An Empirical Analysis of the Industrial Accident Factors Affecting Manufacturing Performance in Korea

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Abstract : In this paper, we investigated the relationship between the variables of the industrial accident factors and the manufacturing performances such as production quantity, quality, cost, and delivery. For this investigation, we collected the real data from 30 small/medium-sized manufacturing industries by performing a questionnaire survey and a on-site interview with the workers. Thirty industries were made up of 10 from each of the following three industries: metal processing, machinery manufacturing, and chemical products manufacturing. The data analysis was made using SPSS PC+. Based on the result of the analysis, we came to the tentative conclusion that only two variables such as work skill and load affected all four manufacturing performances and the rest of them two or three performances.

Key words : empirical analysis, factor analysis, industrial accident, 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 company, and thus have made a great deal of a property loss. For example, Ministry of labor in Korea reported that there were more than 81,434 workers having industrial accidents in 2001 and the direct and indirect economic loss made by the accidents was estimated to be over 8,700 billion won in Korean Currency.

The small/medium-sized manufacturing companies, occupying more than 90 percent of the whole manufacturing companies and employing 50 percent of the total worker, play an important role in Korean economy stable growth, job creation and technology innovation. Nonetheless, many small/medium-sized manufacturing companies 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 company employing less than 100 workers [1]. So it is worth investigation the factors affecting the industrial accidents in a small/medium-sized manufacturing company in Korea. After this investigation is done, we ultimately want to show the relationship between the variables and the corporate performance in this paper.

2. Research Methodology

Improving a quality of the factors [2], being related to a working environment and industrial safety helps reduce the industrial accidents and simultaneously enhance productivity, which is a pre-necessary condition for industry development. It is thus necessary first to select the adequate variables that are related to the working environment and the industrial accidents occurring in the small/medium-sized manufacturing industries and to specify the characteristics of the factors in terms of that of the grouped variables. In addition, we investigate which factors affect the workers health and the job satisfaction which are a condition for happiness pursuit by the basic human goal and a vital of work motivation. The second step is to analyze how the variables of the factors affect production quantity, quality, cost, and delivery which can be measured through the rational

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and scientific control and operation.

To conduct this research, we chose 10 companies from each of three different manufacturing industries (metal processing, machinery manufacturing, and chemical products manufacturing) to collect data by survey. 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 three 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 Classifica-tion	Metal processing	72	34(72/210)
	Machinery manufacturing	74	35(74/210)
	Chemical products manu-facturing	64	31(64/210)
Sex	Male	158	75(158/210)
	Female	52	25(52/210)
Labors	Less than 50	167	80(167/210)
	50-99	29	14(29/210)
	100-149	14	6(14/210)

3-2. First -Step of Analysis

At this step, we determined direct and indirect variables that caused industrial accidents with the date defined from many papers and statistical resources of accident analysis and variables that were measurable about workers health and job satisfaction. To see whether a variable

Table 2. Factor Analysis of Variables that Cause Industrial Disasters

Factors	Variables	Component	Eigen Value	% of Variance	Cronbach's
Industrial safety Activity	Equipment/Machine safety device	.766			
	Protector wearing	.752			
	Safety organization	.745			
	Safety indication	.721			
	Safety training/instruction	.710	4.857	18.682	.9106
	Safety education for unsafe work	.681			
	Protector inspection	.657			
	Inspection of workplace	.542			
Work environment	Temperature	.769	4.371	16.810	.8819
	Dust	.766			
	Noise	.735			
	Humidity	.730			
	Ventilation	.707			
	Smell	.623			
	Illumination	.586			
Facility layout	Transportation method	.758	2.616	10.060	.7950
	Layout method	.742			
	Machine inspection	.687			
	Working space	.607			
Scheduling	Working speed	.776	2.415	9.290	.7017
	Working schedule	.670			
	Skill	.601			
	Work load	.577			
Time	Time to rest	.673	1.803	6.934	.6743
	Overtime work	.626			
	Equipment aging	.561			

with using a factor analysis was performed. First, 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 5 and 2 variable groups as shown in Table 2 and 3, respectively. The first one was classified in relation with the industrial accident occurrence, and the second one was classified a worker's health and job satisfaction. Factors related to variables that cause industrial accidents account for 62% of the dispersion. Depending on the characteristics of variables, the factors are working environment, industrial safety activity, facility layout, scheduling and Time.

Variables related to the workers health and job satisfaction account for 82% of the dispersion. Variables are

named as the health satisfaction and the job satisfaction depending on the characteristics of the variables. A multi-regression analysis was performed to find out what affected variables causing an industrial accident on a workers health and job satisfaction. Five factors related to variables causing the industrial accident are presented as independent and two factors related to health and job satisfaction are presented as dependent. As a result of the research, working environment, industrial safety activity, facility arrangement and schedule of independent variables are important workers motivation within 10% range of significance. They have positive effects (+) on health satisfaction and work satisfaction that are important for motivation and happiness. However, Table 4 and 5 show that factors such as prolonged time to rest overtime work equipment aging have insignificant effect.

3-3. Second-Step of Analysis

Based on the results of the first-step analysis, the aim of this step was to find the effect of variables of health

Table 3. Factor Analysis of Variables Related to Workers Health and Job Satisfaction

Factors	Variables	Component	Eigen Value	% of Variance	Cronbach's α
Job satisfaction	Unemployment rate	.917			
	Absent rate	.894	2.413	40.216	.8740
	Labor morale	.868			
Health satisfaction	Physical fatigue	.926			
	Stress	.921	2.485	41.424	.8923
	Health supervise	.874			

Table 4. The Multi-Regression Analysis between Factors that Cause Industrial Accidents and Job Satisfaction Factor

Dependence variable	Independence variables	B	Sig.T	R square	F value
Job satisfaction	Industrial safety activity	.231	.000***		
	Work environment	.155	.012**		
	Facility layout	.263	.000***	.248	13.410
	Scheduling	.274	.000***		
	Time	.164	.008***		
	(constant)	0	1.000		

Sig. ***: 0.01, **:0.05, n=210

Table 5. The Multi-Regression Analysis between Factors that Cause Industrial Accidents and Health Satisfaction Factor

Dependence variable	Independence variables	B	Sig.T	R square	F value
Health satisfaction	Industrial safety activity	.145	.026**		
	Work environment	.275	.000***		
	Facility layout	.135	.038**	.156	7.523
	Scheduling	.204	.002**		
	Time	$\cdot$ .011	.862**		
	(constant)	0	1.000		

Sig. ***: 0.01, **:0.05, n=210

and job satisfaction on productivity through reasonable and scientific management and control. Among variables that caused industrial accidents, 23 variables were presented as independent and three variables that had no effect on satisfaction of health and job were removed. The P. Q. C. D as measuring index of productivity were presented as subordinate.

The multi-regression analysis was used for this measurement. The Enter Method in which independent variables were input simultaneously was used for the Regression Analysis. Table 6, 7, 8, and 9 show the result of the analysis performed with the significance level of 10%.

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

Table 6. The Multi-Regression Analysis Between Variables that Cause Industrial Accidents and Production quantity

Dependence variable	Independence variables	B	Sig. T	R square	F value
Production quantity	Temperature	-.168	.035**	.353	4.386
	Noise	-.207	.040**		
	Dust	.323	.000***		
	Work load	.247	.003***		
	Skill	-.216	.000***		
	Layout method	.234	.004***		
	Equipment/Machine safety device	.164	.068*		
	Safety Organization	.173	.043**		
	Safety training/instruction	.163	.040**		
	(constant)	1.164	.001***		

Sig. ***: 0.01, **: 0.05, *: 0.1, n = 210

Table 7. The Multi-Regression Analysis Between Variables that Cause Industrial Accidents and Quality

Dependence variable	Independence variables	B	Sig. T	R square	F value
Quality	Humidity	.285	.000***	.859	48.983
	Temperature	.508	.000***		
	Noise	.168	.000***		
	Illumination	-.079	.025**		
	Dust	-.107	.001***		
	Work load	.080	.021**		
	Skill	-.057	.059*		
	Machine inspection	.081	.024**		
	(constant)	-.918	.000***		

Sig. ***: 0.01, **: 0.05, *: 0.1, n = 210

Table 8. The Multi-Regression Analysis Between Variables that Cause Industrial Accidents and Cost

Dependence variable	Independence variables	B	Sig. T	R square	F value
Cost	Work load	.148	.016**	.421	5.840
	Working schedule	.137	.050**		
	Working speed	.233	.004***		
	Skill	-.103	.086*		
	Transportation method	.190	.004***		
	Layout method	-.143	.010***		
	Safety organization	-.153	.015**		
	Safety training/instruction	.101	.086*		
	(constant)	-.400	.104		

Sig. ***: 0.01, **: 0.05, *: 0.1, n = 210

Table 9. The Multi-Regression Analysis Between Variables that Cause Industrial Accidents and Delivery

Dependence variable	Independence variables	B	Sig. T	R square	F value
Delivery	Work load	.123	.035**	.346	4.255
	Working schedule	-.136	.018**		
	Working speed	.237	.002***		
	Skill	.103	.089*		
	Layout method	.177	.009***		
	(constant)	.255	.272		

Sig. ***: 0.01, **: 0.05, *: 0.1, n = 210

financial structure is weak and enough high-quality workers are not available is getting worse.

The purpose of this study was to see what effect unstable factors (that is, variables that cause industrial accidents and are easily exposed to danger) had on a manufacturing performance index. The result of the analysis says that the variables identified to influence a workers health and job satisfaction do not strongly affect a manufacturing performance even though they simultaneously have to have a strong effect on it. This fact was the unexpected result. Therefore, we strongly suspect that the reason for why such result was driven have something to do with an insufficient amount of the sampled data.

Acknowledgement

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