Development of Standardized WBS (Work Breakdown Structure) Based on Risk for Cost Control of Steel Bridge Construction Projects

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Abstract

The steel bridge construction project can be successful if the definition of project scope is in accordance with the requirements. WBS is a smalles work item and easily controlled. WBS standardization is very important because it will greatly affect the cost control. The purpose of this research is to develop WBS in steel bridges based on the regulation of the General Specification of Highways 2010 Revision 3 and Special Specification of Toll Roads 2017 from Toll Road Regulatory Agency (BPJT) for controlling project cost. The results of this study is we can get WBS standards by analyzing possible risks that may affect controlling project cost. So it is expected to assist the contractor in the cost control of steel bridge construction projects.

Keywords
WBS Standard, Risk Factor, Cost Control

1. Introduction

In project planning, cost estimation, scheduling, resource allocation and risk management must be based on WBS [1]. The process of breakdown into smaller and more manageable components of deliverable and project work is the process of compiling the Work Breakdown Structure (WBS) [2]. One of the difficulties encountered in project implementation is the lack WBS standardization which causes controls to cost and time not well defined. In the details of cost and time is critical to the success of the project so it is worth while [4]. WBS standardization is critical to the basic presentation and management of projects from the measurement of each integrated performance [5]. The undefined project is the first step in the planning process in developing the Work Breakdown Stucture (WBS) [6]. The main factor in cost control and schedule is financial risk. In avoiding delays and cost overruns we can used risk analysis so as to assist project managers in managing schedules and costs [7].

2. Research Objectives

The objective of this research is:

1. To develop steel bridge project of standardized Work Breakdown Structure (WBS)
2. To Identify risks that impact to cost performance on steel bridge construction.

3. Literature Review

General Specification of Bina Marga 2010 Revision 3 [8] is a document of general specification of road and bridge construction works which is part of contract document of road and bridge construction works starting from preparation process, implementation method, material, equipment, quality control and payment procedure used to achieve a work product. In the Bina Marga Specification there are 10 divisions:

Division 1 General
Division 2. Drainage
Division 3. Land Works
Division 4. Widening of Road Pavement and Shoulders
Division 5. Coated Pavement and Concrete Pavement
Division 6. Asphalt Pavement
Division 7. Structure
Division 8. Return of Conditions and Minor Works
Division 9. Daily Jobs
Division 10. Routine Maintenance Works

The Special Specification of Freeway and Toll Road 2017 [9] is a Toll Road Service Standard issued by the Toll Road Regulatory Agency (BPJT) which is used as the basis for toll road development.
Division 1 General
Division 2 Cleaning the Workplace
Division 3 Demolition
Division 4 Land Works
Division 5 Cut and fill Structure
Division 6 Drainage
Division 7 Preparation of Ground
Division 8 Aggregate Base
Division 9 Pavement
Division 10 Concrete Structure
Division 11 Structural Steel Works
Division 12 Other Jobs
Division 13 Lighting, Traffic Light and Electrical Works
Division 14 Plaza Tol
Division 15 Redirects and Protection of Existing Equipment
Division 16 Office and Toll Facilities
Division 17 Daily Jobs

The WBS definition according to PMBOK 5th edition [2] is a hierarchical decomposition or description of the entire scope of work that matches job specifications to be completed by the project team in accordance with the project objectives. WBS is divide in to branches of project objectives that connect all levels of branching from highest to lowest [10]. In the WBS details, process can be described as follows:

1. Definition of the main task of the project, then decompose the task into sub tasks. The work to be completed must be known as details
2. Identifying each deliverable to preparation of the budget to the level of detail.
3. Work Packages: Ensure that all work packages can be allocated and detected.
4. Inspecting that the lowest decomposition needs is appropriate or not appropriate

Risk management is the process of action planning and development of options to reduce threats and increase opportunities for project objectives. The tools and techniques used to respond to risks include [2]:

1. Avoid: To avoid risk factors / constraints that may occur
2. Transfer: To moving risk to a third party, for example the insurance
3. Mitigate: To reduce the likelihood of risks to tolerable limits
4. Accept: To accept the risks that exist because it is rare to avoid them.

The analysis resulting risk responses that can be distinguished into 5 different categories [3]:

1. Addition to managerial item
2. Addition to another WBS
3. Addition to related WBS
4. Addition to activity requirement
5. Affecting WBS coefficient

4. Research Methodology

This research is in the processing of combination of Bina Marga and BPJT regulations and is analyz based on benchmarking of 22 Bridge Projects and 5 toll road projects which are then validated to experts who have worked on steel bridges to obtain WBS standard.

For the risk analysis obtained from each job, a pareto analysis of samples of 5 steel bridge projects in Indonesia is obtained and the dominant work package impact on cost. Furthermore, risk analysis has an effect on the cost control at highest risk which is divided into several categories namely 1) job package 2) alternative method 3) activity 4) Material 5) Equipment 6) Labor 7) Environment.

5. Result And Discussion

5.1 WBS Standardization

After processing data processing obtained WBS standard of steel bridge consisting of 9 divisions, among others Preparatory work, drainage work, soil work, widening pavement and shoulder work, pavement grinding & concrete pavement cement, asphalt pavement, structural work, toll service facilities and return of minor condition.

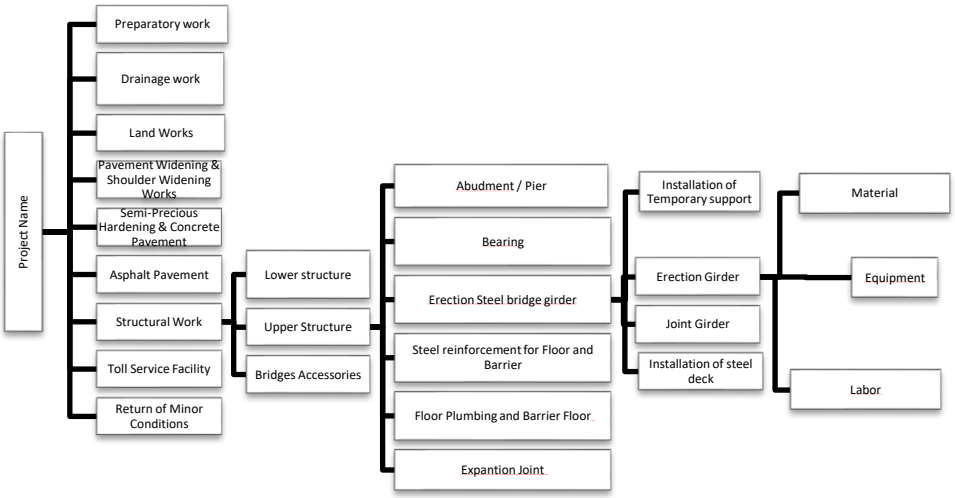

Figure 1 WBS for Steel Bridge Project

5.2 High Risk Factor

Risk factors that affect the control of project costs:

Table 1 Highest Risk Factors

RISK THAT INFLUENCE PROJECT COST PERFORMANCE	
WORK PACKAGE	
X1	The volume of work is not in accordance with the planning
X3	Changes to the scope of work (less work added)
X4	Subcontract productivity is lower than planned
ALTERNATIVE METHOD / DESIGN	
X6	Work methods can not be applied in the field
X7	Limitations of experienced personnel / specialists in the implementation of steel bridge work methods
ACTIVITY	
X8	Installation does not conform to specification or plan drawing
X9	Workmanship is not an appropriate procedure
MATERIAL RESOURCES	
X10	Changes in specifications and types of materials that cause material prices to be higher than the plan
X12	Delivery of material is late from planned schedule
EQUIPMENT RESOURCES	
X23	The purchase price / equipment rent is more expensive than the planned estimate
X24	Equipment maintenance cost exceeds the planned estimate
LABOR CORPORATE RESOURCES	
X28	Labor productivity is lower than planned
X31	Much Overtime
ENVIRONMENT	
X35	Changes in soil conditions during construction
X37	Changes in traffic management

6. Conclusion

After analyzing the benchmarking of 22 bridge projects, 5 toll road projects, from Bina Marga regulations and BPJT regulations, WBS obtains the following:

Table 2 structure of steel bridge

WBS LEVEL -	Name of Project
LEVEL 1	Name of Project
LEVEL 2	Structure
LEVEL 3	Sub Work Section
LEVEL 4	Work Package
LEVEL 5	Activities
LEVEL 6	Resources

Table 3 Structure of steel bridge

WBS Standarization
• Division 1 - Work Preparation
• Division 2 - Drainage Works
• Division 3 - Land Works
• Division 4 - Widening of Pavement and Shoulders
• Division 5 - Gilded Pavement and Concrete Pavement Pavement
• Division 6 - Asphalt pavement
• Division 7 - Structure
• Division 8 - Toll Service Facility
• Division 9 - Refunds and Minor works

From the result of analysis we get 28 Preventive Actions and 24 Corrective Actions as risk responses.

Table 4. Risk Response Category Mapping for Preventive Action

NO	PREVENTIVE ACTION	CATEGORY					RECOMMENDATION
		1	2	3	4	5	
PA1 …	Incorporate the requirements of the specialization and numbers of labors in the contract	●					Managerial
PA28	Always an evaluation of the provision of required resources based on the complexity of the work	●					Managerial

Table 5. Risk Response Category Mapping for Corrective Action

NO	CORRECTIVE ACTION	CATEGORY					RECOMMENDATION
		1	2	3	4	5	
CA1 …	Schedule on delivery should be monitored on a regular basis	●					Managerial
CA24	Change working hours effectively	●					Managerial

There are 15 dominant risk variables for the RBS input, and there are steel girders erection as the dominant sub work section resulting from Pareto analysis for the WBS input of RBSxWBS matrix. The results are 2 risk responses.

Table 6. Risk Response Category Mapping for steel girder bridge (RBSxWBS Matrix)

NO	RBS	WBS	RISK RESPONSE	CATEGORY					RECOMMENDATION
				1	2	3	4	5	
Sub work section: Wall									
1	X6,X7,X8,X9	Steel girder bridge erection	Activity: Chamber checking			√	√		Activity on steel girder erection
2	X6,X7,X8,X9,24	Erection steel girder bridge	Resource: Checking of the cleverness and bearing capacity of the soil base with the provision of steel plate		√	√	√		Resource on temporary support installation

In conducting project cost control it is necessary to pay attention to the highest risk factors that affect the steel bridge project. Here is the sample of standardized WBS which is enhanced by the risk resposes obtained for steel girder bridge erection.

Table 7 Risk-Based Standardized WBS for Steel Girder Bridge Erection

WBS L.4	Alt Method	WBS L.5 Activity	WBS L.6 Resource
Steel girder bridge erection	Temporary support	Temporary support installation	Material : Steel plate
		Girder lifting	
		Chamber checking	
		Bolt firming	
		Installation for Steeldeck	

References

[1] Devi, T. R., & Reddy, S. (2012). Work Breakdown Structure of the Project. International Jornal of Engineering Research and Applications Volume 2 Issue 2, 683-686.

[2] PMBOK. (2013). Project Management Body of Knowledge 5th edition.

[3] Rianty, M., Latief, Y., & Suratman. (2017). Development of risk-based standardized WBS (Work Breakdown Structure) for quality planning of high rise building architectural works.

[4] Vidivelli, B., Vidhyasagar, E., & Jayasudha, K. (2017). Risk Analysis in Bridge Construction Projects. International Journal of Innovative Research in Science, Engineering and Technology.

[5] Ibrahim, Y. M., Kaka, A. P., Trucco, E., Kagioglou, M., & Aouad, G. (2007). Semi Automatic Development of the Work Breakdown Structure (WBS) for Construction Projects. International Built and Human Environment Research.

[6] Kerzner, H. (2009). Project Management, A System Approach to Planning Scheduling and Controlling. Canada: John Wiley & Sons, Inc.

[7] Choudhry, R. M., Aslam, M. A., Hinze, J. W., & Arain, F. M. (2014). Cost and Schedule Risk Analysis of Bridge Construction in Pakistan: Establishing Risk Guidelines. Journal of Construction Engineering and Management.

[8] Bina Marga, (2010).Spesifikasi umum pekerjaan konstruksi jalan dan jembatan
[9] Badan Pengatur Jalan Tol (2017). Spesifikasi Khusus Jalan Bebas Hambatan dan Jalan Tol

[10] Kenley, R., & Harfield, T. (2014). Reviewing the IJPM for WBS: the Search for Planning and Control. Procedia - Social and Behavioral Sciences 119, 887-893.

Biographies

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