Work breakdown structure (WBS) dictionary development for the construction works of flyover projects

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Abstract. The construction works of flyover is common in a developing country as well as developed country all over the world. Flyover is an infrastructure that is built to overcome the massive congestion that cannot be overcome with the use of traffic light. In the construction process of a flyover, traffic is the one main problem that always occurred. To minimize that problem, the flyover construction should be planned and managed effectively. With the development of WBS and dictionary of WBS, the project stages will be planned and managed in details that can be used to analyse work packages, defined methods, activities, and resources that will help to decrease the occurring problems. The WBS Dictionary for the construction works of flyover projects in this study is developed using archive analysis and survey methods, which consists of six (6) levels including project name, division, sub of works, work packages, activities, and resources.

Keywords: WBS, WBS dictionary, flyover, construction works

1. Introduction

The growth in the number of construction services in Indonesia shows a fairly high increase in recent years. This is reasonable because the field of construction is a vital field in the development of a civilization. The field of construction provides the means and infrastructure for a country to develop and run the life of the state. This is what spurred the development of construction services industry. With the rapid development of demanding parties engaged in the construction services industry to improve the quality in project implementation, so that existing projects can be handled effectively and efficiently [1].

A lot of projects are emerging in various types, in the current development of the construction world, especially in the field of infrastructure, such as the construction of toll roads, tunnels, and flyovers [2]. A construction of infrastructure will bring both positive and negative impacts on its surrounding including the impacts on traffic around the construction site [3]. Construction project requires knowledge, expertise, insight, and experience in the construction world. This should all be owned by all parties involved in the construction of a construction project for planners, project leaders, construction managers, and contractors [2].

In the implementation of a project there will be found various problems that will be able to give a negative impact on the project target. Many factors lead to the occurrence of a project problem, such as weather, human resources, material resources, and so on. These problems affect the project

objectives of cost, quality, and time of the project. Based on these reasons something needs to be done to overcome various problems that may occur [4].
One of the solutions is to develop a WBS. A complex project to be easily controlled must be described in the form of individual components in a hierarchical structure, known as the Work Breakdown Structure (WBS). WBS is crucial in project planning, where through WBS the detailed stages of the project will be defined. Structures within the WBS define tasks that can be completed separately from other tasks, facilitating the allocation of human resources and other resources such as labors, materials, equipments, necessary tools, and project control [5].
Meanwhile, the relationship between the WBS elements that describe each element of work is called the WBS Dictionary. WBS dictionary is a work definition tool by explaining the depth of the scope of each work element [6]. This study aims to develop a WBS dictionary for flyover construction works.

2. Literature Review

2.1. Flyover

Flyover is a floating road that is built to avoid the areas that always face traffic congestion problems, passing railway crossings, and to improve traffic safety and efficiency.
There is a fundamental equality between the flyover and the bridge because of its equally floating position, which is a structure building aimed to connect two separate land / road surfaces with each other. Functions and benefits of flyover can be described as follows:

- Flyover is built to overcome the massive congestion that can not be overcome with the use of red lights as a setting.
- Can improve traffic efficiency and reduce the risk of accidents in a crossing areas [7].

2.2. Work Breakdown Structure (WBS)

Work Breakdown Structure (WBS) is a method of organizing a project into a hierarchical reporting structure. WBS is used to breakdown or break each work process into another detail process. This is so that the project planning process has a better level of accuracy. The WBS is structured on the basis of learning of all documents including contracts, drawings, and specifications. The project is then broken down into sections by following certain structural and hierarchical patterns into fairly detailed work items, called Work Breakdown Structures. The more we do breakdown, the more detail the planning will be made [8].
WBS is the foundation for planning. A WBS project can also be used to identify tasks in a project planning model. Therefore, ideally WBS design should be completed before project planning and project scheduling [8]
An effective WBS has the following criteria [10] :

- Deliverable oriented grouping of project elements
- Made by the person that's doing the work
- Define the context of the project
- Is an expression of illustrations, graphs or outlines, providing textual or graphical details
- Arrange all minor and major deliverables in hierarchical structures constructed so that each level of decomposition includes 100% of the work
- Must include at least 2 (two) levels
- Use nouns and adjectives instead of verbs
- Renewed with progressive elaboration of project scope, to baseline scope, and subsequent compliance with project change controls - thus enabling continuous improvement
- Using the coding scheme for each WBS element that clearly identifies the WBS hierarchical nature when viewed in any format.

2.3. WBS Dictionary

WBS dictionary is a work definition tool by explaining the depth of the scope of each work element in the WBS, including:

- Job documents include deliverables, and tools of performance and quantity parameters'
- List of resource requirements and processes to complete the work.
- Identify the completeness of the schedule.
- As a provider of technical design or technical documents [6].

Whereas according to Brotherton, S. A., Fried, R. T., & Norman, E. S., the information that includes in the WBS dictionary are [9]:

- Code of account identifier
- Description of work
- Assumption and constraints
- Responsible organization or person
- List of milestone
- List of schedule activities
- Resources required
- Cost estimates
- Quality requirements
- Acceptance criteria
- Technical information or references
- Agreement (contract) information

3. Methodology

The research methodology used to develop the WBS dictionary for the construction works of flyover in this study includes:

- The level identification of WBS standard for flyover were developed through archive analysis, which was compiled based on *Direktorat Jenderal Bina Marga* specification, *Badan Pengatur Jalan Tol (BPJT)* specification, and several projects data of flyover used as the literature for benchmarking.
- To develop the WBS dictionary for flyover, the benchmarked WBS standard was then validated for its format and contents by 5 experts with minimum 10 years of experience of managing flyover projects in Indonesia.

4. Results and Discussion

The WBS level in this research is defined based on *Direktorat Jenderal Bina Marga* specification and *Badan Pengatur Jalan Tol (BPJT)* specification as archive analysis data which consist of each 10 level and 14 levels. Based on those specifications the 4 level of WBS is defined. The 4 level WBS then benchmarked from BoQ (Bill of Quantity) of 27 roads and bridge projects to determine the activities and resources of each level. A 6 level WBS of Flyover then formed based on those data, which consist of:

WBS Level 1 : Project Name,
WBS Level 2 : Working Group / Division,
WBS Level 3 : Sub of work,
WBS Level 4 : Work Packages,
WBS Level 5 : Activities,
WBS Level 6 : Resources.

Furthermore, the 6 level WBS validated by the 5 experts with background of WBS-based project planning knowledge and a minimum of 10 years work experience to get feedback and comments regarding the WBS standard of Flyover construction projects. The illustration of WBS can be seen in Figure 1.

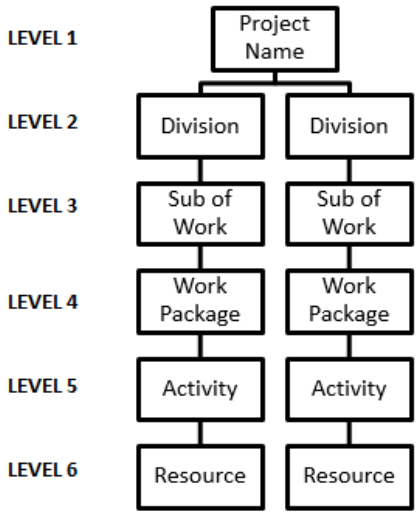

Figure 1. WBS level details

The working group/division of the WBS for Flyover construction projects consist of 9 divisions as follows:

Division 1 : General,
Division 2 : Drainage,
Division 3 : Earth Works,
Division 4 : Pavement Widening and Shoulders,
Division 5 : Concrete Powder and Concrete Cement,
Division 6 : Asphalt Pavement,
Division 7 : Structure,
Division 8 : Toll Facility Services
Division 9 : Restoration Condition.

As an example, Figure 2 shows the detailed components of level 1 - 4 in tree diagram format of WBS Standard of Flyover Works for Upper Structure.

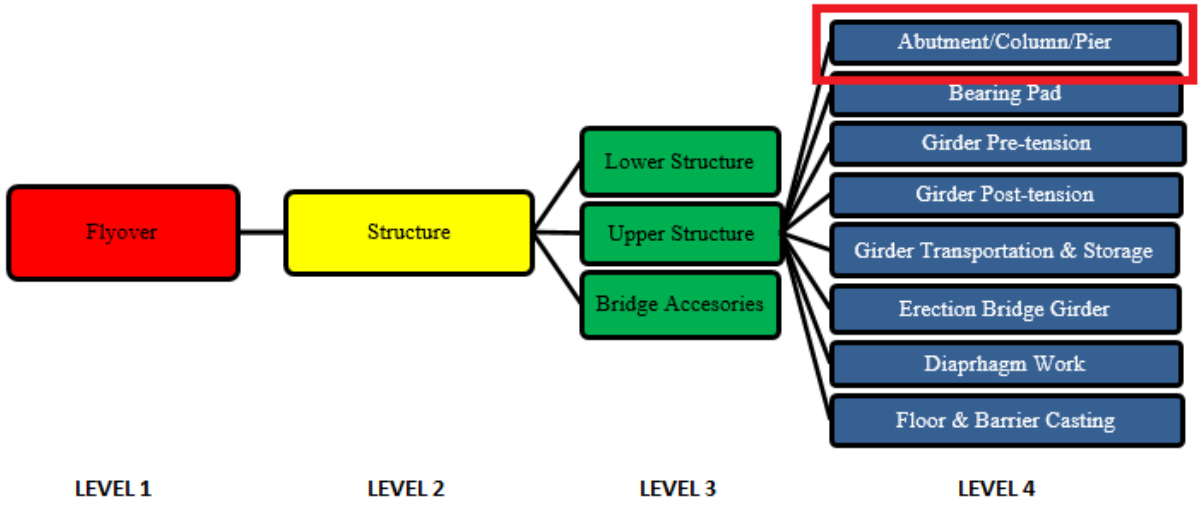

Figure 2. Detailed WBS Standard of Flyover for Upper Structure

The abutment of flyover are used at the ends of bridges to retain the embankment and to carry the vertical and horizontal loads from the superstructure to the foundation. The design requirements for

abutments are similar to those for retaining walls and for piers; each must be stable against overturning and sliding [11]. There are several types of abutment that can be used to build a flyover. Each type of abutment has different uses, conditions, and methods. However, the method of construction is not included in the level list of WBS Standard of flyover construction projects. That is because the method used in each project is likely different due to the decisions of the associated companies and the nature of the environment. With a different method in each work package there will be different activities and resources, thus that is why it is important to determine the method and analyzing the risks that might come with the chosen method. The detailed construction methods and activities will further be defined comprehensively in the flyover's WBS dictionary.
After obtaining the WBS Standard of flyover projects, the initial format of the WBS dictionary for each work package of the flyover was made based on literature study and previous research. The illustration of the initial format of the WBS Dictionary can be seen in Figure 3.

WBS DICTIONARY
DIVISION 7

WBS CODE	WORK FAMILY/DIVISION
XX	Structure
WBS CODE	**SUB OF WORK/SECTION**
XX	Upper Structure

WBS CODE	WORK PACKAGE
XX	Abutment/Column/Pier
PERSON IN CHARGES	

Description
This work includes steel reinforcement work, formwork,readymixed concrete work, curing, quality control, and expansion joint.

Deliverable
Abutment/Column/Pier

Resources :

	Steel Reinforcement Work	Formwork	Readymixed Concrete	Curing	QC (Slump Test)	QC (Cube Test)	Expansion Joint
Man	Worker	Worker	Worker	Worker	Worker	Worker	Worker
	Foreman	Foreman	Foreman				Foreman
	Operator	Operator	Operator				
Material	Steel	Hollow Steel	Cement	Curing Compound	Concrete Mix	Concrete Mix	Expansion Joint
	Wire	Plank	Aggregate				
			Sand				
Equipment	Bar Cutter	Saw	Mixer Truck	Fog Spraying Concrete	Abhram Cone	Mold Cube	Supporting Equipemnt
	Bar Bender	Welding Tools	Concrete Pump				
			Bucket				
			Vibrator				

References:
1. BoQ
2. Expert Validation

Activities :

WBS CODE	ACTIVITY
XX	Steel Reinforcement Work
XX	Formwork
XX	Readymixed Concrete
XX	Curing
XX	Quality Control
XX	Expansion Joint

Figure 3. Initial Format of Flyover WBS Dictionary for each work package

WBS Dictionary is used to describe each element of a project activity up to resources based on the 5th and 6th level of WBS. Experts who are experienced in the field of bridge construction, especially flyover are required to review the form of an accurate WBS Dictionary. The WBS Dictionary are

validated by 5 experts with the help of a questionnaire as a tool to get advice and inputs to obtained a validated WBS Dictionary of Flyover works. Also, with the help of 1 practitioner from the ongoing flyover project, interviews were conducted to discuss the application of the WBS dictionary itself in an actual flyover construction project. Based on the validation and interview results, the WBS dictionary of flyover construction works are formed as follows:

WBS DICTIONARY OF FLYOVER

DIVISION 7 / STRUCTURE

UPPER STRUCTURE

7	Work Family / Division	:	Structure
7.2	Sub of Work / Section	:	Upper Structure
7.2.1	Work Packages	:	Abutment/Column/Pier
	Person in Charges	:	
	Description	:	This work includes steel reinforcement work, formwork,readymixed concrete work, curing, quality control, and expansion joint.
	Deliverable	:	Abutment/Column/Pier
	Reference	:	Contract Document (BOQ) Expert Validation
	Duration	:	
	Cost	:	

Code	Activites	PIC	Resources			Cost
			Man	Material	Equipment	
7.2.1.1	Steel reinforcement work		1. Worker	1. Steel	1. Bar Cutter	
			2.. Foreman	2. Wire	2. Bar Bender	
			3. Operator			
7.2.1.2	Formwork		1. Worker	1. Hollow Steel	1. Saw	
			2.. Foreman	2. Plank	2. Welding tools	
			3. Operator			
7.2.1.3	Ready mixed Concrete		1. Foreman	1. Cement	1. Mixer Truck	
			2. Worker	2. Aggregate	2. Concrete Pump	
			3. Operator	3. Sand	3. Bucket	
					4. Vibrator	
7.2.1.4	Curing	`	1. Worker	1.Curing Compound	1. Fog Spraying Concrete	
7.2.1.5	Quality Control					
	Slump Test		1. Worker	1. Concrete Mix	1. Abhram Cone	
	Cube Test		2. Worker	1. Concrete Mix	1. Mold Cube	
7.2.1.6	Expansion Joint		1. Worker	1. Expansion Joint	1. Supporting Equipment	
			2. Foreman			

Figure 4. Validated Format of Flyover WBS Dictionary for each work package

The validated format showed the structured descriptions of the coding, person in charge, resources and costs of each work package for each defined activities. Hence, the flyover WBS dictionary is easier to read and referred, and mostly can be used effectively during the construction process, particularly for monitoring each work package. Moreover, the results of the validation process also found that the development of WBS Dictionary is not just about a project management tool, but it is the basic document that is essential for construction project planning, that fully supports the sustainability of the project / infrastructure itself, which supports its time, cost and quality performance within the project's lifecycle. As an example, to provide a sustainable product, in this case a flyover, the material quality of the flyover can be thoroughly defined using the WBS dictionary. The WBS dictionary is the basis for defining the resources and quality requirements for each material of the flyover. Any changes of the material quality requirements, which may occur due to environmental or sustainability considerations, can also be facilitated through the details of its WBS dictionary.

In terms of the sustainable development of the project, a sustainable project management is the set of project management policies held, actions taken and relationships formed in response to concerns related to the natural environment (and social and economic issues) with regard to the design, acquisition, production, distribution, use, re-use and disposal of goods and services related to the provision of the built environment. Sustainable development is a new management paradigm relevant to projects and programs that requires a careful consideration of economic, ecologic, and social issues. A detailed WBS dictionary can facilitate this approach by providing a defined and realistic resources and its requirements for each of the project's work packages. Hence, each work package of the project can be planned, constructed and controlled with an environmentally conscious effort [12, 13].

5. Conclusion

The validated WBS dictionary of flyover construction works is a derivative of its WBS standard. WBS dictionary can be used to define the scope of the project work, the job activity along with the sequence of work on the project, the person in charge of a job within the project, the quality requirements of each materials, and can be used to prevent the project from performing any work outside the scope of the project, which may lead to over budget, delayed projects, poor quality, and the failure of project implementation. Further studies of WBS dictionary can be conducted with the selection of implementation methods in construction projects. WBS dictionary are still not widely applied in construction projects in Indonesia. Currently, most projects use the Plan Budget Implementation Document, which is a cost plan document and a detailed project strategy as a reference of the implementation.

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