Development of Risk-Based Standardized WBS (Work Breakdown Structure) for Safety Planning of Coal Mine Project with Surface Mining Methode

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Abstract. The Mining Industry takes an important role in developing the country's economy, especially developing the country. Along with the increase in the coal mining sector, incident in the coal mining sector has decreased. Typical of coal mining activities is very strict safety regulations. Regulation in Mining Safety Management System is the role of the Indonesia government to be approved and provides clear rules in the OSH & Safety Operational system. Indonesian mining which must be applied by mining companies. Mining Safety Management System (MSMS) has begun to be implemented since 2014 in the mining sector, with Permen No. 38/2014. Then in 2018, it was replaced by Permen no. 26/2018, required 7 elements in the application of Mining Safety Management System. Standardized WBS can complement the planning element at MSMS, which is offered in updates related to work accidents. The purpose of this study was to develop a risk-based WBS standard particularly for coal mining project, by using a qualitative approach. The results of this study are WBS standard work standard for coal mining work with risk-based surface mining methods, there are 11 clusters of work, 34 work packages, 70 types of work and 325 work activities in coal mining. The development of risk-based WBS as a form of prevention, reducing and even nullifying the risk of work accidents in the implementation of coal mining projects.

Keywords: work breakdown structure, risk, coal mining

1. Introduction

Statistics on mining accidents in Indonesia concluded that the highest fatality rate occurred in 2013 of 46 people, then gradually decreased in 2014 to 32 people, then in 2015 to 25 people. Then in 2017 there was an increase from the previous year which was 17 people.

From Figure 1, there is a decrease in the number of mining accidents in Indonesia. But the death rate due to mining accidents still exists. In 2018 there were still 17 deaths due to mining accidents. Frequency rate from 2012-2018, there...
is a declining trend. In 2012, the frequency was 0.34, then in 2013 the frequency was 0.31, then in 2014 and 2015 the frequency was 0.22; then in 2016 the frequency rate rose from the previous year to 0.3; then in 2017 there was a decrease in the frequency level to 0.19; then in 2018 it will become 0.17.

Severity rate (severity rate) from 2012-2018 as follows, in 2012, the severity rate was 248.9, then in 2013 the severity rate was 404.21; then in 2014 the severity decreased from the previous year to 272.68; then in 2015 the severity level became 241.59; then in 2016 the severity level decreased from the previous year to become 236.04; then in 2017 there was a decrease in severity to 130.64; then in 2018 it would be 127.32.

Figure 2 shown the results of mining accident analysis based on the location of the accident during 2018 to 2019 the majority occurred in the method of open pit mining (surface mining). In 2018, mining accidents using the surface mining method by 20%; then in 2019 there will be a significant increase of 39% of accidents occurring in surface mining. This is in accordance with the object of research where the biggest problem review is on coal mining projects with surface mining methods.

2. Research Objectives
The objectives of this research are:
- To obtain a standard form of WBS coal mine project
- To identify a potentially dangerous source of risk for coal mine project.
- To develop a WBS standards of coal mine project for risk-based safety planning.

3. Literature Review
3.1. Work Breakdown Structure. WBS is a breakdown of project works into smaller components so it can be better managed (Pratita & Latief, 2018). Work Breakdown Structure (WBS) is a hierarchical decomposition of the scope of work that must be completed by the project team to achieve the objectives and provide the required results. The planned work consists of the lowest level of the WBS component, which is called the work package (PMI, 2017). A comprehensive efficient work breakdown structure (WBS) can prove pivotal within project management planning processes by partitioning projects into stages, deliverables and work packages (Siami-Irdemoosa et al., 2015). A standardized WBS is also used to define project activities (Momoh et al., 2008). The WBS identifies the deliverables and the work packages used to measure project performance on safety planning (Satrio & Latief, 2018). WBS can be used as a planning approach and the practice was reported to reduce probability of work accident, and increased control on site for industrial construction projects.

3.2. Risk Management. Risk is a condition that arises because of uncertainty with the chance of certain events which if they occur will lead to unfavorable consequences. Furthermore, the risk to the project is a condition in the project that arises because of uncertainty with the chance of certain events that if they occur will result in physical or financial consequences that are not favorable for the achievement of project objectives, namely
the cost, time, quality of the project (Soemarno, 2007). The risk of work accidents can be prevented by the initial identification and analysis of the potential hazards that exist in every activity contained in WBS. So that the need for standardized WBS in preventing the risk of work accidents is very important because it will present an assessment of the risks, impacts, and frequency arising from work accidents (Elsye, 2018). There are many factors that have influenced coal mining accidents in China which are very diverse and the interactions are very complicated. (Zhu, 2009). There are many safety problems that occur at various mineral mining locations in Nigeria. This includes reported damage to lives, property and environmental degradation. These problems are made worse because safety rules and procedures are not enforced or adhered to adequately (Emetumah, 2018). Mining practices produce many conditions that have major consequences on human safety and health. These safety and health problems arise as a result of biological, chemical, psychosocial and physical risk factors (Abbasi, 2018).

3.3. Research Methodology
This research used a qualitative approach to obtain the formulation of WBS standards for a coal mine project. Using bill of quantity data from 10 coal mine projects. Then a survey and a deep interview to experts who have more than 20 years’ experience in port construction project. After obtaining the WBS standard, the next process is to identify the risks of each work package, activity, materials, equipment, and labor of WBS standard. The research flow can be seen in figure 1.

3.4. Research Instrument
Questionnaire is used to collect data in survey research. There will be 4 kinds of the questionnaire based on the objective of the research. Questionnaire 1 is applied for collecting data of WBS. Questionnaire 2 is applied for identifying safety risk and risk control. Questionnaire 3 is applied to develop safety plan. And questionnaire is used to collect the safety component. Guttman scale is applied in each questionnaire to get the firm answer “yes” or “no” (Sugiyono, 2018). The questionnaire will produce nominal data for later analysis.

3.5. Sampling Technique
Respondents in this research are selected by non probability sampling technique (Sugiyono, 2018) and expert judgement (PMI, 2017). The requirements to become a sample are consist of 3 to 5 experts who has 10 years professional experience in bridge project and construction safety, minimum bachelor degree. Respondent can be academics, professional associations and practitioners who have minimum qualify as project manager, site engineering manager, site manager and safety manager.

**Figure 3. Research Flow Chart Diagram**
4. Results and discussion

4.1. Result WBS Standards in coal mining work with surface mining methods

Figure 4 shows the levels of standardized WBS. Level 1 shown as project name. Level 2 shown as work section consisting of 11 elements, there are preparation of project owner management, mining exploration, mining construction, land clearing, top soil management, overburden removal, coal getting, coal processing, coal marketing, reclamation, and revegetation. Level 3 is a Sub Work Section consists of 34 elements. Level 4 is the Work Package consists of 70 elements. Alternative Design / Method consists of 86 elements. Level 5 is an activity consisting of 325 elements.

4.2. Potential dangerous source of risk for coal mine project

Identification of risks to coal mine projects that may affect safety planning derived from literature studies, then clarification and validation by experts. Once the content of probability and impact is obtained, the risk score can be calculated by:

\[ R = P \times I \]  

Where R = Risk Factor, P = Probability and I = Impact

After getting the risk value, then the analysis to get the risk response in the form of preventive and corrective action. These risk responses will be added in compiling the WBS at level 4 (work package), level 5 (activity) and level 6 (resources) as a development of WBS standardization in this research. Then the variable is defined in table 1. Risk Variables as follows:

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**Table 1. Risk Variable for Coal Mining Project**
In this study, a questionnaire was conducted that found 30 (thirty) risk variable that affect safety performance, then conducted discussions and validation with 5 (five) experts where from the results of the analysis there were 3 (three) variables omitted so that the final variable used in this study as many as 27 (twenty seven) risk factors that can affect safety performance in coal mining work. From this research, 11 (eleven) highest or dominant risk factors are included in the high risk level category which can affect the safety performance of the Coal Mining project, there are:

1. Sink / Work near water
2. Slope Failure / Avalanche
3. Working with fatigue
4. Fell from a height
5. The unit stops or parks in an unsafe area
6. Disturbances from the surrounding community
7. Occupational Hazards have not been identified properly
8. Tools crashing workers or nearby facilities.
9. Electrocuted
10. Doing work in a critical area
11. Operate Unit without permission

4.3. Develop a risk-based WBS standard to plan safety in coal mining projects using surface mining methods.
Dominant risks are analyzed for the causes, impacts, preventive actions and corrective actions found from the previous research stages which can produce additional or recommended activities to complete WBS coal mining standards. According to Rianty, risk response has an application related to the development of WBS which can be categorized into 5 groups as follows:
1. Additions to management
2. Additions to other WBS
3. Additional relevant WBS elements
4. Additional to job requirements
5. Affects the WBS coefficient

The next stage of the study was a discussion with experts related to the causes, impacts, preventive actions, and corrective actions for each risk event. At the highest risk, found 22 causes, 5 impacts, 13 preventive actions, and 22 corrective actions which were then carried out mapping related to the causes, impacts, preventive actions, and the corrective actions. Here the risk respond based on Dominant Risk Variables that has been compiled at table 2 below.

Table 2. Risk Respond

| No | Pattern Recognition | Grouping |
|----|---------------------|----------|
|    |                     | 1 2 3 4 5 |
| PA1 | Conduct a review of real conditions in the field to learn the appropriate methods in determining the safety plan | ✗ | Grouping: 1. Additions to management |
| PA2 | Identify risk factors that can occur when planning work | ✗ | 2. Additions to other WBS |
|     | Supervisory consistency in reminding operators to be disciplined in procedures and regulations | ✗ | 3. Additional other WBS requirements |
| PA3 | Review the HIRA until you get a hidden danger and make sure you get tired of entering it | ✗ | 4. Additions to the work coefficient |
| PA4 | Ensuring the suitability of the operator's residence So it guarantees adequate rest / sleep | ✗ | 5. Affects the WBS coefficient |
| PA5 | Evaluation of operator policies understanding of company policies and procedures | ✗ |  |
| PA6 | Educate operators about readiness and signs in the body and face danger, and difficulties due to fatigue. | ✗ |  |
| PA7 | Conduct a review of the operator's rest area | ✗ |  |
| PA8 | Review HIRA again | ✗ |  |
| PA9 | Make Work Permit Work at Altitude for special employees who have already conducted training. | ✗ |  |
| PA10 | Make Work Permit Work Near the air for special employees who have conducted training. | ✗ |  |
| PA11 | Improve competence | ✗ |  |
| PA12 | Conducting socialization / CSR programs for residents around the project. | ✗ |  |

5. Conclusion
Based on the standard WBS coal mine project with surface mining method is categorized into 11 (eleven) projects, namely, there are preparation of project owner management, mining exploration, mining construction, land clearing, top soil management, overburden removal, coal getting, coal processing, coal marketing, reclamation, and revegetation.
The standard WBS coal mine project for each category is divided into 6 levels, Level 1: Project Name, Level 2: Work Section, Level 3: Sub Work Section, Level 4: Work Package, Level 5: Activity and Level 6: Resources. Having obtained the risk event variable is also equipped with the risk response of each variable so that the potential danger can be prevented/mitigated. Preparation of safety plan by using risk based WBS standard can be used either as assessment material of service provider auction process or also as guide for contractors in the preparation of safety planning.

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