Development of work breakdown structure (WBS) dictionary for road construction works

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Abstract. In the construction project plan, a description of the project work that will be used as a reference for the implementation of the construction project is required. In fact, there are many construction projects, especially road projects that are not in accordance with the plan in terms of time and cost. For that, we need WBS (Work Breakdown Structure) and its dictionary as a project implementation reference in order to define project activities to the resources. The development of these documents will be discussed in this research so that the implementation of the project is expected to be in accordance with the plan. The results of this study describe the details of the road construction projects to their resources in the form of WBS (Work Breakdown Structure) dictionary.

Keywords: project planning, road construction works, WBS, WBS dictionary

1. Introduction

One of the most crucial aspects of infrastructure is the transportation sector, the transportation itself means the movement of people and/or goods using vehicles or other devices from and to geographically dispersed places. As the fulfilment of transportation needs, it is necessary to construct the essential facility that is the road. Roads are pathways on the earth's surface made by humans with their shapes, sizes, and types of construction so it can be used to funnel people, animals, and freight vehicles from one place to another easily and quickly [1]. The function of transportation infrastructure facilities like roads is to facilitate the mobility of the population and also reduce the cost of delivery of goods to a region. This is necessary because it can support the productivity of the national economy, where the global economic sector is influential. Presented in the Prakarsa journal in 2014, Indonesia needs to modernize its road infrastructure condition to support the national economy, as the quality and performance of logistics in this country are lower than most ASEAN countries. Mentioned by Dalimin [2], the condition of roads in Indonesia (especially outside of Java) is seriously unfavourable, and arguably very unqualified or even non-existent. Therefore, it is necessary to develop roadway infrastructure to improve road quality in Indonesia.

According to Amoatey & Ankrah [3], road infrastructure constantly plays a key role in the movement of passengers and cargo. This is a necessary qualification for poverty alleviation and development in developing countries. The road serves as a system of circulation in the promotion of trade, communications, and socio-economic development. Provision of road infrastructure provides access for rural and urban societies to health, education, employment and other necessary social...
services. This means that without an efficient transport infrastructure, economic and social development will be severely hampered.

From the execution of the existing road construction industry shows the inefficiency in planning and scheduling, causing excess budget and work time [4]. In this case, project management sustains a critical role in planning and control. Planning and control are required to obtain project results in accordance with the planned objectives. The construction activity is a complex operation because it deals directly with time, resources and involves many parties from various aspects of the discipline so that the management of construction projects from the perspective of contractors or project implementers depends on the efficient planning [5]. Planning itself is defined as a process that includes the basics of goals and objectives including the arrangement of all resources to achieve them. Planning provides guidance on the execution of activities to allocate resources [6].

Therefore, to gain profit efficiency, timeliness and budget conformity, more innovative tools and techniques are needed to make it easier for project managers to plan and manage road construction projects. The tool can help the project manager in studying and comparing all the strategies and techniques that may be used during project implementation [4]. In this case, the primary method required as a reference in the planning or control of the construction process is Work Breakdown Structure (WBS).

Based on the 5th edition of the Project Management Body of Knowledge (PMBOK) manual, WBS is used to describe the scope of the project, increase estimates, control project implementation and also to ensure project completion more accurately. WBS provides an essential foundation for project management process, but in Indonesia, WBS is rarely used in a formal form. The package of work has not covered the entire project, even arguably not clear or none at all. So there is difficulty in achieving the project target [7].

An incomprehensive WBS can cause project losses like unclear work tasks, uncertain scope, budget overruns, deadlines and procurement issues [8]. Hence, a WBS-based format is needed to be used directly on the construction project as a reference for project execution, in this case, the proper format is the WBS Dictionary. Based on the 5th edition of PMBOK, the WBS Dictionary is a document that provides details on deliverables, activities and scheduling information about each component in the WBS. It is also mentioned that WBS Dictionary is a supporting document of WBS. Irdeomossa, Dindarloo, & Sharifzadeh [9] explained that WBS standardization is needed in order to obtain a reference in the execution of sustainable construction (in this case road construction) in order to achieve the quality of a project. Therefore, this research is needed to provide solutions on road construction projects to develop WBS in the form of WBS Dictionary [7].

2. Literature Review

2.1. Road Construction

According to Asiyanto [10], The road is a plot of land flattened with a certain gray and hardened surface to be able to serve vehicles passing on it with a strong and secure. In providing a comfort and safe feeling for road users, especially toll roads, on the road surface is given pavement layer with asphalt and/or concrete material classified into two, that is flexible pavement and rigid pavement. Based on the method of work, road conditions in terms of geometry and physical provide an essential role in providing security and comfort for passenger vehicles above, especially for highways or toll roads that are generally bypassed vehicles at high speed.

2.2. Work Breakdown Structure (WBS)

The purpose of the WBS is to provide a structural view of the project and its work. The most commonly used WBS format is the tree structure view, where it tends to present a more clearly understood perspective within a project scope. According to Brotherton, S. A., Fried, R. T., & Norman,
E. S. [11], to develop the WBS effectively and implement it during execution, the project manager must follow the guidelines provided and apply the WBS construction activities independently of the project schedule or scheduling activities. WBS illustrates the project in detail so that a project can be managed effectively. It is well-known that WBS provide an essential foundation for project management process, but in Indonesia, WBS is rarely used in a formal form. The package of work has not covered the entire project, even arguably not clear or none at all. So there is difficulty in achieving the project target [7].

2.3. WBS Dictionary
Based on the 5th edition of PMBOK, the WBS Dictionary is a document that provides details on deliverables, work methods, activities and scheduling information about each component in the WBS. It is also mentioned that WBS Dictionary is a supporting document of WBS. Roswidiayustuti [12] defines the WBS Dictionary as listing each WBS element with its resources with the processes required to produce each of these elements. The WBS dictionary also describes a hierarchical relationship between the elements.

3. Methodology
The development of WBS dictionary for the road construction project uses several methodologies, including:
- The WBS standards of road construction projects are developed based on the Archive Analysis of the Bina Marga and Badan Pengatur Jalan Tol (BPJT) specification.
- The WBS standards of road construction projects are used to form the initial format and content of WBS Dictionary with additional analysis of related literature.
- The WBS dictionary for the road construction project is validated for the format and content to the experienced experts in accordance with the use of the Delphi Technique analysis method.

4. Result and Discussion
In the WBS analysis process, the determination of WBS levels for work packages refers to the general specifications of Bina Marga and Badan Pengatur Jalan Tol (BPJT). Furthermore, benchmarking is conducted on 27 related Bill of Quantity road projects to determine activity and resource levels. Based on the analysis, the composition of WBS (Work Breakdown Structure) is as follows:

- WBS Level 1: Project Name.
- WBS Level 2: Work Division
- WBS Level 3: Type of Work
- WBS Level 4: Work Package.
- WBS Level 5: Activities
- WBS Level 6: Resources (Man, Material, and Machine).

In this WBS development to obtain valid results required validation process to experienced experts. This phase aims to gain constructive feedback, suggestions, and comments on WBS standards. The experts who participated in this phase consist of five people with at least 10 years experience in the field of road construction projects. The experts have at least a bachelor's degree and also have an excellent reputation and experience particularly in road or infrastructure projects in Indonesia.

The detailed WBS Level 1 – 4 are described in the WBS standard for road construction works. Furthermore, the WBS level 5 and 6, which are also part of the WBS standard, are described in more details in the WBS dictionary for road construction works.

The dominant work of road construction projects on the validated WBS standard are Subbase Pavement Work and Base Pavement Work (WBS Level 3 – Type of work), wherein this work
represents an important method of road construction projects. In this paper, we will look at the form of Fifth Division of the WBS (Subbase Pavement Works and Base Pavement Works) into the work packages described as follows:

![Figure 1. WBS levels of Road (Fifth Division)](image)

Figure 1 shows the validated 4 levels of WBS for road construction project. Based on this, the WBS Dictionary is produced which contains the activities and resources of each work package, which describe the details of WBS level 5 and 6. This phase begins with a study of literature about WBS Dictionary as a reference for the determination of its format. The WBS dictionary includes details of each WBS project work package (WBS Level 4) with other additional information such as:

- Project Division
- Name of Activity
- Stakeholders
- Activity Description
- Deliverable
- Reference
- Activity Code

Similar to the previous WBS process, the WBS dictionary needs to be validated to experienced experts on road construction projects in order to obtain inputs or suggestions related to the results of the research with questionnaires. From the validation results obtained, an analysis is performed to determine the appropriate WBS Dictionary format so that it can be used in construction projects. Here is an example of the fifth Division WBS Dictionary for the Aggregate Base Layer Work Package:
Table 1. Validated WBS Dictionary of Road - example

| WBS DICTIONARY OF ROAD |
|-------------------------|
| DIVISI 5 / SUBBASE PAVEMENT AND BASE PAVEMENT |
| Aggregate Base Layer |

Person In Charges:

Description:
This work shall include the procurement, processing, transporting, spreading, wetting and compacting of aggregates on prepared surfaces and has been produced in accordance with the details indicated in the drawings or in accordance with the orders of the Engineer, and maintaining the completed aggregate base layer in accordance with the requirements.

Deliverable:
Aggregate Base Layer

Reference:
Contract Document
Bill of Quantity

| Code  | Activity                              | PIC         | Resources |
|-------|--------------------------------------|-------------|-----------|
|       |                                      | Man | Material | Equipment | Cost |
| 5.1.1.1 | Material Procurement               | 1. Worker | 1. Aggregate Base A | 1. Dump Truck |
|       |                                      | 2. Operator | 2. Aggregate Base B | |
| 5.1.1.2 | Spreading and Aggregate Layer Compaction | 1. Worker | 1. Aggregate Base A | 1. Dump Truck |
|       |                                      | 2. Foreman | 2. Aggregate Base B | 2. Wheel Loader |
|       |                                      | 3. Operator | 3. Motor Grader | 4. Tandem Roller |
|       |                                      |             | 5. Water Tanker | |

This study produces WBS standards in the form of dictionaries for road construction projects. This WBS dictionary serves to describe each work package to its specific activities and resources. The WBS dictionary refers to the Work Breakdown Structure (WBS) planning of a road construction project. The result of this research is general because the work method in this research represents a common method of road construction. So the use of this WBS Dictionary on the project requires a specific evaluation as a process of adjustment to the relevant construction method. Also, the WBS dictionary serves as a basic guideline for the project planning and monitoring. Any changes of activities or resources during the execution of the project can be conducted and the WBS dictionary can always be updated based on its relevant condition.
The object of this research is a road construction project, so the scope of its activities and resources has been summarized in the WBS Dictionary as a result of this study. In Table 1, one of the crucial work packages of the road construction project is found in the aggregate base layer work package. In this case, all existing road construction projects inevitably require an aggregate base layer as part of its pavement work. Therefore, there is a correlation between the activities of road construction projects with the result of this research, thus it can be concluded that the WBS Dictionary of the road construction project can be implemented in the field. This is supported by the statement of experts who revealed the benefits of using the WBS Dictionary in the road construction projects.

According to experts, the WBS Dictionary should be an important guideline in every construction project, especially in Indonesia. This is because the WBS Dictionary facilitates the planning, execution, and supervision of construction projects. The WBS dictionary that contains project resources can be integrated with time, quality, and cost performances, thereby providing added value in project planning and supervision of the project. In fact in Indonesia, the application of WBS Dictionary is minimum, because until now many projects in Indonesia that prefer to use data or archive of the previous project as a reference for project implementation. In the construction project, the person who has responsibility for the use of WBS Dictionary is the person who has the highest responsibility or position on the construction activity in accordance with the RAM/RACI (Responsibility Assignment Matrix) project. And if the construction project in its implementation undergoes a change of method or technical activities of the project, then it is necessary also to change the WBS Dictionary of the project in accordance with what has been agreed by the stakeholders.

This research is expected to have a beneficial impact on the road construction project. The WBS Dictionary of this road construction project is also expected to offer a solution to the problems of planning, supervision, and implementation of road construction projects in Indonesia and other countries.

5. Conclusion

The WBS dictionary is a derivative of a previously validated WBS standard. In the process, a literature study and archive analysis of the road construction project was conducted as a first step in the preparation of the WBS Dictionary. The compiled WBS dictionary is validated to the expert and then further analysis is done for comments and suggestions provided by the experts in order to get a valid final result. The end result of validated WBS Dictionary is WBS Dictionary format which can be used for road construction project as an easy to understand guideline for the road construction project, which provides detailed work methods, activities and resources.

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