

◆ Application Paper

The Effect of Physical Factors Related to Industrial
Accidents on Manufacturing Performance in a
Small/Medium-Sized Manufacturing Industry in Korea¹⁾

Park, Hai-chun*

Lee, Ann-sub*

Abstract

In this paper, we investigated the relationship between the variables related to manufacturing environment and industrial accident. Also we wish to analyze how much these variables influence in production result of company: the manufacturing performances such as production quantity, quality, cost and delivery. For this investigation, we collected the real data from 16 small/medium-sized manufacturing companies by performing a questionnaire survey and one-site interview with the workers. Sixteen companies were made up of the following four industries: metal processing, machinery manufacturing, chemical products manufacturing and electronic products manufacturing. The data analysis was made using SPSS PC+. Based on the result of the analysis, we came to the conclusion that most of variables related to manufacturing environment and industrial safety were connecting with industrial accident occurrence and also influenced in manufacturing performance

1. Introduction

Since Korea was faced with the IMF crisis in 1997, it has gone through a rapidly turbulent change in its economy environment. However, as its economic environment has become stabilized within an unexpectedly short period of time, the job market situation has been also greatly improved causing unskilled workers to be hired. As a consequence of the unskilled workers, a lot of industrial accidents have been incurred in a small/medium-sized manufacturing industry, and thus they have made a great deal of a property loss. For example, Ministry of labor in Korea reported that there were more than 55,000 workers having industrial accidents in 1999 and the direct and indirect economic loss made by the accidents was estimated to be over \$5.2 billion.

1) This study was supported by research funds from Chosun University, 2000

* Department of Industrial Engineering, Chosun University

The small/medium-sized manufacturing industries, occupying more than 90 percent of the whole manufacturing industries and employing 50 percent of the total workers, play an important role in Korean economy stable growth, job creation and technology innovation. Nonetheless, many small/medium-sized manufacturing industries have many difficult problems because of a harmful work environment and a high possibility of accident. Especially, Ministry of labor in Korea reported that more than 60 percent of the total industrial accidents had taken place at a small/medium-sized manufacturing industry employing less than 100 workers[1]. So it is worth investigating the factors affecting the industrial accidents in a small/medium-sized manufacturing industry in Korea[2]. After this investigation is done, we ultimately want to show the relationship between the variables and the manufacturing performance in this paper.

2. Research Methodology

Improving a quality of the factors, being related to a manufacturing environment, helps reduce the industrial accidents and simultaneously enhance productivity, which is a pre-necessary condition for industry development. This study intends to define direct and indirect factors of accidents in domestic manufacturing companies through analysis of records and statistical accident data and assess the effect of these factors on industry[2, 3,4]. These factors have a physical characteristic out of industrial accidents factors and can be controlled with proper management policy effectively and reasonably[5,6]. In this study, it is intended to analyze how the variables affect the manufacturing performance: the variables are production quantity, quality, cost, delivery, labour morale, job satisfaction and the unemployment rate.

Employees from sixteen companies in four different types of industries with frequent accident occurrence, in particular metal processing, machinery manufacturing, chemical production and electronic manufacturing, were given a questionnaire and interviewed. At the time, we used five-point scale method for the fitness test and analysis at the survey method and performed a statistical experiment with using SPSS PC+.

3. Empirical Analysis

3.1 Characteristics of Samples

For this study, we selected four different types of manufacturing industries that had higher injury occurrence rate than any other manufacturing industry to obtain data. To collect a dependable data, we had a direct interview with the relevant workers on each site and asked them to fill in the questionnaire sheet prepared in advance. Table 1 shows a demographic distribution of sampled groups.

<Table 1> Demographic Distribution of Subjects

Class		Sample	Ratio(%)
Industrial Classification	Metal processing	25	24
	Machinery manufacturing	38	36
	Electronic manufacturing	37	35
	Chemical products manufacturing	5	5
Sex	Male	94	90
	Female	11	10
Labors	Less than 50	68	65
	50-100	37	35

3.2 Definition of Variables

<Table 2> Definition of Variables Related to Manufacturing Environment

Variable	Definition
Clothing and protector	Workers habit that wear dress and Individual protection equipment
Equipment aging	Equipment shift time by deterioration
Equipment automation	Equipment automation level
Humidity	Humidity in working place
Temperature	Temperature in working place
Noise	Noise in working place
Ventilation	Ventilation state in working place
Illumination and lighting	Illumination and lighting state in working place
Boundary indication	Boundary indication state in working place
Safety sign	Safety indication state in working place
Safety equipment	Safety equipment
Facility layout	Scientific layout state of facility
Working space	Workers Working space
Work load	Assigned work load
Working speed	Working speed
Working method	Workers working method and posture
Rest time	Cycle and length of rest time
Material	Adaptation of material

<Table 3> Definition of Manufacturing Performance Variables

Variable	Definition
Labour morale	Worker's atmosphere that want to work
Job satisfaction	Accomplishment which worker gets through work
Unemployment rate	Ration that workers leave the company
Production quantity	Production quantity
Quality	Quality
Cost	Cost
Delivery	Delivery

3.3 Correlation Analysis of Variables Related to Manufacturing Environment and Industrial Accidents

The close correlation of direct and indirect variables of industrial accidents included in the statistic data mentioned above should be used to bring out a change in domestic manufacturing activities.

The results of analysis were as follows: They all had a negative correlation. It was demonstrated that among the variables examined, humidity, temperature, noise, ventilation, safety sign, safety equipment, facility layout, working space, work load, working posture and rest time had a very close relation with the occurrence of industrial accidents ; while illumination, protector, boundary indication, equipment aging, equipment automation and material were less relation to industrial disaster< Table 4 >.

<Table 4> Correlation Analysis of Industrial Accident Occurring and Variables Related to Manufacturing Environment

Variable*	Coefficient of correlation	Variable*	Coefficient of correlation
Humidity	-.451**	Facility layout	-.431**
Temperature	-.409**	Equipment aging	-.363**
Noise	-.590**	Equipment automation	-.284**
Ventilation	-.444**	Working space	-.412**
Illumination	-.387**	Work load	-.627**
Protector	-.344**	Work speed	-.584**
Boundary indication	-.380**	Working posture	-.554**
Safety sign	-.433**	Rest time	-.553**
Safety equipment	-.476**	Material	-.379**

* Variables related to manufacturing environment

** sig. 0.05

3.4 The Effect of the Variables Related to Manufacturing Environment on Manufacturing Performance

At this step, firstly, factor analyses were performed on the variables related to manufacturing environment and manufacturing performance. Next, to see whether a variable had an effect on manufacturing performance, regression analysis with using a factor analysis was performed.[7,8]

In the factor analysis, the principal component analysis method (the extraction method) and the Varimax method (the orthogonal rotation method) were used to reduce a number of variables and to classify the variables into a group according to their characteristics. Thereafter, we took a variable group whose Eigen-value was greater than 1 and specified it by a corresponding factor name. The total variables were divided into 2 categories. The first and second categories involve 4 and 2 variable groups as shown in Table 5 and 6, respectively. The first one was classified in relation with the manufacturing environment

and industrial safety, and the second one was classified in relation with manufacturing performance. Four factors that related to the manufacturing environment account for 72% of the total dispersion. Depending on the characteristics of variables, the factors were named working environment, facility, work process and safety activity.

Variables for manufacturing performance had an account of 89% for the dispersion. Variables were named as the Organizational performance and Individual performance depending on the characteristics of the variables.

<Table5> Factor Analysis of Variables Related to Manufacturing Environment

Factor	Variable	Component	Eigen Value	% of Variance	Cronbach's α
Work environment	Temperature	.872	8.059	44.7	.923
	Humidity	.833			.923
	Smell	.730			.923
	Illumination	.691			.921
	Noise	.665			.935
Facility	Equipment automation	.834	2.517	14.0	.924
	Facility layout	.791			.920
	Equipment aging	.741			.922
	Working space	.676			.921
	Material	.674			.922
Work process	Working speed	.839	1.129	7.2	.921
	Work load	.818			.920
	Rest time	.808			.922
	Working method	.763			.921
Safety activity	Safety sign	.804	1.099	6.6	.923
	Boundary indication	.760			.923
	Safety equipment	.744			.923
	Protector	.564			.922

<Table 6> > Factor Analysis of Variables Related to Manufacturing Performance

Factor	Variable	Component	Eigen Value	% of Variance	Cronbach's α
Organizational performance	Cost	.954	3.497	49.9	.762
	Delivery	.943			.757
	Production quantity	.942			.754
	Quality	.899			.752
Individual performance	labour morale	.963	2.727	38.9	.801
	Job satisfaction	.955			.797
	Unemployment rate	.937			.804

To see effect that the variables give in manufacturing performance, a multi-period regression analysis was performed on four independent factors related to the manufacturing environment, and two subordinate factors related to manufacturing performance.

The Enter Method in which independent variables were input simultaneously was used for a regression analysis. As a result of the research, the facility factor and work process factor except work environment factor and safety activity factor have positive effects (+) on organization performance within 5% range of significance. And work environment, work process and safety activity except facility have positive effects (+) on individual performance within 5% range of significance <Table 4 and 5>. And independent variables including regression function affect organizational satisfaction and individual satisfaction as 51% and 61.5% respectively, so the variables related to manufacturing environment affect manufacturing performance suitably.

<Table7> The Multi-Regression Analysis Between Factors Related to Manufacturing Environment and Organizational Performance Factor

Dependence variable	Independence variable	B	Sig. T	R square	F value
Organizational performance	Work Environment	-.109	.122	.510	25.98**
	Facility	.566	.000**		
	Work Process	.420	.000**		
	Safety Activity	.014	.838		

Sig.: **:0.05 n=105

<Table8> The Multi-Regression Analysis Between Factors Related to Manufacturing Environment and Individual Performance Factor

Dependence variable	Independence variable	B	Sig. T	R square	F value
Individual performance	Work Environment	.730	.000**	.615	39.881**
	Facility	.005	.936		
	Work Process	.136	.031**		
	Safety Activity	.251	.000**		

Sig. : **:0.05 n=105

4. Conclusion

The external and internal economic environment of industries is aggravated due to economic crisis. Because of the aggravated economy, productive activity and production efficiency of business was greatly reduced. The state of small/medium-sized manufacturing industries where the financial structure is weak and enough high-quality workers are not available is getting worse.

There are a variety of unstable factors that affect maintenance and enhancement of employees' satisfaction with the manufacturing environment. This study intended to

analyze how the variables that cause industrial accidents affected manufacturing performance.

The analytical results were as follows: variables abstracted from the manufacturing environment and industrial safety have a strong correlation with industrial accidents and business performance. It is expected that the results can be used as basic data in provision of a scientific and reasonable understanding of fundamental reasons for industrial accidents and the development of countermeasures based on human respect. They can also help to establish an efficient management policy that enhances manufacturing performance.

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