Occupational Safety & Health (OSH) Performance of SMEs: A Structured Framework

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Abstract - **This paper deals with the use OSH factors for the correct identification and prioritization of OSH interventions especially within the Small and Medium sized Enterprises (SMEs) context, by taking into account the relevant OSH-factors. However, this should not be done on a one-to-one basis, but rather through a meaningful group of connected factors, which together impact on the OSH performance and on the overall performance. On the basis of the above, this paper aims at identifying the OSH-related factors and to work them into a structured framework, using a Focus Group approach. This framework explains each factor on the basis of a set of sub-factors, and clusters the factors into areas of affinity, thus creating three different levels of detail. Finally, the areas of affinity are worked into a hierarchical structure. The hierarchical structure and the three levels of detail are the tools enabling a rational planning of the interventions.**

Keywords – **OSH factors, interventions, SMEs**

I. INTRODUCTION

Work-related accidents and diseases are common in all parts of the world and often have many direct and indirect negative consequences for workers and their families. This fact not only has a considerable human dimension but also has a major negative impact on the economy. The enormous economic costs associated with poor safety and health at work inhibits economic growth and affects the competitiveness of countries. Because of these reasons, an ongoing and sustainable reduction in accidents at work and occupational diseases is one of the objectives of the European Union (EU) [1]. The EU Commission has launched a new five-year strategy for Safety and Health at work, which covers the period of 2007 to 2012 and aims to reduce by 25% the total incidence rate of accidents at work [1]. To achieve this goal it calls for action by players at all levels – European, national, local and workplaces. In particular, key players to reach this goal are Small- and Medium-sized Enterprises (SMEs).

Following the daily news, it is easy to get under the impression that the European economy is dominated by large, multinational enterprises: what usually gets lost is that more than 99% of all European businesses are, in fact, SMEs. Moreover, between 2002 and 2008, the number of SMEs increased by 2.4 million (13%), whereas the number of Large Enterprises (LEs) increased by only 2000 (5%) [1]. The Occupational Safety & Health (OSH) conditions in SMEs are very often poorer than in the larger enterprises: publications reviewed by Cagno et al. [2] show that there are higher accident rates and worse consequences. This situation occurs for different reasons.

It is firstly possible to consider the scarcity – with regard to LEs – of human, economic and technological resources [3-4]. From another point of view, some papers [5-6] focused on the lack of capacity of Small Enterprises to assess and control risks in an effective way. Even if literature proposes a lot of risk assessment methods, these methods have been developed for LEs and it is now acknowledged that methods developed specifically for LEs cannot be simply transferred to smaller enterprises. Last but not least, further studies (as reviewed by [2]) have underlined that the low level of occurrence of accidents and injuries a SME can experience lowers risk perception, alters approach to risk control and changes the management priorities. Thus, only large severity accidents can have a long term impact on OSH management system, but it can often be too late to intervene.

Summing up, the absence of clear risk assessment techniques and the low risk perception directly affect the way of selecting OSH interventions. Indeed, in this context, OSH interventions will depend much on entrepreneurs and/or managers "limited" experience – if lucky case – and on instinct. Thus, the effectiveness of improvement interventions becomes weak, and SMEs lose a powerful way to improve their safety performance. Moreover, considering the scarcity of resources that SMEs can invest on the improvement of their OSH performance, the importance of a correct selection of the OSH interventions becomes plain.

As a result, the analysis of company OSH-related factors - and their interactions - is a crucial research issue in order to better understand how improvement interventions can impact on companies' OSH-performance. All the possible interventions can be related to different OSH factors; a clear understanding of the relative position in the causal chain and of the level of detail of a factor, would enable to effectively identify and prioritize the OSH interventions themselves.

On the basis of the above, the aim of this paper is to identify the OSH-related factors and to work them into a structured framework. This framework explains each factor on the basis of a set of sub-factors, and clusters the factors into areas of affinity, thus clarifying the level of detail each factor – and each related intervention – can be classified at. Finally, the areas of affinity are worked into

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a hierarchical structure, thus clarifying the level of causality of each factor and, so, of each related intervention.

II. THE DESCRIPTIVE FRAMEWORK OF ANALYSIS

Having in mind the safety picture of SMEs, the suggested framework bears the following main features:

1) Systemic: this allows the treatment of all relevant factors determining safety performance in a company. Global treatment of these factors is, as yet, absent from the literature, in the sense of a meaningful group of connected factors. In contrast, existing studies dig deeper into specific safety aspects; generally, they examine a single factor related to safety and analyze its influence on company dynamics. Such an approach, while it allows better understanding of safety dynamics, does not enable a holistic dealing of the subject. From a practical point of view, a global approach enables each SME to understand, first, the framework in which a given intervention takes place and, second, the aspects that a given intervention emphasizes or neglects.

2) Intervention oriented: this allows allocating resources for improving performance in both a rational and a well-structured way, by means of a proper prioritization of the interventions themselves. The analysis of the interactions between factors allows to understand how a specific intervention may modify the company's safety performance [2]. Each intervention, in fact, stems from either a negative performance in relation to a specific factor, or from a desire to improve company performance in relation to a given factor. Understanding the role that a single factor plays in OSH performance is also understanding the role of connected interventions, and it allows defining a structured scheme to carry out such interventions. According to Mohaghegh [7], any model that intends to establish causal connections between factors and a company's safety performance, shall consider two dimensions: "depth of causality" and "level of detail".

"Depth of causality" defines the level of the "causal chain" from which the model starts in order to establish the causal connections that allow to characterize the company performance. In order to improve the safety level, it is possible to act from the top, e.g.: at corporate policy level, thus impacting on a great number of factors or, to act from the bottom on one specific single factor. The framework proposed here intends to rank the relevant factors. The top and bottom of the hierarchy stand for, respectively, the highest and lowest levels of the causal chain. The proposed hierarchy enables one to comprehend the relative position of each single factor – and thereby the impact of all interventions thereto connected – within the causal chain. The hierarchical structure is thus the first tool provided by the framework enabling a prioritization and a rational planning of the interventions.

In the above cited model [7], "level of detail" defines the specificity of the features of the company under scrutiny. It is possible to speak about more or less specific characteristics when referring to OSH factors, e.g.: "billing company characteristics" is more specific than "company characteristics". As such, the proposed framework intends to organize the OSH factors in various levels, by decomposing factors into sub-factors and by clustering factors in areas of affinity. These three "levels of detail", i.e. affinity areas, factors and sub-factors, allow an exhaustive ranking of factors and so, of their connected interventions.

One specific intervention may well aim at improving performance within a given affinity area, or instead, be restricted to one particular factor. Just like before, an intervention can be more or less specific, i.e., the higher or lower level of specificity in a factor is directly connected to the higher or lower level of interventions' specificity. The three level structuring of the factors is, thus, the second tool allowing a rational planning of the interventions.

3) SMEs-specific: this takes into account the peculiarities of SMEs. Currently, this type of treatment is hardly covered in the literature. The models that deal with factors related to safety performance are, in most cases, intended for large corporations, or have been developed following case studies in big companies. Even from a practical point of view, the operational tools which allow companies to analyze safety problems are mostly intended for large companies and are not directly transferable to SMEs without losing effectiveness.

In short: in all enterprises, but especially within the SMEs context, the *identification and prioritization of interventions* aimed at improving OSH performance, should take into account the relevant factors. However, this should not be done on a one-to-one basis, but rather through a meaningful group of connected factors, which together impact on the OSH performance and on the overall performance. This is surely more effective (attaining the objective) and also more efficient (using less resources).

III. ANALYSIS PROCESS AND RESULTS

Three successive steps have been taken within the 'framework definition' given before.

A. Step 1- Factor and sub-factor definitions

Dealing with SMEs' safety at a global level requires a research methodology that widens available data [8]. Such a methodology, usually referred to as Focus Group, is a team approach in which a group of specialists discuss the subject-matter under the conduction of moderators. This approach allows recreating a situation similar to the ordinary opinion making process, allowing participants to express themselves in a free communication process, or "peer communication". Being a lightly structured method, it allows participants to deal with a topic quite freely, to explore previously neglected areas, and to provide new

ideas. Various other researchers have underlined additional advantages of using Focus Groups such as: validity of results [8], its low implementation cost and high repeatability [9]. The Focus Group that was set-up in this work comprised five main contributors:
- Two Senior OSH-researchers;
- The Vice-President of an SME Association, owner of an SME and Safety Representative;
- An OSH-physician from INAIL (Italian Workers' Compensation Authority);
- The Director of an INAIL Provincial Head Quarters.

The discussions were split into twenty four sessions of 3-hour each, representing a total of 72 hours of talks. The purpose of the discussions were twofold: 1) defining all the factors that determine safety performance within SMEs, and 2) defining sub-factors. In some cases, only a single factor is registered: in such cases, sub-factors provide a more operational measure of their specific factor, which is thus ranked at a higher level of detail.

B. Step 2 – Clustering the factors in affinity areas

In the second phase, the Focus Group members were asked to express their judgment on the relationships among the factors themselves. The data obtained were summed-up by using the Ranking Order Clustering (ROC) algorithm [10]. ROC was developed to gather pieces into families and families into machines, and it can also be used for registering the data holding *conceptual affinity* between factors, within a matrix with value 1 and 0. Through successive (i.e., iterative) ordering of columns and rows, it is possible to select factors that can be grouped in the same affinity area. A meaningful title was given to each area obtained by this process; the title is able to embrace all the factors therein contained. The results from the first two phases are presented in Table 1.

C. Step 3 – Hierarchy definition

Before defining the hierarchy, we have established which of the three levels of detail should be taken into consideration; as a result, we have decided to structure this hierarchy using the affinity areas. In such way, we have kept the hierarchy as generic as possible, in order to make the framework flexible with regard to the characteristics of the various companies.

Depending on the specific situation, each company can, in fact, choose an intervention based on different levels of detail. Within an interaction between two areas (top level), there are a lot of interactions between factors. So, enterprises are free to choose the interactions that best meet their needs.

Once the detail level had been established, the Focus Group discussion was oriented towards the definition of the existing causal connections between the various affinity areas. The analytical tool applied in this last instance was the Interpretive Structure Model (ISM), which is a computer-assisted learning process that allows individuals, or groups, to develop a map of the total existing relationships among the various elements present in a complex system. The basic idea of such a model is to capitalize on the knowledge and experience acquired by experts, in order to break the system down to multiple subsystems and then build a multi-level structural model. [11-12]. The results of the implementation of the ISM model are illustrated in Figure 1.

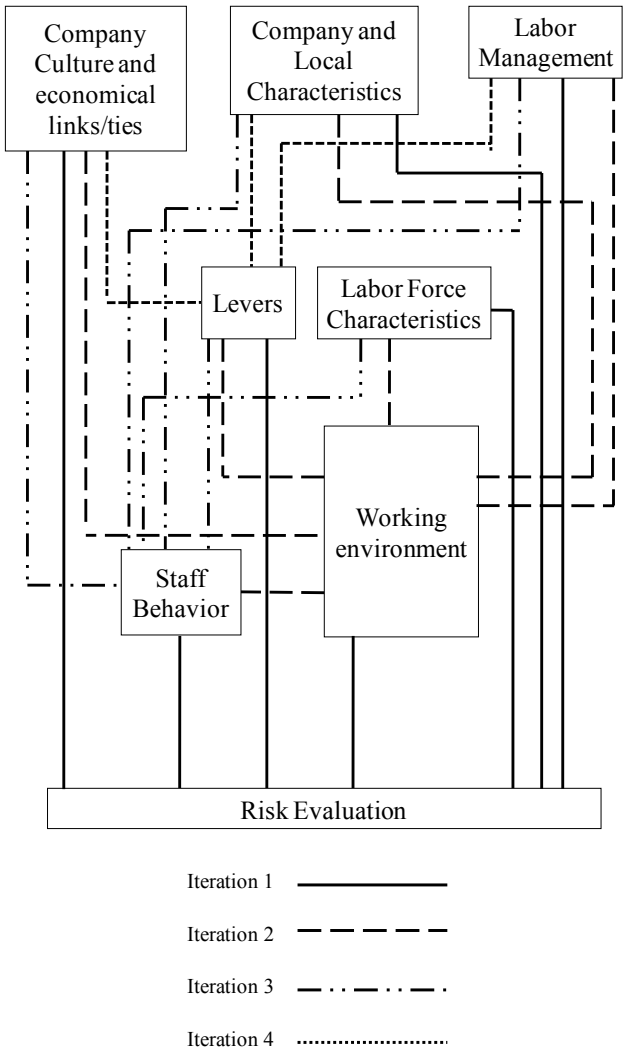

Fig. 1. Results from implementation of the ISM model.

What comes to the surface from the implementation of the ISM model (Figure 1) is that each affinity area impacts at least indirectly on the riskiness situation in the company (i.e., Risk Evaluation), but also each one in a very different way. What does immediately impact on the Risk Evaluation, are, for instance, the Staff Behavior and the Working Environment, which means that a company has an immediate impact and great control on interventions from such areas.

TABLE I
FACTORS, SUB-FACTORS AND AFFINITY AREAS

Affinity Area	Factors	Sub-factors
Company Culture and economical links/ties	Company Culture	Explicit, existing Company Policy; Will to obtain and keep a company safety certification
	Availability and use of resources	Safety Budget allocation; Budget–Actual Conformity
Levers	Premium System	Safety Budget attributed to staff in the form of premium; Actually allocated safety premiums; Maximum premium percentage attributable to remuneration; Percentage of staff remunerated with safety performance incentives
	Penalty System	Internal Penalty System Levels; Maximum penalty remuneration percentage
	Supervision	External supervisory staff; Internal Supervisory Staff; Percentage of Premises covered by Supervision
	Hiring Criteria	Average number of specified certifications for a safety worker
	Training	Average training hours in a working-year; Average training hours for the newly-hired; Specified training; Managing Cultural Sub-layers (cultural differences); Budget allocated to Training; Budget – Actual Conformity for Training Costs
	Information	Average information time-lapse for the newly hired; Information capillarity; Information communication speed following a change; Budget allocation for information; Budget to Actual conformity for Information
	Audit	Number of Internal Audits per year; Number of External Audits per year
	Communication & feedback Systems	Quantity of non-compulsory information transmitted; Percentage of people to whom they are transmitted; Average information transmission time-lapse
	Existence of program plans	Training Plan; Technical and maintenance updating plans; Product substitution plans; Audit programming plan; PPE standard and innovation substitution plans
Staff Behavior	Orientation towards active participation to safety	Accepted worker suggestions
	PPE (Personal Protection Equipment) good practices	Percentage of staff systematically using PPEs in a correct way; Percentage of accidents and non-conformities not linked to incorrect use of PPEs
	Respect of operational procedures	Respect of operational procedures
	Correct use of machinery and tools	Percentage of non-conformity not linked to improper use of machinery and tools
	Correct use of substances	Percentage of non-conformity not linked to improper use of substances
Working environment	PPEs in good conditions	Percentage of accidents and non-conformities not linked to worn out PPEs
	Equipment in good conditions	Percentage of accidents and non-conformities not linked to machinery and equipment in bad conditions
	Working premises in excellent conditions	Percentage of company premises without layout variability; Percentage of accidents and non-conformities not linked to messy and/or dirty work places
Labor Force Characteristics	Age	Average age of work force
	Worker seniority	Number of years working in company; Number o years in specific activities; Prior experience
	Gender	Work-force composition by sex (M – F)
	Integration level of non-EU personnel	Percentage of EU staff; Language understanding level; Country of origin and length of stay in Italy (=cultural vicinity)
	High unemployment rate	Unemployment rate
	Working hours, shifts and recurrence to overtime	Number of shifts; Recurrence to overtime
	Remuneration and hierarchy	Average remuneration; Flat hierarchy
	Type of contract and duties	Time lapse; Goals (=extent of duties)
Company and Local Characteristics	Location and mobility	Percentage of staff traveling less than one hour to get to work; Nearness of production plant to provincial seat; Geopolitical location of production site
	Company size	Company size by billing (total sales); Company size by staff (number of employees)
	Company structure	Juridical nature; Company ownership
	Sectorial risk	Sector, subsector, INAIL code number
	Labor Union active presence	Role of Labor Union
Labor Management	Personnel variation	Staff Increase/Decrease
	Personnel turnover	Personnel turnover (number of workers in and out annually)
Risk Evaluation	Frequency Index	Working accident frequency Index
	Severity Index	Working accident severity Index
	Occurrence probability Index	Risk probability (likelihood)
	Risk magnitude Index	Risk magnitude (severity of injury)

The question is: how can companies change Staff Behavior and Working Environment? Of course, they can intervene on them, e.g. by means of the reduction in the layout complexity and variability (see Table 1), but they can also decide to intervene on areas somehow easier to manage, like Levers and Labor force characteristics, knowing that the causal chain will imply a direct impact on the Risk Evaluation, but also an indirect one (via Staff Behavior and Working Environment). Finally, areas such as Company Culture and Characteristics are not so easy to change, but they are shown to be of great importance because they spread their impact onto the remaining areas, so as to have a huge cumulative impact on the Risk Evaluation.

IV. CONCLUSION

Caring for the safety and health of workers is a strategic priority. Companies attempt to improve their safety performance by various means or interventions; the latter are not, however, planned according to a specific and well structured analysis. The identification of relevant factors that characterize safety within SMEs, and their causal connections, constitute an essential research stream to compensate for the above mentioned missing analysis.

The proposed framework is systemic, intervention-oriented and specifically intended to meet SMEs needs. To set up the framework, all OSH-factors were identified, and this has widened and updated previous work by Cagno et al. [2]. The factors were clustered into affinity areas and also broken down into sub-factors, in order to define the level of detail of interventions. The affinity areas were organized into an hierarchical structure, which allows understanding at what level (of the causal chain) a given intervention operates.

As a result, the framework helps to understand which are the best choices among several possible interventions, enabling to identify and properly prioritize them.

Further research may consider the extension of the framework to a not specifically SMEs and generic context.

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