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The Effect of Safety Costs on Productivity and Quality: A Case Study of Five Steel Companies in Ahvaz

Gholamabbas Shirali,[1] Reza Savari,[1,*] Kambiz Ahmadiangali,[2] and Vahid Salehi[3]

[1]Department of Occupational Health Engineering, School of Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran
[2]Department of Bio-Statistics, School of Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran
[3]School of Industrial and Systems Engineering, Center of Excellence for Intelligent-Based Experimental Mechanic, College of Engineering, University of Tehran, Tehran, IR Iran

[*]*Corresponding author*: Reza Savari, Department of Occupational Health Engineering, School of Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, IR Iran. Tel: +98-6133321628, E-mail: savarireza@gmail.com

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Abstract

Background: The implementation of a safety program is one of the most effective factors in increasing productivity. A look to safety from the perspective of efficiency can indicate necessary investment in safety for all, especially the managers of companies.
Objectives: The aim of this study was to evaluate the effect of safety costs on some indicators of productivity and quality in industrial companies.
Methods: This study was a retrospective analysis and was implemented in five steel companies in Ahvaz. The data relating to the safety costs such as staffing costs and total safety costs, and productivity and quality indicators were collected in five years. This information and data were collected according to statistics from documents and archives of safety, accounting, and production sectors of companies. Costs as well as numbers and figures of variables were expressed in the form of per capita and percentage to make the data comparable. Linear and generalized regression models and Wald Chi-Square test were used by the SPSS 22 software to determine the relationships between them.
Results: Safety costs such as capita labor safety costs and capita total safety costs or percentage safety labor costs to labor costs, showed a significant positive effect on labor productivity, labor competitiveness, total factor productivity, quality index and production rates (in some cases, P = 0.001).
Conclusions: The total safety cost and safety labor compensation generally, regardless of the nature and quality of the safety management system, can impact productivity, quality and quantity of production in addition to other factors of production. Surely if safety programs are targeted and codified, the effect of the investment will be doubled.

Keywords: Safety Costs, Productivity, Quality, Safety Management System, Safety Programs

1. Background

Economic and industrial enterprises have made attempts to ensure their own future and that of their partners through increasing their levels of productivity. In this respect, identification of various factors affecting productivity can be an important step for planning and implementation of effective designs to achieve this goal. Reducing costs and production time as well as increasing quality and improving quantity or a combination of them are considered as the manifestations of increased productivity. However, the implementation of the safety management system (SMS) is taken into account as one of the most effective factors in increasing productivity in some studies (1, 2).

It seems that many managers still consider safety investment as a part of the costs imposed on an organization (3). As a result, considering safety in terms of productivity can highlight the significance of investment in safety for everyone, especially managers (3).

Zhang and Zhao (2014) (4) studied accidents in a non-coal mine in China and stated that, when accidents occur, large economic losses with a bad impact occur for social environments and the life of miners. Zhao et al. (2009) (5) stated that undesired conditions of the workplace were one of the factors, which decline the workforce productivity. Shalini believed that, there is a relationship between job accidents and productivity. His research showed that occupational accidents in addition to direct economic costs and losses, such as damage to materials, devices and machines, downtime and damage through insurance, causes indirect harm such as overtime pay to compensate for the effects of the accident, the loss of prestige of the organization, the negative impact on the relations with the surrounding environment and the impact on product quality (6). Hola (2007) (7) concluded that greater accidents resulted in higher costs and more negative effects on the firm economics.

Loomes (2006) (8) pointed that prioritizing safety programs in the main policies of the organization, increases productivity and enhances employee morale as well as their sense of responsibility.

Folkard and Tucker (9) investigated accidents and risks of night shift and its effects on productivity. Shikdar and Sawaqed (2003) (10) studied health and safety programs that can impact job satisfaction and diseases. The findings have presented weak ergonomic factors in work environments that caused an increase in personnel complaints and absence and decrease in productivity.

Leigh and miller (11, 12) concluded that accidents prevention was one of the most influencial factors on costs decline and increased productivity.

Boden and Brody (13, 14) studied economic expenditures due to job accidents by using insurance payments information, the elapsed time for returning to work and its effects on the worker's life quality and the costs covered by employers. They concluded that job accidents had negative effects on the workers life quality and employers' costs increase.

Since some managers believed that investment in safety is an additional cost, therefore, there was no interest in investing in safety management system. Evaluating the effect of investment on productivity and profit margin can be a good incentive for managers.

It should be noted that it is not possible to check safety only by a simple measuring indicator such as death rates or accident reports and independent performance indicators. Safety should be evaluated with stability and dynamics indicators of the organization (15). The definition of appropriate performance indicators for quality and safety management systems can be effective for improving productivity, and traditionally safety indexes should be combined with other indicators in the efficiency of the safety process (3, 16). The purpose of this study was to evaluate the impact of safety costs on some productivity indicators, and quality and production rates in five steel companies in Ahvaz city for a period of five years.

2. Objectives

This study aimed to evaluate the effect of safety costs on some indicators of productivity and quality in industrial companies.

3. Methods

This retrospective analytical study was conducted in four phases as shown in Figure 1. According to a similar study, five companies out of those active in the fields of steel and steel products located in the city of Ahvaz were randomly selected in the first phase. The total number of employees in these five companies during this five-year study included 4477 people on average. Companies also declared no bankruptcy during this five-year research study.

Figure 1. The Phases of the Study

In the second step, the variables and the data of the five companies that could be calculated in the same manner were selected as costs of safety, productivity indices, and quality index. A number of variables and indicators are also illustrated in Table 1. In the classification, the investment safety elements were categorized in seven groups, including staffing costs, safety equipment and facilities costs, compulsory training costs, in-house safety training costs, safety inspections and meetings costs, safety incentives and promotions costs and safety innovation costs (17). Since in this study the selected companies lacked consistent data collection system with common factors, therefore costs were defined in two main categories, including labor safety costs and total safety cost. Productivity indicators (18) included labor productivity (LP), labor competitiveness (LC), total productivity factor (TPF), quality index (QI) and production rates.

In the third step, a five-year-old data related to safety costs, productivity and quality indicators, was collected according to statistics from documents and archives of safety, accounting, and production sectors of companies and then the indicators were measured. Costs as well as numbers and figures of variables were expressed in the form of per capita and percentage depending on the conditions to make the data comparable.

Finally, these indicators were statistically compared. Moreover, linear and generalized regression models by using the SPSS22 software and Wald Chi-Square test were used to determine the relationships between safety costs and productivity and quality indicators in this study.

4. Results

The relationship between safety costs and output indicators were analyzed by linear regression. Some of the results are shown in Table 2. The statistics results showed

Table 1. Understanding the Variables and Indicators

Index / Variable	Explanation
Value added (VA)	The total additional value created (operating surplus, taxes, depreciation, staff compensation, consumption of fixed capital) in the production process works and services
Labor productivity	Ratio of value added to the number of workers
Labor competitiveness	Ratio of value added to staff compensation
Total factor productivity	Ratio of value added to the total labor and capital
Quality index	Ratio of salable product to produced
Production rate	The rate of product of the year
Labor costs/ staff compensation	Total wages, salaries and benefits, monetary or otherwise regular and non-regular workers
Total costs company	Total costs of the organization (the cost of safety and non-safety costs) to produce the final product

that there was a significance relationship between percentage safety labor costs to total costs (PSLCTC), percentage safety costs to total costs (PSCTC) and TFP ($P < 0.01$). A significant relationship was observed between capita labor safety costs (CSLC), percentage safety labor costs to labor costs (PSLCLC), PSLCTC and QI ($P = 0.001$, $P = 0.001$ and $P = 0.005$).

The relationship between safety costs and output indicators were analyzed by generalized linear model regression (GLM) and Wald Chi-Square test. Some of the results are shown in Table 3. The statistics results showed that there was a significance relationship between CTSC, PSLCLC and LP ($P < 0.01$). A significant relationship was observed between CSLC, PSLCLC and CL ($P = 0.001$ and $P = 0.001$). A significant relationship was observed between PSLCLC and TFP ($P = 0.005$). A significant relationship was observed between CSLC, PSLCLC and QI ($P = 0.031$ and $P = 0.001$). A significant relationship was observed between CSLC, PSLCLC and capita production rate (CPR) ($P = 0.001$ and $P = 0.001$).

The relationship between safety costs and output indicators were analyzed by generalized estimation of equations regression (GEE) and Wald Chi-Square test. Some of the results are shown in Table 4. The statistics results showed that there was a significant relationship between CTSC and LP ($P < 0.01$). Although there was no significant correlated between CTSC and CL ($P = 0.069$), yet the direct relationship is considerable with the P value. A significant relationship was observed between CTSC and TFP ($P = 0.017$). Although there was no significant correlation between PSLCTC and TFP ($P = 0.078$), yet the direct relationship was considerable with the P value.

5. Discussion

The results revealed that total safety costs had a positive impact on TFP, LP and LC. These results were also consistent with the findings of an investigation by Omidvari et al. (2012) (3) on the effect of the safety system on productivity indicators in food industries. Their research study indicated that the implementation of safety programs can lead to an increase in the levels of productivity in an organization, so that there is a direct relationship between development and improved safety indicators ranging from assessment, personnel safety training, risk control assessment, and using rate personal protective equipment with development and improvement LP as well as production per capita index. Fernandez (2009) (19) in a study entitled 'relationship between the management of occupational safety and performance in 455 Spanish companies', reported that SMS had a positive impact on the safety performance, competitive indicators, financial and economic competitiveness performance of the industries.

In another study, Shikdar and Sawaqed (10) studied health and safety program impacts on job satisfaction and diseases. The findings revealed that poor ergonomic factors at the workplace caused an increase in personnel's complaints and absence and decrease in the productivity. Folkard and Tucker (9) investigated accidents and the risks of night shift and its effects on productivity. The results showed negative effect of the working shift on productivity. They also uncovered which safety programs can affect shift work and productivity. They suggested that correct implementation of safety programs and activities within the standards framework minimizes the effects of the working shift on productivity.

The results demonstrated that CSLC was located on the second ranking in terms of its positive effects on productivity indicators compared with CTSC. This reflected the importance of total activities of SMS to the number of safety

Table 2. Results of Linear Regression

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
TFP	pslctc	0.29	0.07	0.63	3.86	0
TFP	psctc	0.23	0.06	0.65	4.11	0
QI	CTSC	0.01	0	0.37	1.94	0.07
QI	CSLC	0.02	0	0.82	6.79	0
QI	pslclc	0.04	0.01	0.83	7.15	0
QI	pslctc	0.05	0.02	0.54	3.08	0.01
QI	psctc	0.03	0.01	0.38	1.98	0.06

Table 3. Results of Generalized Linear Model Regression

GLM	Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test
				Lower	Upper	Sig.
Lp	CTSC	0.23	0.06	0.12	0.34	0
Lp	PSLCLC	1.69	.26	1.18	2.20	0
Lp	PSLCTC	-3.48	1.30	-6.02	-.94	0.01
Lp	PSCTC	-3.47	1.15	-5.74	-1.21	0
CL	CTSC	-0.14	0.059	-0.26	-0.03	0.02
CL	CLSC	0.73	0.17	0.40	1.07	0
CL	PSLCLC	2.95	.42	2.14	3.77	0
CL	PSLCTC	-7.71	1.68	-11.01	-4.42	0
Tp	PSLCLC	1.41	0.51	0.42	2.41	0.01
Tp	PSCTC	-4.27	1.34	-6.88	-1.65	0
Qi	CLSC	0.01	0.01	0.00	0.02	0.03
Qi	PSLCLC	0.04	0.01	0.02	0.06	0
Cpr	CTSC	-16.14	0.45	-17.02	-15.27	0
Cpr	CLSC	15.73	0.44	14.87	16.58	0
Cpr	PSLCLC	6.47	0.12	6.24	6.69	0
Cpr	PSLCTC	-214.17	5.90	-225.73	-202.60	0
Cpr	PSCTC	185.94	5.51	175.14	196.74	0

personnel in productivity.

Furthermore, the results showed that CSLC had greater effects on QI ($P < 0.01$ and $P = 0.065$) and CPR ($P < 0.01$ and $P < 0.01$, but with an inverse relationship). This indicated the impact of continuous monitoring by safety personnel on production lines (the effect of physical presence of safety personnel) and thereby improved quality and increased production. This result is consistent with the study of Oxenburgh et al. (2005) (20), under the name of 'tools to evaluate the efficiency with cost-benefit analysis model for economic evaluation of occupational health and safety in the workplace', in the field of intangible benefits of occupational health and safety programs and the impact of these programs on financial processes and the quality and quantity of production carried out in a four-star hotel. His research showed that safety and health interventions reduced staff turnover from 60% to 40%; a reduction more than expected insurance costs, and increase in the quality of work.

Although safety costs had a positive and significant effect on the number of productivity and quality indexes yet there was a mismatch in some indicators. So that, safety

Table 4. GEE Results of Regression

GEE	Parameter	B	Std. Error	95% Wald Confidence Interval		Hypothesis Test
				Lower	Upper	Sig.
Lp	CLSC	-0.12	0.05	-0.21	-0.03	0.01
Lp	CTSC	0.27	0.05	0.18	0.37	0
Lp	pslclc	-0.3	0.33	-0.94	0.35	0.37
LP	psctc	-2.03	1.05	-4.09	0.04	0.05
Cl	CTSC	0.10	0.06	-0.01	0.21	0.07
TFP	CTSC	0.20	0.08	0.04	0.36	0.02
TFP	pslctc	5.41	3.07	-0.61	11.43	0.08
QI	CLSC	0.02	0.00	0.01	0.02	0
QI	pslclc	0.01	0.00	0.00	0.01	0.02
Cpr	CLSC	15.29	1.15	13.03	17.55	0
Cpr	CTSC	-15.54	0.73	-16.97	-14.11	0

costs had an independent and even inverse relationship with some of the productivity indexes. This result is consistent with Crites research (1995) (21) that compared safety performance with the size and funding of formal safety programs over an 11-year period (1980 - 1990). However, it was found that safety performance was independent of (or even inversely related to) safety investments. In the study mentioned above, it is debatable, whether increasing investment will improve safety performance. The cause may be seen in a variety of factors involved in productivity. Rosekind (2005) (22) in an article on health and safety programs and their costs, defined productivity as an optimal usage of material resources, human forces, scientific facilities, and production costs decline, markets development, employment increase, efforts for increasing real wages and life standards optimization in a manner that is useful for the worker, manager and general consumers. Feng (2013) (17) in a research that was done on 47 construction projects in Singapore, categorized safety investment in three sectors, basic safety investment, voluntary safety investment and sum of these two investments. He concluded that the effect of basic safety investments on safety performance does not hold constant under different project conditions. Basic safety investments have a stronger positive effect on accident prevention under a higher safety culture level and a project hazard level; while the effect of basic safety investment on accident prevention might not be positive if the project hazard level and safety culture level of the project were low.

Assessment of the economical costs that resulted from job accidents and its impact on the worker's life quality and the costs for employers indicated that job accidents have negative effects on worker life quality and employers' costs increase. As indicated, there are many accidents in organizations, which impress organizations with direct and indirect costs (13, 14).

5.1. Conclusion

As it was shown safety costs could generally affect productivity indexes in an organization as well as the quality and quantity of production, regardless of the nature and quality of safety programs. Although no research studies with the same inputs and outputs of this study were found in the literature review, a number of studies such as the present one concluded that the implementation of safety programs had effects on productivity and quality. In terms of the reasons behind independent and even inverse relationships between safety costs and a number of productivity and quality indexes, several constituent variables of the indicators and various factors affecting productivity and economy can be noted including economic sanctions, economic policies, company concession, market status of raw materials and product sales, management programs, and so forth. Furthermore, this study revealed that most costs for safety were significantly related to CSLC. The findings of this study offer better understanding of the theory behind the role of safety investments and provide the theoretical basis for the managers of companies making decisions to invest in safety.

According to these results, the following suggestions were offered in order to increase the efficiency of quality and safety management systems:

1. According to the type of industry, a definition of appropriate performance indicators in quality and safety

management systems should be provided to monitor improvements in productivity and control its changes.

2. Safety costs along with other contributing factors affecting productivity and quality should be directly attended and planned by all the departments of an organization, especially management, accounting, and production.

5.2. Research Limitations

1. The absence of accurate recording of data on safety and its costs.

2. Lack of trust in organizations and lack complete information to investigators, due to high susceptibility to protect company secrets in front of business competitor.

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Footnotes

Authors' Contribution: Concepts, design, manuscript editing, manuscript review: Gholam Abbas Shirali Literature search, experimental studies, data analysis, manuscript preparation: Reza Savari statistical analysis: Kambiz Ahmadi Angali method analysis: Vahid Salehi

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