International Journal of Civil and Structural Engineering– IJCSE
Volume 2 : Issue 2 *[ISSN : 2372-3971]*
Publication Date: 19 October, 2015

Implementation of Occupational Safety and Health Management System (OSHMS) on Bridge Construction

The Project of Middle Span of "Merah Putih" Bridge in Ambon

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***Abstract*-This paper describes about the implementation of the Occupational Safety and Health Management System (OSHMS) and the correlation factors between health and safety (HS) with the OSHMS application on the development of "Merah Putih" Bridge in Ambon. The issues about accident on the workplace indicate that OSHMS have not been successfully implemented. It can be influenced by many factors. Hence, it is significantly important to analyze the factors that can delay and support the implementation of HS in construction site. A series of questionnaires were distributed to the worker on site. The data gained from questionnaires were analyzed with using SPSS 17. Regression and correlation analysis (R) and the coefficient of determination (R Square), and a significance test (t-test) were conducted in SPSS 17. The analysis results indicate that the correlation factors were 99.70% and 98.30% for X-corp and Y-corp, respectively. Hence, the overall effect of independent variables and the application of OSHMS were to support the implementation of nine factors. The analysis results of multiple linear regression were R = 0.999 (X-corp) and 0.991 (Y-corp). It could be concluded that the strong relationship was developed simultaneously between the nine independent variables.**

***Keywords— Occupational Safety and Health Management System* OSHMS, *Health and Safety* HS, occupational accident**

I. Introduction

Accidents can almost happen at any workplaces [1]. In order to prevent that, every construction company has to implement the Occupational Safety and Health Management System (OSHMS) for their workers. OSHMS is a discipline dealing with the prevention of work related injuries and diseases as well as the protection and promotion of the health of workers. It aims at the improvement of working conditions and environment, though not every company has enough commitment to implement it [3].

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Jamsostek (2008) stated that the amount of occupational accidents in Indonesia was quite high with 93823 cases and 85090 victims. About 2124 people had died during the occupational accident and the rests ended with deformity [2]. These indicate that the awareness of the Health and Safety (HS) program is quite low in Indonesia, as shown by the high numbers of victims. The HS program needs to be implemented perfectly due to the high possibility of accident at workplace.

There are many factors affected the occupational accident, such as human, environment and equipments used at work. Therefore, evaluation is needed for each factor to determine the most influent factor. Every construction company has responsibility to preserve the health and safety of their workers. Hence, the OSHMS is essentially needed in this case. The perfect implementation of OSHMS can reduce the number of accidents at workplaces. Finally, this can lead to the more efficient production and decrease the unnecessary expenses.

The large scale enterprises commonly hire workers from different background of education. Hence, there will be additional training needed to improve the quality of workers, especially for workers with high risk sectors. Indonesia government had made regulations about OSHMS as stated in PP No.2 (1948), UU No.1 (1970) and UU No.40 (2004) [4-8].

These regulations were only successfully implemented 2.1% from more than 15000 large companies in Indonesia [8]. This was caused by the misleading assumptions from these companies leaders. They assumed that the implementation of OSHMS could increase their expenses. Though, it was not utterly correct. The local newspaper "Warta Ekonomi (June 2, 2006)" reported that the total expenses used for covering the occupational accident was extremely high in 2003 (about 190 billion Rupiah). It was absolutely higher than expenses used to implement the OSHMS.

To address all these problems, the authors conducted an experimental investigation to the implementation of OSHMS at the project of "Merah Putih" bridge in Ambon. The bridge was constructed by X-corp and Y-corp, as the main contractors. This research aimed to analyze the correlation factors and evaluate the implementation of OSHMS at the project of "Merah Putih" bridge in Ambon.

II. Methodology

A. Bridge description

Fig. 1 shows the location of "Merah Putih" bridge in Ambon city. Ambon city locates at 03^0-04^0S and 128^0-129^0E. "Merah Putih" Bridge is a bridge that connects "Hative Kecil" village with "Poka" village. The proclamation of "Merah Putih" bridge was stated by Ir. Joko Kirmanto, The Minister of Public Works, in 19 August 2011. This bridge construction was the new infrastructure model for transportation which was developed by The Ministry of Public Works.

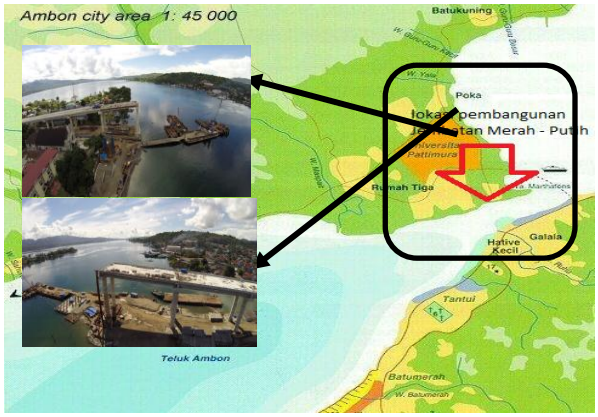

Figure 1. Location of "Merah Putih" bridge

Technical specifications of "Merah Putih" bridge:

- Bridge type : Cable-stayed double pylon
- Pylon type : Double pylon with H-shaped.
- Total length : 1140 m
- Pylon height : 86.5 m
- Main bridge span : 300 m
- Bridge width : 22.5 m
- Clearance area : 100 m x 34109 m
- Maximum gradient 6.5%
- Life span : 100 years

There were three construction phases in "Merah Putih" bridge project. Two phases were each for the bridge span at "Hative Kecil" village and "Poka" village. These phases were started from 2011 until 2012. The other one was the middle span bridge started from July 2013. It was constructed by X-corp and Y-corp with the appropriation budget about 416 billion Rupiah, based on the national budget released by Indonesia government.

B. The OSHMS parameter

The "Merah Putih" bridge was constructed by X-corp and Y-corp started from July, 2013. Since the construction began, there were still some occupational accidents recorded. Hence, the evaluation was carried on to analyze the implementation of OSHMS in this project. There were nine parameters which were used on the OSHMS of this project:

- Provision of HS equipment.
- OSHMS management.
- OSHMS regulation.
- Site-working experience.
- Socializing and information about OSHMS.
- Worker training system.
- Forming of OSHMS committee.
- OSHMS training.
- Medical staff from company.

These parameter aims to analyze and evaluate the implementation of OSHMS at the project of "Merah Putih" bridge in Ambon. Primary data were gathered from the questionnaires and interviewing process. The questionnaires were distributed to 43 workers from X-corp. and 45 workers from Y-corp. It contained several questions about the implementation of OSHMS during construction. Secondary data were gathered from daily, weekly and monthly reports. These were gathered from The National Road Organizer Hall IX, Maluku province.

C. Analysis method

All questionnaires results were recorded, tabulated and given score. The ranks based on the given score were analyzed using regression analysis to obtain the mathematic formula expressing the correlation variables. Regression analysis, correlation analysis, significance test and normality test were used in this research.

Regression analysis is an analysis method to obtain functional correlation between mathematic variables. There are two different variables in this method. First is independent variable and the second is the dependent variable. In this research, the independent variable (X) was the nine parameters of OSHMS of this project. The dependent variables (Y) were the implementation of OSHMS of this project by X-corp and Y-corp. To achieve accurate results and reduce the human error/error term, SPSS 17 was specifically used to assist the data processing. By using it, the significance results on the level of confidence can reach 95% ($\alpha = 0.05$).

$$Y = f(X_1,X_2,X_3,X_4,X_5,X_6,X_7,X_8,X_9) \quad (1)$$

Correlation analysis is an analysis method to validate the correlation between variables. R-value was used to determine the correlation degrees. R-value which is between 0.8 to 1 expresses a very strong correlation. Significance test (t-test) needs to be carried on to the measured variables. It is for determining the correlation between independent variables with the dependent ones. The mathematical model is assumed acceptable whether the measured "t" distribution value is higher than the "t" value on the table.

Normality test is an analysis method to determine the distribution model (normal distribution model or not) of these nine parameters of OSHMS used in this research. Whether it is not the normal one, the average values of nine parameters should not be used for the next analysis step.

III. Analysis Results

A. *Questionnaires results*

As mentioned earlier, total respondents taking the questionnaires were 43 workers from X-corp and 45 workers from Y-corp. Fig. 2 to Fig. 11 shows the response results of the distributed questionnaires. It can be shown that the workers responses were very satisfying (more than 50%) to almost all the nine parameters of OSHMS for both X-corp and Y-corp. Only two parameters provide satisfying responses, which are the worker training system and forming of OSHMS committee.

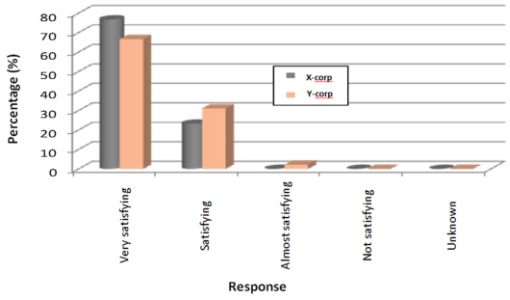

Figure 2. Provision of HS equipment

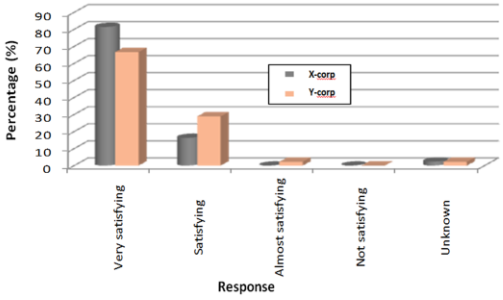

Figure 3. OSHMS management

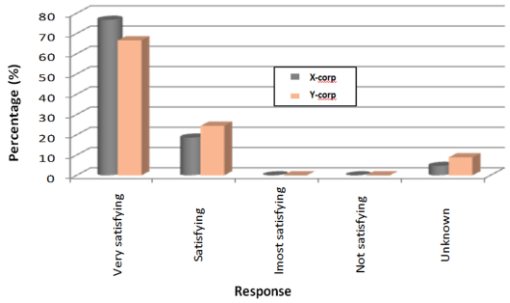

Figure 4. OSHMS regulation

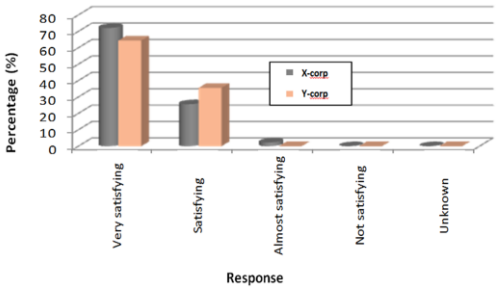

Figure 5. Site-working experience

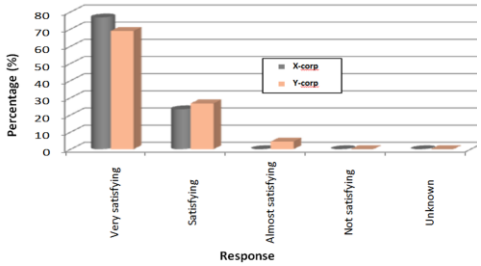

Figure 6. Socializing and information about OSHMS

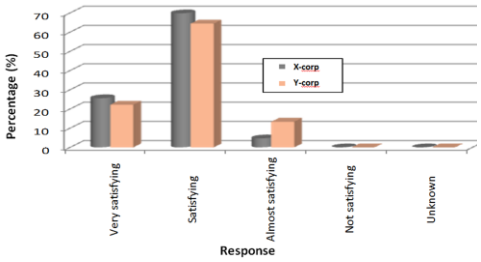

Figure 7. Worker training system

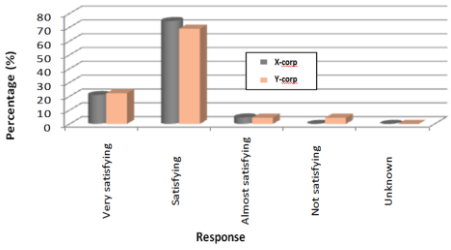

Figure 8. Forming of OSHMS committee

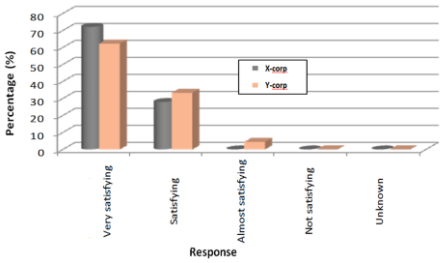

Figure 9. OSHMS training

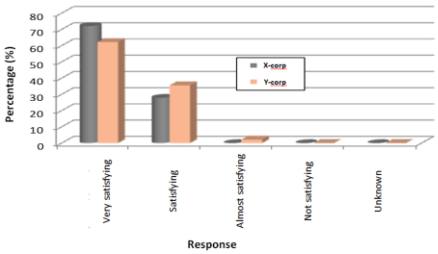

Figure 10. Medical staff from company

The major questionnaires results indicate that the OSHMS were well-implemented by X-corp and Y-corp. Though, there were still needed to improve some sectors, especially the worker training system and the forming of OSHMS committee. Major responses stated that the worker training system had to be more arranged intensively so they could improve their skills. The availability of OSHMS committee was proved by the forming of it (for both X-corp and Y-corp), but it still needed improvement.

B. *Correlation and Regression analysis result*

The questionnaires results were initially tabulated and analyzed by using correlation analysis. This analysis was performed between dependent variables with the independent ones. The primary objective of this analysis is to select the value with higher correlation. Whether one of these independent variables had the higher correlation values than others, the represented values should be selected. The higher correlation value shows the strong correlation between those variables.

Table I and Table II show the correlation matrix of OSHMS for X-corp and Y-corp, respectively. If the correlation value is lower than 0.20 (R<0.20), the correlation value between independent variables can be neglected [10]. Hence, some values on the Table 1 and Table 2 can be neglected due to its correlation value that is lower than 0.20. The higher correlation values are marked by the bold text in the Table I and Table II. As the selective correlation value is finally obtained, the factors with high influence to the implementation of OSHMS can also be determined. The summary result is shown in Table III.

TABLE I. CORRELATION MATRIX OF OSHMS FOR X-CORP

Variables	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9
Y	1									
X1	0.996	**1.000**								
X2	0.979	**0.994**	**1.000**							
X3	0.985	**0.996**	**0.998**	**1.000**						
X4	0.999	**0.998**	**0.985**	**0.989**	**1.000**					
X5	0.996	**1.000**	**0.994**	**0.996**	**0.998**	**1.000**				
X6	0.482	0.400	0.295	0.331	0.453	0.400	**1.000**			
X7	0.401	0.315	0.207	0.244	0.371	0.315	**0.996**	**1.000**		
X8	1.000	**0.996**	**0.979**	**0.985**	**0.999**	**0.996**	0.482	0.401	**1.000**	
X9	1.000	**0.996**	**0.979**	**0.985**	**0.999**	**0.996**	0.482	0.401	**1.000**	**1.000**

TABLE II. CORRELATION MATRIX OF OSHMS FOR Y-CORP

Variables	Y	X1	X2	X3	X4	X5	X6	X7	X8	X9
Y	1									
X1	1.000	**1.000**								
X2	0.999	**0.999**	**1.000**							
X3	0.981	**0.981**	**0.998**	**1.000**						
X4	0.994	**0.994**	**0.990**	**0.965**	**1.000**					
X5	0.997	**0.997**	**0.998**	**0.985**	**0.982**	**1.000**				
X6	0.485	0.485	0.451	0.348	0.563	0.422	**1.000**			
X7	0.485	0.485	0.452	0.356	0.570	0.416	**0.984**	**1.000**		
X8	0.998	**0.998**	**0.994**	**0.967**	**0.997**	**0.990**	**0.543**	**0.539**	**1.000**	
X9	0.994	**0.994**	**0.988**	**0.960**	**0.999**	**0.981**	**0.579**	**0.581**	**0.998**	**1.000**

TABLE III. SUMMARY RESULT OF CORRELATION ANALYSIS

X-corp	Y-corp	Note
Y_1	Y_2	
X_1 = 0.996	X_1 = 1.000	Strong correlation with Y
X_2 = 0.979	X_2 = 0.999	
X_3 = 0.985	X_3 = 0.981	
X_4 = 0.999	X_4 = 0.994	
X_5 = 0.996	X_5 = 0.997	
X_6 = 0.482	X_6 = 0.485	Not strong enough correlation with Y
X_7 = 0.401	X_7 = 0.485	
X_8 = 1.000	X_8 = 0.998	Strong correlation with Y
X_9 = 1.000	X_9 = 0.994	

The correlation value between independent variables (X) which is higher than 0.50 should be selected by one represented value which has higher correlation value (R) than the dependent variables (Y) [10]. Hence, the independent variables (X) can be obtained to be used for the next analysis step. The obtained independent variables are X_3 and X_7. X_3 is OSHMS regulation while X_7 is forming of OSHMS committee.

$$Y_1 = -1.769 + 0.909\ X_3 + 0.171\ X_7 \quad (2)$$

$$Y_1 = -2.533 + 0.970\ X_3 + 0.159\ X_7 \quad (3)$$

Regression analysis is carried on after the correlation analysis. The equations obtained by regression analysis are shown by the Equation (2) and Equation (3) for X-corp and Y-corp respectively. Both equations have strong correlation (R-square 0.997 and 0.983 for X-corp and Y-corp respectively).

C. *Assessment of the implementation of OSHMS*

The coefficient of multiple R is considerably acceptable when approaching a value of ±1. R value based on the regression analysis result (0.999 and 0.991 for X-corp and Y-corp respectively) indicates that a strong correlation is developed simultaneously between the nine parameters. In this case, the nine parameters are represented by both independent variables X_3 and X_7. The coefficient of determination (R-square or R^2) has the interval value between 0 and 1 ($0<R^2<1$). The higher R-square value (R^2 approaches 1) indicates an excellent result of regression analysis. The overall independent variables can be used to explain the dependent variables simultaneously whether the R^2 approaches 1.

TABLE IV. THE COEFFICIENT OF CORRELATION AND DETERMINATION

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
X-corp	0.999	0.997	0.994	2.42154
Y-corp	0.991	0.983	0.966	5.42186

In this case, the result of X-corp regression analysis (R^2=0.997) indicates that the influence of overall independent variables can be explained by the obtained equation with the reliability of 99.7%. Though, there is still 0.3% affected by another variable which is not included in this research. The same interpretation is also applicable with the result of Y-corp regression analysis (R^2=0.983). It indicates the reliability of 98.3% and another variable which is not included about 1.7%.

The t-test value can be obtained from the regression analysis result. There are two different decisions. First, if the calculated t-value provides a higher result than the tabulated t-value hence the hypothesis H_1 shall be selected (the coefficient of regression is significant). Second, the opposite, if the calculated t-value provides a lower result than the tabulated t-value hence the hypothesis H_0 shall be selected (the coefficient of regression is insignificant).

The calculated t-value for X_3 and X_7 are 23.794 and 4.289 for X-corp, while 9.374 and 2.574 for Y-corp. The t (0.05) = 1.684 and 1.683 for X-corp and Y-corp respectively. Comparing the calculated t-value to the tabulated t-value provides a result of the selection of H_1 (calculated t-value is higher than the tabulated t-value). It indicates that the coefficient of this regression analysis partially affects the implementation of OSHMS in this construction project.

IV. Conclusions

An experimental investigation of the implementation of OSHMS was conducted at the project of "Merah Putih" bridge in Ambon. Based on the results from this investigation, the following conclusions can be made:

- The OSHMS was well-implemented for both X-corp and Y-corp. However, X-corp had more satisfying results than Y-corp. Hence, Y-corp should increase their OSHMS parameters or improve their system with more discipline regulation.
- Both coefficients (correlation and determination) indicate that the implementation of OSHMS at "Merah Putih" bridge had been appropriated with the regulations made by the Indonesia government.
- The coefficients of correlation are 0.999 and 0.991 for X-corp and Y-corp, respectively. The coefficients of determination are 0.997 and 0.983 for X-corp and Y-corp, respectively. Hence, a strong correlation was developed between all the nine parameters of OSHMS.

Acknowledgment

This research was partially supported by University of Pattimura, Ambon, Indonesia. This support is gratefully acknowledged by the author.

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