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KEY ASPECT OF SAFETY AT WORK: A COMPREHENSIVE LITERATURE REVIEW

Maria Cristina Arcuri[1]*, Gino Gandolfi[2], Riccardo Melloni[3]
*[1]*Research fellow, CRIS, Università degli Studi di Modena e Reggio Emilia SDA Assistant Professor of "Banking and Insurance", SDA Bocconi School of Management Viale Rustici 52, 43123 Parma, Italy E-mail:*
[2]Full Professor, Department of Economics, Università degli Studi di Parma SDA Professor of "Banking and Insurance", SDA Bocconi School of Management Via Kennedy 6, 43100 Parma, Italy, Email: gino.gandolfi@sdabocconi.it.
[3]Full Professor, CRIS, Università degli Studi di Modena e Reggio Emilia Via Pietro Vivarelli 10, 41125 Modena, Italy Email: riccardo.melloni@unimore.it

***Corresponding Author: -**
Email: maria.arcuri@sdabocconi.it , mariacristina.arcuri@gmail.com

Abstract:-
Safety at work is a challeging issue for firms and governments worldwide. This paper presents a comprehensive literature review on occupational accidents. We analyze causes of injury and risk factors, economic and social consequences, Occupational Health and Safety Management System areas of priority and effectiveness of interventions. We highlight the key role of workers and of prevention programs. Accident prevention is a means of reducing negative effects of accidents and increasing productivity. Furthermore, prevention can raise creditworthiness and lower insurance premiums.

Keywords: - *Safety at work, Accident, Economic and Social consequences, Risk assessment, Prevention, ccupational Health and Safety Management System (OHSMS)*

1. INTRODUCTION

Occupational health and safety (OHS) is a widely debated and important issue. Although considerable progress has been made in protecting workers from occupational injury, too many employees die or are injured every year. Worldwide, every year, there are about 2 million deaths caused by accidents at work or occupational diseases (ILO, 2014). According to the latest Eurostat statistics, there were 3,515 fatal occupational accidents in EU-28 in 2012. Malta had the highest incidence, and the Netherlands, Sweden, the United Kingdom, Greece, Finland and Germany had the lowest incidences of fatal accidents. In 2012, slightly fewer than 2.5 million non-fatal occupational accidents in the EU led to an average of four lost working days per year. In Italy, after a decade of decline, fatal accidents at work increased by 16 percent between January and October 2015. Nevertheless, total injuries, including non-fatal, continue to fall, with an overall decline between 4.5% and 5% in the first ten months of 2015.

But the still existing occupational unsafety requires attention. The aim of this paper is to present a comprehensive literature review on safety at work. We analyze the main aspects of safety at work; causes of accidents, economic and social effects and Occupational Health and Safety Management Systems (OHSMS), and identify the importance of risk assessment and prevention. Occupational risk prevention can reduce negative consequences and enhance firm productivity and reputation. It can also improve creditworthiness of firms and decrease their insurance premiums.

The issue of safety at work is even more important for small and medium-sized enterprises (SMEs), which represent 99% of all businesses in the European Union (European Commission). SMEs are often characterized by a greater number of accidents than larger enterprises. Moreover, they often lack financial resourses.

The paper is organized as follows. Section 2 provides key definitions and an overview of accident causes and risk factors. Section 3 highlights the importance of worker participation in workplace safety. Section 4 describes the economic and social effects of occupational accidents. In Sections 5, 6 and 7 the OHSMS is described, and there is a discussion of the effectiveness and main features of OHSMS. Finally, Section 8 discusses risk assessment, giving an overview of the processes and methodologies for assessing injury risk and OHSMS performance.

2. Health and safety at work

2.1 Injury definition and hazard identification

Accident and injury can be defined as adverse events in a production process. Production involves different kinds of energy interactions in a controlled environment. But sometimes control is lost, and an uncontrolled energy transfer occurs, leading to an accident or injury incident. Some studies (Langley, 1988) use the terms accident and injury synonymously. However, not every accident leads to injury, but every injury derives from an incident (Khanzode et al., 2012). Specifically, injury is a (suspected) bodily lesion resulting from acute overexposure to energy interacting with the body in amounts or rates that exceed the threshold of physiological tolerance (ICECI, 2004).

In general, risk is the "considered expected loss or damage associated with the occurrence of a possible undesired event" (Nieuwhof, 1985). Occupational injury risk is the likelihood of getting injured while executing a job. All enterprises are exposed to this kind of risk and identification of hazards (for example, radiation, rapid pressure changes, mechanical shocks) should be a key activity. Identification of hazards is the first step in assessing risk of injury in a worksystem. Willquist and Torner (2003) describe three main approaches of hazard identification: (1) biased reactive approach, (2) biased proactive approach and (3) unbiased proactive approach. The first approach is based on the analysis of information after an accident. The second approach is based on identifying hazards using historical data from the system. The third approach is based on the analysis of the potential hazardous elements and potential targets (persons or equipment); in other words, analysis before the accident occurs. However, hazard identification requires knowledge of the worksystem because hazards often are specific to the workplace (Maiti, 2005). Both large and small and medium enterprises (SMEs) need to carry out hazard identification, but several studies (Buckley et al., 2008; Fabiano et al., 2004; Fenn and Ashby, 2004; Fera and Macchiaroli, 2010; Morse et al., 2004; Okun et al., 2001) highlight the importance of safety at work, and consequently hazard identification, for SMEs. This is because SMEs endure a greater load of occupational injuries and illnesses than larger enterprises, but they often lack the necessary resources for effective Occupational Health and Safety (OHS) activities (Cunningham and Sinclair, 2015). SMEs therefore need effective OHS intervention: they may require assistance with OHS planning where intermediaries play an important role (Olsen and Hasle, 2015).

2.2 Accident causes and risk factors

An extensive strand of literature examines causation of occupational injuries and illnesses. Several studies (Davis and Coiley, 1959; Guilford, 1973; Irwin, 1964; Keehn, 1959; Kunce, 1967; Kunce, 1974; Whitlock et al., 1963) suggest that certain individuals are more likely to meet accident, due to innate personality traits that can be summarized as "accident proneness". At first, accident proneness was considered to be a non-modifiable characteristic, but more recently it is thought that factors like stress, safety culture and work environment explain and affect accident proneness. Some researchers (e.g. Kjellen and Larsson, 1981) suggest that "domino theory" can be used to explain the causes of injury. This means that there can be a sequence of events like the following:

(i) ancestry, social environment, or absence of management control, (ii) individual fault or mistake, (iii) unsafe condition, (iv) accident and (v) injury. In this theory, removing any one domino ends the chain leading to accident. In this theory, only chance determines severity of injury.

Shannon and Manning (1980) however believe that injury severity is a function of worksystem characteristics. In this perspective, several papers (Leplat, 1984; Leveson, 2004; Purswell and Rumar, 1984; Singleton, 1984b) propose a holistic system approach to explain accidents. Some studies (Ayoub, 1975; Brenner, 1975; Kjellen, 1987; Hale and Hale, 1970; Wooddcock et al., 2005) use simulation-based models; others (Brown et al., 2000; Paul and Maiti, 2008) examine the relationship between different factors and the safety status of the worksystem. Others (Galli, 1999; Morel and Chauvin, 2006; Robinson, 1982; Rasmussen, 1997; Svedung and Rasmussen, 2002) use a sociotechnical system (STS) approach to analyse occupational safety. They believe that a system is composed of two interacting subsystems, social and technical. Numerous studies (Dembe et al., 2004; Simpson et al., 2005; Smith and Dejoy, 2012; Wadsworth et al., 2003) examine the risk factors of occupational injury. Dembe et al. (2004) compare personal and employment characteristics and find that the incidence of injury increases when family income is low, the worker has a rural residence and he or she is exposed to a variety of hazardous activities. Simpson et al. (2005) and Wadsworth et al. (2003) show that injury rates vary as a function of work type, decline with increasing income and age, and are higher for males than females. Smith and Dejoy (2012) examine the risk of occupational injury in terms of: (a) socio-demographic factors (e.g. sex, age, marital status, education and race); (b) employment characteristics (e.g. occupation industry, tenure in job, yearly income, usual work schedule, frequency of working at home, secondary employment or work and extra work); and (c) organizational factors (e.g. participation, safety climate, work-family interference, management-employee relations, organizational effectiveness, job content, advancement potential, resource adequacy, and supervisor support). Smith and Dejoy (2012) find race, occupational category, and work-family interference as risk factors, and safety climate and organizational effectiveness as protective factors for occupational injury. Jeong (1999) shows that increase in age increases risk of injury while Bennet and Passmore (1984) find the opposite. Salminen (2004) states that young workers are at higher risk of non-fatal incidents, while older workers are at higher risk in fatal injuries. Gun and Ryan (1994) find no correlation between age or experience and injury incidents.

Many studies (Haslam et al., 2005; Leigh et al., 1990; Maiti et al., 2001; Maiti et al., 2004) focus on job-related factors (e.g. occupation, location of work, job responsibility) as predictors of injury. In general, negative traits like risky behavior, violations, and negative affectivity contribute to increasing the injury rate (Hill and Trist, 1953). Workers who consider their work environment to be healthy had a high level of satisfaction and commitment and lower turnover intention and absenteeism. Workers‟ perceptions, attitudes, motivation, decision-making and behaviors are affected by management and organizational factors (Makin and Winder, 2008; Vredenburgh, 2002).

Several researchers (Dejoy et al., 2010; Dejoy and Southern, 1993; Shannon et al., 2001; Smith and Sainfort, 1989; Zacharatos et al., 2005) study the relationship between organizational factors and the occurence of work-related injury. Brown and Leigh (1996) believe that organizational climate has a strong impact on motivation to achieve work outcomes. The "safety climate" is a specific form of organizational climate and consists of individual perceptions of the safety level and value in the workplace. Among organizational factors, higher management, supervisor support, greater safety climate and smaller workgroup sizes (less than 15) are found to be associated with low injury risks. Organizational factors could therefore be the source of failures which lead to organizational, environmental and social loss. Makin and Winder (2008) conceptualize the "human performance focused Safety and Health (S&H) management practices" as a subset of the comprehensive S&H management system which influences the „people part‟ of organizational risk. The human performance focused S&H management practices are policies, processes and procedures which organizations can use to increase the probability that workers will make safe choices and, in turn, decrease the probability of incidents. Yorio and Watcher (2014) find that the following practices are potentially important for improving human safety performance: pre- and post-task safety reviews, safe work procedures, hiring for safety and health, cooperation facilitation, employee involvement in implementing specific safety and health related processes, safety and health training, communication and information sharing, accident investigation, detection and monitoring of performance deviation, and safe task assignment. These authors also find that human performance focused S&H management practices can negatively predict rates of occupational injuries and illnesses. In conclusion, safety climate is important because of its relation with both injury rate and safety performance (Gillen et al., 2002; O‟Toole, 2002; Zohar, 2010). Living habits also appear to have an association with injury rate (Dawson, 1994; Zwerling et al., 1996).

Sedano de la Fuente et al. (2014) analyse the potential impact of the recent economic crisis on occupational injury rates and accident severity, in terms of both the number of injuries and the probability of a worker having an injury. Consistent with previous literature (Davies et al., 2009; Kossoris, 1938), they find that all types of injury have fallen. They also find that older workers, workers with more experience, women, workers in larger companies and with permanent contracts have a lower probability of injury.

3. Worker participation in workplace safety and health

Strategic human resource practices are key drivers of organizational performance, including safety performance (Guthrie, 2001; Huselid, 1995; Parker et al., 2001; Way, 2002). Working practices aimed at increasing employee knowledge, skills, motivation, involvement and empowerment are therefore very important (Arboleda et al., 2003; Evans and Davis, 2005; Vassi and Lucas, 2001). Several studies (Didla et al., 2009; Neal et al., 2000; Neal and Griffin, 2006) emphasise the importance of worker participation in workplace safety and health. Workers are key internal stakeholders and can contribute to creating a comprehensive and critical view of the organization. Worker consultation is therefore important for audit activities.

Generally, the process of auditing concerns the domain of finance and accounting, and compliance with regulations on financial accountability and transparency. It can however be extended to include corporate social responsibility. Social audit aims to assess environmental and social responsibilities of the firm, including OHS management. Blewett and O‟Keeffe (2011) consider the lack of worker participation as a failure of social audit. In this view, measuring the level of OHS performance requires consideration of organizational factors including worker consultation. For this, focus groups can be conducted to discover latent conditions and failures and to prioritize the interventions. These *in situ* simulations can be carried out using failure modes and effects analysis - FMEA (Davis et al., 2008). Furthermore, worker engagement contributes to raising general safety performance in organizations. In fact, together with other factors (e.g. communication, management values, organizational practices), employee involvement in workplace health and safety contributes, to predicting occupational accidents (Brown and Holmes, 1986; Dedobbeleer and Beland, 1991; Dejoy, 1994; Hofmann and Stetzer, 1996; Niskanen, 1994; Zohar, 1980).

Organisational culture and learning are essential for employee participation. Organisational learning includes the development of new knowledge, skills, behaviours, and the remedy of errors, the improvement and the development of practices (Daft and Weick, 1984; Easterby-Smith, 1997; Levitt and March, 1988). The organisational context is important because of the incremental development through organisational learning (Anand et al., 2009). Activities that support organisational learning include training, the identification of performance through measurement and documentation, activities that encourage worker participation and reflection. Employee participation in problem solving, for example, requires motivating people with a good level of knowledge.

Improvement in health and safety performance and management is often required to obtain certification, such as OHSMS certification through OHSAS 18001. This is a form of soft regulation covering fulfillment of legal obligation and commitment to the continuous improvement of health and safety conditions (Fernàndez-Muniz et al., 2012; Hohnen and Hasle, 2011). Typically,compliance with OHSAS 18001 is determined by audit activities (Robson et al., 2012). To assess improvement in practices at firm level with regard to health and safety, Granerud and Rocha (2011) apply the management perspective of *continous improvement (CI)*. CI is a way of organising and supporting organisational learning (Bessant and Francis, 1999; Oliver, 2009). It is a management approach that incorporates workers‟ suggestions regarding different aspects of the production process. It is a means of involving workers in improving initiatives (Ellstrom, 2001). The characteristics of organisational learning and CI practices determine the level of CI performance. Granerud and Rocha (2011) find that firms with wider worker involvement and with the integration of CI and OHSMS into the whole organisation show more advanced types of health and safety improvements. In other words, the best organisations make use of employee suggestions in health and safety along with routine worker participation.

4. Economic and social consequences of occupational accidents

The total effects of occupational injuries and diseases extend beyond direct physical injury and include a wide array of social and economic consequences (Anderson et al., 2010; Keller, 2001; Schulte, 2005). Workers‟ families, employers and the wider community are also affected by occupational injuries and diseases (Boden et al., 2001). Dembe (2001) states that an occupational injury or illness can affect every aspect of life; career, leisure activities, personal and group relationships, family responsibilities, religious orientation and practices, etc.

Injuries and illnesses have a potentially big economic impact. They may determine changes in the employment and earnings of the injured worker, negative effects on productivity and competitiveness and economic costs. Several studies (Boden and Galizzi, 1999; Leigh et al., 1997; Miller and Galbraith, 1995) point out that greatest economic burden of occupational injuries falls on workers and their families. This burden consists of lost earnings, medical and non-pecuniary costs.

Reville et al. (2001) analyze the employers‟ costs resulting from occupational injuries and illnesses. They include the costs of worker compensation, the costs of hiring and training replacements for injured workers, the time devoted to the consequences of the injury/illness, the negative productivity impact and the deterioration in labor relations. Among the accident costs for companies, Battaglia et al. (2014) also consider the increase of insurance premiums.

Some of the costs of occupational injury and illness are clear, but the non-economic effects are more difficult to quantify (Weil, 2001). The non-economic effects of occupational injuries and illnesses can be enormous: the injured worker‟s ability to perform their social, work and family role is compromised. Some researchers (Nocon and Booth, 1991; van der Sluiis et al., 1998; Williams,

1989) examine the social consequences of human illness. Others (Ewan et al., 1991; Keogh et al., 2000; Morse et al., 1998; Pransky et al., 2000; Tarasuk and Eakin, 1994) focus on the social effects of work-related illnesses and injuries. The injured workers and their families may suffer significant hardship because of lower earnings, lower self-confidence and self-esteem, depression, anger and physical limitations. In fact, injured workers often report more difficulty in daily life in activities such as writing, bathing, child care, household chires, and driving a car (Keogh et al., 2000). Moreover, occupational injuries potentially impact on coworkers, employers, medical care providers, insurance administrators, labor unions, lawyers (Dembe, 200

First, the extent of social consequences varies according to the extent of injury, so different types of occupational injury need to be identified. Second, the attributes of injured workers (e.g. gender, age, race, nationality, education, social class) may affect the entity of social effects. Third, it is interesting to consider the stage of a patient‟s response to injury and consequential recovery. For example, depression can sometimes develop after a prolonged period of disability and pain. Some studies (Cheadle et al., 1994; MacKenzie et al., 1998) focus on return to work and note that it is influenced by numerous factors (e.g. characteristics of worker and his/her family, social and economic environment). Feuerstein and Thebarge (1991) find that the duration of work disability is longer for patients who experience psychological stress. Imershein et al. (1994) show that injured workers with lower levels of education take longer to return to work after an injury than those with higher levels. Brewin et al. (1983) find that pre-injury job motivation and satisfaction are significant predictors of return-to work, while MacKenzie et al. (1998) find no evidence of this effect. Finally, the availability of suitable work, labor market conditions, and the injured person's skills and experience can also affect the return to work after an occupational injury or illness (Dembe, 2001). The literature reveals various approaches to evaluating the economic consequences of work injury and illness. Weil (2001) distinguishes between workplace fatalities and disabilities and nonworkplace disabilities and compares the three following approaches to measure the cost of fatalities: (1) present value of future earnings, (2) contingent valuation and (3) compensating wage differential. The first approach (Leigh et al., 1997) calculates the present value of foregone earnings stream given assumptions about earnings growth, age and discount rate. The present value of future earnings is an ex post measure of the direct economic loss at the time of death. The second approach (Jones-Lee et al., 1995; Hammitt and Graham, 1999) is a survey-based procedure eliciting willingness to pay for lower risk of death. The third approach (Kneiser and Leeth, 1991; Viscusi, 1993) determines differentials in wages attributable to small differences in risk used in calculating implied value of life. In equilibrium, wage reflects the premium required by the marginal worker for facing the level of fatality risk characterizing the firm. Moreover, three methodologies are proposed for valuation of the earnings impact of work disability.

The fixed earning differential used for disabled workers (Leigh et al., 1997; Miller and Galbraith, 1995) uses fixed ratio of lost earnings as basis of aggregate calculation. The projected earnings based on growth factors measures losses by substracting observed post-injury earnings from projected earnings based on growth factors. The third methodology compares a worker compensation cohort of disabled and less severely affected workers versus a cohort of non-injured workers from the same firms.

Finally, Weil (2001) describes three ways of evaluating the economic consequences of nonwork disability. These are the change in injured worker‟s household income, the change in allocation of the time dedicated to household activities by the injured worker and members of household, and the quality of life.
The literature on the economic and social effects of occupational injuries and illnesses underlines the importance of educating companies and increasing the effectiveness of occupational health and safety management.

5. OHSMS

Several definitions of an Occupational Health and Safety Management System (OHSMS) exist (Robson et al., 2007). Some definitions are too vague; for example in the definition used by the International Labour Organization (ILO, 2001), an OHSMS is „„„a set of interrelated or interacting elements to establish OHS policy and objectives, and to achieve those objectives.‟‟‟ In this definition, it is not clear whether the management system includes only management components or technical and operational components as well. Nielsen (2000) also notes that OHSM systems are not a well-defined set of management systems. There are no clear boundaries between OHS activities, OHS management, and OHSM systems. In general, OHSMSs are distinguishable from traditional OHS programs by being more proactive, better internally integrated and by incorporating elements of evaluation and continuous improvement. Redinger and Levine (1998) identify the specific elements of an OHSMS. They construct a universal OHSMS model containing 27 elements. The 16 primary elements of their model are the following: (1) management commitment and resources, (2) employee participation, (3) occupational health and safety policy, (4) goals and objectives, (5) performance measures, (6) system planning and development, (7) OHSMS manual and procedures, (8) training system, (9) hazard control system, (10) preventive and corrective action system, (11) procurement and contracting, (12) communication system, (13) evaluation system, (14) continual improvement, (15) integration, (16) management review.

Cambon et al. (2006b) identify two dimensions in an OHSMS: structural and operational. The structural dimension is the formal description of the efforts made by the firm in managing occupational health and safety. These are the safety management processes (i.e. hazard identification, definition of safety policy, communication, implementation of documentation) encoded in policies, rules, procedures and guidelines. Structural performance corresponds to the level of compliance of internal processes with safety standards. The operational dimension is the impact the system has on workplace and practice, in other words, the implementation of policies, rules, procedures and guidelines. Cambon et al. (2006a) state that the global performance of an OHSMS needs to consider both structural and operational performance.

6. The effectiveness of OHSMS

The core of an OHSMS is the control of risk (Gallagher and Underhill, 2012), and a wide range of literature investigates the effectiveness of OHSMS actions. Several studies (Cohen, 1977; Mearns et al., 2003) examine the correlations of low injury rates in organizations and show that a more developed OHSMS is correlated with a lower injury or illness rate. Moreover, there are OHS economic outcomes (e.g. firm insurance premiums and workplace productivity) and a potential positive impact on learning process (Zwetsloot, 2000).

Robson et al. (2007) consider an OHSMS intervention when it addresses two or more of the 27 elements in the Redinger and Levine (1998) universal OHSMS framework with at least one of these being a management element.

OHSMS interventions are either mandatory or voluntary. Mandatory initiatives derive from government legislaztion and their use is enforced through inspections and fines. Voluntary initiatives are not linked to regulatory requirements and arise through private enterprise, professional organizations, government, agencies, associations and employer groups. Many researchers (Alsop and LeCouteur, 1999; Bunn et al., 2001; Edkins, 1998; LaMontagne et al., 2004; Pearse, 2002; Walker and Tait, 2004; Yassi, 1998) focus on the implementation and effectiveness of voluntary OHSMSs. Bunn et al. (2001) examine implementation, final OHS outcomes, and economic outcomes of OHSMS interventions. LaMontagne et al. (2004), Pearse (2002) and Walker and Tait (2004) focus on the implementation. Edkins (1998) investigates intermediate OHS outcomes (i.e. safety climate). Alsop and LeCouteur (1999) and Yassi (1998) focus on economic outcomes of OHSMS actions.

Some studies (Alsop and LeCouteur, 1999; Bunn et al., 2001; Edkins, 1998; Yassi, 1998) report on OHSMSs developed and implemented in a single organization. Alsop and LeCouteur (1999) examine an OHSMS integrated with management systems for quality and the environment. Bunn et al. (2001) concern the creation of a Health, Safety and Productivity Department, which integrates all functions concerned with employee health, safety and associated productivity. Edkins (1998) investigates a new system of hazard identification, safety information management, and safety communication, overseen by a new safety manager. Yassi (1998) analyses the systematic identification, measurement, and control of OHS risks, as well as program evaluation. Other researchers (Pearse, 2002; LaMontagne et al., 2004 Walker and Tait, 2004) focus on interventions delivered to multiple organizations. Pearse (2002) describes a community intervention with 20 small to medium fabricated metal product companies. LaMontagne et al. (2004) consider large manufacturers likely to use hazardous substances. Walker and Tait (2004) determine the impact of 90-minute consultation sessions delivered by two non-profit information centres on the OHSMSs of small- and medium organizations. The studies of implementation show the enormous development of OHSMSs. Walker and Tait (2004) highlight marked self-reported changes in terms of a policy statement being present and a risk assessment having taken place.

Bunn et al. (2001), Pearse (2002) and LaMontagne et al. (2004) report positive changes in the scores from a quantitative audit. The study on intermediate outcomes (Edkins, 1998) reports greater positive changes in the intervention group than in the comparison group, for some self-reported measures (e.g., safety culture index) and for some objective measures (e.g. confidential hazard reports, organizational actions). As for the final outcomes, Bunn et al. (2001) find a 24% decrease in illness/injury frequency and a 34% decrease in lost-time case rate over 3 years. They also find a 13% decrease in workers‟ compensation cost per employee. Yassi (1998) and Alsop and LeCouteur (1999) find decreases of 25% and 52% in premium rates, respectively.

Many researchers (Dufour et al., 1998; Lewchuk et al., 1996; Nytro et al., 1998; Saksvik and Nytro, 1996; Saksvik et al., 2003; Torp et al., 2000) focus on the implementation and effectiveness of mandatory OHSMSs. Nytro et al. (1998), Saksvik and Nytro (1996), Saksvik et al. (2003) and Torp et al. (2000) examine the Norwegian regulations on Internal Control (IC) of health, safety, and the environment. Dufour et al. (1998) and Lewchuk et al. (1996) analyse regulations in the Canadian provinces of Quebec and Ontario, respectively. The studies based on the Norwegian IC regulations show an increase from 8% to 47% of workplaces fully implementing the IC requirements over the period 1 year to 7 years post-intervention (Nytro et al., 1998; Saksvik and Nytro, 1996; Saksvik et al., 2003). Saksvik and Nytro (1996) find that, in 1993, a considerable portion of workplaces credited the legislation with improvements in various aspects of an OHSMS. They also find an impact on awareness of health, safety and the environment, an intermediate OHS outcome, with 39% of workplaces attributing an increase to the legislation.

The Ontario study (Lewchuk et al., 1996) examines the effect of the 1979 introduction of Bill 70 legislation on lost-time injury claim rates. The analysis concerns claims data from 1976 to 1989 in six manufacturing and two retail sectors. Results from regression analyses of the manufacturing sector data showed that Bill 70 had a significant effect, equivalent to an 18% decrease in the losttime injury rate. In contrast, in the retail sector, the effect of the legislation was small and statistically not significant. An explanation for this could be a difference in OHSMS requirements, especially the requirement for a joint-health-and-safety committee in only the manufacturing sector. The Quebec study (Dufour et al., 1998) uses pooled time series regression analyses based on the 3 years of annual data across the 19 manufacturing sectors, and specifies six different equations to explain variation in total productivity growth. The regression coefficient for the OHSMS variable, „„percentage of companies having prevention programs"" is positive and statistically significant. The authors conclude that prevention programs reduce injuries, which in turn enhances firm productivity.

7. Prioritization of OHSMS areas

Quality and safety culture are basic elements in well-managed companies. Safety managers often have to implement and mantain effective safety and health programs within budget constraints, but organizations are required to integrate safety management into the overall corporate management system.

Jervis and Collins (2001) propose a ranking of the main areas of OHSMS in the order of the corresponding cost-benefit ratio for actions for the benefit of OHS. Using an analytical hierarchy process (AHP) model, they identify six managerial-type safety program elements and indicate areas with a potentially high ROI (Return on Investment ratio). The six safety program elements ranked from highest to lowest in benefit to cost ratio are: (1) hazard prevention and control; (2) management leadership and employee involvement; (3) concurrence of bargaining agent; (4) worksite analysis; (5) documentation review and (6) safety and health training. Hazard prevention and control offers the greatest benefits in terms of improving safety performance. The authors state that a firm should have a written S&H program, and responsabilities should be clearly assigned. Employees should be involved in the safety and health program, and organizations should identify workplace hazards using a clearly defined method. Self-inspections should be conducted and regular reports drawn up.

Chan et al. (2004) focus on the implementation of OHSMS in the construction sector in Hong Kong in compliance with BS 8800. They suggest that the following 14 key process elements are the basis for a safety management system: (1) safety policy, (2) safety organisation, (3) safety training, (4) inhouse safety rules and regulations, (5) safety committee, (6) programme for inspection of hazardous conditions, (7) job hazard analysis, (8) accident/incident investigation, (9) safety promotion, (10) process control programme, (11) personal protection programme, (12) health assurance programme, (13) evaluation, selection and control of sub-contractor, and (14) emergency preparedness. The authors use the AHP model to determine the order of priority for implementing the measures. This is important in light of the different characteristics of enterprises, e.g. available resources, safety expertise and management support. SMEs, for example, normally lack resources such as capital, equipment, expertise and technical knowhow. Cost, development time, expertise requirement, client requirement and corporate image are used as key criteria. In general, SMEs tend to place higher priority on emergency preparedness, job hazard analysis and safety promotion, and lower priority on safety policy, safety training and safety organisation.

Law and Chan (2006) present a hierarchy decision model for assessing the priority of OHSMS elements in manufacturing enterprises. They use an AHP model and identify 7 decision criteria (e.g. customer requirements, insurance company requirements, employee requirements) and 13 safety management elements. Safety policy, safety organisation and safety training rank highest in the textile industry; safety training, personal protection programme and in-house safety rules rank highest in the electronics industry; personal protection programme, emergency preparedness and safety training rank highest in the printing and publishing industry. Teo and Ling (2006) study OHS in the construction sector, and use an AHP model to identify the hierarchy of issues taken into account by contractors when attempting to ensure a high level of safety on building site.

8. Safety performance and risk assessment of an OHSMS

As described above, assessment of injury risk consists of three phases: identification of hazards, evaluation of risk, and categorization of hazards based on risk index (Maiti, 2005). Risk assessment methodologies are either qualitative or quantitative (Arunraj and Maiti, 2007; Papadakis and Chalkidou, 2008; Tixier et al., 2002). Qualitative methodologies are appropriate when risks are low, and a small number of types can cover an entire range of consequences. Quantitative methodologies are appropriate when risk is high, when relevant data are available and when it is necessary to estimate frequency and injury severity.

Normally, the risk assessment process involves two decisions: (i) selection of criterion variables (ii) selection of modeling techniques. The literature shows that different criterion variables are used to estimate risk of injury. Some studies (Pines et al., 1987) use injury rate based on descriptive statistics as risk measure. Risk can be measured by the lost-time injury frequency rate, severity rate and severity index (Boyd and Radson, 1999), disabling frequency rate and disabling severity rate (Sheu et al., 2000), or the fatal accident rate (Kjellen and Sklet, 1995). These rates are calculated on the basis of incidents per time period, number of workers (Duzgun and Einstein, 2004) and manhours worked. Some researchers (Maiti and Khanzode, 2009; Maiti et al., 2009) use time between incident occurrences as criterion variable. Maiti (2010) proposes a new way of evaluating worksystem safety based on the safety capability index among other indexes. This index is developed by modelling safety in a process approach.

The literature shows that modeling techniques are also used for assessing injury risk. Rao-Tummala and Leung (1996) introduce a two-way priority matrix for risk assessment based on probability and severity of accidents. Soloman and Alesch (1989) present an index of harm methodology that compares occupational risk across industries. Many studies (Chang, 2004; Chung et al., 1986; Coleman and Kerkering, 2007; Cuny and Lejeune, 2003; Freivalds and Johnson, 1990; Khanzode et al., 2011) model injury risk through appropriate statistical distributions by matching distribution of accident frequency and consequences. Some researchers (Bailer et al., 1997) identify differential injury liability across individuals, for example depending on age, experience, occupation. Other studies (Papazoglou and Ale, 2007; Zurada et al., 1997) use soft computing techniques for measuring injury risk. Finally, some techniques are applicable in specific contexts. Quick exposure checklist (QEC), postural loading on the upper body assessment (LUBA) and rapid upper limb assessment (RULA) are methods of assessing risk of ergonomic hazard for industrial workers (David et al., 2008; Kee and Karwowski, 2001; McAtamney and Corlett, 1993). Risk of human error in a worksystem can be evaluated using techniques like the Human Error Probability Index and Cause-consequence Analysis (Khan et al., 2006; Singleton, 1984a).

A wide strand of literature deals with the assessment of OHSMS performance. Various papers (Herrera and Hovden, 2008; Junglaret et al., 2011; Kongsvik et al., 2010) identify "safety indicators". Some researchers (Blewett and O"Keeffe, 2011; Robson et al., 2012; Robson and Bigelow, 2010) show the importance of audit: OHS management audits can in fact analyse OHS management effectiveness. Furthermore, quantitative results of audits can be used as measures of safety performance.

Finally, several studies (Alteren, 1999; Cambon et al., 2006a; Costella et al., 2009; Fera and Macchiaroli, 2010; Kongsvik et al., 2010; Murè and Demichela, 2009; Papadakis and Chalkidou, 2008; Pinto et al., 2011; Podgòrsky, 2015; Rastegar et al., 2015; Redinger and Levine, 1998; Redinger et al., 2002a,b; Saracino et al., 2015; Saracino et al., 2014; Saracino et al., 2012a,b; Zohar, 1980) present different methods for assessing an occupational health and safety management system.

9. Conclusions

Recent statistics show that still far too many people meet injury or die at work today, and this research is based on the premise that there is a great deal of progress still to be made in safety at work. The paper made a systematic review of literature on occupational safety and health. Previous literature focused separately on various aspects, but here they are considered jointly, with the aim of giving an overview.

We found that many aspects of safety at work in fact require further investigation. Causes of occupational injuries and illnesses are varied, and worksystem characteristics affect injury severity.

Many factors determine accidents: socio-demographic, job-related and organizational factors. Moreover, worker participation is important: worker involvement contributes to improving safety performance. Occupational accidents have economic and social effects. The economic effects are usually easy to quantify and various approaches to measuring them have been suggested. The social effects of accidents are less clear, because they involve injured workers" ability to perform their family, social and work roles.

Overall, the literature finds that safety management needs to be made more effective, critical areas in OHSMS identified, and specific S&H interventions carried out. The literature confirms our initial assumption that prevention helps to reduce the negative consequences of occupational accidents and increase business productivity, along with the economic and financial capabilities. A further impact is the potential improvement in firm creditworthiness and reduction in their insurance premiums. In this perspective, the assessment of injury risk and the measurement of safety performance become essential. In the light of their higher exposure to occupational risk and poor financial resources, this is particularly the case for SMEs.

Future research will analyse in more detail the different methodologies available for assessing an OHSMS and selecting the best one for our purpose. In particular, we will try to assess the level of safety at work for SMEs belonging to different economic sectors.

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