Development of Dictionary and Checklist based on WBS (Work Breakdown Structure) of Structure Works in Stadium Construction for Safety Planning

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Abstract. Stadium is a complex structure, needing sturdy structure components while also maintaining its function as a stadium. Stadium construction requires meticulous planning and calculation, as it will be used by many people simultaneously. Therefore, a certain tool is needed to assist the construction planning and control the structural work, so that every work detail can be defined in a detailed manner. The breakdown of each work into smaller work elements is important to minimize the chance of error, by using Work Breakdown Structure or WBS. This research focuses on the development of the WBS into a WBS dictionary and checklist. The research methodology applied are experts’ validation, survey and interview of respondents, as well as descriptive statistical analysis. Therefore, this research’s findings are expected to minimize errors from happening during the construction phase of a stadium structure.

Keywords: stadium, structure, work breakdown structure, WBS dictionary, checklist, safety planning

1. Introduction

Infrastructure plays an important role in order to improve the quality of Indonesian life and increase Indonesia competitiveness in the world in various sector. Based on its type, infrastructure is divided into thirteen categories, one of the category is a city park. The city park includes an open park, playground, and recreational facilities, including a stadium [1].

Stadium construction requires careful planning and calculation because stadium is a building that will be used by many people at the same time. In the development of stadium construction in the world, there are some problems found. One of the problem reported from The Dutch Safety Board and discussed on a research, on July 2011, the construction of the roof expansion of De Grolsch Veste stadium in Netherlands collapsed [2]. The accident is not separated from a bad process of construction management. Even though safety aspects must be prioritized from the construction to operational period.

Work Breakdown Structure (WBS) plays an important role in the construction project in detailing work so as to minimize the work that left behind. Failure of components or project as a whole can be caused and traced through a bad making of WBS. Poorly developed WBS can result in repetitive project planning, scope creep, unexpected cost overrun, delays in completing work, additional products or features that are less needed in the project [3].
The development of good work breakdown structure goes hand in hand with the development of WBS dictionary and checklist as a more detailed and fundamental part of WBS that has been made. An appropriate WBS dictionary and checklist will help to ensure that the project scope is taken into account and assigned to responsible individual and reduce the error potential in the execution period. The objective of this research is to identify work package, work method, activity, and resource from each sub of work of the stadium structure construction that will be arranged in the form of WBS dictionary and checklist.

2. Literature Review

2.1. Structure Works in Stadium
Stadium is a building for sports activities, including facilities for spectators, both matches and races and also for training [4]. The definition of structure based on the context of its relationship with a building is a component to distribute loads and consequences of its use and/or presence of a building into the ground [5]. There are several important works that included in the scope of stadium structure, namely earthworks, sub structure works, top structure works, tribune structure works, and roof structure works.

2.2. Safety Planning
Occupational health and safety (OHS) is conditions and factors that affect, or could affect, the health and safety of employees, temporary workers, contractor personnel, visitors or any other person in the workplace [6]. Effective safety planning with clear and measurable goals is needed in the company or project to achieve successful implementation of the OHS management system. Planning must contain objectives, targets, and performance indicators that are applied by considering the identification of the source of danger, assessment, and risk control in accordance with applicable legal requirements and conducting a preliminary review of OHS [7].

2.3. WBS Dictionary
WBS dictionary is a document in which the components of each work in the construction project will be decrypted [8]. WBS dictionary defines, breaks down, and clarifies various elements of WBS to ensure that each component of the WBS has been accurately written and can be communicated to anyone who refers to WBS [9]. WBS dictionary is almost as important with WBS itself and significantly increased the effectiveness of WBS for project management [10]. Author has discovered a WBS dictionary format that comply with the field requirements in a construction project, as it shown in Figure 1.
2.4. Checklist
Checklist is a useful tool to measure the suitability of making WBS. This checklist refers to the details of activities that exist at each WBS level from the WBS diagram, and based on the description of each activity from the WBS dictionary [11]. Author has discovered the checklist format that comply with the field requirements in a construction project and WBS dictionary, as it shown in Figure 2.

Figure 2. WBS checklist format

3. Methodology of Research
The research methods used to develop WBS dictionary and checklist of structure works in stadium construction as a base of safety planning in this study includes:

- The standardized WBS of structural works in stadium construction developed through the archive analysis, which was compiled based on benchmarking from several Bill of Quantity (BoQ) of the stadium construction projects in Indonesia.
- The making of standardized WBS was conducted by expert validation through a semi-open questionnaire. Expert validation has been done by experts with a minimum of 25 years experience in stadium construction or related projects that use WBS concept.
After each level of WBS has validated, author did another validation in order to validate the development of WBS dictionary and checklist.

By the end of study, author did an interview to find answer of several questions that related to the use of WBS dictionary and checklist in construction project.

The research methods also shown as flowchart in Figure 3 to make clear each steps that author had been through.
Figure 3. Research Methods Flowchart
4. Result and Discussion

According to the WBS dictionary format template that has been validated in the previous studies, the WBS dictionary provides detailed work information such as the WBS code, work package description, deliverables, and references also activities that are needed for the work package and the resources needed for each activity. There were no changes in the WBS dictionary that has been made after its validation to the experts. The experts gave several comments related to further use of WBS dictionary in the construction project and approve the content of the WBS dictionary. According to to experts, most of structural work methods in stadium construction project are still conventional. Rarely to be found, especially for upper structure works, using a prefabricated components in stadium construction project. There are also 22 primary work packages that needed to be done in structure works of stadium construction. The primary work packages as part of several sub of work, namely soil works, lower structure works, upper structure works, tribune structure works, and roof structure works. Figure 4 is an example of a WBS dictionary from one of the lower structure works that has been validated.

Figure 4. WBS dictionary of lower structure works in stadium construction

The format of WBS checklist in this study is a form of table which include the information of work sequences based on the level of WBS, namely level 1 to level 4 and the codes. The description in the checklist can provides explanation about definition, function, work methods, and stages of work. There were no major changes in the WBS checklist content that has been made after its validation to the experts. Figure 5 is an example of a WBS dictionary from lower structure works that has been validated.
Based on the study, tribune structure works and roof structure works are clearly complicated and major works in stadium construction. Despite the tribune structure works seemed to be repetitive like the other structure components (the tribune’s work package include plate, beam, and stairs), mistakes that made in the process of tribune structure works affected significantly to function and architectural aspects. The roof structure works also had major role in function and architectural aspects. The choice of roof frame and methods can affect the esthetical issue and the risk during the construction.

Figure 5. WBS checklist of lower structure works in stadium construction

After the WBS, WBS dictionary, and checklist of structural works in stadium construction are being validated by experts, the risk identification can be made. The correlation between WBS dictionary and checklist with safety planning is that we can easily identify risk/hazards of every WBS dictionary and checklist components since its detailed and comprehensive information compared to WBS. This condition also enhance the accuracy and time that has to be taken to identify any risk/hazard. In the process of risk identification, we have to know the possibility, severity, and impacts.

Figure 6. Hazard severity matrix
of the accidents during the project period. The assessment of possibility and severity of the accidents could be measured by using Matrix shown in Figure 6. The definition of each score in the matrix could be adjusted based on the needs.

| No | WBS Level 4 Work Package | WBS Level 5 Activity | Hazard Identification | Type of Hazard | Requirement or compliance with regulations | Initial Control | Risk Assessment | Advanced Control | Advanced Risk Assessment | Remarks |
|----|--------------------------|----------------------|----------------------|----------------|---------------------------------------------|----------------|----------------|-------------------|--------------------------|---------|
|    |                          |                      | Worker stabbed       | Labor injury    | Permenaker 01/1980                          | Use warning signs and safety equipments |                |                   | Adminstration          | NA        | NA    |
| 1  | Beam                     | Steel Reinforcing    |                      |                |                                             |                | 3              | 1                  | 3 Medium                    |         |

**Figure 7. Risk identification example of stadium construction**

Based on Figure 7, it was found that the hazard caused by steel reinforcing activity classified as medium risk since its three risk point. The initial control and advanced control of the risk had been decided based on separate studies. The form of risk identification could be vary regarding to the company standard or regulations that are used.

**5. Conclusion**

From the conducted research, conclusions that can be drawn are validated WBS dictionary and checklist of structural works in stadium construction has 22 work packages. WBS dictionary that has been made already put out several alternative work methods which theoretically possible to be done on every work package so its use on site can be adjusted. The WBS dictionary and checklist can make it easier to identify hazards for safety planning because its contents are more detailed compared to the WBS. For further use, the format and content of WBS dictionary and checklist can be developed to support aspects of time, cost, risk and quality management planning in stadium construction project.

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