Development of Risk-Based Standardized Work Breakdown Structure (WBS) to Improve Quality Planning of Drainage Construction Work

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Abstract. The Work Breakdown Structure (WBS) is commonly used in current project process management, particularly for infrastructure projects. This is because of the benefits that are obtained with the use of WBS. Infrastructure projects tend to experience constraints if their process planning management is not WBS-based and project outputs, especially irrigation projects that tend to produce higher defects. With the development of WBS standards, project process management could get double benefits in terms of time and cost. This paper aimed to develop the WBS Standard and tried to analyze possible risks to project implementation in terms of quality planning. Risks were calculated in view from the perspective of the contractor as the project implementer. The project in this study was limited to the work of irrigation projects. Data was gathered using questionnaire survey from contractors who have built irrigation project. As a result, this research proposed a risk-based WBS standard for irrigation projects that can improve the quality plan of the project.

1. Introduction

A comprehensive efficient work breakdown structure (WBS) can prove to be pivotal within project management planning processes by partitioning projects into stages, deliverables and work packages. Consequently, it can positively impact other project management processes, such as activity definition, project schedule, risk analysis and response, control tools or project organization [1]. One important measure of a construction project performance is the compliance with quality specifications [2]. Poor quality performance relates with the low reliability of the planning process, where the contractors are unable to manage the increasing complexity of the projects [3]. In order to avoid mismatch with the quality planning which can cause cost and time overrun, and dissatisfaction from the project’s stakeholders it is important to control the quality of the project work [4]. Regarding project quality performance, compliance with quality specifications is an important measurement of the performance of each construction project [5]. If the conformity of specifications is not achieved, rework or extra work is needed due to the incompatibility with the requirement [6].

The objectives of this research were to identify standardized WBS for irrigation construction work, to identify risks from the standardized WBS that may cause quality incompliances, and to develop risk-based standardized WBS. The scope of the study was limited to the following: (1) the development work reviewed was the work carried out by the main contractor, (2) the study used irrigation and normalization project on the last 5 years, (3) quality planning used was the planning for construction work. Risk-based standardized WBS can be utilized for quality planning, to help project executor identifies project works to the smallest items and set quality objective for each items in greater accuracy as a tool to ensure every work has considered the requirements to respond quality-related risks [7].
2. Literature Review

2.1. Work Breakdown Structure for Irrigation Work

The approaches followed by project teams in the development of a WBS are the re-use of a previous WBS with slight changes, to the progressive breakdown of the work required for the project, and the development of a deliverable-based WBS with the focus on the ultimate functionality of the end product [8]. Instead of developing WBS for each project, it is sometimes appropriate to develop a general WBS for typical project, then the necessary segment can be modified. It is suitable for organizations which perform similar projects [9].

In making WBS each organization uses each term to classify WBS components according to their level in the hierarchy. There are organizations that use different levels as tasks (tasks), sub-tasks and work packages. While other organizations use the terms facilities, work items, work packages and activities. Some opinions on the level of WBS development, for example, are used in the following form [10]:

1. Product-oriented WBS, for example: Level 2 is geographic; Level 3 is a product.
2. Function-oriented WBS with centralized responsibilities, for example: Level 2 is a product; Level 3 is geographic.

WBS developers can have two main focuses, namely focusing on the product and focusing on the process. In choosing which one is better, it depends on the target needs of each project.

The basis for the development of WBS for irrigation work obtained from bill of quantity of various irrigation projects and adapted to Minister of Public Works Regulation number 28/PRT/M/2016 about Guidelines for Price Analysis of Public Works Work Units and Minister of Public Works Regulation number 12/PRT/M/2014 about Implementation of Urban Drainage Systems.

2.2. Risk Management

The integration of risk management with other project management functions can be seen that the risk relationship with quality is to the standard requirements [11]. Similar to this, compliance with quality specifications is an important performance measurement of any construction project [12]. Factors for success criteria that have a high level of importance related to the management of the scope and quality of the project:

1. Definition of scope / management of the scope is well defined and maintained.
2. Compliance with technical specifications
3. Achieve the quality standards specified in the initial specifications

2.3. Quality Planning

Project quality management involves a process that requires and guarantees that the project will meet the required requirements including all activities that involve the overall management function, including quality, objectivity and responsibility policies and implementation of quality/quality planning, quality assurance, control quality/quality, and quality/quality improvement [13]. The main objective of quality management in a project is to ensure and validate the implementation of the project to meet project requirements including product requirements. The focus of quality management is to make adequate quality planning, followed by implementation that meets the requirements to obtain work results that meet customer satisfaction [14]

3. Methodology

This research used a qualitative approach to generate WBS standards using benchmark data of 27 irrigation work projects. Then, a survey and a deep interview to experts who have minimum 10 years experience in appropriate field was conducted. After obtaining the WBS standard, we identified the risks of each work package, activity, materials, equipment, and labour of the WBS standards.

The flow diagram of this research is showed in figure 1. Main research question used in the questionnaires or interview were:

1. How to generate WBS standard for drainage work?
2. What are the work methods of each drainage work package?
3. What are the activities of each drainage work package?
4. What are the resources needed for each activity for each drainage work package?
5. What are the risk factors that come from work packages, activities and resources that affect quality performance on drainage work?
6. How do developing risk-based WBS be used to improve quality performance on drainage work?

Figure 1. The Research Flow Diagram

4. Result and Discussion
Based on the literature review and data of 27 irrigation projects, it was found that the irrigation project was divided into 6 occupations: preliminary work, land work, cliff strengthening construction work, road inspection and carrying channels, control of water discharge, and miscellaneous work. Each of these categories had WBS that follows figure 2. Figure 2 showed example for each level of WBS that build the main project work.

Figure 2. Work Breakdown Structure Diagram
Level 1 was for the project name, level 2 was the Work Section which consists of Preliminary Work, Land Work, Stone Work, Cliff Strengthening Construction, Road Inspection and Carrying Channels, Controlling Water Discharge, and Misc. Work. Level 3 was the Work Sub-Section. Level 4 was a Work Package. Level 5 was an Activity and level 6 was a Resource consisting of Material, Equipment and Labour.

This research used 36 risk variable to identify possible risk that could impact in quality of construction drainage work. Every risk variable was given a score base on its probability and impact. Using statistical step and statistical test to verify data, this research resulted in 10 dominant risk variables that impacted the quality performance.

| Rank | Var | Category     | Highest Risk Events                                                |
|------|-----|--------------|-------------------------------------------------------------------|
| 1    | X4  | Work Package | The qualification of the subcontractor was not in accordance with the plan |
| 2    | X31 | Equipment Resources | The planned productivity of the tool is not as needed             |
| 3    | X14 | Activity     | Control and monitoring work is not good                           |
| 4    | X15 | Activity     | Inadequate investigation of unpredictable soil conditions         |
| 5    | X34 | Equipment Resources | Not optimizing equipment scheduling especially mixer ready mix cars |
| 6    | X30 | Labor Resources | The duties and authority of workers are not according to planning |
| 7    | X24 | Labor Resources | Workforce specialization is not according to planning              |
| 8    | X7  | Alternative method | Data from land investigation results are less accurate           |
| 9    | X9  | Activity     | Installion is not in accordance with the specifications or drawing plan |
| 10   | X3  | Work Package | Subcontractor productivity is not according to planning            |

From this dominant risk variable, the validation of high risk factor was conducted by the experts who have had minimum 10 years experience in drainage construction project. Also, they conducted deep interview to analyze impact and cause, as well as its preventive and corrective actions.

5. Conclusion

WBS standard are very necessary to manage project activities and resources. The development of the WBS standard was conducted by benchmarking the bill of quantity channel / irrigation projects and conducting expert interviews and survey respondents. Based on the process of creating this WBS standard, it can be concluded that drainage construction work was categorized into 6 (six) works, namely the Preliminary Work, Land Work, Stone Work, Cliff Strengthening Construction, Road Inspection and Carrying Channels, Controlling Water Discharge, and Misc. Work. WBS drainage work standard for each category work was 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. The risk-based standardized WBS can be utilized for the basis of quality planning to help project executor in identifying project works to the smallest items and setting quality objective.

Acknowledgment

The authors would like to thank the financial support provided by University of Indonesia through the PITTA funding scheme number 233/UN2.R3.1/PPM.00/2018 managed by Directorate for Research and Public Services (DRPM) University of Indonesia.
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