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# Activity-based – risk breakdown structure as an initial stage in formulating OHS unit cost analysis in the construction project

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**Abstract.** Implementation of occupational health and safety in a construction project must be applied, referring to existing regulation. Previous research indicates that budget planning is one of the most basic aspects of OHS implementation problems in a construction project. Effective approach to formulating appropriate OHS cost models still needs further effort. This research tries to develop an activity based-risk breakdown structure as an initial stage in formulating the OHS unit analysis model based on the existing unit cost analysis model referring to Regulation of Ministry of Public Work and Human Settlement number 28/2016 about Unit Cost Analysis in Construction Project in Public Work Field. The methodology used in this research is archive analysis and expert judgment on activity based-risk breakdown structure analysis using HIRADC (hazard identification risk assessment determining and controlling) theory that attached to the workers and the project method used in each work unit. This research tries to deliver a simple job risk analysis method as an initial stage in formulating a reference for making a cost safety analysis formula in a construction project.

## 1. Introduction

The issuance of new regulations on the procurement of goods and services in the construction sector, namely Permen PUPR No. 07/2019 concerning Standards and Guidelines for Procurement of Construction Services through Providers, brings new hope for the development of OHS Management Systems for Indonesian construction society. This regulation indirectly corrects the shortcomings of previous regulations that do not accommodate OHS budget planning on a project to be obliged into a construction contract offer.

Unfortunately, this regulation still carries the weakness of the previous regarding OHS Construction Management System [1], which has not included technical instructions or procedures for calculating OHS cost units in planning construction project budgets properly. It weakened the level of review of occupational safety aspects because, from the stages of project planning, the cost of implementing SMK3 could not be calculated in detail.

The Ministry of Public Works has issued technical regulations related to project budget planning, namely Permen PUPR No 28/2016 concerning Unit Cost Analysis in Public Works Field, which includes procedures for calculating the work item consisting of 3 (three) main components, namely



wages, materials, and tools. However, if it is associated with the obligation to calculate OHS costs in a contract offer, this regulation also does not include the procedure for calculating it.

It shows the importance of a technical guideline that contains procedures for calculating K3 unit costs that are simple, easy to understand and refer to the applicable regulations as well as existing technical rules. This research is an advanced stage of the existing writing on the development of a model for calculating OHS unit costs, referring to the existing calculation method of work unit analysis. Where the findings are expected to be a simple, easy to understand calculation model referring to the most basic part of the work structure, namely work item, which is then analyzed based on the Hazzard Identification Risk Assessment Determining Control (HIRADC) approach. The contribution of this study will provide input to service providers (contractors/consultants) and service users (Ka Satker / PPK) in preparing an analysis of work units containing elements of OHS costs by applicable regulations [2].

This writing tries to begin the development of the OHS unit cost calculation method by trying to apply a risk analysis method to a job using a WBS from work itself. This research is expected to provide an overview of how to analyze the risk of construction work directly from the lowest level of work so that it can facilitate the OHS planning process in a project where one of them is calculating the cost of OHS itself.

## **2. Risk-based WBS for safety planning**

Based on the theory, the ability to identify risks completely and to manage all risks effectively is very related to the success of a project. In general, job risk is divided into 2 (two) categories, namely a) individual risk both related to individual work or risk that is part of a stage of work or scope of work, and b) overall risk, namely risk which is a combination or combination of risks in each of the interrelated scope of work [3].

### *2.1. The benefit of WBS for job risk analysis*

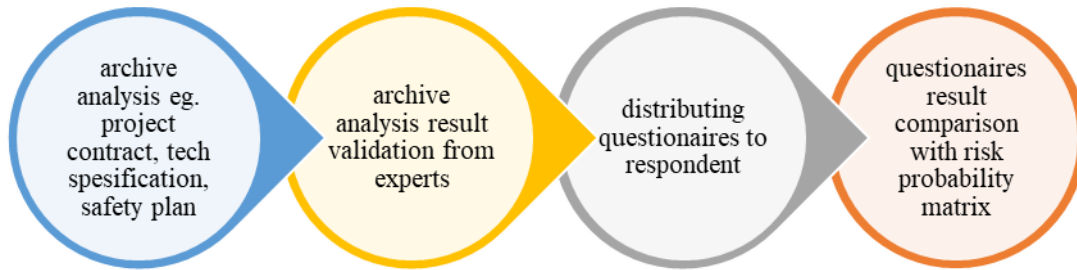
One of the easiest ways to break down the potential risk of work in detail is to identify the complexity of the work from the details of the product, method, and scope of work itself (Project Management Institute, 2017). The use of WBS in breaking down all potential job risks is highly recommended because the WBS can identify methods and work packages used to measure project performance in terms of safety planning. The WBS can also be used as a planning approach and this practice is reported to reduce the likelihood of workplace accidents and improve control at the location of construction projects [4].

### *2.2. Risk-based WBS for easier job risk analysis*

Project risk is an uncertain event that has a positive or negative impact on the project objectives. If the event occurs, it can affect the scope, schedule, cost, or quality of the project. Risk can be prioritized by assessing the probability of events and impacts through risk analysis (Project Management Institute, 2017). Risk-based WBS is an upgrade of standard WBS that is added to the types of risks associated with the work activity intended. With the availability of a WBS that is equipped with the types of risks in each activity, the risk will be more easily identified and controlled [5].

## **3. Research methodology**

To identify WBS models commonly used in project budget planning within the Ministry of Public Works, data was collected from archives study of project budget plan examples, project safety plan, and literature studies on technical regulations related to budget planning issued by the Ministry of Public Works and interviews with 3 experts with experience over 5 years to validate the results of the literature study.



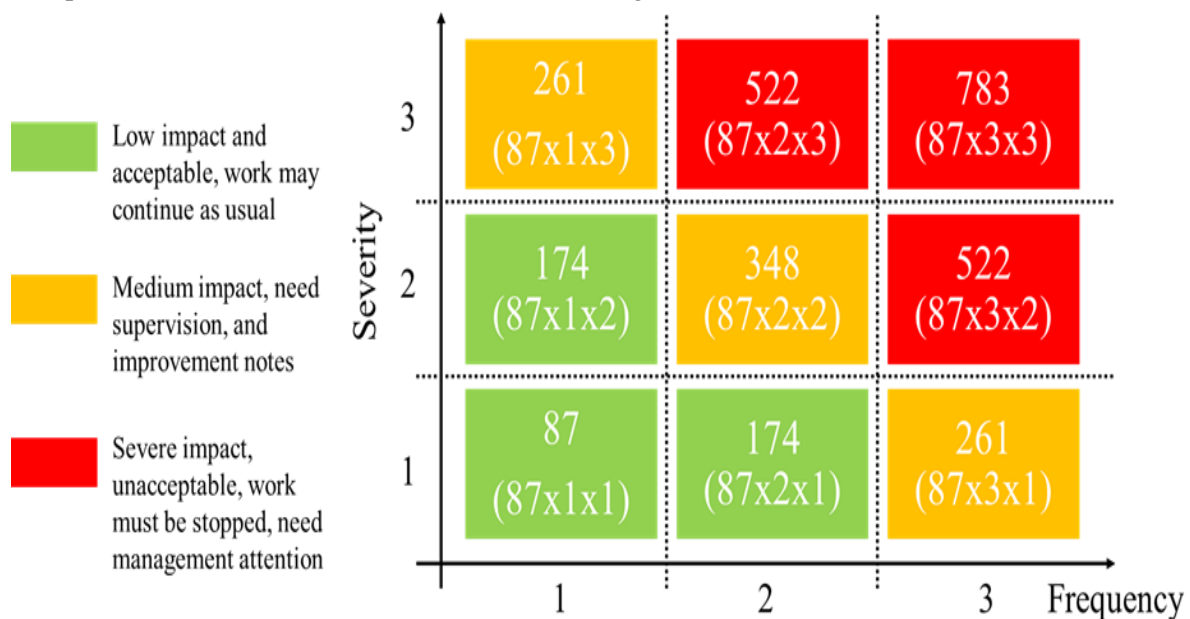
**Figure 1.** Research stage

WBS identification begins with analyzing project budget planning examples, work technical specifications, and project safety plan examples followed by classifying the results of the analysis into WBS structure groups commonly used in auction bidding, then matching the results of the classification with existing regulations. These results are then combined with the general WBS theory, where the lowest work hierarchy is taken to continue the decomposition.

The lowest level of work referred to is described by adding 2 new levels, which are adjusted to Risk Breakdown Structure theory from PMBOK, the results of which are consulted with relevant experts to obtain validation and input for improvements if necessary. The results of the validation are used as a reference for the writer to propose an RBS model/template based on activities/stages of work.

WBS analysis is carried out on the lowest structure of a job, which is a work item by adding 2 WBS levels below, the activity level and activity risk level. To simplify the preparation of risk analysis templates, 1 type of work is chosen, namely land cut works manually with 3 meters depth.

The questionnaire was made according to the type of RBS which was completed with details of activities and examples of risks compiled in comparison probability matrix of frequency (F) and severity (A). The questionnaire was then distributed to respondents such as consultants, contractors, and service users. From the 87 questionnaires returned, quantitative analysis was conducted to look for examples of risks that were considered dominant using the risk cluster matrix.

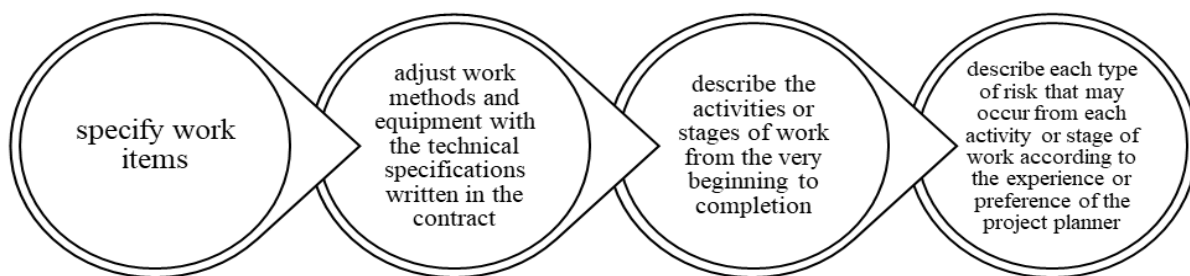


**Figure 2.** 3x3 risk probability matrix (Frequency x Severity) from 87 respondent

#### 4. Findings

Based on the theory, the lowest level of the WBS is a work package with four hierarchies levels, namely a) job name, b) division of work, c) subdivision of work, d) work package (Project Management Institute, 2017). While the common WBS model that is generally used in the Public Works project mainly consists is a work item with 4 level hierarchies, namely a) project name b) job division / main occupation c) work subdivision / main work sub-sector and d) work item.

Then added two complementary levels, namely a) level 5 activities and b) level 6 risk of activities identification where the decomposition at the activity level is very dependent on the work method of work items located at level 4, these two additional levels are not the core structure of the WBS. Then the author makes a separate WBS, which only consists of 3 levels for easier understanding, namely a) level 1 work items, b) level 2 activities/stages of work, and c) level 3 risks of activities/stages of work as seen in figure 4.



**Figure 3.** The stages of composing a risk breakdown structure based on activities or stages of work

This additional level is adjusted to the theory of risk breakdown structure that applies in PMBOK, where each risk is attached to each activity/stage of the work item according to the example of the work method used as seen in figure 3. The author uses examples of 2 different work methods for the same work item to be described following the previous explanation.

Figure 4 shows that the addition of level 5 (activity) and level 6 (risk of activity) is carried out after determining the 4th level (work item) of the WBS itself. Determination of level 4 (work items) is carried out after selecting work methods and equipment to be used. This process can be adjusted to the provisions contained in the technical specifications on the contract of a job.

In figure 6, these examples show that although certain risks appear to have a large impact if taken the average value will decrease in the magnitude of the impact. Then the majority of respondents also see risks such as being buried by a landslide or electric shock having a low impact because these risks rarely occur based on their experience.

From figure 5, we can see that each risk has a value according to the respondent's answer. Each recapitulation of the value is then grouped into risk clusters adjusted to the Risk Probability Matrix that was compiled in the previous stage. The average value is taken from the risk of activity that repeatedly occurs in many activity.

These results also verified and validated through expert judgment. Experts who carry out validation of the proposed risk breakdown structure model based on activities or stages of work agree on the model proposed by the author. The model is considered easy to understand, applicable and under the existing regulation and practice habit in the project.

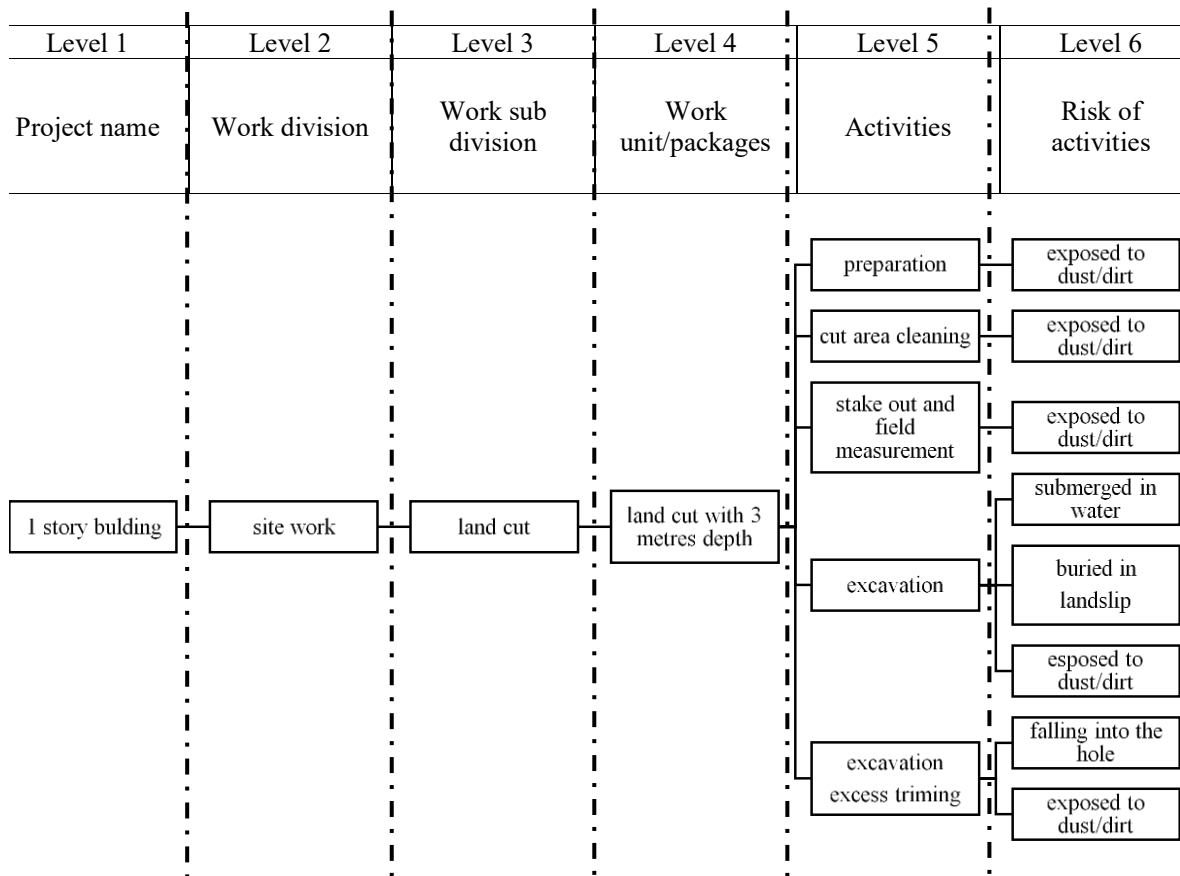


Figure 4. WBS of manual landcut with an additional level of activities and level of risk activities

\*FxA value for each risk in each stage of the answer recap of 87 respondents

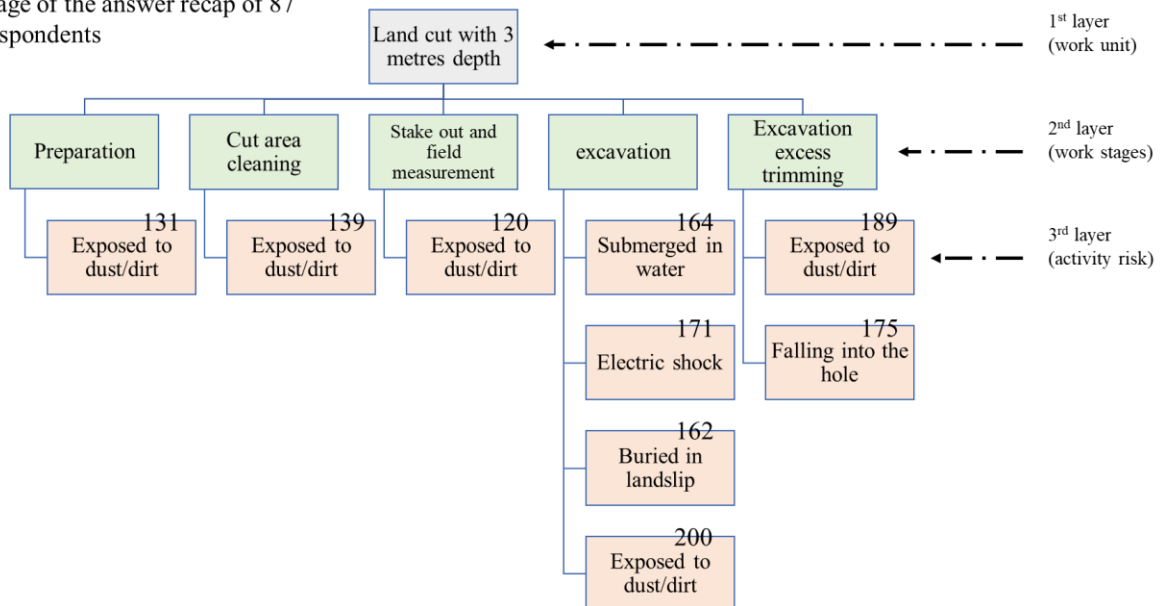
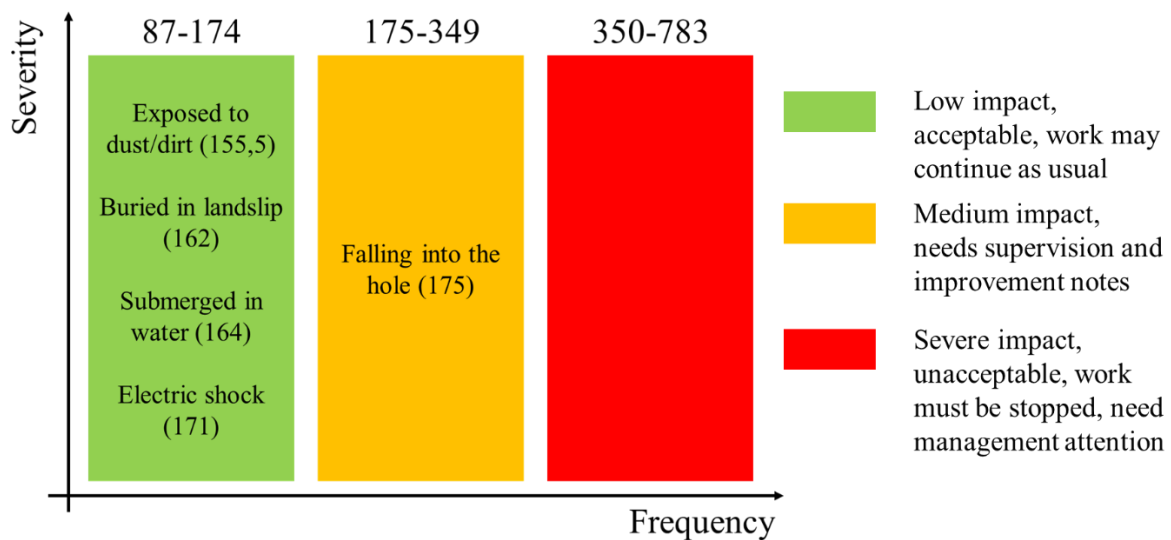


Figure 5. FxA recapitulation for each activity risk in risk breakdown structure based on activity for landcut with 3 metres depth work



**Figure 6.** Risk cluster recapitulation results of respondent's answers

## 5. Conclusion

The risk breakdown structure model that is based on the activities/stages of this work is made as simple as possible and adjusts the rules for preparing the analysis of work units that are already applied. Where the activities referred to are based on workers (wage coefficient) and work methods (coefficient of materials and tools). The decomposition process can be carried out on any work method either manually (human labor) or mechanical (using heavy equipment) on any work item during the decomposition of the hierarchy/work structure, adjusting the applicable provisions in the Minister of Public Works Regulation No. 28 of 2016. This method is used to simplify readers' understanding and simplify the validation process with related experts. The example is land cut works manually with 3 meters depth and open-cut using an excavator. This different example shows the different types of risks that might occur if the work methods and work equipment used are different.

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