

Development of work breakdown structure standard based on risk for safety planning on dam construction work

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Abstract. Work activities on construction projects can experience disruptions caused by various things, one of the causes is the occurrence of work accidents. Identification and early analysis of potential hazards in each work packet, work methods, work activities, resources and environments in the WBS (Work Breakdown Structure) can prevent work accidents. Thus the need for WBS standardization is very important in presenting the assessment of risk, impact and frequency arising from workplace accidents. The purpose of this study was to develop a risk-based WBS standard for safety planning on dam construction. The results of this study are WBS standards, implementation methods, activities, potential hazard risks, safety planning using risk-based WBS standards, WBS dictionaries and WBS checklists on dam construction work, as an effort in preventing, reducing or eliminating the accident in dam construction work.

1. Introduction

The potential of water resources in Indonesia is very large reaches 3221 billion cubic meters per year and the potential of hydroelectric power of 75000 MW. But that has been utilized about 691 billion cubic meters per year. Besides the uneven distribution of water between the western region with the eastern region, the western region is larger than the eastern region. Thus dam construction is required throughout Indonesia [1]. Although dam provide enormous benefits, the construction is not without risk of failure. Therefore, dam safety is a matter that needs attention.

Construction of dam projects is a complex series of work activities and requires caution in its construction which is limited by time, resources and selection of appropriate construction methods. Due to its complexity, the success of a project is strongly influenced by the defining phase of the project and project scope. The next stage after defining the scope is the preparation of WBS (Work Breakdown Structure). One common approach used by the project team to create WBS is the use of previous WBS projects with some changes. However, although each project is unique, most can be standardized to enable the provision of a stronger forecast base for project management [2]. WBS has a major role in a project, so the creation of WBS is an obligation in project management both in the planning and implementation phases. But in practice in Indonesia there are still many projects that do not use WBS or rarely made WBS in the formal form [3].

Each WBS level that has been assigned brings WBS to a more complex level of activity, in which case activity is severely affected by risk. Risks will have an impact on the safety plan. As part of the management process, the implementation of risk management in SMK3 to assist management to prevent losses through accurate risk management. In risk management, risk assessment is very influential in determining the consequences or exposure of potential hazards, because through risk assessment, the accident can be prevented or eliminated [4].



Risk management is the core of SMK3, therefore OHSAS and PP no.50/2012 requires the existence of risk management.

Fundamentally work accidents can be reduced if activities on the project are well defined and work packages can be placed at levels and levels corresponding to a standardized WBS. At each level WBS leads to a more complex level of activity that is heavily affected by risk and has an impact on the safety plan. In any activity that has been classified under WBS standards it is easier to identify potential risks and contractors can make risk mitigation forms from existing risk sources so it is important to develop a Work Breakdown Structural (WBS) standard for a risk-based safety plan so that it is expected to obtain usable outputs as a construction guideline.

2. Research Objectives

The objectives of this research are :

- a. To create WBS standards for dam construction (RQ1)
- b. To identify the working method for each dam construction work package (RQ2)
- c. To identify the activities of each dam construction work package (RQ3)
- d. To identify the resources for each dam construction activity (RQ4)
- e. To identify the risk that come from work packages, activities and resources that affect the safety performance of dam construction work (RQ5)
- f. To develop of risk-based WBS standards used to develop safety plans for dam construction work (RQ6)
- g. To create WBS dictionary based on the needs used to develop a safety plan on dam construction work (RQ7)
- h. To create WBS checklist from every WBS level to the work packages (RQ8)

3. Literature Review

3.1. Work Breakdown Structure at Dam Construction

The WBS is a hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables. The planned work is contained within the lowest level of WBS components, which are called work packages. A work package can be used to group the activities where work is scheduled and estimated, monitored, and controlled [5]. The approach followed by the project team in terms of WBS development revolves around the previous WBS with some changes, to progressive details of the work required for the project, to the development of WBS-based deliverables with a focus on the basic functionality of the final product [6].

Initial input for the development WBS of dam is done by reviewing the regulations in the form of guidelines related to the implementation of dam construction such as Embankment Dam Construction Guidelines issued by Department of Settlement and Regional Infrastructure Directorate General of Water Resources Directorate of Technical Development Year 2004, Instrumentation of Embankment Dam Construction Guidelines issued by Department of Settlements and Regional Infrastructure number 360/KPTS/M/2004 Year 2004 and Regulation of the Minister of Public Works and People's Housing Nomor 28-PRT-M-2016 about Guidelines for Analysis of Public Work Unit Work Unit Prices.

3.2. Risk Management

Project risk management is a systematic process of project risk identification, analysis, response, and control. Risk management is aimed at increasing the probability and / or impact

of positive risks and to decreasing the probability and / or impact of negative risks in order to optimize the project's success [5]. In risk management, risk assessment is very influential in determining the consequences or exposure of potential hazards, because through risk assessment, the accident can be prevented or eliminated [4]. Therefore, to be able to identify risks, the categorization of WBS starts from the work package, method / design, activity, material resources, tools, and labor as well as the environment as a category of risk events that can affect the objectives of safety performance.

3.3. Performance Concepts of Occupational Safety and Health

Occupational safety and health, hereinafter abbreviated as K3 is all activities to guarantee and protect the safety and health of the workforce through prevention of occupational injuries and occupational diseases [7]. In the Ministry of Public Works projects the safety plan is known as RK3K (Contract Safety Plan). RK3K is a complete document of SMK3 construction plan of Public Works and constitutes a unity with contract document of a construction work made by the owner and approved by the contractor, to further serve as a means of interaction between the owner and the contractor in the implementation of SMK3 public works construction.

3.4. WBS Dictionary

The WBS dictionary is a brief description of each work package that includes an explanation of the WBS code, the WBS level, the job responsibilities, the job package description, the deliverables, references or job references, activities and resources. The WBS dictionary uses a format that shows a hierarchical relationship.

3.5. WBS Checklist

The WBS checklist contains a checking guide from every WBS level to the work package. Checklist is a useful tool in measuring the suitability of WBS. This check refers to the details of the activities that exist at each level of the WBS from the WBS diagram, and based on the description of each activity of the WBS dictionary

4. Methodology

This research was conducted with qualitative approach to answer the research objectives. surveys and interviews were conducted using structured questionnaires to dam construction experts with more than 20 years of experience. The research flow diagram can be seen in figure 1.

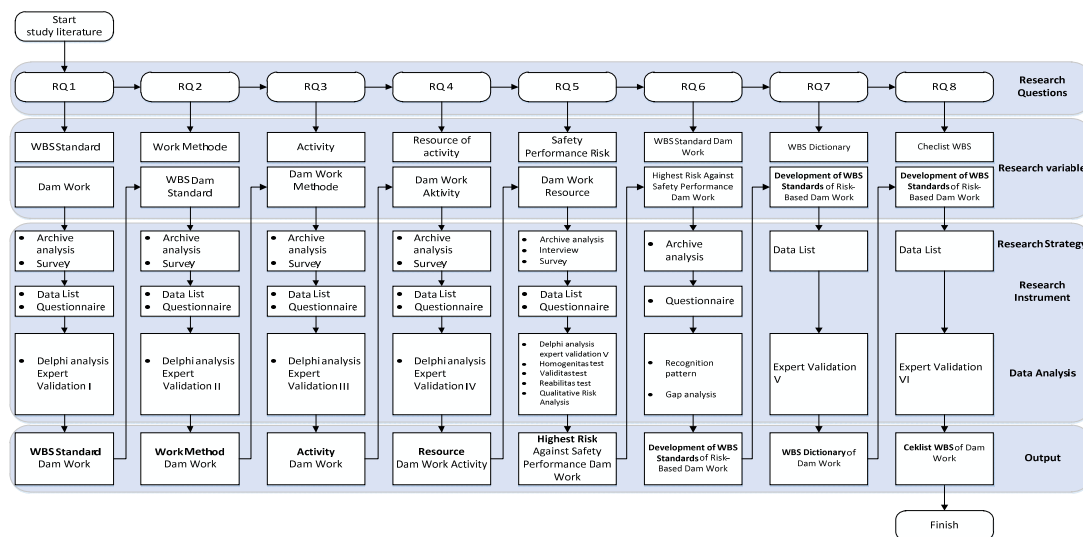


Figure 1. The research flow diagram

5. Result and Discussion

a. To answer RQ1, RQ2, RQ3 and RQ4

Based on the literature review on the dam construction technical guidance and 13 (thirteen) previous project data it is found that dam construction work is categorized into 8 (eight) work that is preparation, access road & bridge, cofferdam, tunnel & channel, main dam, spillway, intake and public facilities. Each of these categories has WBS that follows figure 2. In Figure 2 is shown one of the 8 (eight) work categories that is for the main dam.

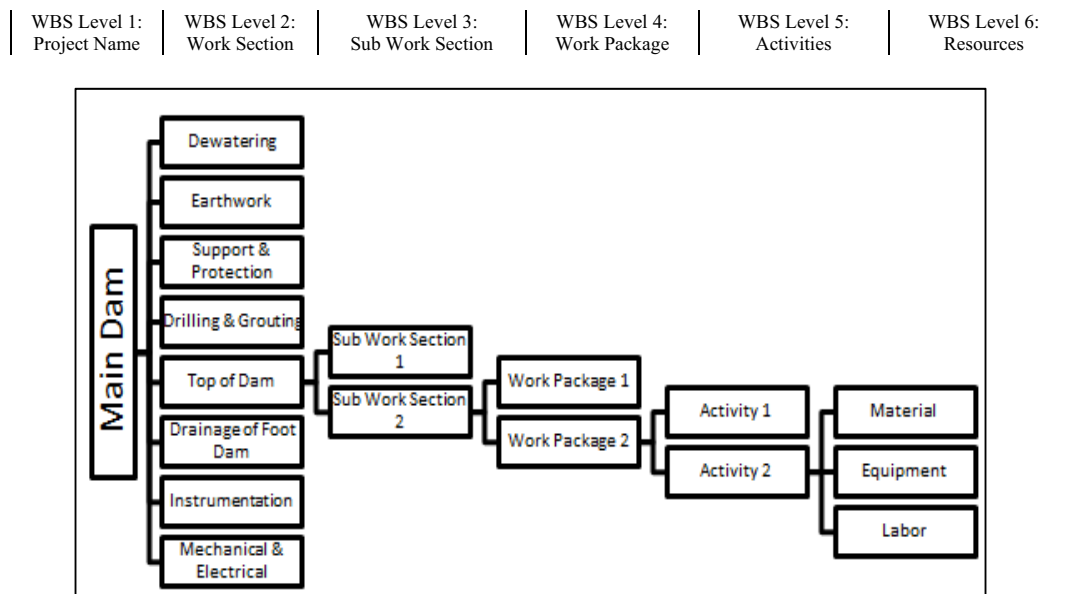


Figure 2. Work Breakdown Structure Diagram

Level 1 is for the name of project, level 2 is work section that consist of dewatering, earthwork, support & protection, drilling & grouting, top of dam, drainage of foot dam, instrumentation and mechanical & electrical, level 3 is sub section work, level 4 is work package, level 5 is activity and level 6 is resources that consist of material, equipment & labor.

b. To answer RQ 5

Identify any potentially hazardous risks in dam construction obtained from literature studies that are then verified, clarified and validated for content and constructs to experts. Experts are asked whether they agree or disagree with such risk factors and input on each of the risk factors, impacts and causes. In addition, experts are required to provide additional risk factors. Once the probability and impact are determined, the risk score can be calculated by following:

$$\mathbf{R} = \mathbf{P} \times \mathbf{I} \quad (1)$$

Where R = risk factor, P = probability and I = impact.

c. To answer RQ 6

After knowing what activities are carried out on the dam construction (WBS level 5) the next step is to create a potential risk and look for potential sources of risk that is very influential on K3, so that the results obtained in the form of safety planning recommendations based on the format contained in appendix RK3K of government regulations PU 05/PRT/M/2014 with the addition of work packages (column 2), activity (column 3) and risk control (column 9). The result follows figure 3.

Table 1. HAZARDS IDENTIFICATION, RISK ASSESSMENT, PRIORITY SCALE, SAFETY RISK CONTROL AND RESPONSIBILITY

Company Name :
 Activity :
 Location :
 Date :

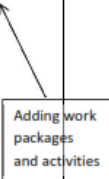

No	WBS Level 4 Work Package	WBS Level 5 Activities	Hazard Identification	Risk Assessment			Priority Scale	Safety Risk Control	Person in charge (officer)
				Frequency	Severity	Risk Level			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
									

Figure 3. Safety Planning

d. To answer RO 7

WBS Dictionary is done by following the format in figure 4. Figure 4 is one of the WBS dictionaries for one of the 8 (eight) dam's work categories, that is for the main dam.

WBS DICTIONARY DAM

MAIN DAM

Earthwork

2 Work Section : Earthwork
 2.1 Sub Work Section : Land Clearing, Grubbing and Stripping
 2.1.1 Work Package : Tree Cutting

Responsible Person :

Description : This work must consist of cleaning all trees with diameters smaller than 15 cm, fallen trees, including stump dismantling, roots and disposal of all spilled material resulting from clearance and stripping of land according to specifications.

Deliverable : Tree Cutting

Reference : Dam Technical Guidelines
BOQ
Expert Validation

Code	Activitas	Resource		
		Manpower	Material	Equipment
2.1.1.1	Implementation of Tree Cutting	1. Labor	-	-
		2. Workers		

Figure 4. WBS Dictionary

e. To answer RQ 8

The WBS checklist is done by following the format in figure 5. Figure 5 is one of the WBS checklists for one of the 8 (eight) dam's work categories, that is for main dam.

CHECKLIST WBS DAM

MAIN DAM

WBS Level 1 : Project Name
 WBS Level 2 : Work Section
 WBS Level 3 : Sub Work Section
 WBS Level 4 : Work Package

LEVEL WBS	CODE	DESCRIPTION
1		MAIN DAM
2	1	Dewatering Work
3	1.1	Dewatering
4	1.1.1	Surface Drainage
4	1.1.2	Gravity Drainage
4	1.1.3	Sump Pumping
4	1.1.4	Well point Pumping
4	1.1.5	Deep well Pumping
2	2	Earthwork
3	2.1	Land Clearing, Grubbing, and Stripping
4	2.1.1	Tree Cutting

Figure 5. Check List WBS

6. Conclusion

Based on the process of making this WBS standard can be concluded that dam construction work is categorized into 8 (eight) work that is preparation, access road & bridge, cofferdam, tunnel & channel, main dam, spillway, intake and public facilities. WBS dam standard for

each category work divided into 6 Level, 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 safety plan on dam construction was made using the risk-based WBS standard which was then developed based on the RK3K PU 05 / PRT / M / 2014 RK3K document. From this development, the result is safety planning recommendations for dam construction.

7. Acknowledgment

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