Journal of Loss Prevention in the Process Industries 22 (2009) 434–438

Contents lists available at ScienceDirect

Journal of Loss Prevention in the Process Industries

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

The costs of industrial accidents for the organization: Developing methods and tools for evaluation and cost–benefit analysis of investment in safety

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ARTICLE INFO

Article history:
Received 8 January 2009
Received in revised form
12 February 2009
Accepted 12 February 2009

Keywords:
Accident
Process industry
Economic model
Cost
Theory of constraints
Bottleneck

ABSTRACT

This paper proposes methods for reliable evaluation of the costs involved in industrial accidents for an organization – especially in relation to loss of production. We use a management approach that is based on the "Theory of Constraints". Industrial accident costs contain two major cost-categories: direct costs and indirect ones. While direct costs are easily recognizable indirect costs cannot always be easily recognized attributed to the accident. The research shows the importance of evaluating indirect costs and develops a model that calculates the real cost of an accident.

1. Introduction

This paper proposes methods for reliable evaluation of the costs involved in industrial accidents for an organization – especially in relation to loss of production. We use a management approach that is based on the "Theory of Constraints" (TOC) developed in the 1980s. TOC was planned to overcome a management failure resulting from the approach of "management by numbers" which put the American industry in an inferior position as compared to Japan. The core of the TOC is that the entire functioning of a production system is constrained by its "bottlenecks" so these points in the production process have to be managed carefully in order to reach full production capacity (Nahmias, 2001). We take this approach to develop reliable measurement methods of accident costs.

The damage caused by industrial accidents is mainly a function of the accident location in the production chain. The distinction between types of damage as a function of location is therefore critical and not at all trivial. On one hand, the number of work stations which are bottlenecks is usually small while, on the other hand these stations are the most loaded which may result in safety failures and thus accidents. Our goal is to develop a model that takes these aspects into account.

Many studies have concluded that the true cost of industrial accidents for an organization is significantly higher than the direct costs (Corcoran, 2002; Dorman, 2000; Heinrich, 1959; LaBelle, 2000; Michaud, 1995; Monnery, 1998; Neville, 1998; Shim & Siegel, 2000). The real challenge is to develop a reliable evaluation of indirect costs which are usually also the uninsured costs. Direct costs such as compensation, medical care and new equipment are usually easy for pricing and are usually insured, so the tendency is usually to concentrate on them (LaBelle, 2000; Neville, 1998; Vincoli, 1994).

The reliable evaluation of the cost of industrial accidents for an organization can help managers and workers to internalize the importance of safety measures from an economic-managerial perspective, and to locate the work stations that require investment in safety measures. Also, reliable evaluation assists managers to correctly plan investment in safety measures. Indeed, Dastous, Nikiema, Maréchal, Racine, and Lacoursie're (2008) argue that in order to manage risk properly, it will be necessary to define, implement and improve a series of processes and most importantly, provide guidance to managers (Kletz, 2001; Richardsson, & Impgaard, 2002).

The paper proceeds as follows. In the next section, we present a theoretical background for the model. In the third section, we present the model and numerical example of the calculations. The fourth section concludes the paper.

2. Theoretical background

Most organizations do not systematically calculate accident costs, owing to managers' lack of knowledge and understanding of

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doi:10.1016/j.jlp.2009.02.008

the compensation mechanisms involved in accidents. Managers tend to believe that most expenses are insured and therefore do not see a real reason to calculate these costs which requires data collection. Furthermore, the common economic approach for calculating the advantages of safety investment is based on the assumption that managements regard industrial accidents as undesired side effects, while their direct and indirect costs are assumed to be a kind of sank costs (Oi, 1974; Thaler & Rosen, 1975). According to this approach, the optimal organizational investment in safety is calculated by a standard model of profit maximization. The implicit assumption is that accidents may be productive for the organization and prevention is advantageous only if it can produce marketing and reputation benefits. Adnett and Dawson (1998) criticize this approach, arguing that the calculation method should include organizational, social and macro-economic parameters. One of the goals of the current paper is to provide tools which will help overcoming the narrow economic approach adopted by many managers.

Other possible reasons for the marginalization of accident costs by managers include: measurement difficulties, overloaded managers, biased accounting methods and the low status of safety departments (Dorman, 2000). Dastous et al. (2008) suggest that to manage risk properly, not only necessitates the development techniques but also to develop processes, at the personnel level as well as at the organizational level, which will take human nature into account. Appropriate mechanisms will also have to be set up to reconcile "public interest" and "risk management". It will thus be necessary to define, implement and improve a series of processes and most importantly, provide guidance to managers.

The real challenge in evaluating the costs of industrial accidents is to develop reliable evaluation of indirect costs which are usually also the uninsured costs. Yet, researchers have recognized also the importance on indirect costs. For example, LaBelle (2000) suggests a method for cost evaluation based on several categories: cost of time spent in relation to medical care, reduced production of the injured worker after returning to work, cost of supervision and investigation, reduced production, cost of replacement, learning and management cost and cost related to legal processes. Yet, the methods used for these evaluations are relatively old and especially lack integration of central components in the production process. Therefore, they may be regarded not reliable by managers.

The model we propose assume that as the workload increases, whether it is mental or physical workload, the probability of industrial accidents increases. This assumption is supported in the literature both theoretically and empirically (Adnett & Dawson, 1998; Sanders & McCormick, 1992: 667; Sanders & Shaw, 1988). Since the definition of a bottleneck station refers to the workload which characterizes this station, we infer that the probability for industrial accidents is relatively higher in bottleneck stations as compared to other locations in the production process.

3. The model

In order to construct a model for estimating the total cost of an industrial accident, we take into account all parameters that reflect the possible costs imposed by the accident. We start by presenting the general structure of the model in which the total cost of an industrial accident is the sum of its direct costs (C_{direct}), indirect costs (C_{indirect}), payment (C_{payment}) and immeasurable costs ($C_{\text{immeasurable}}$).

$$\text{Total cost} = C_{\text{direct}} + C_{\text{indirect}} + C_{\text{payment}} + C_{\text{immeasurable}} \quad (1)$$

The parameters that reflect the direct costs are formulated as

$$C_{\text{direct}} = C_{\text{damage}} + C_{\text{medical}} + C_{\text{fine}} + C_{\text{insurance}} \quad (2)$$

where

C_{damage}- The damage of products, equipment and machinery. Very often, an accident not only entails injuries, but also includes damage of products, equipment and machinery. This cost includes, among other things, the damage caused to machinery, raw-materials, damaged equipment, and the cost of cleaning and returning the working area back to functioning.

C_{medical}- Immediate medical treatment costs. This cost includes payment to evacuation to the hospital, payment for treatment given at the site of the accident, hospitalization, and the medical equipment that becomes unusable after the accident.

C_{fine}- If an accident is caused due to violations of safety procedures or even breaking the law, the organization may be exposed to fines and claims given by the authorities.

$C_{\text{insurance}}$- The premium increase. The annual payment a company pays as an insurance premium is determined according to an estimate of absence leave, number of hospitalization days, the severity of the accident, potential lawsuits and the financial damage of equipment, commodities and facilities. The premium varies from year to year according to the events occurring in the previous year. Thus, an accident can cause an increase of the insurance premium of the following year. Since the premium increase is a direct cause of an accident, the difference between the previous payment and the new payment can be regarded as a direct cost. In addition, $C_{\text{insurance}}$ also includes all legal expenses due to different lawsuits charged by either the authorities or the employees.

The parameters which reflect the indirect costs are formulated as (Appendix 1 presents the specific calculations for each parameter):

$$C_{\text{indirect}} = C_{\text{capacity lost}} + C_{\text{schedule}} + C_{\text{recruit}} + C_{\text{work time}} + C_{\text{wip}} + C_{\text{mang}} \quad (3)$$

where

$C_{\text{capacity lost}}$- The costs resulting from capacity loss. An accident can cause a slowdown in production and even halt it for a period of time, for example, evacuation of the injured workers and damage to the equipment which should be handled immediately (like fire). Also, an accident may result in a new bottleneck causing production processes to slow down and imposed additional costs.

C_{schedule}- When an accident occurs, slowdown in production will affect the time table schedule and causing damages to the client. Clients can cancel the contract or demand a lower price. There may be solution that the company will create the absented product by contractor that will help the company to handle the schedule.

C_{recruit}- The cost of hiring additional workers to replace the injured ones, which includes the time invested in recruiting and training the new workers.

$C_{\text{work time}}$- The work managers invest in investigating the accident. Work time is also dedicated to instruction of the simple workers. Also the additional work hours that needed to replace the injured worker (it depends on the policy of the company if there are recruiting new workers or letting the senior to work extra hours).

C_{wip}- When an accident occurs, it creates a new bottleneck. As a result, the inventory starts to grow and accordingly the cost connected to it grows as well. Managers need to find a solution to fit the inventory to the new bottleneck which will cause additional expenses. This cost is handled by specific managers and hence may vary from company to company based on managerial considerations.