RISK ASSESSMENT AS A STRATEGY TO PREVENT OF MINE ACCIDENTS IN INDONESIAN MINING

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Abstract:
The paper is present the result aimed to develop of mines safety management properly in Indonesian mining throughly characterise risks associated with mine accidents in Indonesian mining, especially in coal mining. The risk assessments are based on data obtained from the Directorate General of Mineral and Coal reports, which mines accidents that occured from 2003 upto 2010. The paper focus on 2009 involved 44 fatality and 2010 included 94 serious mines accident and 15 fatality. The process or procedure of risk assessments in the mine accidents are involvd hazards identification, risk analysis, and risk evaluation (process of evaluating the risk to determine if it can be tolerated or accepted). Risk levels are then developed using a pre-established risk matrix that ranks them according to probability and severity (e.g. high risk, low risk, or risk tolerable or acceptable). The resulting assigned risk value can be used to prioritise risk control strategies to achieve goals. The analysis of mine accidents were used 13 groups of criteria from coal mining industry only. The hazards and risks are improperly managed in the coal mining operations will impact to occupational health and safety directly or indirectly to the company (e.g. workers, process). Regarding to International Lost Control Institute (ILCI) model (Bird & German, 1985) the immediate cause of accidents are composed of unsafe acts and unsafe conditions in the workplace or in mine sites. The human failure is a significant point to address of mine accidents in the workplace, such as not follow the working instruction or procedure properly, working violence, lack of knowledge and skill, lack of coordination, and unwear personal protective equipment (PPE) as required. Increasing of Indonesian coal production on year to year will influence toward company image and performance achievement without occupational or mine accidents. Mining accidents are preventable with a good condition and practice of safety in mining (e.g. PDCA model, STOP model), and can let to economic and social benefits.
Keywords: *hazard; risk; risk level, accident, mines accident, mining, production.*

1. Introduction

Historically, mining has been one of the most hazardous and risk work environments in many countries around the world, including Indonesia. Although progress has been made, over the past ten years the number of Indonesian mining fatalities, fatality incidence rates, severity rates and injuries have fluctuated with shown increased and unacceptably high.

Most mines in Indonesia using surface mine methods such as an open pit mining (more than 90%), because the majority of mine reserves found in the lowlands or in mountainous areas.

The mine accidents data is based on historical of Indonesian mines accident with period of time from 2003 to 2010. The accident is the potential risk impact from mining industry activities, which has become more significant with the increasing production, storage and use of hazardous substances, has emphasised the need for a clearly defined and systematic approach to the control of such substances in order to protect workers, public, and the environment. But all mines accidents are preventable, accidents do not happen without causes. Identifying and controlling the cause is the key to accident prevention. Typically, accidents are the result of unsafe acts committed by people and/or the existence of unsafe physical or mechanical conditions. The mines accident (article 39) in Indonesia have different criterias regarding to the Minister of Mining and Energy Decree No. 555.K/26/M.PE/1995, as follow (Table 1):

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Table 1 *Mine Accident Elements*

Element	Criteria
1	The accident is actually occurred;
2	Resulting in injury to mine workers or people who were given permission by the Technical Mines Manager (*Kepala Teknik Tambang*);
3	As a result of mining activities;
4	Accident occur during working hours toward to the miners who may have injuries or any time people are given permission and;
5	Accident occurred in the area of mining activity or project area.

Note: The mine accident will be stated if the five elements were involved properly.

Occupational or working accident definitions are the accident happened on the worker / employee of a company because of the employment relationship, the mines accident is part of the working accident. Criteria for occupational injuries must meet the following requirements:

Table 2 *Occupational Accident Elements*

Element	Criteria
1	An accident is occured
2	Resulting injury to the worker (s)
3	An accident occurred related to the employment relationship
4	An accident occurred during working hours.

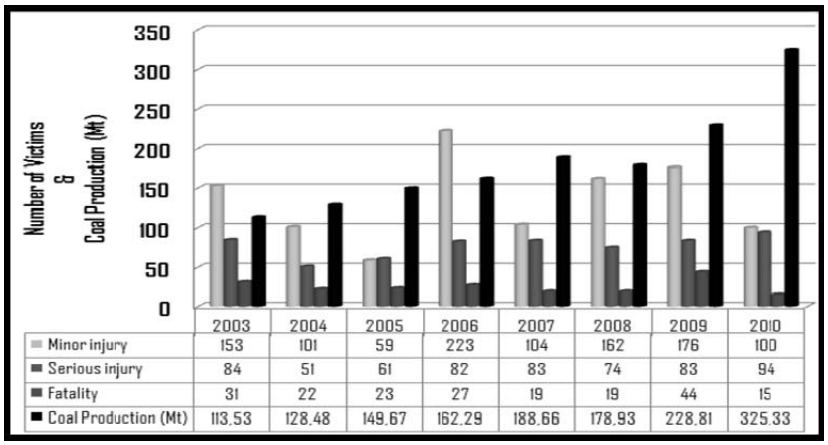
Risk assessment is comprised of the processes for identifying, analysing and evaluating risks, as shown in Figure 1 below. In these paper the author will be used the risk assessment of ISO 31000 model to analysis of mine accidents in Indonesia, and after this analysis, an evaluation of the level of risk is required to makes decisions about further risk treatment.

Fig. 1 *The Risk Management Process*

The mining industry has an important and strategic role in economic development in Indonesia. Particularly in the coal production was increased significantly from 1996 to 2011 of 50.33 upto 371.00 million tons. Indonesia is a second largest of coal exporter country following Australia, with total export more than 70% from national output. In the year 2008 to year 2010 revenues increased from IDR 42.12 trillions to IDR 66.33 trillions[1], or contributing around approximately 4.4% of total state revenue, excluded oil and gas mining industry[2]. Wherever the coal production is increased on year to year but the number of mine accidents are always become a problem in the mining industry in Indonesia (Fig. 2).

According to the International Labour Organisation (ILO), the number of work-related accidents has increased, and more people are dying from workplace injuries and illnesses. The ILO has subsequently attacked employers for neglecting Health and Safety standards at work. On the messaged by the Director General of ILO has said for 2011 each every year around 337 million people are victims of work accidents and more than 2.3 million people died because of occupational injuries or work-related diseases. ILO calculation has said the losses of money caused of working accidents in the developing countries are around 4% from GNP[3], it's too much money[4].

[1] Bank of Indonesia, 26 March 2012, exchange rate, 1 USD = IDR 9,181.
[2] Directorate General of Mineral and Coal, Ministry of Energy and Mineral Resources of Indonesia, 2011.
[3] Abbreviation, GNP: Gross National Product.
[4] ILO report 2010.



	2003	2004	2005	2006	2007	2008	2009	2010
Minor injury	153	101	59	223	104	162	176	100
Serious injury	84	51	61	82	83	74	83	94
Fatality	31	22	23	27	19	19	44	15
Coal Production (Mt)	113.53	128.48	149.67	162.29	188.66	178.93	228.81	325.33

Fig. 2 *Comparing between Mine Accident and Coal Production in Indonesia*

2. Methodology and Case Study

This paper is based on historical mines accident data for case study, the period of time is from 2003 to 2010 obtained from the Directorate Technique and Environment of Mineral and Coal reports, but the analysis of fatality mines accident and serious accidents are concerned only in 2009 and 2010 cause in these time period called a mines disaster in Indonesia in particularly 2009. In this paper also will be described the risk assessment based on the sample data from one of the biggest surface coal mining company in Indonesia, and the mine accident inventory table containing all identified of mine accidents from minor, serious and fatality are shown later in this paper.

The methodology in these paper will be used the risk assessment of ISO 31000 model to analysis of mine accidents in Indonesia by statistical approach. According to Haimes (2004), Brauer (2006) and various internationally recognised standards (Department of Defence, 2000; Canadian Standards Association, 2002; Standards Australia / Standards New Zealand, 2004), the risk assessment process involves three steps: 1) risk identification; 2) risk analysis; 3) risk evaluation. According to Kates and Kasperson (1983), risk is a hazard measurement, taking into consideration its likelihood (probability) and consequences (severity).

Risk analysis is the second stage of the risk assessment process. According to Joy (2004), if the severity (consequence) of the loss can be measured objectively and the frequency (probability) of the event can be determined from the historical data, then a quantitative risk assessment can be performed. If the severity and frequency cannot be specified but can be estimated based on judgement or opinion, then a qualitative risk assessment can be performed. In this study, quantitative risk analysis was considered to be appropriate. The risk (R) associated with a particular activity is judged by estimating both the probability (Pr) and the severity (S), in relative terms such as insignificant, low, moderate, severe,and catastrophic.

In the context of this study, probability is considered as the likelihood that the hazard will cause a minor accident, serious accident and fatality in a future year and is calculated as the number of years in the study period divided by the total number of years (10 years). The risk matrix of mine accident inventory is described in 13 items, but in this paper only explain **five items** are type of company, type of job, factor of mine accident, mine accident location and source of mine accidents (Table 6). The proposed severity and probability classifications are shown in Tables below. Risk evaluation is the final step in the risk assessment process and focuses on the decisions required to address the analysed risks.

Table 3 *Hazard Severity (S) Classification*

Severity	Definition		
	Minor	**Serious**	**Fatality**
Catastrophic	More than 100 minor injury in the examined year	More than 30 serious injury in the examined year	More than 10 fatality in the examined year
Severe	$70 < X \leq 100$	$20 < X \leq 30$	$7 < X \leq 10$
Moderate	$30 < X \leq 70$	$10 < X \leq 20$	$4 < X \leq 7$
Low	$10 < X \leq 30$	$4 < X \leq 10$	$2 < X \leq 4$
Insignificant	$X \leq 10$	$X \leq 4$	$X \leq 2$

Table 4 *Hazard Probability (Pr) Classification*[5]

Probability	Definition of Minor or Serious or Fatality
Almost Certain	Minor accident will occur with a probability of Pr = 0.91 – 1.0
Likely	Pr = 0.61 – 0.9
Moderate	Pr = 0.41 – 0.6
Unlikely	Pr = 0.11 – 0.4
Rare	Pr = < 0.10

Table 5 *Risk Assessment Matrix*

Probability	Almost Certain	L	M	H	VH	VH
	Likely	L	M	M	H	VH
	Moderate	VL	L	M	M	H
	unlikely	VL	L	L	M	M
	Rare	VL	VL	VL	L	L
		Insignificant	Low	Moderate	Severe	Catastrophic
		Severity				

Risk Level: VL = Very Low, L = Low, M = Medium, H = high, and VH = Very High

Regarding to the risk assessment matrix above, time frames to ensure that risk are removed, as the following action required:

Table 6 *Example Risk Level or Ranking Categories*[6]

Risk Rank	Risk Level	Category	Description
I	Very High	Unacceptable risk	Action required immediately: The proposed task or process activity must not proceed. Steps must be taken to lower the risk level to as low as reasonably practicable using the hierarchy of risk controls or should be mitigated with engineering controls of risks.
II	High	Undesirable	Action required today: The risk level has been reduced to as low as reasonably practicable using the hierarchy of risk controls; e.g. OHS Standards and rules, Safe Working Procedure, and the supervisor must review and document the effectiveness of the implemented risk controls. Or should be mitigated with engineering controls of risks within a specified period of time.
III	Medium	Acceptable with control	Action required this week: The risk level has been reduced to as low as reasonably practicable using the hierarchy of risk controls; e.g. the risk assessment has been reviewed and approved by the Supervisor and and a Safe Working Procedure or Safe Work Method has been prepared.
IV	Low	Acceptable as is	Action required this month: Managed by local documented routine procedures which must include application of the hierarchy of controls or no mitigation required.
V	Very Low		

[5] sources: MITRE, Bedford, Massachusetts
[6] Sources: CCPS Guidelines for Hazard Evaluation Procedures, second edition.

3. Discussion and Conclusion

3.1. Discussion

In the past of eight years, the mines accident in Indonesian mining excluded oil & gas mining has shown increasing from 2003 upto 2010 with total fatality is 200 miners died, particularly in 2009 the mines dissaster are occured with of 44 miners died, and the highest contributed by underground coal mining (small scale mining) with 33 miners died (Fig.2).

According the risk assessment of mine accidents from 2003 upto Sem. I from the biggest coal mine company (example for serious injury from five items as a mention above in page number 4 has been resulted of the severity and probability score of the risk assessments (Table 7). In this case, the author only calculated of the risk level for example only two (2) items of the source of mine accident and mine accident location. The final score of the risk level both of them are following;

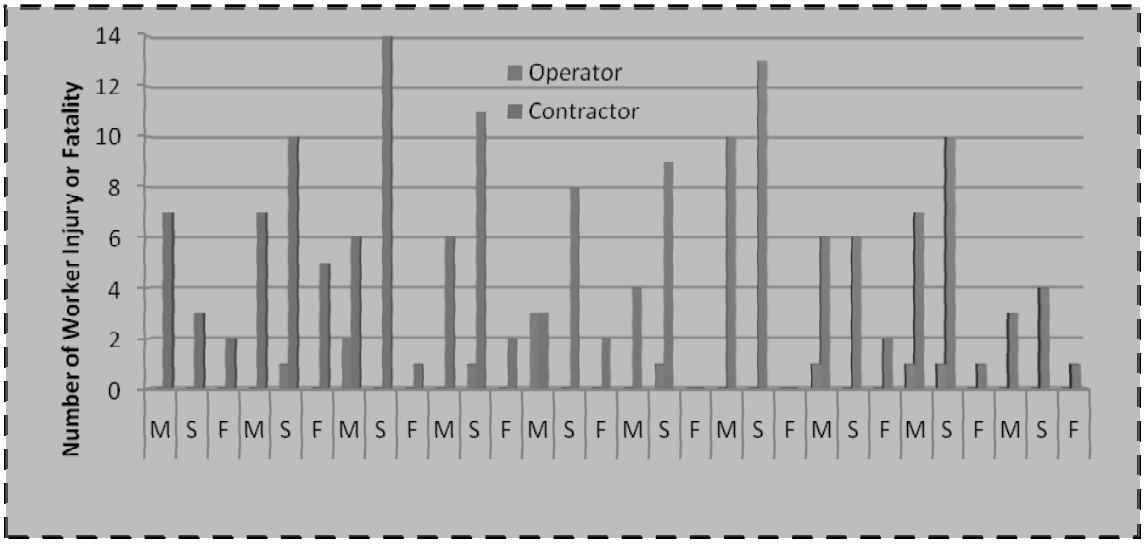
- the source of mine accident is tools with very high risk level and;
- the mine accident locations are workshop and mine pit with risk levels are very high and high (Table 8).

Table 7 Mine Accident Inventory by One of the Biggest Coal Mining Company in Indonesia

No.	Mine Accident Inventory	Year																																			
		2003			2004			2005			2006			2007			2008			2009			2010			2011			Sem.I 2012								
		Type of Injury																														Severity			Probability		
		M	S	F	M	S	F	M	S	F	M	S	F	M	S	F	M	S	F	M	S	F	M	S	F	M	S	F	M	S	F	M	S	F	M	S	F
A	**Mining Company Type**																																				
	Operator	0	0	0	0	1	0	2	0	0	0	1	0	3	0	0	0	1	0	0	0	0	1	0	0	1	1	0	0	0	0	7	4	0	0,4	0,4	0
	Contractor	7	3	2	7	10	5	6	14	1	6	11	2	3	8	2	4	9	0	10	13	0	6	6	2	7	10	1	3	4	1	59	88	16	1	1	0,8
B	**Type of Job**																																				
	Driver	1	2	2	3	4	1	3	5	1	1	1	1	1	3	0	0	2	0	4	1	0	2	2	2	0	2	1	1	0	0	16	22	8	0,8	0,9	0,6
	Welder	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	1	0	3	1	0	0,2	0,1	0
	Mechanic	5	1	0	3	2	3	3	5	0	0	8	0	3	3	0	4	5	0	1	7	0	4	1	0	6	6	0	0	2	0	29	40	3	0,8	1	0,1
	Operator	0	0	0	1	2	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	1	0	0	0	0	2	0	0	5	4	0	0,4	0,3	0
	Blaster	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0,1	0,1
	Electrician	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0,2	0
	Foreman	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	4	1	0,1	0,4	0,1
	Supervisor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0,1	0
	Helper	1	0	0	0	2	0	2	2	0	5	3	1	1	1	0	0	1	0	1	4	0	0	1	0	2	2	0	0	1	1	12	17	2	0,6	0,9	0,2
	Crew Boat/ship	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Etc.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C	**Factor of Mine Accident**																																				
	Unprocedure	2	1	1	1	0	1	0	3	0	2	3	1	0	2	2	1	3	0	4	3	0	1	2	1	3	5	0	1	2	1	15	24	7	0,8	0,9	0,6
	Unwear PPE	0	0	0	2	1	0	0	3	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	9	0	0,1	0,4	0
	Inadequate SOP	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0,1	0,1
	unsafe working place	0	0	0	0	0	0	2	1	0	0	0	0	1	0	0	0	2	0	1	1	0	0	0	0	0	1	0	0	0	0	4	5	0	0,3	0,4	0
	unsafe body position	2	0	0	1	2	4	1	0	0	0	2	0	1	2	0	3	0	0	2	1	0	0	0	0	0	2	1	0	0	0	10	9	5	0,6	0,5	0,2
	substandard tools	2	2	0	3	5	0	3	4	0	3	3	1	3	2	0	0	4	0	0	3	0	4	3	0	3	3	0	1	0	0	22	29	1	0,8	0,9	0,1
	lack of coordination	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2	0	0,1	0,2	0
	not available SOP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	unproper job	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Etc.	1	0	1	0	3	0	2	3	0	0	2	0	1	2	0	0	0	0	3	1	0	2	0	1	2	0	0	1	2	0	12	13	2	0,7	0,6	0,2
D	**Mine Accident Location**																																				
	Hauling Road	1	0	2	2	2	1	2	2	1	6	1	2	0	3	0	0	0	0	4	1	0	1	0	2	0	3	0	3	1	1	19	13	9	0,7	0,7	0,6
	Reclame area	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pit/ mine excavation	0	0	0	2	4	0	1	5	0	0	4	0	2	2	2	0	5	0	3	4	0	2	3	0	4	3	0	0	0	0	14	30	2	0,6	0,8	0,1
	drilling	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0,1	0
	explosive warehouse	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0,1	0
	port	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	workshop	5	1	0	3	2	4	3	5	0	0	4	0	0	2	0	4	4	0	2	8	0	3	3	0	4	3	1	0	3	0	24	35	5	0,7	1	0,2
	ship	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	processing plant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	power plant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	construction area	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	project area	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0,1	0,2	0
	etc.	1	0	0	0	3	0	2	1	0	0	1	0	3	0	0	0	1	0	1	0	0	1	0	0	0	2	0	0	0	0	8	8	0	0,5	0,5	0
E	**Source of Mine Accident**																																				
	machining	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0,1	0
	people transportation	0	0	2	0	0	1	1	0	1	2	1	1	0	3	0	0	0	0	2	3	0	0	0	2	1	1	0	0	1	0	6	9	7	0,4	0,5	0,5
	Load, dig & lift equipments	0	1	0	1	0	0	1	2	0	0	0	0	1	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	4	5	0	0,4	0,3	0
	Haul equipments	1	0	0	2	1	0	0	2	0	3	2	1	0	2	0	0	2	0	3	2	0	0	1	0	1	2	1	0	0	0	10	14	2	0,5	0,8	0,2
	fire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	explosives	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	working condition	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	6	0	0	0,4	0
	radiation (ray-x)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	gases	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	tools	6	2	0	3	5	4	3	4	0	1	7	0	3	3	0	4	3	0	5	7	0	3	3	0	3	5	0	3	3	0	34	42	4	1	1	0,1
	machine tools	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0,1	0,1	0
	static equipments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	etc.	0	0	0	1	2	0	1	3	0	0	2	0	2	0	2	0	2	0	0	1	0	3	2	0	3	1	0	0	0	1	10	13	3	0,5	0,7	0,2

Notes: M = Minor Injury, S = Serious injury, F = Fatality

The distribution of mine accident of the biggest coal mining company in indonesia between 2003 upto Sem.I 2012 are shown in the Figure 3. The majority of mine accidents are contributed by cantractor. The risk level of the mine accidents are shown in the Table 8



Note: M = Minor Injury, S = Serious Injury, and F = Fatality

Fig. 3 *Distribution of Mine Accident of the Biggest Coal Mining Company in Indonesia between 2003 upto Sem.I 2012*

The risk level has been assessed as the following.

Table 8 Risk Level Result

Source of Mine Accident	Severity	Probability	Risk Level	Mine Accident Location	Severity	Probability	Risk Level
Machining	2	0,1	VL	Hauling Road	13	0,7	M
People transportation	9	0,5	L	Reclame area	0	0	n/a
Load, dig & lift equipments	5	0,3	L	Pit/ mine excavation	30	0,8	H
Haul equipments	14	0,8	M	Drilling	2	0,1	VL
Fire	0	0	n/a	Explosive warehouse	2	0,1	VL
Explosives	0	0	n/a	Port	0	0	n/a
Working condition	6	0,4	L	Wrkshop	35	1	VH
Radiation (ray-x)	0	0	n/a	Ship	0	0	n/a
Gases	0	0	n/a	Processing plant	0	0	n/a
Tools	42	1	VH	Power plant	0	0	n/a
Machine tools	1	0,1	VL	Construction area	0	0	n/a
Static equipments	0	0	n/a	Project area	2	0,2	VL
Etc.	13	0,7	M	Etc.	8	0,5	L

3.2. Conclusion

Regarding to the risk assessments of mine accidents from 2003 up to 2010 especially for serious injury in an expalianation above said the source of mine accident potential is tools (substandard tools) and mine accident locations are workshop and mine pit, with the risk level from high and very high (not follow the safe working procedure or standard operating procedure properly). The hauling road of mine accident location is contributed of moderat risk level shown in the Table 9.

Considering it, to many mines accident occurances in these period of time were shown the lack of awareness of workers to working safely. Therefore, requires proactive action how to prevent, reduce and avoid of accidents in the workplace or in mine sites.

Risk management is required not only the involvement of the management but also the commitment of management and all parties concerned. The risk analysis of mines accident is part of checking and corrective action in the safety management system, as stage of control. If we can control the hazards and risks in the workplace or equipments, so we can prevent and control the accident. The hierarchy of control is a practicable of sequence process to prevent accidents (e.g. hazards and risks) in the workplace or in the mine sites such as eliminate, substitute, isolate, engineering, administrative and personal protective equipment (PPE), and all dependent on the type of jobs activities and situations. The mine accidents are preventable with a good condition and practice of safety in mining, and can let to economic and social benefits.

References

1. Janicak, C.A.
Applied statistics in occupational safety and health. Director safety program, Department of health sciences, Illionis State University (2000)

2. Health and Safety Executive, UK
Five Steps to Risk Assessment

3. Heinrich, H.W.
Industrial incident prevention: A scientific approach (4th ed.). New York: McGraw-Hill Book Company (1959)

4. ISO 31000 Risk Management
Overview and Implications for Managers, 2009

5. Lack, R.W.
Essential Safety and Health Management, Lewis Publisher, 1996

6. U. S. Department of Labor
MSHA Handbook Series, Accident/Illness Investigation Procedures, June 2011

7. Zainalabidin, M.N., Kecojevic V., Komljenovic, D., Groves W.
Risk assessment for loader- and dozer-related fatal incidents in U.S. mining. The Pennsylvania State University, PA, USA, Department of Industrial Engineering, University of Quebec, Hydro-Qu bec, Canada (2008).