Development of WBS (Work Breakdown Structure) risk based standard for safety planning at seaport project

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Abstract. A construction project consist of many activities. In order to make it easier to manage, the activities broken down into smaller one that called work package. Meanwhile the work on the construction project and its elements is relatively similar and this can be standardized and used as the basis for a universal program for construction works. Standardization of the WBS will enable the automation of the project planning process and hence will minimize the occurrence of work accidents on construction project. The aim of this study is to develop a risk based WBS standard for seaport project, identify source of potentially dangerous risk may occur and to develop safety plan using a standardized risk based WBS, this will be a way to preventing, reducing and nullifying the risk of workplace accidents to obtain zero accidents in a construction site. The scope of this study is sea port construction project only.

1. Introduction

In the administration of President Joko Widodo launched a program called Sea Toll. This program is to facilitate access to commerce from west to east Indonesia. This is important because based on data from the ranking of Global Competitiveness Index, Indonesia is still ranked 77th in 2015, and still inferior to neighbouring countries such as Thailand, Malaysia, Singapore [1]. Therefore, President Joko Widodo’s effort to catch up with this by building infrastructure. One of the infrastructure facilities that is concern is port development. Given the importance of port development, careful planning is required before project implementation. The success of a project's management will largely depend on the ability of the project manager to specify the work package in terms of products and activities. WBS becomes one of the major tools for planning and controlling work packages [2].

So in this case, WBS is expected to be a dynamic tool to become a reference framework that can organize and regulate the scope of the approved project, assist in ensuring the assignment of all work, and review the risk-based safety plan for each activity undertaken. With the identification of risks arising in each activity in the grouped structure work, it is expected that it can be registered properly and produce a safety plan that can be used as input for the contractor in particular, due to the presence of WBS that has been based [3].

2. Research objectives

The objectives of this research are:

- To obtain a standard form of WBS port construction project.
- To identify a potentially dangerous source of risk for port construction project.
- To develop a WBS standards of port construction project for risk-based safety planning.

3. Literature review

3.1. Stakeholder analysis

3.1.1. Work Breakdown Structure (WBS). WBS is a hierarchical decomposition of work oriented towards deliverables to be executed by the project team to achieve project objectives and create the required deliverables [2]. The Intended deliverability can be a unique result or capability to display services that must be produced to complete the project process, phase, or stage. Usually used as the subject of approval by the sponsor or owner. Deliverables also define as any results or items measured, real, verifiable, which must be produced to complete a project or part of the project [4]. A standardized WBS for the project is used to facilitate the preparation of project financing and a standardized WBS is also used to define project activities [5].

3.2. Risk management

Risk is potential event that can be avoided or reduced as small as possible so that the impact is minimal in accordance with the plan, or that can be accepted within the tolerable limits that are permitted and does not interfere significantly with the set goals [6]. Project Risk Management is a process that includes, plans for risk management, identification, analysis, response plans and risk control in a project [2]. Risk management is an important part of the process of making decisions on construction project management, especially in terms of integration, scope, quality, cost, time, communication, human resources and procurement. To identify uncertainties and possible risks by using RBS (Risk Breakdown Structure) [7].

Performance Concepts of Occupational Safety and Health Due to worker negligence and undisciplined workers in the project environment caused accident that may result in serious physical injuries and damage. So in order to prevent that happen, workers and top management have to raise awareness in the workplace hazard handling strategy or construction [8].

Safety Plan is a plan document containing practical safety that can assist companies in avoiding potential hazards and can control them in the best way when in these hazardous conditions, the importance of safety planning training during the planning, design and implementation phase of a project because it is able to minimize the risk of construction projects and can improve workers' safety [9].

4. Methodology

This research used a qualitative approach to obtain the formulation of WBS standards for a port construction project. Using bill of quantity data from 19 port 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 labour of WBS standard. The research flow can be seen in figure 1.
5. Result and discussion

5.1. Standardization WBS of port project
Based on the literature review and data of the previous port project, it is found that the port project is divided into 9 (nine) occupations: preliminaries, docks, trestle, dredging, causeway, container yard, facility buildings, mechanical electrical, and breakwater. The division of the project at the port can be seen in figure 2 below:

![Diagram tree of port project](image)

**Figure 2.** Diagram tree of port project.
The sub project on the main project (the port) becomes WBS level 1 which will then be divided into the smallest part called the work package.

![WBS Diagram](image)

**Figure 3.** WBS for facility buildings at port project.

WBS level 1 is the project name of the dock. Level 2 is a work section of structure, breasting dolphin & mooring dolphin, and misc. Level 3 is sub work section in the form of upper structure and sub structure. Level 4 is a work package in the form of concrete slab, beam and stiffen beam. Level 5 is an activity and level 6 is a resource (equipment, material and labour).

5.2. Potentially dangerous source of risk for port construction project

Identification of risks to port construction 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. Dominant Risk Variables as follows:

| Risk Variable affecting project performances | Score | Rank | Risk level | category |
|---------------------------------------------|-------|------|------------|----------|
| X30 High wave                               | 0.262 | 1    | H          | environmental factor |
| X5 The safety plan does not adjust the method that has been made | 0.248 | 2    | H          | Alternative Method |
| X15 Low level of evaluation of the safety plan that has been made | 0.232 | 3    | H          | Labour Resources |
| X6 Material / tools falling on project workers | 0.196 | 4    | H          | Alternative Metode/Desain |
| 24 Tides occur                             | 0.193 | 5    | H          | environmental factor |
| X7 Job sequences do not accommodate risks   | 0.191 | 6    | H          | Activities |
| X2 Acceleration (crashing) does not pay attention to safety (procedure) | 0.186 | 7    | H          | Work Package |
| X20 Underwater conditions differ from the assumption of tenders | 0.182 | 8    | H          | environmental factor |
| X18 There is no quality control on the use of tools | 0.149 | 9    | H          | Tool Resources |
| X9 Inappropriate material testing procedure | 0.145 | 10   | H          | Material Resources |
5.3. Safety plan for port construction project

Here the risk respond based on Dominant Risk Variables that has been compiled at table 2 below.

| No | (Pattern Recognition) | Grouping | Grouping: |
|----|------------------------|----------|-----------|
| PA1| Launch work safety manuals / programs before the project starts | ● ● | 1. Additional procedures for management |
|    |                        |          | 2. Add to other WBS elements |
|    |                        |          | 3. Additional related WBS elements |
|    |                        |          | 4. Addition to job requirements |
|    |                        |          | 5. Affect the WBS coefficient |
| PA2| Conduct training on mastery of specifications, project location, drawings, and implementation schedule for the project team who will carry out the work | ● | |
| PA3| Increase the data bank for the specifications of the type and method of work | ● ● | |
| PA4| Making Work Instructions (WI) for new work methods to be easily understood by workers | ● ● | |
| PA5| Use experts when making a specific safety plan & expert staff according to job requirements | ● ● | |
| PA6| Make Work Instruction (WI) (risk-based) for new work methods to be easily understood by workers | ● ● | |
| PA7| review of real conditions in the field in determining the safety plan | ● ● | |

6. Conclusion

Based on the standard WBS manufacturing process it can be concluded that the port construction project is categorized into 9 (nine) projects, namely preliminaries, docks, trestles, dredging, causeway, container yard, facility buildings, mechanical electrical and breakwater. The standard WBS project port 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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