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"Lean occupational" safety: An application for a Near-miss Management System design

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ABSTRACT

A critical component of a safety management system is the Near-miss Management System (NMS). An effective NMS aims to recognize signals from the operational field in order to apply more effective prevention strategies. These systems are widespread in industrial contexts characterized by a high risk level, such as major hazard and hospital sectors. Few examples occur in manufacturing processes which are characterized by different operational conditions at workplace and, consequently, different risk types. The Lean Thinking (or Management) strategy currently represents a worldwide competitive tool for improving productivity in the manufacturing sector all over the world. Thus, the application of these principles forces firms to define new approaches to design and manage the whole organization and consequently the safety management system. The paper proposes innovative design of a NMS based on the integration of principles of Lean Management in occupational safety for a worldwide automotive supplier firm. As no reference model has been previously defined, several factors have been assessed aiming to efficiently integrate occupational safety in the current Lean Management system. Innovative features characterizing the proposed model have been also discussed together with first results obtained by the full scale application.

1. Introduction

Recognizing signals (or precursors) before that an accident occurs, offers the potentiality to improve safety by developing effective prevention strategies; several industrial organizations all over the world have sought to develop programs to identify and benefit from both "ex ante" and "ex post" analysis. The first one refers to alerts, signals and prior indicators – usually defined as near-miss events – which allow to define more effective prevention strategies; the latter focuses on accident analysis. Both are the basis of the well known "Learning From Experience", LFE paradigm (Nielsen et al., 2006; Sepeda, 2006; Pasman, 2009; Dechy et al., 2012) which aims to identify knowledge derived from accident analysis as well as precursors in a structured way. The paper focuses on precursors of an accident, such as near-miss events. A near-miss event is a hazardous situation where the event sequence could lead to an accident if it had not been interrupted by a planned intervention or by a random event (Jones et al., 1999; Meel et al., 2007). Starting from pioneer studies carried out by Heinrich et al. (1980) and Bird and Germain (1966) to more recent ones (Masimore, 2007; Manuele, 2011), all authors agree with the importance of managing efficiently near-miss events in order to improve risk prevention in a firm. The level of complexity differs managing near-miss events compared to accident events: the two types differ both quantitatively – as reported in Fig. 1 – and also qualitatively. These events point out lacks in safety system as they provide "weak signals": each near-miss could heavily contribute to improve the knowledge and the safety culture in several complex industrial sectors (Mason et al., 1995; Muermann and Oktem, 2002; Nivolianitou et al., 2006; Grabowski et al., 2007; Agnello et al., 2012).

Currently, Near-miss Management Systems (NMSs) are widespread in process industry starting from chemical to petrochemical sectors (Van de Schaaf, 1995; Marsh and Kendrick, 2000; Phimister et al., 2003; Oktem, 2003; OECD, 2008; Koo et al., 2009) where they are mandatory on the Major Accident Hazard (MAH) legislations. Recently, few applications are developing in new industrial sectors such as construction and health care (Cambraia et al., 2010; Wu et al., 2010a, b).

Several papers are facing with NMSs in the chemical sector. An interesting analysis of near-miss reporting system is proposed by Van de Schaaf (1995) in the Major Accident Hazard (MAH) context. Oktem (2003) proposed a reference schema to integrate environmental, health and safety issues in near-miss management for large chemical sites. Therefore, the application of a NMS in the manufacturing sector is not widespread as several factors have

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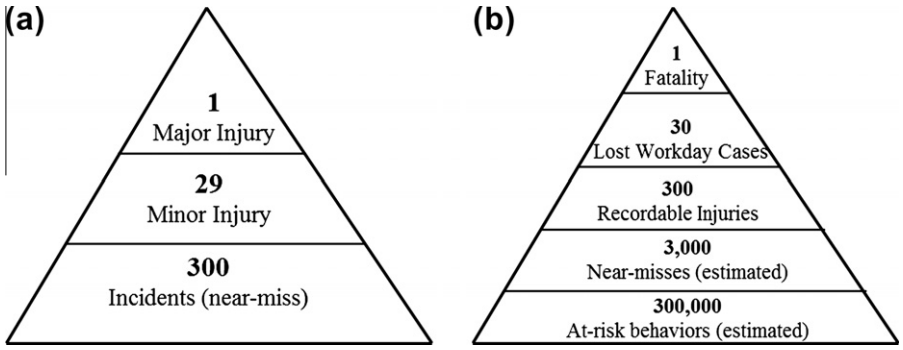

Fig. 1. Traditional representation proposed by Heinrich (a) and the more recent one proposed by Massimore (b).

contributed to. Firstly, according to a risk point of view, these production systems are quite different from the process industry. First of all, risk types are quite different: risk analysis in the manufacturing sector focuses on Occupational Safety and Health (OSH) hazards more than MAHs. Thus, the criticality is more on the frequency of occupational accidents rather than on the consequence analysis.

According to an organizational point of view, manufacturing firms are strictly oriented to guarantee a higher level of customer satisfaction and simultaneously to reduce costs. An effective strategy applied worldwide is the Lean Thinking or Lean Management concept (Womack et al., 1990), firstly developed in Toyota production sites. In brief, the focus is to reduce "waste" aiming to improve productivity in all process phases. Several tools and models have been developed to support this strategy in all core process phases such as "Just in time", "Total productive maintenance", "Six sigma" tools. Thus, several studies have been focused on analyzing how Lean Management could support performance improvement in industrial processes (Shah and Ward, 2003; Melton, 2005; Abdulmalek and Rajgopal, 2007; Bollbach, 2010; Pettersen, 2009; Behrouzi and Wong, 2011; Yang et al., 2011; Vinodh et al., 2011). Few recent works are facing with the integration of safety issues in Lean Management approaches. Several papers regard the construction sector where these concepts seem to be more common. An interesting review analysis about the integration of occupational safety management in the lean construction sector is proposed by Ghosh and Young-Corbett (2009). Court et al. (2009) described positive impacts obtained by an UK construction firm due to an effective integration of lean principles on its health and safety management system. Nahmens and Ikuma (2009) analyzed by a survey analysis the positive perception of practitioners about the application of lean principles in order to enhance both productivity and occupational safety in the construction industry. Finally, Rozenfeld et al. (2010) proposed an innovative method for analysis and assessment hazard designed to support lean construction projects.

On the other hand, very few papers analyze this prospective in the manufacturing industry. Positive contributions of Lean Management were analyzed in Brown and O'Rourke (2007): the study outlined how the intensive worker participation – i.e. typical of Lean Management – could support more effective occupational safety management as each employee has to be involved in identifying and solving problems. Moreover, authors pointed out as this feature could also contribute to reduce potential negative impacts due to frequent re-engineering of work procedures usually characterizing lean processes. On the other hand, the new paradigm could also determine potential negative impacts due to technological and organizational re-engineering (Harrisson and Legendre, 2003). Saurin and Ferreira (2009) outlined by an ergonomic study how Lean Management application affected working conditions in an assembly line of an automotive firm.

This brief review highlights that new requirements for occupational safety management in Lean Management contexts: the traditional prospective has to be changed in a more proactive one as the safety level of a firm have to be "pulled" by actual system requirement rather than "pushed" uniformly into workers and procedures.

The aim of the paper is to discuss an integration of Lean Management concepts in occupational safety: the proposed approach has been applied in the NMS design carried out for a worldwide automotive supplier firm. The paper has been organized as follows: a real Lean Management system is firstly discussed in Section 2 aiming to point out the complexity level of current occupational safety management system; the design of the NMS is detailed in Section 3. First results and critical discussion are in Sections 4 and 5 respectively.

2. Occupational safety management in the Bosch Lean Management system

Lean manufacturing concepts were first introduced by Womack et al. (1990) aiming to describe the working philosophy and practices of Toyota, the well-known Japanese vehicle manufacturers. Nowadays, Lean Manufacturing concepts are widespread all over the world in different industrial sectors (EPA, 2000; Aitken et al., 2002; Aberdeen Group, 2006). Several operational methods could be applied in different firm activities starting from production planning to environmental issues. Nowadays, Lean Manufacturing represents a core strategy in the automotive industry: the focus is the elimination of all waste in all firm activities for improving process efficiency (Wu, 2008). The present study has been developed for international company in the automotive supply chain. In detail, the firm analyzed is the Bosch Bari Plant which produces equipment for the automotive supply chain. It is one of Bosch's largest production sites in Europe and it is the most important Bosch factory in Italy. About 2200 people work in the plant, which produces braking systems, including the 'common rail' pump for diesel engines for the whole European automotive market.

Few years ago, the company has designed its own Lean Management reference model – the so called Bosch Production System (BPS) – which is currently applied in about 250 plants worldwide. It represents an evolution of the original Toyota Production Systems as new concepts concerning safety and environmental protection have been introduced. Main principles constituting the BPS are depicted in Fig. 2.

Differently from traditional process industries, "pull principles" focus on getting flow into factories by eliminating all source of "waste" in order to reduce costs and guaranteeing quality and time to customers. "Personal responsibility" concept represents one main pillar of the BPS: each employees contribute according to its own competence to improve firm performance as the