AENSI Journals

Australian Journal of Basic and Applied Sciences

ISSN:1991-8178

Journal home page: www.ajbasweb.com

Risk Analysis Work Accidents on The Implementation of Toll Road Project Surabaya-Mojokerto

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ARTICLE INFO

Article history:
Received 25 June 2014
Received in revised form
8 July 2014
Accepted 10 August May 2014
Available online 30 September 2014

Keywords:
Risk analysis, risk response, work accidents

ABSTRACT

In Indonesia, work accidents in the construction sector are considered high due to work health and safety negligence. This will affect the project activities. The problems of the implementation of work health and safety in the construction sector are the result from the company's management's orientations focusing on production target and cost saving. Workers' low awareness of work safety and weak implementation of the government regulation on work health and safety also contribute to the problems. This research aims to find an out risk level of work health and safety on the implementation of toll road construction project and its response in an attempt to minimize the negative impacts which might occur. Survey method was employed in this research. Data collection was obtained from the questionnaire distributed to respondents who consisted of managers, head of the sections and site engineers. The risk analysis used was the qualitative technique which indicated the probability and risk level of work accident ranging from low to high level. The research finding indicates that on the land work, the risk was the incident of heavy equipment at the time of operation and on the structure, work was the falling of scaffolding due to its inability to hold or withstand the burden. The work accident risk of the two types of work had an average category. Meanwhile, the work health and safety risk of the implementation of the project as a whole was acceptable, or it was in accordance with contractors' ability to take risks.

To Cite This Article: Feri Harianto and Mintoro., Risk Analysis Work Accidents on The Implementation of Toll Road Project Surabaya-Mojokerto. ***Aust. J. Basic & Appl. Sci.,*** *8(14): 65-69, 2014*

INTRODUCTION

Project construction activities have a lot of risks. One of them is concerning with work health and safety as a result the number of work accidents in this sector is quite high compared to those in other industrial sectors(Monica *et al*., 2013; Osama *et al*., 2006; Thanet and Hadikusumo, 2008; Carter and Smith, 2006). The highest work accident happening in the construction project is falling from the height and slipped (Bentley *et al*., 2006; Osama *et al*). Work accidents happen due to unsafe conditions as well as dangerous actions. Risky conditions occur accordingly of ineffectiveness of work health and safety management. This is because construction companies have still focused on production target and cost efficiency, while dangerous activities happen as a result of low awareness of work safety (Mathew, 2010). In addition to unsafe conditions and actions, work accidents occur due to weak implementation of government regulation on work health and safety in construction sectors (Fang *et al*, 2004 Javier *et al*, 2005; Michael, 2002). Several researches works about work accidents have been conducted stating that they were caused by improper equipment design and work environment as well as by workers who did not wear protective equipment (Wang and Chou, 2003; Pransant and Hendrickson, 2001). Furthermore, design of construction should consider work health and safety, thus, work accidents can be reduced (Brenda *et al*., 2008; Daud *et al*, 2004). Therefore, work health and safety should be paid more attention. Bad work health and safety will not only harm the workers but also the company as well as the workers' family and society (Carlos and Dulcy, 2004). This research aims to conduct risk analysis and its response on the implementation of toll road project Surabaya - Mojokerto in an attempt to minimize the negative impacts.

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Australian Journal of Basic and Applied Sciences, 8(14) Special 2014, Pages: 65-69

Methodology:

Survey method was employed in this research. Data collection was obtained from a questionnaire which was distributed to project managers, site engineers and heads of sections. The questionnaire parameters were based on construction activities, which were identified into six variables namely; preparatory work, vehicle traffics and routine work, land work, activity of arriving materials, structure work, road pavement work, and toll road facility work. Out of the six activities, 81 risk variables were found. Realizing the condition and complexity of the facilities or installation and the danger during operation as well as incomplete supporting data, qualitative analysis was used (Soehatman Ramli, 2010; Asiyanto, 2009). Furthermore, Likert scale was used to measure the probably with weighing scales: very low = 1, low = 2, average = 3, high = 4, and very high = 5. Moreover, to measure the impacts of work accidents, the following weighing scale was used: less than three-times occurrence = 1, 3-5 times occurrence =1, 5-8 times = 3, 8-10 times = 4 and more than 10-times occurrence = 5. Meanwhile, risk analysis (R) is the multiplication of probability (P) and impacts (I), thus, an accident could be considered to have high risk if it had a score of 11 – 25; average 5 -10 and low 1 – 4. While to measure probability and impacts, Severity Index Method (SI) was used with the formula as follows: (Al Hammad and Assaf, 1996)

$$\mathrm{SI} = \frac{\sum_{i=0}^{4} ai\ xi}{4\sum_{i=0}^{4} x\,i}(100\%)$$

Where:

ai = constant coefficient.

xi = respondent frequency.

i = 0, 1, 2, 3, 4, … n

x_0, x_1, x_2, x_3, x_4, is respondent frequency.

Risk coefficient is based on company's policy with categories as follows: very low (VL) which is less than 20%, low (L) = 20% - 40%, average (A) = 40% - 60%, high (H) = 60 – 80% and very high (VH) = more than 80%.

RESULT AND DISCUSSION

Table 1 shows respondents' level of educational which indicated that most of them were university graduates (S-1), while Table 2 reveals that types of work which were handled by the respondents were mostly road and bridge projects.

Table 1: Level of Education.

Level of Education	Percentage
Postgraduates S2	10%
UndergraduatesS1	80%
High School graduates	10%

Table 2: Work Experience.

Types of Work	Percentage
Roads and Bridges	50%
Reservoirs	10%
Buildings	20%
Wharfs	10%
Others	10%

Meanwhile, table 3 indicates the probability of activity with high-risk category or with high frequency (60% - 80%) namely structure work with risk variables as the squirt of concrete materials, inhalation of dust caused by rigid cutting, and concrete piece blow at the time of concrete cutting and breaking, while average risk categories on structure work with risk variables were hit by concrete piece and the falling of scaffolding due to inability withstand a burden. This is because on structure work, girder, column or foundation and reinforced steel are large-volume work. Currently, on preparatory work, vehicle traffic and routine work had the average category (40% - 60%) with risk variable as exposed to dust. On land work with average category was risk variable of the incident of heavy equipment at the time of operation.

In impact analysis, activity with high-risk category was land work with risk variables as digging work hitting water supply pipes, utility cables and electric wires. This is because in the toll road work sites were found water supply canals, underground electrical cables and other utility cables such as telephone cables. While risk variables with average impact category were heavy equipment collision, heavy equipment incident while operation, slipped crane at the time of stake driving into the ground, slipped scaffolding due to inability to hold or withstand burden and slipped crane at the time of girder lifting. In table 3, it shows that most of the work had low risk variables except land work with risk variables as the incident of heavy equipment at the time of operation and on structure, work was slipped scaffolding due to its inability to withstand the burden which had an average risk category. This is due to high frequency of happening and its big impacts.

Australian Journal of Basic and Applied Sciences, 8(14) Special 2014, Pages: 65-69

Table 3: Risk Analysis.

Risk Variables	Probability (P)		Impact (I)		Risks (R=PxI)			
	SI %	category	SI %	category	P	I	R	category
Preparatory Work, Vehicle Traffic, Routine Work								
Hit by vehicles	5	VL	5	VL	1	1	1	L
Bitten by animals	12,5	VL	2,5	VL	1	1	1	L
Dust	65	A	5	VL	3	1	3	L
Getting electrical shocks	2,5	VL	7,5	VL	1	1	1	L
Swindled by cables	7,5	VL	2,5	VL	1	1	1	L
Heavy equipment collision	2,5	VL	57,5	A	1	3	3	L
Hit by materials, slipped, scratched, etc.	37,5	L	10	VL	2	1	2	L
Land Work								
Heavy equipment accident	7,5	VL	40	L	1	2	2	L
Workers run over by heavy equipment.	2,5	VL	12,5	VL	1	1	1	L
Heavy equipment incidence at the time of operation	40	A	40	A	3	3	9	A
Heavy-equipment operator accident	2,5	VL	5	VL	1	1	1	L
Heavy equipment slipped.	17,5	VL	7,5	VL	1	1	1	L
Land digging area sliding	32,5	L	12,5	VL	3	1	3	L
Digging hole's danger workers	5	VL	2,5	VL	1	1	1	L
Digging work hit water supply and electrical cables.	2,5	VL	67,5	H	1	4	4	L
Getting the electric shock of bore pile.	5	VL	2,5	VL	1	1	1	L
The work of arriving materials								
Broken steel wire hit workers.	2,5	VL	2,5	VL	1	1	1	L
Reinforced steel broken	5	VL	10	VL	1	1	1	L
Movement of equipment hit the surrounding things.	2,5	VL	7,5	VL	1	1	1	L
Hand trapped by iron when lifting.	7,5	VL	20	VL	1	1	1	L
Hit by reinforced steel	2,5	VL	7,5	VL	1	1	1	L
Steel wire for carrying girder broken	2,5	VL	17,5	VL	1	1	1	L
Unbalanced and irregular movement of the girder	5	VL	2,5	VL	1	1	1	L
Cement dust inhaled by workers.	5	VL	5	VL	1	1	1	L
Hit by cement bag	2,5	VL	7,5	VL	1	1	1	L
Hit by land aggregate materials	2,5	VL	10	VL	1	1	1	L
Truck carrying land slipped.	5	VL	2,5	VL	1	1	1	L
Fire extinguisher explosion	2,5	VL	0	VL	1	1	1	L
Structure Work								
Crane slipped at the time of stake driving into the ground.	2,5	VL	45	A	1	3	3	L
Hit by the deep pile at the time of lifting	2,5	VL	2,5	VL	1	1	1	L
Movement of deep pile equipment danger workers	5	VL	7,5	VL	1	1	1	L
Hit by pile drilling equipment	2,5	VL	2,5	VL	1	1	1	L
Drilling equipment movement danger workers	7,5	VL	7,5	VL	1	1	1	L
Stumbled into a pile drilling hole	2,5	VL	5	VL	1	1	1	L
Inhalation of welding smoke connecting deep pile	2,5	VL	10	VL	1	1	1	L
Hit by welding sprinkling	20	VL	20	VL	1	1	1	L
Accident causing burning	2,5	VL	15	VL	1	1	1	L
Hit by grindstone at the time of cutting	5	VL	2,5	VL	1	1	1	L
Hit by concrete piece	42,5	A	5	VL	3	1	3	L
Pinched at the time of installing iron	2,5	VL	10	VL	1	1	1	L
Hit by cutter at the time of iron cutting	5	VL	7,5	VL	1	1	1	L
Scratched at the time of iron installment	17,5	VL	2,5	VL	1	1	1	L
Pierced by cables	34,1	L	7,5	VL	2	1	2	L
Hooked by iron, wires or cables	2,5	VL	2,5	VL	1	1	1	L
Pierced by nail, crashed by frame work materials.	7,5	VL	20	VL	1	1	1	L
Slipped at the time of installing in the height	2,5	VL	2,5	VL	1	1	1	L
Hit by frame work materials	5	VL	5	VL	1	1	1	L
Fallen on by materials in the height	20	VL	12,5	VL	1	1	1	L
Scaffolding falling due to inability to with stand burden	40	A	52,5	A	3	3	9	A
Scaffolding falling due to not strong connection	2,5	VL	5	VL	1	1	1	L
Workers falling or slipped from scaffolding.	5	VL	10	VL	1	1	1	L
Scaffolding hit by drivers	2,5	VL	2,5	VL	1	1	1	L
Casting heavy equipment danger workers	5	VL	7,5	VL	1	1	1	L
Hit by mixer truck	2,5	VL	17,5	VL	1	1	1	L
Squirted by concrete materials	70	H	0	VL	4	1	4	L
Girder hit by vehicle	2,5	VL	2,5	VL	1	1	1	L
Crane slipping during girder lifting	5	VL	45	A	1	3	3	L
Girder falling at the time of being driven into the ground	2,5	VL	20	VL	1	1	1	L
Girder slipped from the pier head.	2,5	VL	17,5	VL	1	1	1	L
Hit by concrete plate material	2,5	VL	2,5	VL	1	1	1	L
Nipped by concrete plate at the time of installment	5	VL	10	VL	1	1	1	L
Cut by cutter during rigid cutting	2,5	VL	17,5	VL	1	1	1	L
Inhaling dust caused by rigid cutting.	70	H	2,5	VL	4	1	4	L

Hit by concrete piece at the time of cutting	70	H	12,5	VL	4	1	4	L
Skin allergy to cement materials	2,5	VL	0	VL	1	1	1	L
Hit by concrete pieces at the time concrete breaking	72,5	H	5	VL	4	1	4	L
Legs or fingers hit by hammer.	20	VL	2,5	VL	1	1	1	L
Inhaling dust caused by concrete breaking.	40	L	7,5	VL	2	1	2	L
Hands scrapping at the time of concrete breaking	20	L	2,5	VL	2	1	2	L
Falling from girder	2,5	VL	12,5	VL	1	1	1	L
Road Pavement Work								
Run over by compactor while moving backward	5	VL	10	VL	1	1	1	L
Inhaling dust or affected by dirt	37,5	L	0	VL	2	1	2	L
Workers hit by tack coat asphalt	32,5	L	0	VL	2	1	2	L
Workers hit by hot asphalt	2,5	VL	2,5	VL	1	1	1	L
Missed by vehicles at the time of making line	5	VL	10	VL	1	1	1	L
Hit by road lining materials	2,5	VL	0	VL	1	1	1	L
Toll Road Facility Work								
Inhaling welding fumes (poisoned by metals)	2,5	VL	5	VL	1	1	1	L
Welding sparks (eye irritation)	7,5	VL	7,5	VL	1	1	1	L
Falling from the height during installation	2,5	VL	20	VL	1	1	1	L
Workers nipped at the time of unloading sentry box	5	VL	10	VL	1	1	1	L
Nipped by railing material of toll road	17,5	VL	2,5	VL	1	1	1	L

***Conclusion**:*

It could be concluded that work accident risk analysis on the implementation of Mojokerto- Surabaya toll road could be regarded to have the low category, except incident of heavy equipment at the time of operation on the land work and slipped scaffolding due to its inability to withstand a burden on structure work, which had the average category. Meanwhile, the response to the work which had the average risk category could be overcome by conducting regular maintenance and calibration to the equipment and providing adequate workshop equipment. In addition, it could be solved by prior calculation of the scaffolding strength and the application of wood or iron plate on the land foundation.

ACKNOWLEDGEMENT

The researcher would like to express his gratitude to PT. WIKA as the main contractor who allowed an opportunity to its staff to fill in questionnaire form.

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