Analysis cost of safety on project irrigation/channel base on WBS (Work Breakdown Structure)

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Abstract. The implementation of construction projects in Indonesia in general the number of work accidents also increased. Referring from BPJS, nationally the number of work accident accidents in the construction sector was recorded as the national sector with the highest number of occupational accidents. The regulations regarding OHS financing in Indonesia have not been clearly and measurably regulated. Existing regulations regarding HSE financing are regulated in three regulations, namely, Permen PUPR No. 31/2015, SE Menteri PUPR No. 66/2015, Permen PUPR No. 28/2016, and the last in SE Menteri PUPR No. 11/2019. Activity-Based Costing (ABC) has emerged as a new approach that connects costs directly related to business activities with manufactured products. This study aims to identify any risks that are potentially hazardous in irrigation work, making a safety plan using risk-based WBS standards, and the results of this research can make Analysis cost of safety for irrigation works.

1. Introduction
Irrigation and Channel can’t be separated from human living. It has a vital role because in addition to flowing water from the centre of the settlement to the final reservoir, it also functions to supply water for agricultural, plantation and fishery lands. In agricultural areas, irrigation is very necessary to divide water into agricultural fields so that agricultural crops obtain sufficient water intake. Referring from BPJS Employment the number of work accidents has increased. The work accidents in 2016 with a claim value of only Rp 792 billion. This figure increased in 2017 with a claim value of more than Rp 971 billion.

The implementation of Occupational Health and Safety Management System (SMK3) financing in Indonesia especially on irrigation channels has not been clearly regulated. The existing regulations in the construction sector, are found in several regulations, including the following: Permen PU No. 05/2014 concerning Guidelines for Occupational Health and Safety Management System (SMK3) in the Construction of Public Works; Permen PUPR No. 31/2015 concerning the Third Amendment to Pemen PU No. 07/2011 concerning Standards and Guidelines for Procurement of Construction Works and Consultancy Services, in this regulation safety costs enter into overhead costs; SE Menteri PUPR No. 66/2015, in this regulation OHS costs are allocated within general costs and are calculated based on the level of OHS risk; Permen PUPR No. 28/2016, in this regulation OHS costs are influenced by general OHS costs, OHS special costs and OHS OS costs; Permen PUPR No. 07/2019 concerning Standards and Guidelines for Procurement of Construction Services through Providers, regulates the costs of...
implementing a Construction Safety Management System (SMKK); SE Menteri PUPR No. 11/2019 in this regulation discusses the details of the last regulation of Permen PUPR No. 07/2019 concerning technical instructions in carrying out the details of the implementation of the Construction Safety Management System and aims to realize an orderly implementation of construction work.

Activity-Based Costing (ABC) emerged as a new approach in linking costs directly related to business activities with manufactured products. ABC provides more accurate information especially in complex structures and allows one to obtain information about cost items that are ignored in traditional methods. Work Breakdown Structure (WBS) divides the project into several parts to make activities more manageable. Each section is considered a product, so planning, cost estimation, observation and control can be done through these sections [1].

2. Research objective
The objective of this research as follow:

- To analyze Work Breakdown Structure (WBS) standard in irrigation/channel projects.
- To identify potential hazards and occupational safety risks in irrigation/channel projects.
- To identify OHS targets and programs from risk control that occurs in WBS irrigation/channel projects.
- To identify the component of safety costs in irrigation/channel projects.
- To determine the amount of safety costs used in irrigation/channel projects.

3. Literature review

3.1. Irrigation/channel
Irrigation is an effort to supply and regulate water to support agriculture, while an irrigation network is a unit of channels and buildings that are needed for regulating irrigation water, from the provision, taking, sharing, giving and using it. In an irrigation network, four main elements can be distinguished, namely:

- Headworks, where water is taken from its source (rivers, reservoirs, etc.);
- Main Channel, in the form of channels that drain irrigation water into Tertiary plots;
- Tertiary plot, with a water distribution system and a collective disposal system;
- Irrigation water is divided and distributed to the fields and excess water is collected in a disposal system in a tertiary plot;
- Drain system, which exists outside the irrigation area to remove excess river water or channel-natural channels.

3.2. Work breakdown structure
According to the Project Management Institute (2017), Work Breakdown Structure (WBS) is a hierarchical decomposition of work that is deliverable oriented to be carried out by the project team in order to achieve project objectives and produce the required deliverables. Each activity that has been grouped in a standard WBS.

3.3. Hazard identification, risk assessment and risk control base on work breakdown structure
According to Permen PUPR No. 5/2014, an assessment of the level of OHS risk of construction can be done by combining the frequency of occurrence of OHS hazard events by combining the frequency of occurrence of OHS hazards with the severity/loss/impact of the damage caused [2]. Construction OHS risk level is the result of multiplication between the frequency of occurrence of construction OHS risk and the resulting severity value.

3.4. Safety plan
Based on Permen PUPR No. 5/2014 that OHS targets are divided into two types namely:

- General Targets: Zero fatal work accidents at construction work.
Specific Targets: Specific targets are detailed targets per activity which has OHS risk which are prepared in order to achieve the General Targets [2].

Base on Permen PUPR No. 5/2014 that the provisions in the preparation of the OHS program are as follows: The OHS program is created, implemented and maintained to achieve OHS goals; Resources needed to carry out work programs; The period of time determined to carry out the work program; Indicators of achievement, which is a measure of the success of program implementation; Monitoring is carried out in order to ensure that the achievement of targets is met throughout the time of implementation; Appointment of person in charge of implementing the OHS program; and Costs for the need to implement the OHS program.

3.5. Safety cost

According to Permen PUPR No. 28/2016, safety cost divided by 3, i.e. general cost, specific cost and security cost [3]. SE Menteri PUPR No. 11/2019 shows that safety cost consists of Personal Protective Equipment, Safety Plan, Socialization, Promotion and Training, Working Protective Equipment, Insurance and Licensing, Safety Personnel, Medical Facilities, Infrastructure and Devices, Safety Sign, Consultation with Experts Related to Construction Safety, Others [4].

4. Research methodology

The Research survey is used to collect data from experts. Data will be analyzed by using descriptive analysis with a qualitative approach. There are five steps in this research. Figure 1. shows the process of the research.

![Figure 1. Research methodology.](image-url)
5. Research variable
In 5 stages of research, there are 4 X-variables and 1 Y-variable as shown in Table 2. In Y-variable there are 3 sub-variables and 11 indicators as shown in Table 3.

| Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 |
|---------|---------|---------|---------|---------|
| Code    | X1      | X2      | X3      | X4      | Y       |
| Variable Name | Activities Irrigation/Channel WBS Level 5 | Hazard Potential & Safety Risk Control in Irrigation/Channel Works | Safety Program in Irrigation/Channel Works | Safety Cost Components in Irrigation/Channel Works | Safety Cost |
| Reference | Pasaribu, 2018 | Permen PU No. 05/2014 & PMI, 2017 | OHSAS 18001 | Permen PU No. 05/2014 | Permen PUPR No. 28/2016 & SE Menteri PUPR No. 11/2019 |

6. Research instrument
Questionnaire is used to collect data in survey research. There will be 4 kinds of the questionnaire base on the objective of the research. Questionnaire 1 is applied for collecting data of WBS. Questionnaire 2 is applied for identifying safety risk and risk control. Questionnaire 3 is applied to develop safety plan. And questionnaire is used to collect the safety component. Guttman scale is applied in each questionnaire to get the firm answer “yes” or “no”. The questionnaire will produce nominal data for later analysis.

7. Results and discussion
The result of the research as follows:
- Research objective #1, standardized WBS of Irrigation/Channel work activities, as shown in Table 4., is achieved by validating road work activities from the WBS standardization from Pasaribu & Latief [5], by asking experts such as the first questionnaire.
### Table 3. Standardized WBS of irrigation/channel project.

| WBS LEVEL1 (PROJECT NAME) | WBS LEVEL2 (WORK SECTION) | WBS LEVEL3 (SUB-WORK SECTION) | WBS LEVEL4 (WORK PACKAGE) | WBS LEVEL5 (WORK ACTIVITIES) |
|---------------------------|---------------------------|-------------------------------|---------------------------|-------------------------------|
| Irrigation/Channel Project| Preparation Work          | Mobilization & Demobilization | Mobilization Program      | Material Mobilization         |
|                           |                           |                               |                           | Personnel Mobilization        |
|                           |                           |                               |                           | Heavy Equipment Mobilization  |
|                           |                           |                               |                           | Heavy Equipment Mobilization  |

- Research objective #2, potential hazards and risk control, as shown in Table 5., is achieved by searching for potential hazards and risk control in any irrigation/channel work activities that have been validated by experts, from the literature then re-validated by experts whether the risk hazards are appropriate or not.
- Research objective #3, safety plan, as shown in Table 6., is achieved by compiling a safety plan based on following the Permen PU No. 05/2014, then the safety plan is validated by experts. This is used to determine the suitable safety plan.

### Table 4. Potential hazard & risk control of mobilization program.

| WBS LEVEL4 (WORK PACKAGE) | WBS LEVEL5 (WORK ACTIVITIES) | RISK FACTORS | POTENTIAL HAZARDS | FREQUENCY | SEVERITY | RISK LEVEL (FxS) | RISK CONTROL |
|---------------------------|-----------------------------|-------------|-------------------|-----------|----------|-----------------|--------------|
| Material Mobilization     | Mobilization Physic/ Mechanics | Hit when maneuvering | 2 | 3 | 6 (High) | Installation of Safety Signs Creating, Socializing, and Evaluating SOP Make A Proper Working Space Installation of Safety Signs Creating, Socializing, and Evaluating SOP Load checking |
| Heavy Equipment Overturned |                             | Heavy Equipment Overturned | 1 | 3 | 3 (Moderate) |

### Table 5. Safety plan of mobilization program.

| WBS LEVEL 5 (WORK ACTIVITIES) | POTENTIAL HAZARD | RISK CONTROL | OBJECTIVES | PROGRAM |
|-------------------------------|------------------|--------------|------------|---------|
| Material Mobilization         | Hit when maneuvering | Creating, socializing and evaluating SOP | There is no accident | Supervisory report per term of work / Safety report |
|                               |                  |              | Workers following SOP & WI | Safety officers, Supervisors, QC Engineer |
|                               |                  |              | Documents, Induction, Directions, Meetings, Trainings, Banner, Information Boards Safety Signs | |
|                               |                  |              | During work activity | |
|                               |                  |              | There is no injury to workers | |
|                               |                  |              | Supervisory report per term of work / Safety report | |
|                               |                  |              | Safety officers, Supervisors, QC Engineer | |
|                               |                  |              | There is no accident | |
|                               |                  |              | Workers following the Safety Signs | |
|                               |                  |              | During work activity | |
|                               |                  |              | There is no injury to workers | |
|                               |                  |              | Supervisory report per term of work / Safety report | |
|                               |                  |              | Safety officers, Supervisors, QC Engineer | |
|                               |                  |              | There is no accident | |
|                               |                  |              | Workers follow safety signs | |
|                               |                  |              | During work activity | |
|                               |                  |              | There is no injury to workers | |
|                               |                  |              | Supervisory report per term of work / Safety report | |
|                               |                  |              | Safety officers, Supervisors, QC Engineer | |
Research objective #4, components of safety cost as shown in Table 7. The safety cost component is identified based on Permen PUPR No. 28/2016 and SE Menteri PUPR No. 11/2019. Where safety costs divided into: general costs, special costs, and security costs. Based on SE Menteri PUPR No. 11/2019. After the component is identified, then validated by experts.

| WBS LEVEL 5 (WORK ACTIVITIES) | POTENTIAL HAZARD | RISK CONTROL | OBJECTIVES DESCRIPTION | PROGRAM | SAFETY COST COMPONENT |
|--------------------------------|------------------|--------------|-------------------------|---------|-----------------------|
| Material Mobilization          | Hit when manuevering | Creating, socializing and evaluating SOP | There is no accident | Supervisory report per term of work / Safety report | Safety officers, Supervisors, QC Engineer |
|                                |                  | Installation of safety signs | Not hit by heavy equipment | Supervisory report per term of work / Safety report | Specific Cost |
|                                |                  | Make a proper working space | There is no accident | Supervisory report per term of work / Safety report | Specific Cost |

Research objective #5, amount of safety Cost, is achieved by calculating the amount of cost of each safety component based on SE Menteri PUPR No. 21/2019, then compared with the previous project case study examples. The case study will show the percentage of the safety cost is needed from the entire value of the irrigation/channel works.

8. Conclusion

Research and analysis results obtained from this research are:

- Standardization of WBS from irrigation/channel works based on 6 levels: level 1 (Project Name), level 2 (Work Section), level 3 (Sub-Work Section), level 4: (Work Package), Alternative Methods/Design, level 5 (Activities)
- Alternative Methods/Design is not part of level WBS, but Alternative Methods/Design can determine level 5 (Activities)
- Identification of potential hazards and risk control in every irrigation/channel work activity. So the risk of irrigation/channel work can be minimized
- Safety plan based on WBS irrigation/channel works that are already risk based and developed according to Permen PUPR No. 5/2014
- Safety cost components based on the Safety Plan. These components are in accordance with Permen PUPR No. 28/2016 and SE Menteri PUPR No. 21/2019.
- The amount of safety costs on irrigation/channel projects is calculated based on several previous project case studies.

References
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