindful acceptance of HSE responsibilities by the entrepreneur, managers, supervisors and workers.

On the other hand, the enabler consultancy “co-produces” risk prevention with its internal clients. The strong points in favour of the enablers are as follows:

- The (faster) growth of a common HSE culture at company level;
- The participation of and co-production by employees in the prevention of risks and the mindful acceptance of HSE responsibilities, especially by those holding managerial roles.

The weak (organisational) point is that some HSE activities, such as the monitoring of the compliance with the HSE procedures and behaviours, are responsibilities which cannot be shared between the HSE function and its internal clients.

From the standpoint of the authors, the enabler approach is preferable as it fosters the growing of a mature HSE culture. Yet, given the weak point of this approach, a possible organisational solution is to ask the HSE professional to adopt a “double hats” approach, namely:

- To behave as reliever when HSE problems at stake are regulated by the Law or for those problems for which specific technical and/or legal competencies are required;
- To behave as enabler in all other cases especially when it is necessary to create an interdisciplinary approach centred on the internal client and aimed at fostering a mature HSE culture).

To gain a managerial status in the company and be efficient, the HSE unit ought then to be managed in a hybrid way, namely: with a reliever approach when it comes to non-shareable activities (such as the audit and compliance activities), and with an enabler approach when it comes to shareable activities (such as the consultancy to search for the best solutions). This organizational choice is the best to build a common HSE culture and, in turn, will assure more efficient HSE behaviours and results.

Broadly speaking, Italian RSPPs are (still primarily) playing the role of the reliever for the following reasons:

- Professional competencies held are mainly legal and technical ones;
- The reliever is the role that gives a professional identity consistent with those of colleagues operating in the functional organizational form (which is the one most adopted by Italian companies), based on the division of labour based on technical competencies;
- The reliever is also the role more consistent with the criminal liabilities established by Law no. 81/2008. This law defines the RSPP as a consultant whose criminal liabilities are only professional ones (lack of competence/experience, negligence, and disregard of safety laws), while in the case of an injury and/or a death, the sole criminally responsible is the entrepreneur/employer. The RSPP is criminally liable only “if the injury/death is objectively due to a dangerous situation that the RSPP should have the obligation to know and communicate to the entrepreneur/employer” (as per the sentence of the Criminal Court “*Cassazione Penale, sez IV 27/01/2011n. 2814*”).

In short, the knowledge and skills of the HSE managers, as well as those of the HSE unit, are to be (come) those of the (traditional and well known) managerial roles (and units), namely:

- To plan and to control a process to get specific objectives;
- To speak the same business language;
- To negotiate for resource allocations and for “do what, for what” agreements;
- To economically measure activities;
- To co-produce HSE services (and find the best HSE solutions) with internal clients by putting themselves in their clients’ shoes to understand their problems.

5. HSE education and supply of services

The education standard to start an HSE professional (RSPP) career has been set higher from 1994 (Law no. 626) to 2008 (Law no. 81), transforming the requirement from the possession of a high school diploma into that of a university bachelor’s diploma. Since 2011 the Italian State and its Regions have agreed to define compulsory courses that entrepreneurs, managers, RSPP, workers and their RLS representative must attend in order to be compliant with the requirements of Law no. 81 and to give concrete form to workers’ rights to HSE information and training. The agreement, the so-called “*Accordo Stato-Regioni*” (State-Regions Agreement), was updated in 2016. It regulates the contents of compulsory HSE courses for HSE professionals; their length, updating process, and certification and the authorization to be an HSE training provider. The HSE specialist becomes an HSE professional (i.e., an RSPP) after having passed Modules A and B, the specialising course (depending on the domain), and, finally, Module C. In short, to become an HSE professional, i.e., an RSPP, the following length of courses are required, varying between 136 h (for the healthcare services, i.e., 28 h + 48 h + 12 h (healthcare services) + 24 h) and 142 h (for the mining and building sector, i.e., 28 h + 48 h + 18 h (mining and building) + 24 h)

Further, the HSE professional has to go through 40 h of compulsory training, over a period of every 5 years, to maintain the certification.

Table 6 summarises the plan of compulsory courses for HSE

professionals (RSPP). It shows that for the Italian legislator the HSE professional role (i.e., the RSPP) must have both technical and relational competences. It is a valuable and ambitious approach, but it is complex to pursue. In practice, Italian companies tend to emphasise the technical competences to manage HSE aspects.

Providers of compulsory and voluntary courses on risks prevention are both public and private entities. Public providers are: Ministries of Labour, Interior, Health, and Economic Development; the INAIL; the regional health prevention local units (SPSAL); the Italian public management school; universities’ departments and universities’ business and doctoral schools. Overall, Italy’s business schools offer 15 Masters in safety specialization; but only one in safety management (i.e., the one offered by the “*University of Modena and Reggio Emilia*”).

Private companies (consultancy and training ones) must meet specific HSE professional standards and must have field experience to be authorized by a single Region to provide HSE compulsory courses to companies. Private companies provide also consultancy HSE services, methods and tools for a complete and adequate risk prevention within companies.

Besides, there are 2 further actors, that are neither private companies nor public institutions, which play an important role in the overall HSE framework. These are the two main non-profit HSE professional associations AIAS and AIFOS,⁹ on the one hand, and on the other hand the “*Organismi Paritetici*” (Joint Bodies), which are “joint ventures” between companies and workers’ unions (in the majority of economic industries) established by law no. 81 (Table 5).

The Associations of HSE professionals (AIAS and AIFOS) offer HSE courses for their associates in addition to their activities to protect and develop HSE professionalism among their associated members.

The “*Organismi paritetici*”, raise funds from (and for) their workers and company members to finance compulsory or voluntary HSE courses for managers and workers. The contents of the courses are focused on the prevention of all (HSE-related) risks and they satisfy the full range of education and training needs of HSE professionals. The market also provides consultancy services, methods and tools for a complete and adequate risks prevention within companies.

The driving force for the fast growth of HSE education and training, as well as for the development of HSE services market to satisfy companies, are 3 specialized fairs (“*Ambiente e Lavoro*”, “*Safety Expo*”, and “*Ecomondo*”), 3 safety magazines (“*Ambiente e Sicurezza*”, “*Ambiente e Lavoro*”, “*Quotidiano Sicurezza*”) and some 10 business publishers that offer specialized books on risk prevention and safety management.

6. From the HSE professional to the HSE manager

The aforementioned explanation of the Italian evolution of the HSE system may be better appreciated by looking at the quantitative indicators regarding accidents and deaths caused by unsafe working conditions. Table 7 shows the accident and mortality rates, recorded by the observatory “*Osservasalute*” of the Milan’s “*Università Cattolica del Sacro Cuore*”, for the period 2000–2016.

These numbers confirm the progressive reduction of accidents and deaths in the Italian working context. Actually, in the sixties and seventies of the past century, accidents were 1.5 million. In the eighties and nineties of the same century, they decreased down to 900.000–1.000.000. Further, occupational deaths were 4.000 per year in the sixties and nowadays are slightly above the 1.000 per year; in 2016 the recorded figure by the INAIL was 1016 deaths (INAIL, 2017),

⁹ AIFOS is the “*Associazione Italiana Formatori ed Operatori della Sicurezza*” (Italian Association of Trainers and Safety Operators). AIFOS, similarly to AIAS, is a regulated professional group association that carries out training and consultancy HSE services and issuing the certificate for the “*Qualità e qualificazione professionale dei servizi prestati dall’associato*” (Quality and professional qualification of the services provided by the member).

Table 6
Compulsory HSE courses for the HSE professional.

Courses	Contents	Length
Mod. A	The basic knowledge of risk prevention and HSE legislation	28 h Total
A1	The knowledge of risk prevention and HSE legislation (Law no. 81/2008)	8 h
A2	The Knowledge of the institutional risk prevention and control systems: public actors and their functions	4 h
A3	The process of risk prevention in the enterprise	8 h
A4	The HSE organization in the company: risk evaluation, emergency management, health surveillance	4 h
A5	The knowledge of HSE information and training rights and their concrete application	4 h
Mod. B	Risk evaluation and prevention techniques (minimum contents)	48 h Total
B1	Specific risk evaluation techniques and injury analysis	
B2	Environment and workplaces	
B3	Fire-fighting and emergency management	
B4-B5	The typology of injury risks	
B6	Ergonomic and organizational related risks	
B7	Psychological-social risks (work-related stress, burn-out, mobbing)	
B8	Physical agents	
B9-B10	Chemical, carcinogenic, mutagenic and biological agents, asbestos. Risks related to narcotics, psychotropics and alcohol	
B11	Risks related to particular activities (enclosed workplaces, roadside activities)	
B12	The safe organization of the production processes	
Mod. B	Specialization sessions in addition to Mod. B (minimum contents)	.
SP1	Agricultural and fishing industries risks	12 h
SP2	Mining and building industries risks	18 h
SP3	Healthcare services risks	12 h
SP4	Chemical and Petrochemical industries risks	16 h
Mod. C	Basic organizational and relational competences	24 h Total
C1	HSE information and training design competences	8 h
C2	HSE integrated organizational systems (ISO 9001-14001, ISO 45001:2015, ISO 14001:2015)	8 h
C3	Relational and communicational system with HSE stakeholders (RLS, Trade Unions, competent medical doctor, HSE inspectors, etc.)	4 h
C4	Organizational wellbeing (safety culture, wellbeing, team building)	4 h

Table 7
Average of accidents¹ and mortality rates for 100.000 workers.
Source: “Osservasalute”.

	2000–2005	2006–2008	2009–2011	2012–2016
Accident rate	5.56933	4.59742	4.40038	3.0540
	2014	2015	2016	2017
N. of accidents	663.627	637.199	636.812	635.433
	2000–2005	2006–2008	2009–2011	2012–2016
Mortality rate	7.85	6.07	5.53	5.73

¹ Requiring worker’s absence from workplace for more than 3 days.

which translates into an average of more than 4.6 deaths per day (on a 220 working days basis per year). Certainly, the figure is far better than the one recorded in the sixties of the past century; yet the death toll is still embarrassingly high as every single occupational death (and invalidating injury) ought to be simply seen and perceived as unacceptable. This inadequate situation is confirmed by the comparison with the European situation depicted in Fig. 3, which highlights that Italy is still significantly above the EU-28 average.

More precisely, according to Eurostat, in 2015 Italy has recorded an incident of 2.42 per 100.000 person employed against an EU-28 average of 1.83.

Empirical research on accidents and injuries at the workplace (made by the Ministry of Labour, INPS, Trade Unions, as well as research centres) explains the still negative situation from two different perspectives.

The technical explanation is based on safety statistics. It classifies Italian companies into three categories:

- Outlaw, “black” companies that do not observe HSE norms, pursuing an opportunistic behaviour and an unfair competition based on cost savings, the inefficiency of the inspection system, as well as tax evasion. The most dangerous industries in Italy are the

agricultural and the building companies where the small companies (no more than 15 employees) are the majority and they work in outsourced activities;

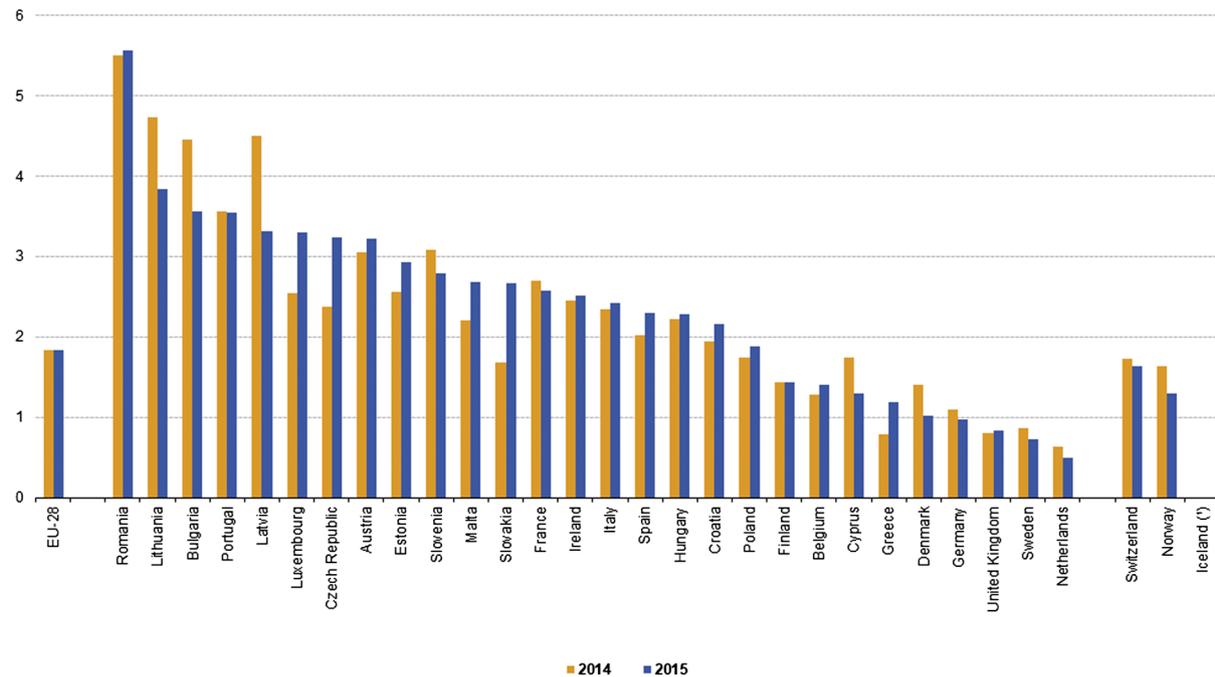
- Bureaucratically compliant, “grey” companies that formally observe HSE norms, but are not able to efficiently prevent risks;
- Mindful, “white” companies that consider the risk prevention and, more specifically, the HSE area as a business activity to be managed (to get an efficient HSE performance) according to the same criteria as the production and sales activities.

The socio-technical explanation goes beyond figures. In general, it assumes organizational risks are the driving determinants of the bad HSE performance of Italian companies. Five organizational risks explain the majority of injuries:

- The low working experience of young employees when it is not balanced with adequate training;
- The mental workload of workers due to digital interfaces that operate at high speed and require fast reaction which is not prevented or mitigated with an ergonomic design of the workplace;
- The emphasis on the technological imperative in ruling human–machine interaction that imposes the need for a diligent, but also an uncritical, behaviour based on following procedures;
- The refusal to consider non-work-related elements (such as the amount of time to reach the workplace, the personal family habits) as contributors to unsafe behaviour at the workplace.

The common feature underlying the two approaches is the cultural model of the company leadership: the entrepreneur for the SME; the top manager and CEO, for the large and public company. Feng (2013, 2014) has empirically demonstrated that a strong safety culture related to companies in the Hong Kong building industry, explains the efficiency of investments in risk prevention (and vice versa), measured by an efficient HSE performance. As explained in the introduction, the cultural model to build a strong HSE orientation is the socio-technical model.

Fatal accidents at work, 2014 and 2015
(incidence rates per 100 000 persons employed)



(*) 2013 instead of 2014. 2015: not available.
Source: Eurostat (online data code: hsw_n2_02)

eurostat 

Fig. 3. Eurostat Data on fatal accidents at work 2014 and 2015.

7. The Italian HSE surveillance system

The Italian HSE surveillance and monitoring system began with the disruptive reforming Law no. 833 in 1978. With it, Italy's State decentralized three functions to its Regions, specifically to their regional health services (ASL) and environment protection (ARPA) units:

- To supply “*Livelli Essenziali di Assistenza (LEA)*” (minimum levels of care services) to Italy's regional citizens;
- To manage HSE services complying with yearly defined economic balance sheet standards;
- To promote risk prevention and control the compliance with HSE Laws (by private companies and public institutions).

More specifically, the last function was shared amongst the SPSAL, the specialized safety unit of the ASL, the ARPA and the local unit of the IL. The aim of the reorganization was to strengthen surveillance and HSE inspections to compensate for the insufficiency of the controls made by the IL. Six years later with the introduction of Law no. 758/1994, the repressive approach changed into the “carrot and stick” one, which is a mix of prevention and repression attitudes. The new approach (confirmed and strengthened by the Laws no. 626/1994 and no. 81/2008), which is the one still adopted today, works in the following way.

If the inspector (a judicial policeman) finds a non-compliant condition with relation to the HSE legal requirements, s/he:

- Writes “*la prescrizione*” (the prescription) requiring the company to solve the identified problem (i.e., the non-conformity) by a certain date;
- Monitors, at the expiration date, whether the prescription has been solved or not.

Should the control be:

- Positive, the inspector closes the file by fining the company (i.e., with a so-called administrative sanction), thus avoiding activation of a criminal trial;
- Negative, the inspector sends the (unresolved) prescription to the Criminal Court to activate a criminal trial.

In short, the inspector (as a judicial policeman) adopts a preventive approach for the period s/he suspends the activation of the criminal charge and a repressive approach when the unresolved prescription is sent to the criminal court.

This new way of HSE surveillance has the twofold beneficial effect of reducing the workload of Criminal Courts and inducing companies to comply with HSE legal requirement more quickly.

Law no. 149/2015 transformed the “*Ispettorato del Lavoro (IL)*” (Labour Inspectorate) into a National Agency called “*Ispettorato Nazionale del Lavoro (INL)*” (National Labour Inspectorate). The aim of the Law was to overcome the fragmentation of inspection activities among the different Institutions that act to monitor the compliance of companies with labour contracts (social security, black practices, etc.), and with health and safety conditions (compulsory insurances, regular work environments, etc.), concentrating them in one agency. The aim has yet been only partially achieved as yet, as the Agency only started to work at the beginning of 2019: the INL will be staffed with new appointments (1.000 persons) starting from 2019 and only the Ministry of Labour has transferred its staff and control functions to INL. [Table 8](#) summarises the current structure of the HSE surveillance system.

The coordination of HSE inspections began with the 5-year national plan of the Ministry of Health. The first launched, spanning from 2014 to 2019, formulated the objectives expected to be pursued. Amongst them, the quantitative reduction in specific occupational injuries and

Table 8
The Italian surveillance system.

Public Institution	Core surveillance functions assigned by law and carried out by inspectors as judicial policemen	Inspection organization
INPS (National Social Prevention Institute)	To control the payment of contributions legally owed under the employment contracts. To combat undeclared and illegal work practices (the black labour market and its entrepreneurs) To monitor the correct enjoyment of contributions by retired or invalidated workers	National headquarter, Regional and Provincial branches
INAIL (National Institute for workers' compulsory insurance for occupational accidents)	To control the payment of the compulsory insurance premium against occupational injuries and diseases by employers To promote risk prevention through the dissemination of safety organizational systems (SGSL) and best practices. INAIL stimulates employers to improve safety conditions of their companies though the reduction of the insurance premium and the financing of <i>ad hoc</i> safety projects.	National headquarter, Regional and Provincial branches
INL (National agency of labour inspectorate)	To carry out the same inspection functions of INPS, INAIL, SPSA. The HSE professionals are divided in two roles: (1) the administrative experts to control the compliance with contributions, compulsory insurances and work practices; (2) the technical experts to inspect health and safety conditions in particular of companies in the building and railway industries.	National headquarter and Inter-regional branches
Corpo nazionale dei Vigili del Fuoco (National Firefighters)	To inspect the compliance of plants, facilities and buildings (new and old ones) with the legal fire prevention requisites. To control the authenticity and updating of the fire prevention certificates (which are renewed periodically).	National headquarter, Regional and Provincial branches
SPSAL (The local specialized health prevention unit of the Regional Health Authority - ASL)	To control the compliance of work environments to safety and hygiene laws through inspections to companies of the province To make surveys and research on occupational injuries and hygiene to discover causes and find remedies To express preventive opinions on safety and hygiene requisites of new working environment designs. To carry out and to coordinate medical checks and examinations on workers subject to occupational risks and diseases using competent medical doctors	Regional headquarter and Provincial branches
ARPA (Regional Agency for Environmental Protection)	To inspect the compliance of plants and storage sites with the legal environmental prevention requisites (from combating atmospheric and acoustic pollution to interventions for the protection of surface and underground water, from monitoring electromagnetic fields to investigating contamination of soil and remediation processes).	Regional headquarter and Provincial branches

the quantitative increase in work disease complaints to fight the black company behaviour of concealment¹⁰ are considered to be particularly important. Each institution (in this specific case the SPSAL and INL) coordinates its own yearly inspection plans in each province with a meeting twice a year (at the beginning and in the middle of the year). The two positive points of the latest Laws (no. 149/2015 and no. 183/2016) reforming the inspection system are as follows:

- The strengthening of the inspection staff of HSE professionals in the INL;
- The formalisation of the technical guidelines to operationalise the national information system for occupational risk prevention, the so-called “*Sistema Informativo Nazionale per la Prevenzione nei luoghi di lavoro (SINP)*” (National Information Systems for the Occupational Prevention).

The SINP was established by the Law no. 81/2008 and it will be managed by the INAIL and composed by the database of the five public institutions of Table 8. The weak point is that INPS and INAIL will keep their inspection functions until all of their inspectors will be retired; and this will easily cause problems for the many years to come.

The new HSE manager profile is recognised *de facto* by the market (for the aforementioned reasons), but ignored *de jure* by all European legislators. In Italy only the HSE professional is normed by the law, i.e., the RSPP, To improve the situation and valorise the profile, in 2016 the AIAS association and a pool of large multinational companies (led by

Fiat Chrysler Automobiles – FCA), with the support of professionals (representing different stakeholders) and university professors (including the authors), stimulated the creation of a panel of experts. The goal of the working group was the creation of a voluntary norm to define, on the one hand, the knowledge, the skills and the competencies the HSE manager has to possess, and, on the other hand, the educational and experiential framework for its qualification.

In July 2018 the voluntary norm was published as UNI 11,720 and, to the knowledge of the authors, is the first norm at the European level that defines both the profile of the HSE manager (in terms of knowledge, skills, and competencies) and the qualification framework that is to be associated with it (in terms of areas of knowledge, the number of modules and their contents for each educational area, the overall amount of educational hours, and the balance of educational hours for each area of knowledge).

8. The structure of Italy's voluntary norm UNI11720 on the HSE manager

The UNI11720 took more than 2 years to be produced and published by the UNI (Italy's National Standardisation Body representing Italy at the CEN and ISO organisations). The norm defines the knowledge, skills and competencies of the HSE Manager profile as well as the framework for its qualification.

The UNI working group, after an organisational analysis of the HSE organisation in Italian companies, ended up with the conclusion that it would be useful to define two types of HSE Manager profiles, namely:

- The (Senior) Operational HSE Manager;
- The (Senior) Strategic HSE Manager.

¹⁰ This is a counterintuitive goal to set; yet it starts from the assumption that there is an existing hidden, crystallized situation of non-conformity and then the increase in complaints would be considered as a first positive trend towards the eradication of consolidated negative, but concealed HSE conditions.

Table 9
Qualification framework of the norm UN111720.

Background Knowledge	Specific Knowledge	Managerial Experience (Strategic-Operational)	EQF	Exemptions on experience
Master of Science Diploma (120 ECTS) ¹	Up to 400 h distributed in the 5 knowledge areas defined by the norm (Table 10) The candidate is required to fill the gaps according to the knowledge held vs. that required by the norm (Table 11)	<ul style="list-style-type: none"> at least 10–8 years' work in HSE at least 6–2 years in a managerial role 	7 for the Strategic profile 6 for the Operational profile	Industrial PhD Diploma (3 years exemption) Academic PhD Diploma (2 years exemption) Specialisation Master Diploma in HSE 2nd Level ² – 60 ECTS, EQF 8 (2 years exemption) Specialisation Master Diploma in HSE 1st Level – 60 ECTS, EQF 7 (1-year exemption) Specialisation Master Diploma in HSE 1st Level – 60 ECTS, EQF 7 (1-year exemption)
Bachelor/Undergraduate Diploma (180 ECTS)		<ul style="list-style-type: none"> at least 12–10 years' work in HSE at least 6–2 years in a managerial role 		
High School Diploma		<ul style="list-style-type: none"> at least 18–16 years' work in HSE at least 6–2 years in a managerial role 		
Middle School Diploma		<ul style="list-style-type: none"> at least 22–20 years' work in HSE at least 6–2 years in a managerial role 		

¹ ECTS stands for European Credit Transfer (and Accumulation) System.

² In Italy the 2nd level Master diploma is a specializing diploma whose training program can be accessed by those holding a bachelor/undergraduate diploma. Thus, those holding a Master of Science diploma (of 120 ECTS). On the other hand, the 1st level Master diploma is a specializing diploma whose training program can be accessed by those holding a bachelor/undergraduate diploma. Thus, those holding a Master of Science diploma (of 120 ECTS) can access both 1st and 2nd level Master courses, while those holding a bachelor/undergraduate diploma can only access 2nd level Master courses of specialization.

Table 10

Area of knowledge of the training modules and their relative weight in terms of hours.

Area No.	Training Module	Length (h)	
		Strategic HSE Manager	Operational HSE Manager
1	Organisational-managerial Area	128	48
2	Administrative-judicial Area	32	32
3	Occupational Safety Area	64	96
4	Occupational Health Area	64	96
5	Environment Area	112	128
	Total	400	400

The Operational HSE Manager was meant as the profile that carries out its activity in an organizational position with:

- Full decision-making autonomy in relation to the management of operational aspects; but
- Limited decision-making autonomy with reference to the strategic aspects that are defined and decided at a higher level of the organization.

On the other hand, the Strategic HSE Manager operates in an organizational position with full decision-making autonomy with reference to the strategic choices of the organization in the HSE sphere. Its role is identified by the top management of the organization in order to have a professional profile that can support it in defining strategic choices and related HSE objectives. Where the organization is divided into several organizational units, this figure can play a coordinating role with other HSE Managers for the implementation of action plans necessary to achieve the established HSE objectives.

The seniority (adjective “Senior”) is used to recognise the professional experience acquired both in terms of duration of the experience spent performing the role and the growth of skills (gained through the attendance at courses of particular relevance).

The qualification framework (equal in structure for the 2 profiles but different in the contents) has a structure that considers the background (i.e., level of knowledge acquired through legally recognised educational titles), the specific knowledge and its extent (acquired through specific HSE courses with a syllabus that covers the contents specified in the norm), the managerial experience, the corresponding European Qualification Framework (EQF) level, as well as the recognition of legally recognised extra qualifications (such as the Philosophy Doctor programs). Table 9 shows the structure of the qualification framework.

The rationale followed for the definition of the qualification framework is simple: the higher the title held, the shorter the experience required to qualify. Thus, for example, an HSE professional holding an Industrial PhD Diploma wanting to qualify as Strategic HSE Manager, has to go through 7 years' experience in HSE (given by the 10 years required by the norm with the 3 years of exemption subtracted), 6 of which must be spent covering managerial roles (of any type, not necessarily in HSE). Further, should the PhD path followed not be consistent (in terms of contents) with the knowledge required by the norm the candidate will have to go through a specific course (or a set of courses), of a maximum total duration of 400 h, to fill the gap(s) (i.e., acquire the knowledge not acquired during the PhD experience). The seniority (“Senior” status) will be reached after 1,5 times the length of experience required for the non-senior profile. Thus, the Strategic HSE Manager will become Senior Strategic HSE Manager after an overall 10,5 years' experience in HSE. In the best case (i.e., with no interruptions), in Italy this will possibly happen only when the person is at least 38 years old.

Table 11
Broad contents for each the 5 modules defined by the norm.

Area No.	Training Module	Broad contents
1	Organisational-managerial Area	<ol style="list-style-type: none"> 1. Fundamentals of work and company organization 2. Models and tools for managing human resources 3. Work relationship: basic elements of formal and informal contracts 4. Organization, management and control model pursuant to Legislative Decree no. 231/2001 (point F.4 [20]) with regard to crimes related to the protection of health and safety at work and to environmental crimes 5. Fundamentals of dynamic systems and intra-organizational relationships (relations trade unions, inter-functional) and inter-organizational (public regulatory bodies and external companies) 6. Theories on group dynamics and group employment techniques (for decision-making and of organizational control) and of taking collective decisions 7. Theories and techniques of communication (public speaking, media system of the internal organizational communication, etc.) 8. Interviewing techniques 9. In-depth knowledge of the technical, technological and organizational aspects of the organizations 10. Fundamentals and models of corporate strategy in national and international competition 11. Performance of the organization and potential for improvement regarding HSE: HSE performance, safety budget, prevention costs, performance indicators (Key Performance Indicators), social and environmental report 12. HSE performance of competing best performers in the reference market of the organization 13. Evolution and development trend of the main HSE prevention aspects
2	Administrative-judicial Area	<ol style="list-style-type: none"> 1. The legislative system on HSE at European and national level 2. Main national and European laws on HSE and their development 3. Roles, activities and civil and criminal liability of internal and external actors in the HSE business 4. Administrative responsibility (pursuant to Legislative Decree No. 231/2001 (point F.4 [20])) and company insurance protection (risk management strategy) 5. The activities of the supervisory bodies and internal inspection procedures (e.g., security audits) and external to the company 6. The internal and external sanctioning system and elements of criminal legislation 7. Main administrative requirements aimed at obtaining and maintaining authorizations in HSE matters 8. Fundamentals of labour law and labour relations
3	Occupational Safety Area	<ol style="list-style-type: none"> 1. Methodologies and techniques for the analysis, evaluation and integrated management of risk, at system level, in the field of safety at work 2. Methodologies and techniques for the analysis, assessment and management of risk in the field of safety at work 3. Prevention and protection measures (individual, collective, procedural, technical and organizational) from risks in the field of safety at work 4. Elements of investigation techniques and monitoring of work environments (methods for monitoring and measuring chemical, physical and biological agents and main laboratory methods) 5. Methodologies and techniques for the analysis and integrated assessment of accidents (near misses), missed accidents and injuries 6. Methods and techniques for preventing and managing emergencies 7. Fundamentals of energy and energy carrier management 8. Fundamentals of occupational psychology, behaviour management 9. Audit methods and techniques on health and safety at work 10. Main technical standards UNI, CEN, ISO, CEI, CENELEC and IEC concerning health and safety at work 11. Elements of reliability, safety and maintainability of machines and systems for the management of safety aspects and risk containment 12. Fundamentals of statistical analysis applied to safety aspects
4	Occupational Health Area	<ol style="list-style-type: none"> 1. Methodologies and techniques for the analysis, evaluation and management of occupational health risk 2. Fundamentals of physical, cognitive and organizational physiology and ergonomics 3. Fundamentals of occupational psychology, (social behaviour and relationships, communication and group dynamics) 4. Fundamentals of toxicology, hygiene and occupational medicine 5. Fundamentals of epidemiology and health statistics 6. Fundamentals of psycho-social risks: stress, burnout, mobbing, aging, gender differences, harassment 7. Role and method of employment (internal vs externalized) of the physician in charge of risk prevention and health surveillance 8. Methods and techniques for the prevention and management of emergencies in the field of occupational health 9. Audit methodologies and techniques in the field of occupational health 10. Fundamentals of reliability, safety and maintainability of machines and plants for managing occupational health aspects and limiting health risk
5	Environment Area	<ol style="list-style-type: none"> 1. Methodologies and techniques for the analysis, evaluation and management of environmental risk 2. Methodologies, techniques, technologies and facilities for managing environmental aspects and reducing environmental impact 3. Methods and techniques of investigation and environmental monitoring (methods for monitoring and measuring environmental aspects in situ and main laboratory methods) 4. Methodologies and techniques for the analysis and evaluation of accidents and missed environmental incidents 5. Methods and techniques for prevention and management of environmental emergencies 6. Methods and techniques for environmental remediation 7. Elements of energy and energy carrier management 8. Environmental audit methods and techniques 9. Main technical standards UNI, CEN and ISO regarding the environment 10. Fundamentals of reliability, safety and maintainability of machines and plants for the management of environmental aspects and the reduction of environmental impact 11. Elements of environmental statistics

The norm even specifies the macro training modules (divided into 5 areas of knowledge) with their relative weight (in terms of hours). [Table 10](#) summarises the 5 macro modules and their relative weight as defined by the UNI11720 (voluntary) norm.

Finally, for each of the 5 macro modules reported in [Table 10](#), the norm defines even the broad contents that ought to be conveyed to the professional. [Table 11](#) summarises these contents.

9. Conclusions

Over the last century, Italy's HSE professionals have gone through a significant change to face both the increasing complexity of the business and the decreasing acceptability of non-market risks (and the associated social costs of accidents and injuries at work) by European citizens. According to Ansoff's (1987) perspective, this requires a shift from a "simple function orientation" (product/technology driven or market driven) to a "multifunctional orientation" (what Ansoff defines as the strategic or profitability ROI orientation of the company). This practically translates into the joint optimization of market and non-market risk prevention by top management. Yet, as Ansoff pointed out, the most critical point in applying this shift is the required cultural change (i.e., to become aware and understand the need to transform the company cultural model). More specifically, from the top managers perspective it requires the company to give up inadequate cultural models and to prefer either the HTO model or that of the High Reliability Organizations (as explained in Section 1). From the HSE professional perspective, the company orientation change requires an increase in the complexity of competencies to be owned to face the imposed challenges and to be more effective in their duties.

In Italy this change was strongly induced by a rapid evolution of the legislative framework and the paradigm shift was given when the HSE professional was transformed from a process/risk owner to a consultant to the entrepreneur (and the associated line managers), thus moving the legal responsibility of occupational accidents from the HSE professional to the entrepreneurs/employers themselves.

To improve their effectiveness HSE professionals should have transformed their status from that of technicians to that of professionals. Yet, this transformation would have required a market and, with it, an adequate education offer to satisfy it. The Italian State and its Regions understood this need and agreed to require compulsory courses to be followed by both HSE professionals and all of those involved in the risk prevention, namely: entrepreneurs, managers, supervisors, as well as HSE representative of workers. Thanks to this *stimulus* and the activity of the associations, a significant (public and private) market of HSE education and services has grown over the years. Yet, despite an adequate HSE education offer, the demand is still significantly in favour of compulsory and updating courses, leaving voluntary courses still perceived as a luxury and not as a profitable investment. Indeed, the composition of the demand reveals that for entrepreneurs and their line managers, as well as for the role's holders (quite surprisingly), it is difficult to leave the technician role (mindset) in favour of the professional one. This difficulty precludes the possibility for HSE professionals to provide their most crucial and beneficial consultancy, namely: the promotion of the HSE culture starting from the entrepreneur, going through the managers and supervisors, to conclude with the workers. Yet, within this apparently not really encouraging framework, the newly conceived voluntary norm on the HSE manager (the first in Europe), which was strongly wanted by a group of large companies (led by FCA) and the professional associations, leaves space to hope for a rapid transformation and improvement of the HSE marker and its associated profiles.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssci.2019.06.002>.

References

Addaria, N. (a cura di), 1976. *Inchiesta sulle condizioni dei lavoratori in fabbrica (Investigation Into the Conditions of Factory Workers)*. Einaudi, Torino.

Ansoff, I.H., 1987. *Strategic management of technology*. J. Bus. Strategy 7 (3) Cambridge.

Argyris, C., Schön, D.A., 1978. *Organizational Learning: A Theory of Action Perspective*. Addison-Wesley, Reading, Massachusetts.

Berlinguer, G., 1973. *Medicina e politica (Medicine and Politics)*. De Donato, Bari.

Bonazzi, G., 1983. *Colpa e Potere (Guilt and Power)*. Il Mulino, Bologna.

Briante, G. (a cura di), 1977. *Ambiente di lavoro. La fabbrica nel territorio (Work environment. The factory in the territory)*. Editori Riuniti, Roma.

Burns, T., Stalker, G.M., 1961. *The Management of Innovation*. Tavistock Publication, London.

Casali, L., Colombo, S., Golzio, L., Lalla, M., Marchionni, A., Zini, A., 2018. *Cultura della sicurezza, investimenti e controllo economico nella prevenzione dei rischi (Safety Culture, Investments and Economic Control in Risk Prevention)*. Fondazione Ruber Triva, Roma. Final Report of an Action Research in Two Public Utilities Companies (under publication).

Contratto nazionale di lavoro dei chimici (Chemists' national working contract), 1947.

Emery, F., Trist, E., 1963. *The causal texture of organizational environment*. Human Relat. 18, 21–32.

Feng, Y., 2013. *Effects of safety investments on safety performance of building projects*. Safety Sci. 59, 28–45.

Feng, Y., 2014. *Exploring the interactive effects on safety investments to safety culture and project hazard on safety performance: an empirical analysis*. Int. J. Project Manage. 32, 932–943.

Gochfeld, M., 2005. *Chronologic history of occupational medicine*. J. Occup. Environ. Med. 47 (2), 96–114. <https://doi.org/10.1097/01.jom.0000152917.03649.0e>.

Gronroos, C., 2000. *Service Management and Marketing: A Customer Relationship Management Approach*. John Wiley & Sons, Chichester.

Hollnagel, E., 1993. *Human Reliability Analysis: Context and Control*. Academic Press, London.

INAIL, 2017. *Dati INAIL. Andamento degli infortuni sul lavoro (INAIL Data. Work-related Injury Trends)*. January 2017, No. 1, 2, ISSN 2035-5645.

Karlton, A., Karlton, J., Eklund, J., Berglund, M., 2014. *HTO – a complementary ergonomics perspective*. In: Broberg, O., Fallentin, N., Hasle, P., Jensen, P.L., Kabel, A., Larsen, M.E., Weller, T. (Eds.), *Proceedings of Human Factors, in Organizational Design and Management – XI. Nordic Ergonomics Society Annual Conference*, 46, Copenhagen.

Lawrence, P.R., Lorsch, J.W., 1969. *Organization and Environment*. Irwin Dorsey, Homewood.

Normann, R., 1984. *Service Management: Strategy and Leadership in Service Business*. John Wiley & Sons, Chichester.

Onofri, F., 1955. *La condizione operaia in Italia (Italy's Workers Condition)*. Editori Riuniti, Roma, pp. 1955.

Ramazzeni, B., 1713. *De Morbis Artificum Diatriba (Italian Trad., "La malattia dei lavoratori")*, Carocci, Napoli, 1982).

Reason, J., 1990. *Human Error*. Cambridge University Press ISBN 9780521314190.

Righi, M.L., 1992. *Le Lotte per l'ambiente di lavoro dal dopoguerra ad oggi (The Fights for the Work Environment from the Post-war Period to Today)*. Studi Storici, n. 2-3.

Rollenhagen, C., 2000. *A framework for assessment of organisational characteristics and their influences on safety*. Safety Sci. Monitor 4 (1), 1–16.

Smircich, L., 1983. *Concepts of cultures and Organizational analysis*. Admin. Sci. Quart. 28 (3), 339–358.

Trist, E.L., 1981. *The evolution of socio-technical systems as a conceptual framework and an action research program*. In: Van De Ven, A.H., Joyce, W.F. (Eds.), *Perspective on Organizational Behavior and Design*. Wiley and Sons, New York ISBN 0471093580.

Weick, K.E., Sutcliffe, K.M., 2001. *Managing the Unexpected: Assuring High Performance in an Age of Complexity*. Jossey-Bass Publishing ISBN 0787956279.

Weil, S., 1965. *La condizione operaia (The Workers' Condition)*. Edizioni Comunità, 1965.

Italian Norms (in chronological order):

R.D. n. 80/1898. "Assicurazione obbligatoria contro gli infortuni e le malattie professionali" (Compulsory insurance against accidents and occupational diseases).

R.D. n. 380/1906. "Istituzione del Corpo degli Ispettori del lavoro" (Establishment of the Corp of Labour Inspectors).

R.D. n. 530/1927. "Regolamento generale sull'igiene del lavoro" (General Regulation on Occupational Hygiene).

R.D. n. 262/1942. "Approvazione del testo del Codice Civile" (Approval of the Text of the Civil Code).

Assemblea Costituente, 1947. "Nuova Costituzione repubblicana" (New Republican Constitution).

D.P.R. n. 547/1955. "Norme sulla prevenzione degli infortuni sul lavoro" (Rules on the Prevention of Accidents at Work).

D.P.R. n. 185/1964. "Sicurezza degli impianti e protezione sanitaria dei lavoratori e delle popolazioni contro i pericoli delle radiazioni ionizzanti derivanti dall'impiego pacifico dell'energia nucleare" (Plant Safety and Health Protection of Workers and Populations Against the Dangers of Ionizing Radiation Deriving from the Peaceful Use of Nuclear Energy).

D.Lgs. n. 277/1991. "Attuazione delle direttive n. 80/1107/CEE, n. 82/605/CEE, n. 83/477/CEE, n. 86/188/CEE, n. 88/642/CEE, in materia di protezione dei lavoratori contro i rischi derivanti da esposizione ad agenti chimici, fisici e biologici durante il lavoro, a norma dell'art. 7 Legge n. 212/1990" (Implementation of Directives n. 80/1107 / CEE, n. 82/605 / CEE, n. 83/477 / CEE, n. 86/188 / CEE, n. 88/642 / EEC, Concerning the Protection of Workers Against the Risks Deriving from Exposure to Chemical, Physical and Biological Agents During Work, pursuant to art. 7 Law n. 212/1990).

Legge n. 131/1970. "Norme sulla tutela della libertà e dignità dei lavoratori, della libertà sindacale e dell'attività sindacale, nei luoghi di lavoro e norme sul collocamento" (Rules on the Protection of Workers' Freedom and Dignity, Trade Union Freedom and Trade Union Activity, in the Workplace and Placement Regulations).

Legge n. 833/1978. "Istituzione del servizio sanitario nazionale" (Establishment of the

- National Health Service).
- D.P.R n. 175/1988. “Applicazione dell’art. 12 del decreto del Presidente della Repubblica 17 maggio 1988, n. 175, concernente rischi rilevanti connessi a determinate attività industriali” (Application of the Art. 12 of the Decree of the President of the Republic 17 May 1988, n. 175, Concerning Significant Risks Related to Certain Industrial Activities).
- Legge n. 142/1990. “Ordinamento delle autonomie locali” (Local Autonomy Regulations).
- D.Lgs. n. 277/1991. “Attuazione delle direttive n. 80/1107/CEE, n. 82/605/CEE, n. 83/477/CEE, n. 86/188/CEE e n. 88/642/CEE, in materia di protezione dei lavoratori contro i rischi derivanti da esposizione ad agenti chimici, fisici e biologici durante il lavoro, a norma dell’art. 7 della legge 30 luglio 1990, n. 212. (Pubblicato sul Supplemento Ordinario alla Gazzetta Ufficiale 27 agosto 1991, n. 200)” (Implementation of Directives n. 80/1107/CEE, n. 82/605/CEE, n. 83/477/CEE, n. 86/188/CEE and n. 88/642/EEC, Concerning the Protection of Workers Against the Risks Deriving from Exposure to Chemical, Physical and Biological Agents During Work, pursuant to art. 7 of the law of 30 July 1990, n. 212. (Published in the Ordinary Supplement to the Official Journal of 27 August 1991, No. 200)).
- D.Lgs. n. 626/1994. “Attuazione delle direttive 89/391/CEE, 89/654/CEE, 89/655/CEE, 89/656/CEE, 90/269/CEE, 90/270/CEE, 90/394/CEE, 90/679/CEE, 93/88/CEE, 95/63/CE, 97/42, 98/24 e 99/38 riguardanti il miglioramento della sicurezza e della salute dei lavoratori durante il lavoro” (Implementation of Directives 89/391 / CEE, 89/654 / CEE, 89/655 / CEE, 89/656 / CEE, 90/269 / CEE, 90/270 / CEE, 90/394 / CEE, 90/679 / CEE, 93/88 / EEC, 95/63 / EC, 97/42, 98/24 and 99/38 Concerning the Improvement of the Safety and Health of Workers at Work).
- D.Lgs. n. 152/2006. “Norme in materia ambientale” (Environmental Norms).
- D.Lgs. n. 81/2008. “Attuazione dell’articolo 1 della legge 3 agosto 2007, n. 123, in materia di tutela della salute e della sicurezza nei luoghi di lavoro” (Implementation of Article 1 of the Law of 3 August 2007, n. 123, Concerning the Protection of Health and Safety in the Workplace).
- Legge n. 133/2008. “Conversione in legge, con modificazioni, del decreto-legge 25 giugno 2008, n. 112, recante disposizioni urgenti per lo sviluppo economico, la semplificazione, la competitività, la stabilizzazione della finanza pubblica e la perequazione tributaria” (Conversion Into Law, with Amendments, of the Decree-law of 25 June 2008, n. 112, Containing Urgent Provisions for Economic Development, Simplification, Competitiveness, Stabilization of Public Finance and Tax Equalization).
- D.Lgs. n.231/2011. “Disciplina della responsabilità amministrativa delle persone giuridiche, delle società e delle associazioni anche prive di personalità giuridica, a norma dell’articolo 11 della legge 29 settembre 2000, n. 300” (Regulation of the Administrative Liability of Legal Persons, Companies and Associations, even Without Legal Personality, Pursuant to Article 11 of the Law of 29 September 2000, n. 300).