Development of WBS Dictionary and Checklist Based on WBS of Railway Construction for Safety Planning

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Abstract. Railroad construction works are common in developing or developed countries throughout the world. Railroad construction work is a complex project. Inside, there are work activities that can be disrupted due to work accidents. Work accidents that occur can be detrimental to the project. Therefore, to prevent accidents, it is necessary to develop a WBS dictionary and checklist on railroad work for OHS planning. The need for a standardized WBS dictionary and checklist of WBS in preventing work accidents is very important. This study discusses OHS planning by developing a WBS dictionary and checklist on railroad work using expert validation methods and interviews using a questionnaire with descriptive statistical analysis of data. With the development of the WBS dictionary and checklist for OHS planning, project stages will be obtained in detail that can be used to analyze work packages, specified methods, activities, and resources. So that it can reduce and even nullify the risk of work accidents (zero accidents) in the implementation of construction projects.

Keywords: railway, wbs, wbs dictionary, checklist wbs, safety planning

1. Introduction

Construction industry in Indonesia is an important contributor to the development of the country’s infrastructure and is the key to facing global economic competition. Basic problems relating to poverty and population discrepancy can be overcome by the availability of infrastructure [1]. One of the infrastructures that is being intensively carried out is the railway project. Railway projects require sophisticated technology, complex structures, high quality and high technical standards due to long-term use. If project planning is not done effectively it will become an obstacle in the realization of construction projects [2]. Railroad development planning must be done carefully in order to get the results of an effective and efficient development [3], therefore it is necessary to have a careful calculation and planning so that the costs incurred in accordance with the budget and does not cause cost overruns [4]. So that the construction of the railroad tracks can run according to their functions to create safety and comfort for users, namely the community [5].

The process of building construction projects is generally an activity that contains many elements of danger [6]. Related to work accidents, the massive infrastructure development is always accompanied by the large number of work accidents that occur [7]. In Indonesia, there has been a work accident in one of the railway constructions, namely the Jatinegara DDT Railway project [8]. The occurrence of work accidents is based on lack of careful planning. Planning and arranging the correct and systematic stages are the key to project success, therefore a WBS (Work Breakdown
Structure) is needed as the basis for project planning [9]. The making of WBS produces basic documents that provide the basics for planning and managing costs, resources, project schedules, and changes [10].

There is a solution to eliminate the number of work accidents by creating a WBS dictionary and checklist. During the process of making WBS, it is inseparable from making WBS dictionaries and checklists. WBS dictionaries and checklists define, detail, and clarify various WBS elements to ensure that each component of the work is described [11]. The WBS dictionary includes a description of each work package, as well as other planning information such as schedule dates, budget, and work [12]. The WBS checklist is a more detailed work breakdown that covers all work activities of a project. This study aims to develop a WBS dictionary and checklist on the railway project for standardized WBS-based OHS planning.

2. Literature Review

2.1. Railroad WBS

2.1.1. Railway. Constitutional Review Number 13 of 1992 defines railway infrastructure as railroad tracks and stations, including facilities needed for railroad facilities to be operated. Railway infrastructure can be classified in more detail as: 1) Track or railroad, 2) Station building, 3) Bridges, and 4) Signals and telecommunications.

2.1.2. Work Breakdown Structure. Work breakdown structure (WBS) is a method of organizing projects into hierarchical reporting structures [11]. WBS is used to breakdown or solve each work process in more detail. According to Lei Su [13], WBS has four important objectives including the following:

- As a planning and design tool, which can help project managers and project teams identify and manage projects effectively.
- WBS is also a planning tool, which can show the completeness of work packages in a project and detailed instructions for completing projects in each work unit.
- WBS can determine the work milestone, project status reports to senior managers and customers, and project deliverables should be further decomposed into WBS. WBS can prevent negligence of project deliverables and help project managers pay attention to project objectives and clarify tasks, create visualizations of project deliverables, and estimate workload.
- WBS can also help improve the accuracy of estimated time, cost and resources; help build project teams and acquire projects.

2.2. OHS Performance

Occupational Health and Safety (OHS) performance according to OHSAS 18001: 2007 is a measurable result of managing OHS risks. The OHS performance measurement included in the measurement is the effectiveness of control implemented by the organization. The aim is to provide information about the current status, as well as the progress of strategies and processes used by companies to reduce OHS risk. According to Lu, Cheung, Li, & Hsu [14], OHS performance consists of five indicators, including: 1) Safety awareness; 2) Discipline behavior; 3) Safety costs; 4) Accident rate; 5) OHS Productivity.

2.3 WBS Dictionary

The WBS dictionary is a document that provides detailed deliverables, activities, resources, and information about scheduling about each component listed in the Work Breakdown Structure (WBS) [12]. The WBS dictionary has some related information, the information contained in the WBS dictionary [12], namely: 1) Job description; 2) Identification code; 3) Responsible organizations; 4)
Assumptions and limitations; 5) Milestones; 6) Schedule of activities; 7) Resources needed; 8) Quality requirements; 9) Acceptance criteria; 10) Estimated costs; 11) Agreement information; and 12) Technical references

2.4 Checklist
The WBS checklist is a document created to help with the breakdown of each activity up to the compilation of resources and outputs generated such as the costs required in a project so that it can be calculated. At the time of WBS development, the WBS checklist helped in the process of completing the steps that had to be carried out.

3. Methodology
The research methodology used to develop the WBS dictionary and checklist for railway work in this study includes:

1. The WBS standard for railway works developed through archive analysis, which was compiled based on benchmarking of 3 railway projects in Indonesia then were validated by experts.
2. WBS dictionary and checklist on railway works were developed by creating WBS dictionary and checklist in reference to the standard WBS which were then being validated by 5 experts with a minimum of 25 years’ experience managing railway projects in Indonesia.

4. Result and Discussion
In the process of preparing WBS, determining the level of WBS level is based on archival analysis with benchmarking Bill of Quantity (BOQ) which was conducted on 3 railway projects in Indonesia. Then WBS is organized into 6 levels, consisting of:

WBS Level 1: Project Name
WBS Level 2: Work Group
WBS Level 3: Work Type
WBS Level 4: Work Package
WBS Level 5: Work Activities
WBS Level 6: Resources (Labor, Materials, Equipment)

To produce a standardized WBS, the first stage of WBS validation is carried out by experts in the field of railway construction. The experts who participated in this process are five people by means of interviews with instruments in the form of questionnaires. The minimum criteria of the experts is having a Bachelor’s degree and 25 years work experience with the requirement of having been or involved in handling railway construction projects and having an understanding of the concept of WBS (Work Breakdown Structure) on construction work in general, especially on railway construction projects. The purpose of WBS validation is to find out whether the independent variables in the form of standardized WBS (levels 1-6) obtained from the archive study are in accordance with the standardization of railway construction work and solicit input and responses from experts.

From the results of the archived data from literature study and expert validation, it is obtained the standardized WBS for railway construction in 9 groups of work, as follows:

Group 1 : Preparatory Work
Group 2 : Drainage Works
Group 3 : Railroad Land Work
Group 4 : Railroad Structure Work
Group 5 : Railroad Bridge Earthworks
Group 6 : Rail Bridge Structure Work
Group 7 : Electrical Work
Group 8 : Station Building Work
Group 9 : Other Work

After the process and analysis of WBS validation stage-1 is completed, the stages in the preparation of the WBS dictionary are then validated by experts (stage-2) regarding the content of the WBS
dictionary. The WBS dictionary and checklist are validated by the same 5 experts and the same process as stage-1 validation. The WBS dictionary validation aims to describe each work package contained in the railway construction project, as well as details of the person in charge, deliverables, and references of each work packages so at this stage a more detailed description of WBS is carried out. An illustration of the initial content of the WBS Dictionary can be seen in Figure 1.

![Figure 1](https://example.com/figure1.png)

**Figure 1. Illustration of WBS railway project dictionary content for each work package**

From the results of the WBS dictionary validation, there are inputs and responses from each division or Work Group contained in the questionnaire as a reference for developing a complete standardized WBS dictionary. The results of the validated WBS dictionary contain the WBS code, description of the work package, person in charge, deliverables, references, activities and resources needed. The results of WBS dictionary after validation did not change much, there were only a few improvements from some of its contents. It is from this change in the WBS dictionary that makes the contents of the WBS dictionary more informative. Figure 2 is an example of the results of the WBS dictionary that has been validated.

![Figure 2](https://example.com/figure2.png)

**Figure 2. Validated WBS dictionary of railway projects for each work package**

Validated content shows a structured description of the encoding, person in charge, resources and clear deliverables. The person in charge was intentionally left blank because it can be adjusted to each railway project. The work package from ballast work is an important activity in the railway project because ballast work is quite specific which is only be found in the railway project. Good ballast material comes from rock angled, broken, hard, same grade, because the ballast layer serves to hold the vertical, lateral and longitudinal forces charged to the bearing so that the bearing can maintain the railroad in the required position. Based on the results of the validation, a description of the ballast work must also be made in detail by explaining the grain size / gradation of the rock used.

In stage-2 validation along with the checklist validation, which contains job descriptions of each level, is intended to review and check so that no work is left behind. Experts are asked to validate the description as well as the completeness of the WBS checklist. An illustration of the initial checklist content can be seen in Figure 3.
From the results of the checklist validation, not many changes have been made to the initial data, there are only a few improvements or simplifications from the worker description listed on the WBS checklist. The WBS checklist explains the description of each work and the scope of the work packages carried out on the project to make it easier for the person in charge to understand the work and scope in order to achieve the project's objectives. The following is an example of the results of the WBS dictionary that has been validated in Figure 2.

Validated WBS checklist shows the breakdown of each level of WBS, starting from the name of the project, cluster of work, type of work, to the work package. The description in the ballast work package checklist shows the order or list of work to be done, along with the WBS code in the WBS checklist that functions to know the order of activities of each work sequence so that no work items are left behind.

Additionally, further validation is done regarding the implementation of the WBS dictionary and checklist of railway works in the field. At the moment, the implementation is still lacking in the field because up to this point, the reference for the project is still using the Implementation Plan Budget Document, which is the implementation cost plan document complete with a construction method plan and project strategy. If the WBS dictionary and checklist formed are applied to the project, it can affect the success of the project. WBS can also be used as a planning approach and reduce the likelihood of work accidents and improve field control for industrial construction projects [15]. OHS planning is related to the conditions needed for each work package in WBS because risks are related to the requirements of OHS, specifications conformity of OHS is an important indicator of construction project performance [16].

5. Conclusion
This study resulted in WBS dictionary and checklist of railway construction work that has been validated with 109 work packages. Validated WBS dictionary and checklist have been described in detail from work methods, activities, to resources. Implementation of the use of WBS dictionaries and
checklists in the field can minimize the occurrence of overbudget, delayed projects, and reduce/eliminate work accident rates, therefore, the WBS dictionary and checklist can be used as a tool in OHS planning by identifying potential hazards contained therein. Further studies on the WBS dictionary can be done by selecting implementation methods in construction projects for cost or quality planning.

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References
[1] C. Calderón and L. Servén, “Infrastructure, Growth, and Inequality: An Overview. WPS7034,” Policy Research Working Paper, no. September, pp. 1–29, 2014.
[2] Q. Li, R. Liu, J. Zhang, and Q. Sun, “Quality risk management model for railway construction projects,” Procedia Eng., vol. 84, pp. 195–203, 2014, doi: 10.1016/j.proeng.2014.10.426.
[3] Q. Z. Yu, L. Y. Ding, C. Zhou, and H. B. Luo, “Analysis of factors influencing safety management for metro construction in China,” Accid. Anal. Prev., vol. 68, pp. 131–138, 2014, doi: 10.1016/j.aap.2013.07.016.
[4] D. Hermiaty, “Pemodelan dan Analisis Proporsi Upah Tenaga Kerja pada Proyek Konstruksi,” 2007.
[5] S. H. T. Utomo, Jalan Rel. Yogyakarta: Beta Offset, 2009.
[6] Y. T. Tsang, I. W. H. Fung, V. W. Y. Tam, C. P. Sing, and C. T. Lu, “Development of an accident modelling in the Hong Kong construction industry,” Int. J. Constr. Manag., vol. 17, no. 2, pp. 124–131, 2017, doi: 10.1080/15623599.2016.1222664.
[7] D. Benny and D. Jaishree, “Construction safety management and accident control measures,” Int. J. Civ. Eng. Technol., vol. 8, no. 4, pp. 611–617, 2017.
[8] C. Akbar, “Accident on Railway Construction Site, Project Halted - engteco_news Tempo.co,” Tempo.co, 2018. [Online]. Available: https://en tempo.co/read/915463/accident-on-railway-construction-site-project-halted. [Accessed: 19-Apr-2020].
[9] V. Elsye, Y. Latief, and L. Sagita, “Development of Work Breakdown Structure (WBS) Standard for Producing the Risk Based Structural Work Safety Plan of Building,” MATEC Web Conf., vol. 147, 2018, doi: 10.1051/matecconf/201814706003.
[10] A. Tamara, Y. Latief, and R. A. Machfudiyanto, “The development of safety plan to improve OHS (occupational health and safety) performance for construction of irrigation channel based on WBS (work breakdown structure),” IOP Conf. Ser. Earth Environ. Sci., vol. 426, no. 1, 2020, doi: 10.1088/1755-1315/426/1/012016.
[11] PMI, Practice Standard for Work Breakdown Structures Second Edition. 2006.
[12] PMBOK, A Guide to the Project Management Body of Knowledge (PMBOK Guide), 6th Edition. Newtown Square, Pennsylvania: Project Management Institute, 2017.
[13] L. Su, “WBS-based risk identification for the whole process of real estate project and countermeasures,” Proc. 2012 Natl. Conf. Inf. Technol. Comput. Sci. CITCS 2012, no. Cites, pp. 780–783, 2012, doi: 10.2991/cites.2012.19.
[14] M. Lu, C. M. Cheung, H. Li, and S. C. Hsu, “Understanding the relationship between safety investment and safety performance of construction projects through agent-based modeling,” Accid. Anal. Prev., vol. 94, pp. 8–17, 2016, doi: 10.1016/j.aap.2016.05.014.
[15] Andi, S. Winata, and Y. Hendarlim, “Faktor-faktor Penyetab Rework Pada Pekerjaan Konstruksi,” Civ. Eng. Dimens., vol. 7, no. 1, pp. 22–29, 2007.
[16] G. Satrio and Y. Latief, “Development of Risk-Based Standardized WBS (Work Breakdown Structure) for Safety Planning of Cable Stayed Bridge Project,” Proc. Int. Conf. Ind. Eng. Oper. Manag., vol. 2018-March, pp. 2694–2710, 2018.