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Designing national systems to support the analysis and prevention of occupational fatal injuries: Evidence from Italy

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ABSTRACT

Analysing injury causes is an essential activity for both companies as well as national and local authorities involved in safety at workplace. For a single company, benefits mainly consist of pointing out root causes of an occurred injury aiming to prevent its replication. At the national level, injury analysis enables a stronger evaluation of actual critical risk factors that usually lead to accidents at similar workplaces. If data are gathered from different companies, the analysis of critical risk factors could support more effective and focused preventative activities in Occupational Safety and Health surveillance. The proposed work aims to describe and critically analyse a good practice developed under the current Italian national surveillance system to control and prevent occupational fatal injuries based on a structured system for collecting and analysing data about occurred injuries and then, developing proactive activities to support prevention at workplace. A system called Infor.Mo has been developed by a project between national and local institutions. The Infor.Mo system involves methodological and operational tools as it includes a model for analysing critical factors that have contributed to injury development, and a software-based tool to collect and disseminate information extracted by analysed data. The methodological model is based on a multi-factor analysis of risk factors aiming to determine the actual dynamic of an injury and its root causes. A final critical discussion about positive results and current challenges, derived by practical experience of a multi-year application of the proposed system, is also proposed.

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Designing national systems to support the analysis and prevention of occupational fatal injuries: evidence from Italy

Abstract: Analysing injury causes is an essential activity for both companies and national as well as local authorities involved in safety at workplace. For a single company, benefits mainly consist of pointing out root causes of an occurred injury aiming to prevent its replication; at the national level, injury analysis enables a stronger evaluation of actual critical risk factors that usually lead to accidents at similar workplaces. Thus, if data on injuries are gathered from different companies working in the same local area as well as in the same industrial sector, the analysis of critical risk factors could support more effective and focused preventative activities developed by companies and control authorities involved in Occupational Safety and Health (OSH) surveillance. The proposed work aims to describe and critically analyse a good practice developed under the current Italian national surveillance system to control and prevent occupational fatal injuries based on a structured system for collecting and analysing data about occurred injuries and, next, developing proactive activities to support prevention at workplace. A system called Infor.Mo has been developed by a collaborative project developed between national - the Ministry of Health, the Italian National Institute for Insurance against Accidents at Work (INAIL) – and local institutions, i.e. Regions, Autonomous Provinces, and local surveillance authorities. The Infor.Mo system involves methodological and operational tools as it includes a model for analysing critical factors that have contributed to injury development, and a software based tool to collect and disseminate information extracted by analysed data. The methodological model is based on a multi-factor analysis of risk factors aiming to determine the actual dynamic of an injury event thus allowing to point out root causes of the event. A final critical discussion about positive results and current challenges, derived by practical experience of a multi-year application of the proposed system, is analysed aiming to support both researchers and safety experts in designing effective supporting systems for occupational fatal injury surveillance.

Keywords: occupational injury prevention, national surveillance system, company assistance, risk factors, multi-factor analysis.

Introduction

One critical issue for national strategies to prevent occupational injuries and diseases at the workplace regards the institutional support provided to companies for improving their activities in OSH management (ILO-OSH, 2001). National surveillance systems should therefore collect and analyse data about occurred injuries, by identifying related causes to support a more effective prevention system for accidents at the workplace. Otherwise, results obtained in a recent European Project – i.e. the SESAME Project- have outlined, from one side,how is critical the development of more standardized and effective approaches for injury analysis, on the other side, the project has also pointed out the importance of a wider diffusion of knowledge about critical risk factors to companies (Walters et al., 2018). A promising option to create a proactive surveillance system is to develop

national health plans aiming to effectively and efficiently extract, analyse and share accident-related causes. Thus, an effective communication system between companies and other stakeholders is essential as well to disseminate knowledge. However, although surveillance systems have been differently developed all over the world (e.g. at a sectoral, federal or national level), a common feature could be outlined: surveillance systems often become critical in emergency conditions even if they exist in the background of public health programs (National Academies of Sciences, Engineering, and Medicine, 2018). This is a critical issue as prevention activities require a continuous effort to obtain short and long-term results. Another common issue is a lack of coordinated tools for OSH accident analysis and data sharing across OSH authorities, companies and other involved stakeholders , thus reducing the efficacy of prevention activities (Roed-Larsen and Stoop, 2012).

At company level, Lundberg et al. (2010) highlighted the reduced capability of such a company in systematically analyse occurred occupational accidents due to several factors One potential cause could be the lack of a systematic expertise in injury analysis methodologies often due to low exposure to accidents in their company (Roed-Larsen and Stoop, 2012)). In addition, Salguero-Caparros et al. (2015) also outlined how often several investigation reports do not include detailed descriptions of the dynamic of events that have led to injuries/accidents.; moreover, the analysis stops on immediate causes thus not detecting all levels of critical causes. (Salguero-Caparros et al., 2015, 2019). In addition, it has to be considered as the accident investigation process is *"merely one of the elements in the process of learning from accidents. For safety improvements to be achieved, it is essential that the recommendations on remedial actions presented in the accident investigations […] are implemented"* (Cedergren, 2013). Often, follow up activities are not developed in an effective way thus reducing the global effectiveness of such an intervention (Cedergren, 2013).

In this context, interventions at the national level proposing standardized and coordinated approaches to collect and analyse data about occurred fatal events and to share knowledge among all actors involved in accident prevention are becoming urgent, especially for supporting effective preventative activities at Small and Medium-sized Enterprises (SMEs) and micro companies. These are the companies, which generally allocate few resources for OSH prevention as they hardly adopt effective OSH management models (Hasle and Limborg, 2006; Micheli and Cagno, 2010; Masi and Cagno, 2015; Cagno et al., 2016 Walters et al., 2018). Past analyses have outlined a high effort, in terms of both human and economic resources, required by these companies in effectively applying safety management systems (Masi and Cagno, 2015).It has to be also noted that the low frequency of accidents occurred in absolute in SMEs is contributing to reduce the efficacy of their accident investigation models thus causing a not effective adoption of preventative measures (Roed-Larsen and Stoop, 2012).

An effective national surveillance system would help to fill this gap by developing standardised approaches by providing to private and public stakeholders consistent and coherent information derived from different sources (e.g. different companies) but with common features that provide reliability of such a source. Companies and organizations would benefit from this surveillance system, as it will represent a reliable source of information to prevent accidents at their workplace. The availability of this type of tool would also help those companies – e.g. SMEs - , which have not yet fully developed their systems to analyse and monitor accidents.

Furthermore, the availability of a huge and standardized amount of data gathered among "similar companies" (e.g., working in the same industrial sector and/or with similar hazardous activities) could allow developing more accurate data analysis and preventative project plans at a local and national level.

By analysing the literature, the current organisations of national surveillance systems, developed in different countries, can be classified into two main categories based on the activities they perform. The first one refers to national (or international) systems that apply approaches to classify and analyse injuries; they mainly operate at an operational level as they should provide "reliable" information about past occurred events (ICECI Coordination and Maintenance Group, 2004; Wiatrowski, 2013). Usually, follow up activities are not an essential element of these systems. The latter category is composed of multi-year plans developed at a national (or international) level for work accident prevention; they mostly aim at developing effective strategies and interventions to prevent injuries at the workplace (NIOSH, 2020; Aspinwall and Jacinto, 2003). Thus, the focus of these systems is not on outlining critical factors based on field data. Finally, despite there are several national surveillance systems all over the world, only few of them can be considered "complete", i.e., including data collection and analysis as well as effective communication systems to extract and share knowledge with stakeholder involved in injury prevention.

Hence, this work proposes a critical analysis of a "complete" good practice - currently applied in Italy - developed to support local OSH authorities as well as companies in the control and prevention of occupational fatal injuries. The system has a multi-year application: it consists of a coordinated set of methodological and operational tools for collecting and analysing available data about occurred fatal injuries in Italian companies and sharing knowledge extracted by field data. In detail, the paper aims at critically analysing the application of this system – which is called Infor.Mo- in Italy, thus providing major opportunities and threats related to its application and further improvements points to support researchers and safety experts in designing similar systems in other national and local contexts.

The paper is organized as follows: in *Section 1*, a review of the current state of development of national surveillance systems is proposed; in *Section 2*, the Italian national surveillance system (Infor.Mo) is explained in detail; finally, in *Section 3*, early results derived from the multi-year application of the Italian system are critically discussed.

1. Analysing current national surveillance systems for occupational injuries

A critical overview of current typologies of national surveillance systems is provided. First, the main features and potential advantages of these surveillance system are discussed (see *Section 1.1*), and next, the current state of the art is analysed (*Section 1.2*), aiming to outline current applications of these systems at different levels. .

1.1. Main features and limits analysis

Analysing occurred injury events for supporting more efficient prevention activities is confirmed as a priority for both companies and institutions. Ex-post analyses usually outline the dynamic of an accident event, its severity, and the most relevant factors (e.g., technical, organisational) contributing to its occurrence, aiming to design more effective preventative actions.

This analysis could be performed at different levels of analysis, i.e., at international, national and company level. At the international level, injuries are mainly categorised to compare aggregate data of each country: the main purpose is to analyse trends and compare data rather than to define specific preventative actions in OSH systems (Tedone, 2017). By analysing current models, it has to be noted that standardised classifications have been developed more frequently for a specific nation or for countries, which have some common features; therefore, comparing international data on accidents is extremely challenging due to heavy differences in national legislation and regulations, which induce differences in OSH national systems and, consequently, in their objectives (Tedone, 2017).

At the company level, the same result could be outlined: each company usually applies a specific model for analysing accident events aiming to define operational measures and their specific policies to prevent injuries. As a not standardized approach is often applied, results extracted by the accident analyses can be hardly shared with other firms, as they are heavily dependent on the specific organization of the company and/or to the specific type of work performed. In addition, another issue has to be considered together with technical ones: companies are not very helpful in sharing their "sensitive data" with external organisations. Although, information could be collected in an anonymous way and no sensitive data could be shared, the problem still remain critical, if it is still possible to trace back the source of the data; this is mainly true in small local areas, where few companies are working in specific sectors. In this case, innovative models must be applied to provide

companies the correct level of information security. According to Dien et al. (2012), accidents should be analysed with a wider perspective, which overcomes company boundaries, aiming to aggregate more data - compared to the analysis developed by a single company- thus designing more effective plans for injury prevention.

According to this issue, OSH campaigns at an international and national level are designed to develop more effective solutions and practical tools for injury prevention at the workplace. As an example, EU-OSHA campaigns aim at disseminating high-quality information on several specific subjects. The 2020-2022 EU-OSHA campaign focuses on work-related musculoskeletal disorders prevention (EU-OSHA, 2021). These campaigns are centrally managed by EU-OSHA; the local application is developed by European nations, which develop the specific activities trough by their national networks (INAIL, 2020a). In addition to the EU international campaigns, every nation promotes specific prevention campaigns aligned with its national specific targets. As an example, the Italian National Institute for Insurance against Accidents at Work (INAIL) currently promotes a national campaign to foster the return to work of people with occupational disabilities (INAIL, 2021a). These international and national prevention campaigns represent a powerful tool to focus on specific injuries and diseases problems; however, a more detailed analysis of occurred events must be also developed at national level as outlined by Lunt (2013), as, by aggregate a larger volume of data about occurred injuries and their basic causes, more reliable information could be extracted to develop standardised procedures supported by national regulations.

Thus, national surveillance systems are the main tools to acquire and analyse data from the operational field – i.e. companies – aiming to define effective national and local strategies to prevent injury occurrence at the workplace. Identifying actual causes of events allows to define operational guidelines, which could be adopted by policy makers as well as safety experts to develop more effective national and local surveillance approaches (Salguero-Caparros et al., 2015). This is also confirmed by (Katsakiori et al., 2009) that outlined how a combination of models for injury analysis could support the development of a system with less fragmented information and Molinero-Ruiz et al. (2015) which focused on evaluating benefits of standardised approaches for collecting data and pointing out event causes.

Table 1 summarises general features that should characterise a national surveillance system.

NATIONAL SURVEILLANCE SYSTEMS FOR PREVENTING INJURIES	
users	Local surveillance authorities and companies.

Expected results	Defining multi-year plans for work accident prevention according to continuous improvement of safety at the workplace.
Overall benefits	Increasing self-awareness of hazards at workplace by an aggregate view of occurred accidents.

FIELD	OPPORTUNITIES	THREATS
Volume of data	Extracting reliable knowledge based on an aggregate level of information.	Collected information might be strictly dependent on specific factors , i.e. industry sector and/or the type of work performed. Privacy-related issues might also arise.
Categorisation of events	Developing a unique classification for detecting basic causes and event dynamic	
Models for accident analysis	Combining various models for accidents analysis to build a more reliable system with less fragmented information	Approaches are often company/sector-specific (low flexibility). A lower level of detail for accident analysis compared to the analysis developed at company level.
Standardised approaches/plans for accident analysis	Developing standardised approaches aiming to support the collecting data and cause evaluation processes.	Low diffusion of of standardised approaches at national and local levels. . Low responsiveness at national level to develop corrective action plans than at the company level.
Communication model	Multi-directional flows of information between stakeholders, institutions, and companies.	Communication approaches not fitted to specific requirements. Limited diffusion of information.

Table 1. Key features related to national surveillance systems.

1.2. An overview of the state of the art

The analysis of technical reports, institutional websites, and scientific papers has outlined two main typical components in national surveillance systems: statistical classification and accident analysis models. The national surveillance system discussed in this work covers both aspects (i.e., accident investigation and statistical classification) and proposes some additional elements to imcrease the overall efficacy of the system.

Thus, in paragraphs *1.2.1* and *1.2.2*, these two models are rispectively discussed aiming to evaluate how these two processes are developed in current national systems aiming to evaluate the current state of the art of applications.

1.2.1. Statistical classification models

The European Union through the European Statistical Office (Eurostat) has developed from 1994 annual European Statistics on Accidents at Work (ESAW) reports. These reports record and analyse statistical information collected at the European level in a unified way, that is by an harmonised

methodology for injury classification (across all industrial sectors) based on specific country data sources (Jacinto and Aspinwall, 2004). The main purpose of this approach is to extract non-subjective information related to an injury event, such as the occurrence place and date, and the injury type and severity. Furthermore, the method allows to collect and store information regarding causes and specific circumstances characterising the specific event collected at national level. This information are essential to develop specific policies at a national level aiming to prevent and/or reduce injury occurrences based on historical data.

Another similar example is the Nordic Medico-Statistical Committee (NOMESCO), which was established in 1966 to coordinate health statistics management in EU Nordic countries. The first edition of NOMESCO Classification of External Causes of Injuries (defined as NCECI) was published in 1984; in the following years, various revised editions were presented and this classification has been actively applied to support injury prevention and control in EU Nordic countries (Jørgensen et al., 2007).An evolution of the NCECI model is the International Classification of External Causes Injuries (ICECI) model, which is characterized by a wider application as it has been applied in the World Health Organization Family of International Classifications (WHO-FIC), firstly released in 2001. ICECI enables an analytical description of the dynamic of an injury, supporting also the development of a systematic data collection system (ICECI Coordination and Maintenance Group, 2004). In addition, this method aims to support researchers and technicians in:

- defining more precisely the domain of injuries;
- clarifying the circumstances in which injuries occurred;
- providing more detailed information about specific cases (e.g., those related to transport, sport or violence).

Several types of data can be collected by adopting the ICECI method not strictly collected to external causes of an injury, such as demographic data items (e.g., age, sex), time of injury occurrence, thus enabling a wider perspective on events to be analysed.

In the U.S., starting from 1992 and updated in 2012, the Bureau of Labor Statistics (BLS) introduced the Occupational Injury and Illness Classification System to classify and describe fatal injuries as well as the most severe non-fatal ones (U.S. Department of Labor, 2012). The current version of the model includes a larger category of diseases, and proposes a standardization to improve the information available for designing injury prevention actions (Wiatrowski, 2013). The system includes four hierarchical coding structures: nature of the injury or illness; part of the body affected by the injury or illness; the primary and secondary source of the injury or illness; type of event or exposure (U.S. Department of Labor, 2012).

With a wider perspective of application, the International Labour Office (ILO) has started several years ago an activity to draw up a code of practice for recording occupational accidents and diseases worldwide (ILO, 1996). Similarly to previous analysed cases, this model aims to support a more effective design of accident prevention activities based on historical data. This code of practice is used as a guideline for coordinating actions developed by employers and activities implemented by governments, control institutions and other organisations.

In conclusion, this brief analysis has outlined that statistical classification models provide a system to collect a large amount of data characterising the accident event by recording a wide range of potential related causes and conditions. However, data are usually only stored and not fully critically analysed, therefore defining preventative measures is not so effective compared to the theoretical target. As an example, the ILO's code of practice requires additional actions to outline what type of interventions must be applied by governments, private organisations, and companies to effectively prevent accidents at work.

1.2.2. Accident investigation approaches

Structured accident analysis approaches that could be applied for analysing data at a national level have been selected starting from a recent work proposed by Salguero-Caparros et al. (2019), where an extensive review of the scientific literature aiming to classify the existing approaches for analysing occupational accidents is proposed An interesting result proposed by the authors is that, although there is a broad range of approaches, most of them are industry-specific, thus their applicability in cross-sectoral contexts is not so simple (Salguero-Caparros et al., 2019). In addition, an evolution could be outlined in these models, which range from traditional single cause detection approaches to methods aiming to identify multiple causes as well as organisational weaknesses (Katsakiori et al., 2009; Dien et al., 2004). As the aim of this paragraph is not to discuss all the features of these models that could be potentially applied in a national surveillance method, only a quick mention is just proposed as follows for completeness. The most well known are MES (Multi-Linear Event Sequencing) (Benner, 1975); MORT (Management Oversight and Risk Tree) (Johnson, 1980); STEP (Sequentially Timed Events Plotting) (Hendrick and Benner, 1987); FTA (Fault Tree Analysis) (Ferry, 1988). All these models could be adopted to develop effective national surveillance programs for accident analysis and prevention since they are adaptable and flexible to be applied in several contexts.

By analysing current adopted methods, the first example is the WAIT (Work Accidents Investigation Technique) model: it has been adopted by the Portuguese Labour Inspectorate for the official classifying and analysing serious accidents occurred at Portuguese workplaces (Jacinto and

Aspinwall, 2003; Jacinto et al., 2011). WAIT provides a systematic and structured model that could be applied for both classifying and analysing accidents occurred across all sectors of industrial activities. It provides the identification of active failures together with critical factors that have influenced the dynamic of the injury, by adopting a standardised coding classification proposed by Eurostat. WAIT is based on nine steps, grouped in two main stages: investigation and in-depth analysis. The first focuses on outlining immediate causes and circumstances that have contributed directly to the accident. The second step identifies possible weaknesses outlined for the company organization to perform a complete and in-depth analysis; this activity aims to detect the root causes of the specific injury by analysing the "actual" dynamic of the accident. This allows to evaluate improvement opportunities for the specific company as well as national policies.

By enlarging the perspective of the analysis, two relevant examples of national programs for accident analysis are reported below aiming to provide a more complete picture of the current condition of accident analysis methods not specifically based on a specific approach.

The first one is developed in the U.S. and it is the so called BLS Occupational Safety and Health Statistics program. The approach aims at underlining the root causes of an injury focusing on integrating five specific approaches (Wiatrowski, 2013):

- examining the sequence of events to understand the dynamic of the accident;
- considering the accident frequencies;
- assessing the injury severity;
- evaluating context factors that have contributed to the accident;
- identifying contributing factors.

Another program developed in the U.S. is the Fatality Assessment and Control Evaluation (FACE) carried out by the National Institute for Occupational Safety and Health (NIOSH): it is a voluntary program, which involves states in sharing with NIOSH data about a specific type of injury, traumatic occupational fatalities (NIOSH, 2020). Afret data collecting, NIOSH analyses overall conditions and causes that have led to traumatic occupational fatalities; information are shared publicly for providing a guideline to learn from these occurred events that could be useful for safety professionals, researchers, employers, trainers, as well as workers. The primary purpose is to share information useful for preventing future fatal injuries. In detail, data are categorised following four criteria: location, industry type, causes of death (e.g. confined spaces, electrocutions, machine-related, falls, motor vehicles, trenching, etc.) and populations (foreign citizens, temporary workers, etc.). Reports are used to highlight contributing factors (i.e. a complete list of causes) for each analysed event; recommended intervention strategies are also developed together with dissemination activities for

increasing worker awareness. Several years of application have confirmed its effectiveness in reducing the rate of fatal injuries (Menendez et al., 2012).

2. Injuries surveillance and prevention: a national system's design and a multi-year application

A good practice concerning the Infor.Mo system, the Italian system to support fatal injury surveillance at the workplace, is described in detail as follows. It is a complete tool, which integrates methodological approach and operational models for collecting, analysing data about fatal injuries occurred at Italian workplaces and disseminate knowledge extracted by field data. It has been developed by the Italian National Institute for Insurance against Accidents at Work (INAIL), Regions and Autonomous Provinces, and Local Health & Safety Departments (LHSDs), which are the centres of administrative operations related to public healthcare in Italy under the National Healthcare Service. LHSDs are responsible to develop prevention and control activities at the workplace: thus, they are the main Health & Safety at Work authorities at the local level in Italy. The Infor.Mo system currently represents the tool to collect and analyse fatal injuries occurred at the workplace across the Italian territory. It started from a pilot research project in 2002 (ISPESL, 2006) and, for several years, it has been supported by specific projects of the Ministry of Health. Furthermore, it has been recently introduced as a structured system in the National Prevention Plan (NPP): it now represents the main source of information for evaluating injury risk factors. The NPP is defined in accordance with the Italian Ministry of Health and Regions; it defines strategies to be adopted by all structures of the National Health services and sets specific objectives. (Rosso et al., 2015). The NPP involves activities in several fields (e.g., chronic non-communicable diseases, communicable diseases and vaccinations) including accidents at workplaces, which is the field of interest of this study. The NPP is updated approximately every 3–5 years. Recently, the last version of the NPP covering from 2020 to 2025 has been published (Ministero della Salute, 2020). Thus, for occupational injury and disease prevention, the NPP has confirmed the adoption of standardised and proactive surveillance systems based on the Infor.Mo model. They are organised in collaboration with regions aiming to integrate traditional surveillance activities developed at regional levels with supporting activities to prevent injuries at workplace.

The Infor.Mo system is based on a set of coordinated and standardised approaches to collect and analyse data about fatal injuries occurred at the workplace and to support companies in their prevention activities by disseminating extracted knowledge about critical risk factors. The Infor.Mo system aims at developing activities in four main directions:

- implementing a national registration system about fatal injuries occurred in Italy, based on a mandatory analysis carried out by LHSDs in each territory;
- providing reliable information to support more efficient prevention activities developed at local levels;
- promoting and sharing approaches with companies to monitor the effectiveness of their risk analysis tools and to outline effective corrective actions;
- sharing interventions and programs to support companies in preventing injuries with institutional stakeholders (e.g., employer associations, labour unions), which are involved in communicating and spreading knowledge extracted from the Infor.Mo system.

Furthermore, the Infor.Mo system works at two levels: operational and strategical. At the operational level, the main targets are the analysis of fatal injuries occurred at the workplace and the assessment of critical risk factors that have potentially caused the event. At the strategical level, providing reliable information to develop more effective prevention plans at different levels (company, industrial sectors, regional areas) in collaboration with LHSDs and INAIL represents the main target. Thus, four are the main actors involved in the Infor.Mo system:

- **INAIL**: is responsible to define the adopted methodology, collect and analyse data on fatal injuries, manage the database with all the gathered information, and train LHSD technicians on the approach used for injuries' analysis;
- **LHSDs**: are responsible for the data collection on fatal injuries occurred in companies located within their geographical area;
- **Stakeholders**: collaborate with institutions to support injury prevention at the workplace;
- **Companies**: interact with LHSDs and INAIL to collect critical information on occurred injuries.

In addition to these direct informative flows, INAIL supports feedback informative flows between LHSDs, stakeholders and companies to disseminate the knowledge acquired from data analysis.

A National Coordination team (including representatives of INAIL, LHSDs and the Ministry of Health) manages and approves the development of project activities and the methodological and organisational aspects of the surveillance system. Locally, activities are managed by Regional Coordination teams, which ensure the completeness and quality of information collected at the

regional level. The roles and relations among the actors defined previously are depicted in Fig. 1.

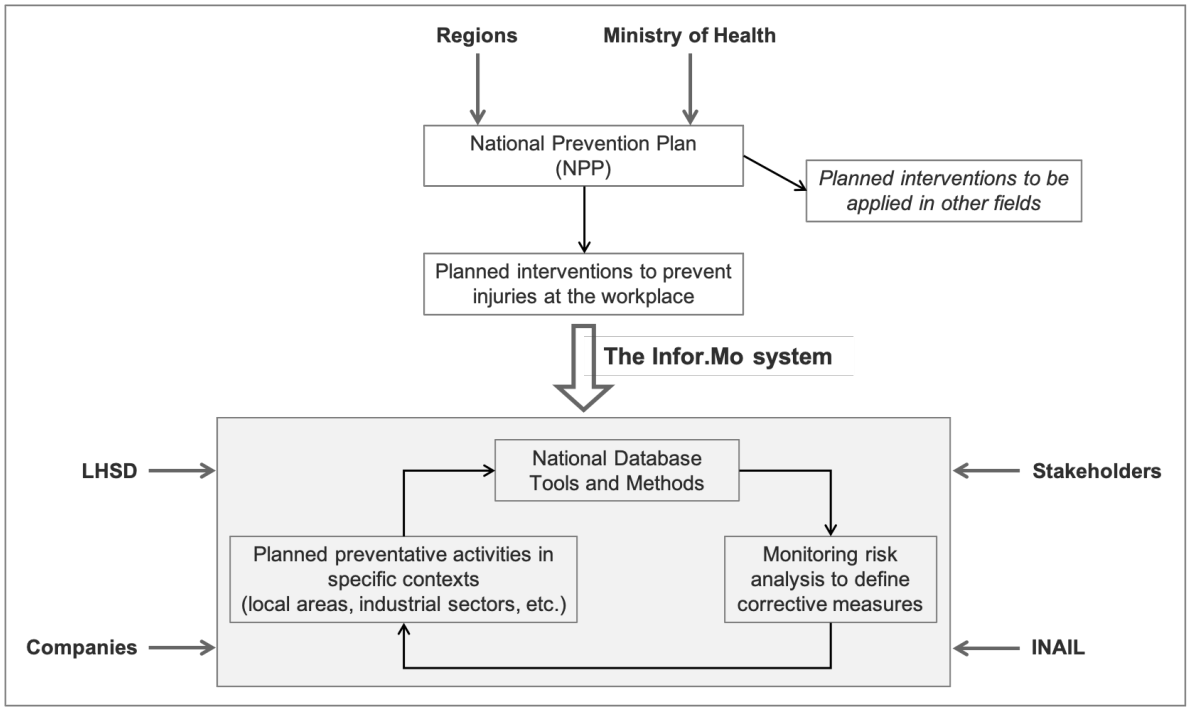

Fig. 1. Interactions in the Italian National system to prevent injuries at the workplace.

Figure 2 shows the building blocks of the Infor.Mo system (on the right side) that have been generalised (on the left side) by defining the major elements that should characterise and support in designing efficient common national systems to prevent injuries at the workplace.

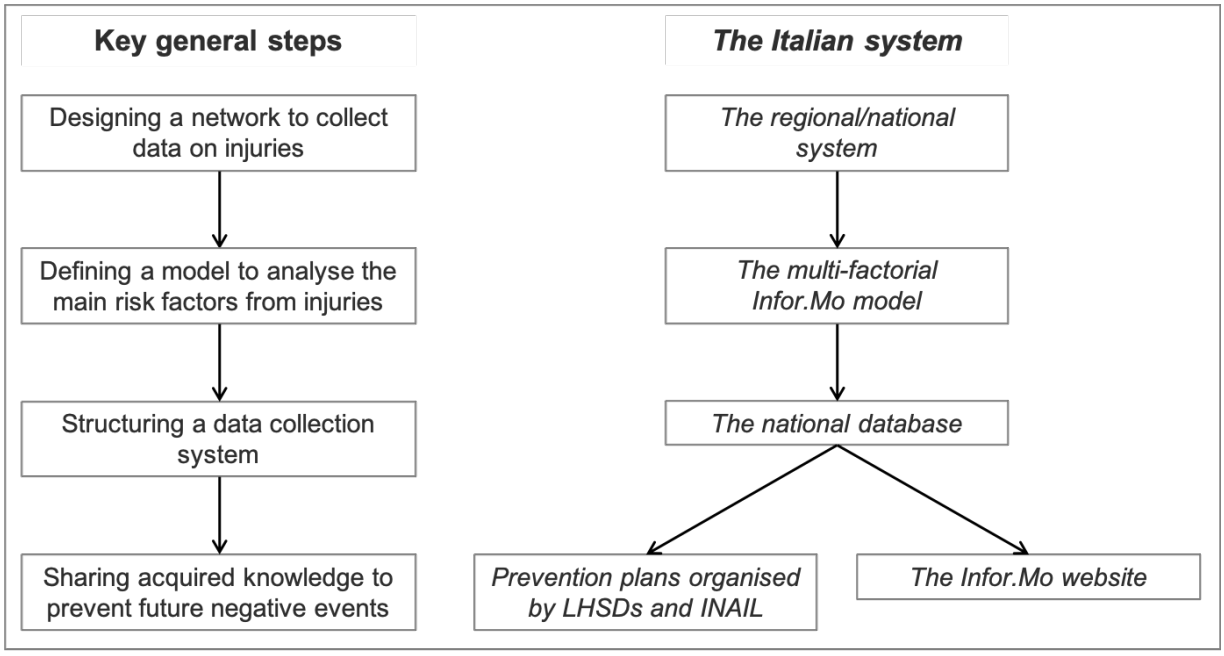

Fig. 2. Building blocks of national surveillance systems and their application in the Infor.Mo system.

The blocks of the Infor.Mo system are detailed below.

First, the ***definition of the network*** and the flows of information have been defined. The flow starts from LHSDs that interact with companies where a fatal injury occurred to collect data through a standardised protocol identified ex-ante by INAIL researchers.

This protocol supports the application of a **multi-factorial model**, developed and validated by INAIL and LHSDs, for analysing the main causes of fatal injuries. The adopted multi-factorial model belongs to the category of cause tree models (Kjellen and Larsson, 1981; Laflamme, 1990; Laflamme, 1998; Campo et al., 2006) and it allows to evaluate in a structured way the dynamic of the injury event. Thus, starting from data collected for the event, the model provides the dynamic of the injury event, based on five elements. Three elements (biological damage, the contact, and the accident) help in defining the full dynamic of the fatal injury and they can be objectively assessed. The two other elements are defined as the modulator and determinant factors and they are the most affected by the analyst's subjectivity. Details of these five elements are reported below.

- **Biological damage**: is defined as a combination of the place and type of occurred damage.
- **The contact**: is defined as the combination of the contact agent (machine, equipment, materials, etc.) and the part of the body involved.
- **The accident**: represents a specific event "providing" the hazardous energy that became uncontrolled in the workplace (e.g., workers falling from altitudes, overturning of a working vehicle).
- **Modulators factors**: represent risk factors that have contributed to increasing the severity of the analysed accident.
- **Determinant factors**: represent risk factors that have contributed to increasing the probability of the analysed accident.

Each risk factor (i.e., modulator or determinant depending on the specific dynamic of the event) has to be evaluated based on a predefined list, which is reported in Table 2.

Risk factor category	Definition
Activity developed by an injured person	Inappropriate actions, movements, etc., carried out by an injured worker during the event
Activity developed by a third subject	Incorrect actions developed by other workers or people (different from the injured one) during the event
Equipment, machine, plant, working tool	Equipment of any type (or part of it) that presented criticalities in the dynamics of the event
Materials	Issues on the processed materials that influenced the dynamics of the event
Working environment conditions	Critical aspects related to workplace conditions

Personal Protective Equipment (PPE) and clothing	Issues on PPE or work clothes that influenced the injury occurrence

Table 2. Risk factor categories evaluated in the Infor.Mo multi-factorial model.

The Infor.Mo multi-factorial model identifies two major typologies of accidents based on the behaviour of the potentially harmful energy, as represented in Fig. 3. The first one is generated by a quick and unintentional transformation of hazardous energy which causes **an injury due to a variation of energy**, while the other refers to an event that occurred due to a **variation in the interface** between the worker and the standard dangerous energy in the workplace. In the latter case, there is no variation of energy and the accident and the contact overlap.

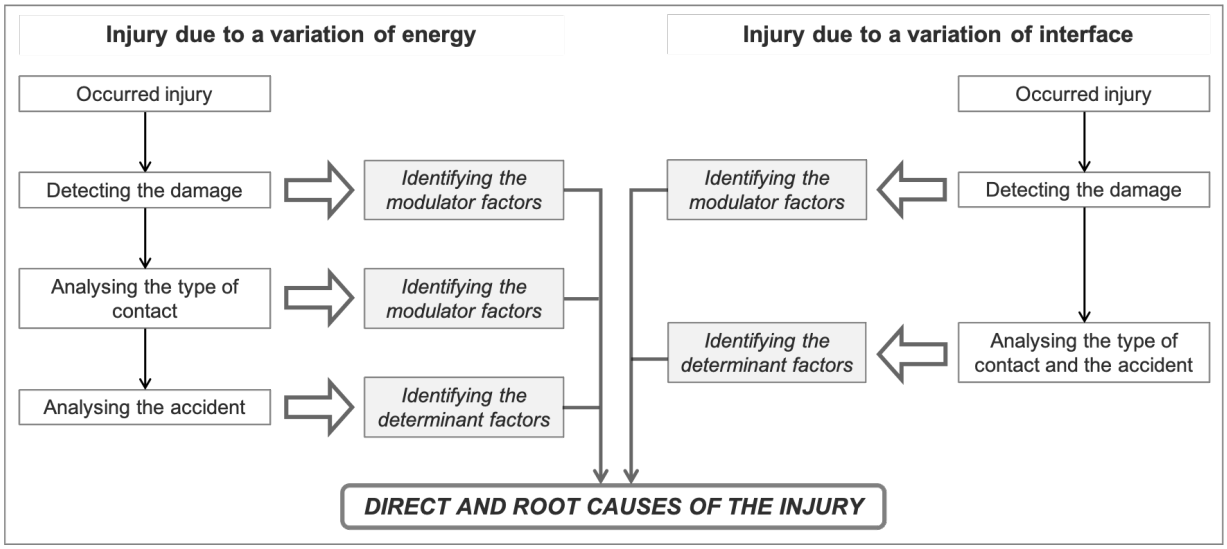

Fig. 3. The Infor.Mo system basic logic.

The proposed multi-factorial model allows outlining, in a standardised way, the most critical factors (i.e. technical and organisational) that contributed to the dynamic of the analysed injury. In detail, the joint analysis of modulators and determinants can allow also to point out organisational aspects contributing to an injury, which are "indirect" factors not usually easy to identify.

Detailed information is collected for each risk factor identified through the model (i.e. determinant or modulator factor), including the *Safety Issue* variable. This variable, characterized by the risk factor categories reported in Table 2, outlines details on the safety problems, which represent the direct causes of the event characterizing the specific injury dynamics; this information allow to definitively evaluate organizational root causes. As an example, when a fault is outlined in a task procedure

carried out by the worker, the direct cause could be associated with the lack of training, which derives from a not effective control prcess developed by the company .

After designing the multi-factorial model to classify and analyse occurred events, a structured data collection tool has been developed to provide simple support to LHSDs. Thus, LHSDs compile a standardised form with all data needed to analyse the injury event occurred in their territorial area.

Further information on the data entry process and methodology are described in Rosso et al. (2015) and are available at the Infor.mo website in Italian (INAIL, 2020b). Next, INAIL, responsible to feed the **national database**, develops a coherent analysis containing all information collected from LHSDs.

Results provided by the national database are accessible for free via a **website** managed by INAIL (INAIL, 2020b). Data are stored anonymously, adopting various strategies to ensure a high level of data protection. As an example, some data contained in the national database, have been reported in Figure 4, which shows information about fatal injuries occurred in Italy and recorded in the database from 2002 to 2018. Data are reported based on a first analysis (Fig. 4) regards the geographical distribution of fatal injury events in the Italian territory divided into 4 areas: North-West (NW), North-East (NE), Centre (C), South and Islands (S&I).

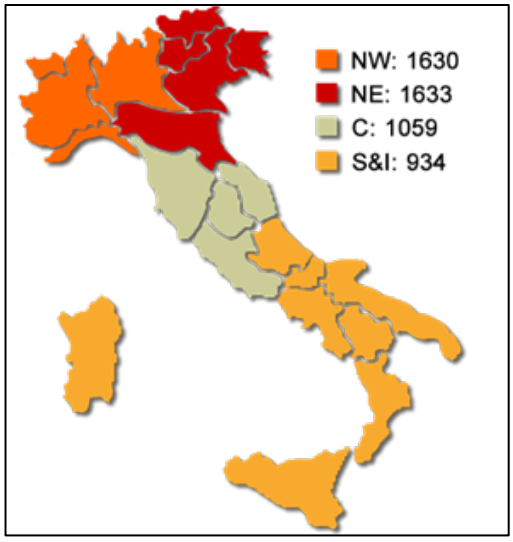

Fig. 4. Data about occurred injuries from 2002 to 2018; different colours apply to different geographical areas: North-West (NW), North-East (NE), Centre (C), South and Islands (S&I). .

The total number of fatal injury events is equal to 5,300 and the total number of risk factors (i.e., determinants and modulators) evaluated for this sample is 10,220. More details about the risk factors evaluated for these events are in Table 3.

Risk factor category outlined in the analyzed sample	Occurrence
Activity developed by an injured person	4,442
Activity developed by a third subject	986
Equipment, machine, plant, working tool	2,054
Materials	371
Working environment conditions	1539
Personal Protective Equipment (PPE)	828
TOTAL	**10,220**

Table 3. Risk factor categories evaluated for events from 2002 to 2018.

The three largest risk factor categories outlined for collected events cover almost about 80% of the total values: they are "Activity developed by an injured person" with a 43%, the"Equipment, machine, plant, working tool" representing about 20%), and finally, the "Working environment conditions" representing 15% of the total value.

In addition to the website publication, another activity – i.e. developing the so called Oriented Prevention Plans (OPPs) - has been developed to spread the knowledge acquired on critical risk factors by actively supporting companies and local departments in defining **more effective prevention plans**. OPPs are dissemination and training events organised for one or multiple companies in specific areas of the Italian territory. LHSDs authorities, in collaboration with INAIL, develop OPPs aiming to communicate, share and discuss with companies, data acquired by the system about critical risk factors in a collaborative approach. The main idea behind OPPs is to share specific knowledge about critical risk factors and, consequently, help companies in increasing the effectiveness of their prevention activities. Local authorities, therefore, started developing assistance activities in addition to traditional surveillance ones to promote continuous improvement plans for managing risk factors at the company level (INAIL, 2021b).

A recent example of OPP has been designed for port areas. Eight Italian port clusters have been fully involved in disseminating and sharing knowledge about critical risk factors for their specific sectors. The data of companies operating in those areas have been extracted by the Infor.Mo database, then interventions to eliminate and/or mitigate the impacts of these critical risk factors have been shared with companies involved in OPPs organization (INAIL, 2019; INAIL, 2020c).

3. Discussion

The Infor.Mo system, born as a research project in 2002, now represents a structured approach to monitor injuries at the local level and support companies in increasing their performance in OSH

management. From its first application, the idea was to create a territorial and participatory system to assist companies in promoting more effective actions to prevent injuries at their workplace.

The first activity performed to support the development and diffusion of the Infor.Mo system was to analyse common projects and initiatives developed at the Italian and international level. This allowed defining a standardised and effective system that integrates traditional mandatory surveillance activities, developed by local authorities at the workplace, with assistance activities to directly support companies in improving their risk analyses and control processes. Thus, the Infor.Mo system provides multiple tools to companies: from a standardised approach to collect and analyse occurred injuries at the workplace, to informative support to revise risk analysis documents and share knowledge on the most critical risk factors.

Besides, the proposed system is in line with the European Directives and the Italian legislation on OSH, which requires new organisational models to support both the public (Ministry of Health, LHSDs, research centres, etc.) and the private system.

The application of the proposed model in multi-year plans has brought out some open discussion points. Both positive and negative elements are discussed below, as they might be useful to local authorities and private companies to develop more effective OSH management.

First, the **opportunities** arisen from the multi-year application of the Infor.Mo system are detailed.

- **Knowledge diffusion**: the spread of institutional information systems has supported an increased knowledge on critical risk factors that heavily contribute to occupational injuries and has improved the planning process of prevention activities developed by public and private actors.
- **Knowledge integration**: the integration of information about fatal injuries with other data derived from different sources (e.g., epidemiological studies) provides policymakers and researchers with a clearer picture of the actual condition of such hazardous conditions.
- **Deep knowledge of risk factors**: the Infor.Mo system has provided a structured knowledge about risk factors that mainly contribute to injury occurrence. This availability has supported the OSH public system in developing guidelines for risk analysis and control at the workplace of specific territories and industrial sectors. These guidelines could be used by large companies as well as by SMEs to improve their risk analysis process.
- **Deep knowledge of cause-and-effect relationship:** the adoption of a multi-factorial model, shared by public and private actors, provides a more reliable assessment of the relationship between damage-accident-cause in occurred injury events. This knowledge allows to effectively re-direct efforts of public institutions and companies to better define their specific prevention activities.

- **Development of tailored interventions**: the integration between the specific working activity and the dynamic of the injury enables the development of "tailor-made" training projects (e.g., OPPs) specific for each industrial sector.

Next, the **challenges** related to the proposed Infor.Mo system are outlined below.

- **Efforts dedicated to training staffs**: some initial resources (especially in term of competence and time) must be dedicated to inform and train people that are involved in collecting and analysing injury events on the use of the software tool and the multi-factorial model. Over the years, this activity has been carried out by INAIL experts directly to every LHSD staff. This implies that a continuous training effort is needed to maintain the system at its full capability.
- **Sensitivity in selecting appropriate approaches for data integration of occurred fatal injuries**: the choice of the approach to jointly address data inputs coming from different sources, with a potentially different level of granularity, is not as easy as it may seem and is crucial to their correct assessment and integration as, after all, affects the detection of proper risk factors.
- **Not completely standardised approaches of local authorities to effectively integrate assistance (i.e., complementary) and surveillance (i.e., mandatory) activities:** although the Infor.Mo system adopts standardised approaches to analyse risk factors, any standardised strategy is mandatory to overcome and prevent critical factors. Each local authority could establish a specific way to treat a certain phenomenon: some of them could focus on increasing mandatory surveillance activities (e.g., inspections at the workplace) towards companies, while others could concentrate on assisting companies through prevention activities before performing inspections. Thus, in local areas, there is still a lack of a unified approach to assist companies. This limits the global effectiveness of the system due to insufficient coordinated strategies. Nevertheless, the new Italian NPP has already started by promoting the application of standardised activities that can effectively integrate assistance and surveillance in a common strategy.
- **Not fully developed follow-up activities after knowledge diffusion**: a lack of indicators to monitor ex-post company performance after the development, through OPPs, of dissemination activities. Some leading and lagging indicators are monitored at the local level soon after an OPP, but few attempts are developed to monitor the effectiveness of OPPs over the years. This activity should require more involvement of stakeholders in ex-post monitoring by following overtime companies in their prevention activities.

The above-stated opportunities and challenges of the Infor.Mo system are now reported in Table 4.

Obtained results	Opportunities	Challenges
Knowledge development about critical risk factors in OSH	- enlarging capabilities of current surveillance systems - integrating data belonging to different sources (i.e., databases) - sharing approaches for data analysis between public and private actors involved in OSH management	- allocating permanent resources - identifying and integrating data with appropriate approaches - increasing of communication between local institutional actors (e.g., LHSDs)
Development of flexible networks focusing on OSH management	- strengthening the coordination between national institutions and involved local authorities - promoting active participation of all private and public actors	- increasing the awareness of specific roles - increasing the effective coordination in the "enlarged" network (i.e., between stakeholders, companies, institutions)
Development of structured activities of assistance and monitoring for companies	- developing "tailor-made" interventions for each local area/industrial sector based on actual risk factors - developing more effective incentive policies for companies	- allocating resources focused on additional tasks (i.e., assistance activities) beyond mandatory surveillance
Sharing of best practices developed after OPP organisation	- increasing potential audience of prevention interventions and overcoming the limited number of companies participating in OPPs	- standardizing approaches of analysis
Evaluation of realised prevention activities' effectiveness	- adopting leading and lagging indicators - reinforcing the legislative compliance of companies - adopting more effective and efficient economic incentives for companies through a continuous improvement approach provided by institutions - collecting data and monitoring the OPPs realised for each local area	- putting in place an ex-post monitoring process for companies involved in OPPs - using appropriate KPIs

Table 4. The Infor.Mo system: opportunities and challenges.

Conclusions

There are several national and local surveillance systems to monitor and analyse fatal injuries occurred at the workplace, however organisational and assessing models usually differ among countries. The difference between national legislations and the target to be achieved through the defined system by each specific institution is one of the leading causes (National Academies of Sciences, Engineering, and Medicine, 2018).

This paper aims at defining a guideline, based on a multi-year field experience, to support the effective development of national surveillance systems. Thus, this study proposes a critical analysis of a "good practice", developed in Italy for several years, to design a national surveillance system for

occupational fatal injuries: the Infor.Mo system. Its structure is based on a wide network of actors; it has been developed in collaboration with local authorities that collect data about accidents occurred in their local areas, and INAIL, which has developed the specific software tool and the multi-factorial model for analysing accidents. The system, which started as a research project, is now a relevant pillar of the Italian NPP for OSH management. The Infor.Mo system involves not only a software tool to collect data and a multi-factorial model to extract root causes of fatal injury events, but it also represents a source of knowledge for companies to plan innovative prevention activities in collaboration with local authorities. The most relevant examples are OPPs that promote dissemination activities towards companies to communicate and analyse critical risk factors identified by the data collected over time in the Infor.Mo system. The multi-year application has shown positive results and areas for improvement that will be managed in the next future.

By comparing the Infor.Mo system with other ones developed at the international level, it has to be noted that it provides a deep and complete model for assessing the root causes of occurred injuries. Indeed, the Infor.Mo system can point out the full dynamic of the event together with the main risk factors that contributed to its occurrence. Besides, all these data are obtained from the adoption of a standardised and consequently comparable approach, which allows a more structured analysis of information. This capability enables to design more specific preventative interventions for companies and surveillance authorities.

Finally, further developments will be directed towards the enlargement of the application field of the Infor.Mo system by including in its system the analysis of near-miss events: the aim is to increase the global effectiveness of prevention activities by providing knowledge not only on occurred severe events but also on precursor events that are characterised by common causes. The model has the intrinsic capability of outlining the root causes of occurred events with the highest severity and with no severity, like near-miss events. The adoption of the multi-factorial model to analyse near-miss events could also contribute to increasing the awareness of companies about their actual risk factors. This possible evolution of the Infor.Mo system will also require a design of an “enlarged” network of actors, like an ecosystem, where all of them work together in a more coordinated way. In conclusion, this would be an additional step to enhance the efficacy of prevention activities developed by companies, especially SMEs.

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References

Benner, L., 1975. Accident investigation: multilinear events sequencing method. J. Safety Res. 7(2), 67–73.

Cagno, E., Masi, D., Leão, C.P., 2016. Drivers for OSH interventions in small and medium-sized enterprises. Int. J. Occup. Saf. Ergo. 22, 102–115. https://doi.org/10.1080/10803548.2015.1117351

Campo, G., Guglielmi, A., Marconi, M., Pianosi, G., 2006. The reconstruction of the causes and dynamics of work-related injuries using the model "We learn by our mistakes". Prevention Today, 2 (1-2), 27–38.

Cedergren, A., 2013. Implementing recommendations from accident investigations: A case study of inter-organisational challenges. Accident Anal. Prev. 53, 133–141. https://doi.org/10.1016/j.aap.2013.01.010

Dien,Y., Llory, M., Montmayeul, R., 2004. Organisational accidents investigation methodology and lessons learned, J.Hazard. Mater. 111, 147–153. https://doi.org/10.1016/j.jhazmat.2004.02.021

Dien, Y., Dechy, N., Guillaume, E., 2012. Accident investigation: from searching direct causes to finding in-depth causes. Problem of analysis or/and of analyst ? Saf. Sci. 50 (6), 1398–1407. https://doi.org/10.1016/j.ssci.2011.12.010

EU-OSHA, 2021. Healthy Workplaces Campaigns - Safety and health at work [WWW Document]. URL https://osha.europa.eu/en/healthy-workplaces-campaigns (accessed 6.11.21).

Ferry, T.S., 1988. Modern Accident Investigation and Analysis. John Wiley & Sons, Canada.

Hasle, P., Limborg, H.J., 2006. A review of the literature on preventive occupational health and safety activities in small enterprises. Ind. Health 44, 6–12. https://doi.org/10.2486/indhealth.44.6

Hendrick, K., Benner, L., 1987. Investigating accidents with STEP. Marcel Dekker, New York.

ICECI Coordination and Maintenance Group, 2004. International Classification of External Causes of Injuries (ICECI), version 1.2. Consumer Safety Institute, Amsterdam and AIHW National Injury Surveillance Unit, Adelaide.

ILO, 1996. Recording and notification of occupational accidents and diseases. International Labour Office, Geneva.

ILO-OSH, 2001. Guidelines on occupational safety and health management systems. International Labour Office, Geneva.

INAIL, 2019. Problematiche di sicurezza e dinamiche infortunistiche in ambito portuale [WWW Document]. URL https://www.inail.it/cs/internet/docs/alg-informo-problematiche-sicurezza-dinamiche-infort.pdf (accessed 2.24.21).

INAIL, 2020a. Campagna europea 2020-2022: Gestione dei disturbi muscolo-scheletrici sul lavoro [WWW Document]. URL https://www.inail.it/cs/internet/comunicazione/campagne/campagna-euosha-2020-2022.html (accessed 6.11.21).

INAIL, 2020b. Informo [WWW Document]. URL https://www.inail.it/cs/internet/attivita/ricerca-e-tecnologia/area-salute-sul-lavoro/sistemi-di-sorveglianza-e-supporto-al-servizio-sanitario-naziona/informo.html?id1=6443100306764#anchor (accessed 2.24.21).

INAIL, 2020c. Modello territoriale di intervento integrato in materia di salute e sicurezza rivolto alle imprese che operano in aree portuali. Attività di innovazione tecnologica [WWW Document]. URL https://www.inail.it/cs/internet/docs/alg-pubbl-fact-sheet-sicurezza-aree-portuali-innovazione.pdf (accessed 2.24.21).

INAIL, 2021a. "Con Inail, ricomincio dal mio lavoro", l'edizione 2021 della campagna di comunicazione sul reinserimento professionale delle persone con disabilità da lavoro [WWW Document]. URL https://www.inail.it/cs/internet/comunicazione/campagne/reinserimento-integrazione-lavorativa-2021.html (accessed 6.11.21).

INAIL, 2021b. Piani mirati e strategie di prevenzione [WWW Document]. URL https://www.inail.it/cs/internet/attivita/ricerca-e-tecnologia/area-salute-sul-lavoro/sistemi-di-sorveglianza-e-supporto-al-servizio-sanitario-naziona/piani-mirati-di-prevenzione-e-panel-aziendali.html (accessed 2.24.21).

ISPESL, 2006. Indagine integrata per l'approfondimento dei casi di infortunio mortale, Rapporto nazionale

finale [WWW Document]. URL https://www.inail.it/cs/internet/docs/5_report-informo-2006.pdf?section=attivita (accessed 2.03.21).

Jacinto, C., Aspinwall, E., 2003. Work accidents investigation technique (WAIT) – Part I. Safe. Sci. Monit. 7(1).

Jacinto, C., Aspinwall, E., 2004. A survey on occupational accidents' reporting and registration systems in the European Union. Saf. Sci. 42, 933–960. https://doi.org/10.1016/j.ssci.2004.07.002

Jacinto, C., Soares, C.G., Tiago, F., Silva, S.A., 2011. The Recording, Investigation and Analysis of Accidents at Work (RIAAT) process. Policy Pract. Heal. Saf. 9, 57–77. https://doi.org/10.1080/14774003.2011.11667756

Johnson, W.G., 1980. MORT Safety Assurance Systems. Marcel Dekker, New York.

Jørgensen, K., Larsen, O.B., Ojala, M., Mogensen, B., Wetteland, S.S., Berg, L., Tennlind, A., 2007. NOMESCO Classification of External Causes of Injuries, Fourth rev. ed. Nordic Medico-Statistical Committee (NOMESCO), Copenhagen.

Katsakiori, P., Sakellaropoulos, G., Manatakis, E., 2009. Towards an evaluation of accident investigation methods in terms of their alignment with accident causation models. Saf. Sci. 47, 1007–1015. https://doi.org/10.1016/j.ssci.2008.11.002

Kjellen, U., Larsson, T.J., 1981. Investigating accidents and reducing risks - A dynamic approach. J. Occup. Accid. 3, 129–140. https://doi.org/10.1016/0376-6349(81)90005-5

Laflamme, L., 1988. Modèles et methodes d'analyse de l'accident du travail: de l'organisation du travail aux strategies de prevention. Italian version edited by Pianosi G., ARPAT, 2000, Firenze.

Laflamme, L., 1990. A better understanding of occupational accident genesis to improve safety in the workplace. J. Occup. Accid. 12, 155–165. https://doi.org/10.1016/0376-6349(90)90094-C

Lundberg, J., Rollenhagen, C., Hollnagel, E., 2010. What you find is not always what you fix. How other aspects than causes of accidents decide recommendations for remedial actions. Accident Anal. Prev. 42, 2132–2139. https://doi.org/10.1016/j.aap.2010.07.003

Lunt, J.A., 2013. Towards a Standardized Approach for Behavior Change in 21st Century Occupational Health. Occup. Med. Heal. Aff. 01, 1–4. https://doi.org/10.4172/2329-6879.1000119

Masi, D., Cagno, E., 2015. Barriers to OHS interventions in Small and Medium-sized Enterprises. Saf. Sci. 71, 226–241. https://doi.org/10.1016/j.ssci.2014.05.020

Menendez, C.C., Castillo, D., Rosenman, K., Harrison, R., Hendricks, S., 2012. Evaluation of a nationally funded state-based programme to reduce fatal occupational injuries. Occup. Environ. Med. 69, 810–814. https://doi.org/10.1136/oemed-2011-100213

Micheli, G.J.L., Cagno, E., 2010. Dealing with SMEs as a whole in OHS issues: Warnings from empirical evidence. Saf. Sci. 48, 729–733. https://doi.org/10.1016/j.ssci.2010.02.010

Ministero della Salute, 2020. Piano Nazionale della Prevenzione 2020-2025 [WWW Document]. URL http://www.salute.gov.it/portale/news/p3_2_1_1_1.jsp?lingua=italiano&menu=notizie&p=dalministero&id=5029 (accessed 2.03.21).

Molinero-Ruiz, E., Pitarque, S., Fondevila-McDonald, Y., Martin-Bustamante, M., 2015. How reliable and valid is the coding of the variables of the European Statistics on Accidents at Work (ESAW)? A need to improve preventive public policies. Saf. Sci. 79, 72–79. https://doi.org/10.1016/j.ssci.2015.05.005

National Academies of Sciences, Engineering, and Medicine, 2018. A Smarter National Surveillance System for Occupational Safety and Health in the 21st Century. The National Academies Press, Washington, DC. https://doi.org/10.17226/24835

NIOSH, 2020. Fatality Assessment and Control Evaluation (FACE) Program [WWW Document]. URL https://www.cdc.gov/niosh/face/default.html (accessed 2.24.21).

Proto, A. R., Mazzocchi, F., Cossio, F., Bortolini, L., Pascuzzi, S., Caruso, L., ... & Zimbalatti, G. (2016). A survey on occupational injuries in works on trees in Italy. Procedia-Social and Behavioral Sciences, 223, 435-441.

Roed-Larsen, S., Stoop, J., 2012. Modern accident investigation - Four major challenges. Saf. Sci. 50, 1392–1397. https://doi.org/10.1016/j.ssci.2011.03.005

Rosso, A., Marzuillo, C., Massimi, A., De Vito, C., de Belvis, A. G., La Torre, G., Federici, A., Ricciardi, W., Villari, P., 2015. Policy and planning of prevention in Italy: Results from an appraisal of prevention plans developed by Regions for the period 2010–2012. Health Policy, 119(6), 760–769. https://doi.org/10.1016/j.healthpol.2015.03.012

Salguero-Caparros, F., Suarez-Cebador, M., Rubio-Romero, J.C., 2015. Analysis of investigation reports on occupational accidents. Saf. Sci. 72, 329–336. https://doi.org/10.1016/j.ssci.2014.10.005

Salguero-Caparros, F., Suarez-Cebador, M., Rubio-Romero, J.C., Carrillo-Castrillo, J.A., 2019. Methodologies for investigating occupational accidents and their use in occupational health and safety research. Literature review. Environ. Eng. Manag. J. 18, 665–683. https://doi.org/10.30638/eemj.2019.061

Tedone, T.S., 2017. Counting injuries and illnesses in the workplace: An international review. Mon. Labor Rev., U.S. Bureau of Labor Statistics. https://doi.org/10.21916/mlr.2017.23

U.S. Department of Labor, 2012. Occupational Injury and Illness Classification Manual. Bureau of Labor Statistics.

Walters, D., Wadsworth, E., Hasle, P., Refslund, B., Ramioul, M., 2018. Safety and health in micro and small enterprises in the EU: Final report from the 3-year SESAME project. European Agency for Safety and Health at Work, Luxembourg.

Wiatrowski, W., 2013. Using workplace safety and health data for injury prevention. Mon. Labor Rev., U.S. Bureau of Labor Statistics. https://doi.org/10.21916/mlr.2013.34