Original Article

The relationship between the cost due to accidents in the drug industry and the investment in the Safety Management System

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Abstract

Introduction: Accidents in the drug industry are one of the major problems in the world. Deaths caused by occupational accidents result in the loss of life, working hours, and related costs. These accidents create a lot of wastes for the community and labour organizations. Occupational accidents lead to socio-economic losses such as disability, loss of work time, and enhancement in medical care. Despite extensive investigations, measuring the cost of accidents is still not clear and practical, therefore, the ultimate goal of the current investigation is to provide a novel framework in the determination of the direct and indirect cost of accidents in the drug industry. **Method:** In this study, by the use of a new and structured approach in Six-step, the cost of accidents in the industry has been calculated. To calculate the cost of accidents of industry in the year 2016, the intensity of accidental results were classified into 5 groups, e. i. short-term absences, long-term absence, small disability, total disability, and death, and on the basis of borne costs in six groups including production disturbance costs, human capital costs, medical costs, administrative costs, transfer costs, and other costs according to the direct or indirect costs caused by the incident and impose costs on workers, employers and society which, has been analyzed by using statistical tests. **Results**: Statistical analysis revealed the direct and indirect costs of accidents, and before and after the safety management system had a significant difference (P-value=0.007). In another word, direct and indirect costs were significant with several differences. This research indicated that the indirect cost was four times greater than the direct costs. **Conclusion**: Hence, accidents resulting in deaths, total disability, and partial disability impose huge cost borne on society and the employer than the relative cost, which is because of the health, treatment, and welfare systems of society for the treatment and rehabilitation of injured employee and his family. Therefore, investment in the safety management system is effective and associated with reducing accidents.

Keywords: Occupational hazard, healthy working environment, strategic management, risk analysis, welfare economics

Introduction

Accident is an unfortunate incident that happens unexpectedly and unintentionally, typically resulting in damage or injury [1, 2]. Accidents cause huge financial costs in industries [3]. The most important part of these costs is the human cost, and deaths caused by occupational accidents result in the loss of life and years of work [4]. Every year, millions of occupational accidents happen worldwide. Some of the accidents are fatal and others result in temporary and permanent disability [3]. Human contemporary history has noted many disasters with multi-billion dollar financial losses and human casualties include the explosion of the shuttle Challenger (1986), nuclear reactor explosion at Chernobyl (1986), accident in Mexico (1985), and Bhopal plant accident in India (1981) [5]. Approximately every year 120 million occupational accidents and more than 200 thousand deaths caused by accidents occur worldwide [6]. In India, 120 million labour force and annually 7.7 million occupational accidents have been reported, representing the loss of 3.25 working days for the occurrence of an accident [6]. In 2007, the number of occupational accidents with more than three days of

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absence from work in manufacturing companies in 15 European countries was about 942000 [5, 7]. Different industries, particularly the construction industry including the UK with 10 per cent of GDP and more than 1.5 million play an important role in the economy of world countries [8]. In the U.S, occupational accidents of construction industry led to the death of about 17.29 workers out of 100,000 between 1980 to 1992 [9]. Feng (2013) reported that safety investment in the construction industry will enhance safety culture and behaviour [10]. Also, Teo and Feng (2011) stated that investment in safety management decreases accidents and the costs borne on the industry because of enhanced employee satisfaction and the quality of life of workers [11]. These accidents have brought great losses for the community, organization and workers, and related costs along with adverse effects on economic indicators at national and household level are obstacles on the way of predetermined objectives [1, 12]. The premature mortality of the labour force is the worst consequence of occupational accidents [4, 8].

Work-related injuries are the biggest health issue worldwide and about 14 deaths per 100,000 occur because of occupational accidents. Occupational accidents result in socio-economic losses such as disability, decrease in working time, and the enhancement in health care [13, 14]. The annual human cost per foot is 3.36 billion dollars and total human costs of occupational accidents leading to death are 3% of GDP [2]. One of the most dangerous jobs is the construction industry with the accidents resulting in death and total disability at the worldwide range, but its risks and losses remain somewhat unclear [8-10].

The safety management system is a regular, systematic, and explicit procedure, accomplished with the comprehensive methods in the objective of planning, documentation, and modifying the methods to manage the detrimental factors, safe the threats and risk analysis. Like the other management systems, the safety management system is developed to provide a healthy working environment with a minimum amount of job-related incidents and dangers [10]. In this investigation, we purposed to provide a novel framework in the calculation of the direct and indirect cost of accidents by applying the safety management system in the drug industry of Iran.

METHODS:

In this investigation, by the utilization of a new and structured procedure in seven-step the cost of accidents was determined for before and after the establishment of the safety management system. To determine the cost of accidents, accidents were classified into five groups based on the intensity of the result of an accident, e. i. short-term absences, long-term absence, small disability, total disability, and death, and on the basis of borne costs in six groups including production disturbance costs, human capital costs, medical costs, administrative costs, transfer costs, and other costs on the basis of the direct or indirect costs caused by the incident and impose costs on workers, employers and society. Eventually, by the utilization of provided formulas, the direct and indirect costs of accidents and also the borne costs on employee, employers and society were determined. The technique is explained in detail below:

Step One: To measure the cost of accidents, firstly, accidents were grouped into five groups on the basis of the intensity of the result of an accident, i.e. short-term absences, long-term absence, small disability, total disability, and death [12].

Second Step: The accident was grouped on the basis of borne costs in six groups including production disturbance costs, human capital costs, medical costs, administrative costs, transfer costs, and other costs. The following explanation is utilized to measure the cost groups of accidents. Production disturbance costs (PDC) incurred in the short term until the product reaches to level before the accident. Human Capital Costs (HCC) were long-term costs, a potential decrease in production, after a restructuring of the production level before the accident happens. Medical Costs (MEDC) were costs incurred by the workers and the society during the medical treatment of injured workers in work-related accidents. Administrative Costs (ADMINC) incurred in the implementation of the indemnification projects, accident investigation, and legal fees. Transfer costs (TRANC) were deadweight losses correlated with the administration of the tax and welfare. Other costs (OTC) were costs not grouped elsewhere, such as costs of career, assistance modifications and renovations.

Step Three: each cost group in more detailed classification was classified in cost cases and then a code was allocated to each of the cost sections.

Step Four: All the accidents were classified into direct (direct = D) and indirect (indirect = I) sections, then were analyzed based on the cost borne on the employer, the employee, or society [1, 2, 10-12]. Table 1 indicates the summary of the above-mentioned cases.

Table 1. A summary of the classification of accidents in terms of groups.

Cost Group	Variable	Cases of cost
PDC: Production disturbance costs	PDC1	Overtime costs
	PDC2	Additional payments of employer
	PDC3	Cost of employee turnover
	PDC4	Employee training and retraining costs
	PDC5	Loss of current income
	PDC6	Indemnification
HCC: Human Capital Costs	HCC1	Loss of future earnings
	HCC2	Loss of governmental revenue
	HCC3	Social welfare payments for lost earning capacity
MEDC: Medical Costs	MEDC1	The threshold of medical payments

	MEDC2	Medical and rehabilitation costs
	MEDC3	Rehabilitation
	MEDC4	Health care costs
ADMINC: Administrative Costs	ADMINC1	Fines and legal sanctions
	ADMINC2	Study costs
	ADMINC3	Travel costs
	ADMINC4	Legal costs
	ADMINC5	Cost of death (funeral)
	ADMINC6	Inspection and examination costs
	ADMINC7	All travel privileges for workers with total inabilities
	TRANC1	Welfare costs of welfare payments and tax losses
TRANC: Transfer costs	OTC1	Care costs
OTC: Other Costs	OTC2	Help and changes

Step five: Statistical Analysis

Cost data were entered into SPSS 16 statistical software and analyzed by statistical tests as it follows:

First, the Kolmogorov Smirnov test was used to determine the normality of the accident cost data. In the case of the normality of Cost variable, two-way ANOVA was used to determine the significance of the differences between the type of cost of accidents (production disturbance costs, human capital costs, medical costs, administrative costs, transfer costs, and other costs) by the outcome of accidents (death, total disability, partial disability, long-term and short-term absence), accident costs (direct and indirect) and borne costs on workers, employers, and the society before and after the establishment of the safety management system. P-value< 0.05 was considered statistically significant.

A practical example of calculating costs in the Drug industry in Iran for 2016

Kolmogorov Smirnov test indicated the normality of accident cost data (P-value = 0.604). In 2016, the total amount of investment in safety management system was 533700$, that included administrative costs (34400$), educational costs (30100$), equipment costs (210000$), committees costs (31000$), costs of promotion and incentives (30200$), the cost of new technologies, methods or design tools (142000$), the costs for recognition, measure and control of risks to health and the environment (31500$), and costs for investigation, documentation and certification of the safety management system (24500$).

Table 2. Analysis of the calculated costs of accidents in the drug industry ($).

Cost Group		Result of Accident					Sum	P-value
		Short-Term Absence	Long-Term Absence	Partial Disability	Total Disability	Death		
Costs of accidents before establishment of safety management system	PDC: Production disturbance costs	86000	172000	168000	100000	42000	568000	**0.000**
	[CC: Human Capital Costs	60000	120000	75000	36000	0	291000	
	MEDC: Medical Costs	5000	80000	30000	12000	12000	139000	
	ADMINC: Administrative Costs	15000	26000	21000	24000	12000	98000	
	TRANC: Transfer Costs	3000	6000	6000	0	0	15000	
	OTC: Other Costs	11000	22000	27000	20000	18000	98000	
Costs of accidents after establishment of safety management system	PDC: Production Disturbance Costs	0	13000	0	50000	17500	80500	
	[CC: Human Capital Costs	0	60000	0	18000	0	78000	
	MEDC: Medical Costs	0	40000	0	6000	5000	51000	
	ADMINC: Administrative Costs	0	13000	0	12000	5000	30000	
	TRANC: Transfer Costs	0	3000	0	0	0	3000	
	OTC: Other Costs	0	11000	0	10000	7500	28500	

The present study indicates that before establishing the safety management system, the maximum calculated cost was related to the production disturbance cost (568000$), human capital costs (291000$), and the lowest cost was related to medical costs (139000$), administrative costs (98000$), transfer costs (15000$), and other costs (98000$). After the establishment of the safety management system, the maximum calculated cost was related to the production disturbance cost (80500$), human capital costs (78000$), and the lowest cost was related to medical costs (51000$), administrative costs (30000$), transfer costs (3000$), and other costs (28500$). The difference in the costs of accidents before and after the establishment safety management system was statistically significant (P-value = 0.000).

A significant difference could be seen between the cost of accidents resulting in death, total disability, partial disability, long-term and short-term absence (P-value=0.005), which indicates that the highest costs were the accidents resulting in the long-term absence (before: 426000$; after: 213000$). The lowest cost accident of before establishment of the safety management system was death (84000$), and after the establishment of the safety management system was short-term absences and partial disability (0 $). Statistical analysis indicated that the difference in direct and indirect costs of accidents before and after establishment of the safety management system was significant (P-value= 0.007). In another word, direct and indirect costs were significant and had several differences.

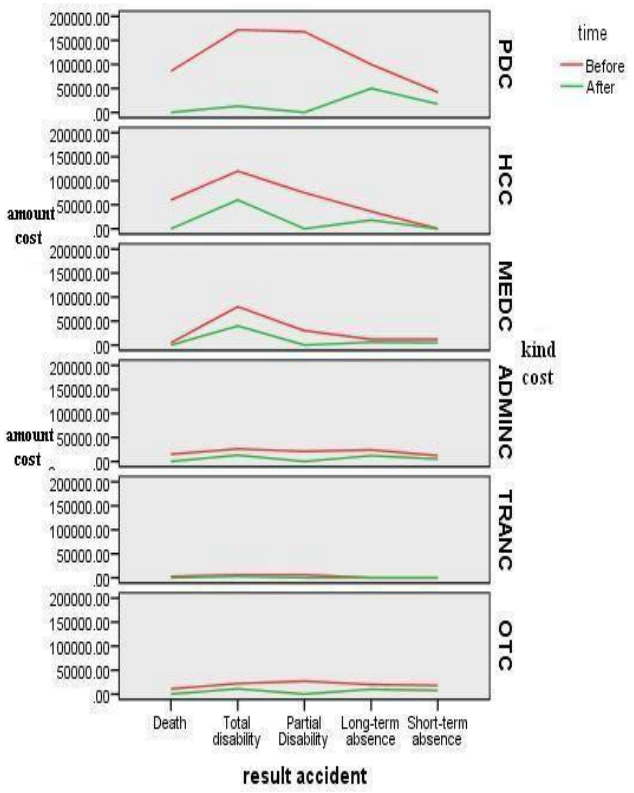

Figure1: Relation of the result of the accident with the type of accident cost.

Discussion

The present research studied the drug industry in Iran from 2016 to 2017. The results showed that the safety management system decreases the direct and indirect costs of accidents. Additionally, the system has a significant effect on the PDC and the HCC cost groups (Fig 1). study indicates that the safety management system reduced costs in all aspects of the intensity of accidents partially in the short-term absence and partial disability. The safety management system resulted in decreasing costs drastically in the aspects of total disability and long-term absence which imposed the least cost on employer. Besides, the costs of partial disability and short-term absence tended to zero.

The results of this study implied that the accident has the worst effects (death, partial or total disabilities) and impose a lot of costs on the community, but the employer suffers relatively fewer costs. The reason refers to the reimbursements that the health system committed to pay to the injured employees and their families. Accidents with less severe effects like short-term absence impose more costs on employers as the result of excessive costs, payments, and treatment for the damaged worker. However, in long-term absence, most of the costs imposed on employees due to the reduction of the salary.

In this study, we discussed the safety management system. However, Wu et al. proposed a systematic structural equation modelling (SEM) to evaluate safety performance prospectively. In this system, they categorized accident by their effects into six dimensions of falling injuries, collapses, object strikes, crane machine accidents, electric shocks, and others which was more adapted and specific for drug accidents [15]. We proposed these scales for the safety analysis of future drug projects. However, Sousa et al. emphasized on quantifying occupational safety and health risk in drug projects on the basis of the guidelines set by the international standard ISO 31000:2009 [16]. Accordingly, they suggested Health Potential Risk Model (OSH-PRM) which is designed to estimate the statistical cost of occupational safety and health risk. This study merged both qualitative scale and quantitative analysis using the safety management system.

The results indicated that the PDC with a total disability would cause the most financial loss after the establishment of the safety management system. The results are in accordance with Pinto et al. as they reported that compensation costs for medical treatment and in the drug are four times higher than in other industries [17]. However, the costs of injuries depend on the profession and part of the injured body. Waehrer et al. [18] found that the most fatalities resulting in the highest annual fatality are related to drug labourers. So, the establishment of the safety management system, as well as cost estimations, are both important in the drug industry.

Limitations:

Although the safety management system method is essential for planning preventive or protective actions in the drug industry, unfortunately, they are not commonly used, due to specific limitations for the drug industry due to lack of familiarity of managers with the technique, being time-consuming, doubts about their applicability, and requiring the availability of accurate data.

Conclusion and Future Deliberation:

Adequate safety could be achieved through sustaining a safety climate that ensures the prevention of accidents and illnesses. In this regard, management commitment, workers' specialization in the application of equipment, enough budgets for health as well as supervisory environments would help to reach a safety climate. Additionally, risk assessment in occupational safety was developed mostly by qualitative

models known as Qualitative Risk Assessment Method (QRAM). QRAM focused mostly on objective data that stakeholders' attitudes are based on. However, we suggest that evidence-based data should be provided by direct observation, interviews with workers and foremen and review of documentation of the site (health and safety plan, reporting accidents and incidents, records of meetings, work procedures), such as finding relation with other risk assessment workplaces (air pollution [19]) by reducing the cost of accident and increasing satisfaction of workers. In the future, the results of this research will reduce accidents and find a way to control the cost of the accidents leading to death.

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