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Diagnosis and monetary quantification of occupational injuries by indices related to human capital loss: analysis of a steel company as an illustration

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Abstract

Prevention of occupational injuries is an important task of human resource management. In this study, new indices of human capital loss of occupational injury including cumulative injury rate, proportion of potential workdays lost, and potential salary lost were applied to the analysis of registry data of occupational injuries from 1986 to 1994 of a steel company in Taiwan. In addition, we compared these indices with disabling frequency rate and severity rate. The results showed that the average disabling frequency rate and cumulative injury rate of the whole company were 4.12 and 0.41, respectively; and the average disabling severity rate and proportion of potential workdays lost of the whole company were 563 and 229×10^{-6}, respectively, during 1986–1994. There was no consistent improvement in occupational safety in this period. The average potential salary lost of the whole company was more than US$ 2 million per year with a discount rate of 0.04, which was equivalent to 92 times of average annual income of a worker. The major monetary loss were due to non-traffic injuries of operators and traffic injuries of non-operators, which amounted to US$ 145 and 152 per person per year. As the new indices can provide additional information on lifetime occupational risk and human capital loss in monetary values, we concluded that they may be useful supplementary tools for monitoring and analyzing occupational injury data in a company. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: Cumulative injury rate; Proportion of potential workdays lost; Potential salary lost; Potential salary lost per person

1. Introduction

Occupational injuries can harm the reputation of a company, decrease productivity, and result in huge costs. Injured workers suffer from not only pain or discomfort, but also temporary or permanent disabilities, or even death. These injuries can cause a loss of ability to work and can produce a serious impact on the workers themselves and their families, in both economic and psychological aspects. According to the estimation of Health and Safety Executive for the UK, the total costs of all work accidents and work-related illnesses are equivalent to between 2 and 3% of the total Gross Domestic Product (Neil and Paul, 1994). Thus, it is an important and challenging issue for companies and governments to effectively prevent occupational injuries.

To tackle the above problem, accurate measurement tools for occupational injuries are needed, which are efficient in application and suitable for surveillance. The current monitoring tools, such as DFR and DSR, adopted by the ANSI (American National Standard

Abbreviations: ANSI, American National Standard Institute; CIR, cumulative injury rate; CIR_{20-64}, cumulative injury rate with respect to the ages from 20 to 64; DFR, disabling frequency rate; DSR, disabling severity rate; PAWD, potential affordable workdays; PP-WDL, proportion of potential workdays lost; PSL, potential salary lost; PSLP, potential salary lost per person; PWDL, potential workdays lost; SI, Severity index; USD, United States dollar.

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Institute, 1967) and widely used throughout the world for more than several decades (Grimaldi and Simonds, 1975), have their limitations. As rates of disabling occupational injuries were different among different age strata in Taiwan (Liu and Wang, 1992, 1993), DFR, which does not take age of employment into account, can not interpret the lifetime risk of a worker, nor is it suitable for direct comparison among different mills or through time in years in a company. DSR, which counts the loss of workdays for death and permanent disability at a fixed pre-set charge regardless of individual differences in the age when injury occurred and remaining working capability, can not properly reflect future productivity loss and estimate the economic cost of occupational injuries of a company. Thus, although these two indices have been used extensively, they are not usually taken very seriously by the management for shaping occupational safety policy in a company unless there is a tremendous change in these figures. Chang and Wang recently developed CIR, PPWDL, and PSL as supplementary indices to quantify the loss of occupational injuries in the aspect of human capital loss (Chang and Wang, 1995). The newly developed indices have been used to see the time trends in occupational injuries for different industrial sectors at a national level (Chang and Wang, 1997). However, these indices have not yet been applied to show their usefulness in the analysis of occupational injuries in a firm or company. In this article, we applied the above indices to diagnose the trends and quantify the monetary loss of occupational injuries of a steelmaking company in Taiwan and compared the performance between the new indices and ANSI's indices.

2. Method and material

The object of this study is a steelmaking company (Company X) in southern Taiwan with a comprehensive registration system of occupational injuries. Detailed data on disabling occupational injuries and wage compensation of labor insurance were collected from January 1986 to December 1994, which included dates of birth and injury, sex, types of work, outcomes of occupational injuries (death, permanent disability, and temporary dysfunction), workdays lost, injured body parts (head, hand, …etc.), types of injury (cuts, falls, …etc.), injury media (powered machinery, electric apparatus, …etc.), places of injury, grades of permanent disabilities (15 grades of the Bureau of Labor Insurance for Taiwan, 1992), and finally the time charges of wage compensation in terms of days. Moreover, the personnel data, which included birthday, sex, department, and type of work were also obtained.

We applied new indices of occupational injuries developed by Chang and Wang (1995), i.e., CIR, PPWDL, and PSL; to evaluate the frequency and impact of occupational injuries of Company X. In addition, we calculated DFR and DSR by making use of the above data.

2.1. DFR and DSR

DFR is the number of disabling injuries per million person-hours worked as proposed by ANSI.

Disabling frequency rate

$$= \frac{\text{total number of disabling injuries} \times 1\,000\,000}{\text{total number of employee-hours worked}}$$

DSR is the number of days charged for disabling injuries per million person-hours worked. The time charges include the number of actual workdays lost for temporary total disability and specific scales for death, permanent total disability, and permanent partial disability. For example, death and permanent total disability are charged with the highest workdays lost of 6000 days; loss of sight of one eye, 1800 days; loss or complete loss of use of one foot at the ankle, 2400 days; etc.

Disabling severity rate

$$= \frac{\text{total disabling days} \times 1\,000\,000}{\text{total number of employee-hours worked}}$$

2.2. CIR, PPWDL, and PSL

If we take the age distribution of employees into consideration in measuring occupational injuries, cumulative incidence rate in common epidemiological measurements becomes CIR_{20-64} (Breslow and Day, 1980; Miettinen, 1985; Wang, 1990).

$$CIR_{20-64} = 1 - e^{-\sum (IR)i \times \Delta ti}$$

where i is the age stratum, $(IR)i$ is the injury rate of a specific age stratum, Δt is the span of each stratum.

However, the estimation of age-specific injury rate may be relatively unstable in a small mill because of small numbers of injuries and employees in a specific age stratum. Therefore, the value of CIR, which weighs the injury rate of each age stratum equally, may heavily depend on the span of age stratum. Trying to solve this problem, we performed repeated random sampling of the span of age stratum to obtain 30 sets of the span of strata between 5 and 10 years. We merged employees older than 50 years old into one stratum, or incorporated them into the preceding stratum because of the small numbers of workers of older ages. For example, if one set of the span of strata by random sampling was 5, 7, 7 and 8 years, the age strata were 20–24, 25–31, 32–38, 39–46, and 47–64 years old. Thirty values of CIR were calculated from 30 sets of age strata for the