

Identification of Precast Box Girder Erection Activities to Develop Work Breakdown Structure in Elevated Railway Infrastructure Project

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ABSTRACT

The railway infrastructure development is being a concern to the government of Indonesia nowadays. One of construction methods mostly applied in building the railway infrastructure is box girder erection with launching gantry. After observing several big projects with this construction method, some problems are identified. One of the problems is different work activities conducted during box girder erection. According to this situation, this research was conducted to identify precast box girder erection activities to develop work breakdown structure. The Work Breakdown Structure (WBS) will enhance the efficiency and effectivity of similar projects in the future. To conduct the analysis, there are three steps to be executed. They are archive analysis, expert judgement and surveys. For archive analysis, two big projects are observed and compared. Secondly, the judgements are obtained from five experts who have fulfilled more than ten years working experiences especially in public infrastructure construction. Thirdly, the direct surveys were held to thirty elected respondents regarding this topic. Finally, the descriptive analysis was applied to draw the result. This research conveys the WBS which has been developed according to aforementioned analysis method. There are 13 identified activities. They are preparation, box girder transportation, box girder lifting, position setting, epoxy gluing, temporary PT bar stressing, alignment surveying, PC stand and accessories installment, permanent stressing, patching, grouting and bearing installation re-surveying. This WBS is necessary to be used as a reference standard for future similar projects.

Keywords: *Activities, Box Girder, Erection, Work Breakdown Structure, Railway, Infrastructure.*

1. INTRODUCTION

The government of Indonesia currently concern with railway infrastructure development. The commencement of Mass Rapid Transit construction in Jakarta has been a new milestone in railway infrastructure construction in Indonesia. The construction phase was begun in 2013 and completed in 2019 [1]. After that milestone, there were so many other train infrastructures had been started, such as the LRT Jakarta, the Jakarta Double Double Track, high speed rail and LRT development plans in other major cities in Indonesia. According to President rule in 2017, 15 intercity railway projects and 8 intra city railway projects are included in the national strategic infrastructure project acceleration in all around Indonesia [2].

Railway infrastructure is mostly built using the box girder with launching gantry method nowadays. Differences in work activities on segmental box girder erection are problems for future similar projects. Though, in guiding the construction process effectively and meeting project requirements, detailed activities are required [3] hence it should not be any differences.

Activities are things that the project team does to achieve project goals [4]. A construction project cannot be separated form a series of tasks or activities [5]. The complex level of activity is generated by work breakdown structure [6] or work breakdown structure is used to define project activities [5].

Girder erection work had been studied in previous research. However, the previous research was only

explained precast concrete highway bridge work breakdown structure and precast girder erection generally [7] with no specific materials and methods. And another research explained about PCI girder erection with double crane method [8] and launching gantry method [9]. Whereas, a different construction method in work package level will determine different activities [10]. The research about activities on box girder erection with launching gantry method in elevated railway has not been conducted before even though this is very important since there will be a lot of elevated railway infrastructure projects to be constructed in recent time.

It is very important to do research in identifying activities of precast box girder erection in railway infrastructure project. In the line with urgency, the purpose of this research is to identify activities of precast box girder to develop work breakdown structure in elevated railway infrastructure project by conducting archive analysis, asking the experts and surveying respondents. This research can develop activities which will complement the standardized work breakdown

structure that has been developed in several previous research. Hopefully, the result of this research can become a standard reference for future similar projects even though each construction project is unique and has its own characteristics, but mostly they are almost similar and possible to be standardized [7].

2. METHOD

There are three steps to answer the research question. The first step is to analyze the archives and create a comparison table of the observed project samples. The projects observed are international and national railway infrastructure projects in Indonesia. The Mass Rapid Transit (MRT) CP 103 Elevated section and Double Double Track (DDT) Manggarai - Jatinegara project will become samples in this study. The second step is to ask for experts' judgment according to PMI [11] or in other words experts' validation (see Table 1.). The final step is to conduct a survey of 30 respondents who are considered to have the capacity and competence in the construction of box girder bridges and elevated trains.

Table 1. Expert profile

No	Expert	Position	Working Experience	Education
1	Expert 1	Project Manager	20 Years	Master Degree
2	Expert 2	Project Manager	17 Years	Master Degree
3	Expert 3	Site Manager	14 Years	Bachelor Degree
4	Expert 4	Site Manager	12 Years	Bachelor Degree
5	Expert 5	Engineering Manager	10 Years	Bachelor Degree

Descriptive analysis was applied to know the opinion from experts and respondents. Their opinions were "yes" or "no" opinion based on Guttman scale applied to the questionnaire which were distributed [12]. After

finishing data analysis, the latest process was to develop wbs tree diagram which explains more detail about box girder erection activities. Table 2 show comparison of box girder erection activities.

Table 2. Comparison of box girder erection activities

No	Activity		
	MRT CP 103 Project	Double Double Track Project	LRTJ Project
1	Delivery Box Girder	Delivery Box Girder	Delivery Box Girder
2	Hanging Up Segment	Hanging Up Segment	Hanging Up Segment
3	Setting Position	Setting Position	Setting Position
4	Gluing Works	Gluing Works	Gluing Works
5	Temporary PT Bar Stressing	Temporary PT Bar Stressing	Temporary PT Bar Stressing
6	Survey Alignment	Survey Alignment	Survey Alignment
7	Installing PC Strand and Accessories	Installing PC Strand and Accessories	Installing PC Strand and Accessories
8	Permanent Stressing	Permanent Stressing	Permanent Stressing
9	Patching Works	Patching Works	Patching Works
10	Grouting Works	Grouting Works	Grouting Works
11	Re Survey for Bearing Installation	Re Survey for Bearing Installation	Re Survey for Bearing Installation (Geometric Control Check)

3. RESULT AND DISCUSSION

3.1. Results

The result of analysis show that there are 11 activities in precast box girder erection work. Starting from

delivery box girder, lifting box girder segment, position setting, epoxy gluing works, temporary PT bar setting, alignment surveying, installing PC strand and accessories, permanent stressing, patching work, grouting work and the latest is resurveying for bearing installation. Table 3 show the results of data analysis.

Table 3. Results of expert judgment

No	Validated Activity	Expert Judgement		
		Yes	No	Conclusion
1	Delivery Box Girder	100.00%	0.00%	Yes
2	Lifting Box Girder Segment	100.00%	0.00%	Yes
3	Position Setting	100.00%	0.00%	Yes
4	Epoxy Gluing Works	100.00%	0.00%	Yes
5	Temporary PT Bar Stressing	100.00%	0.00%	Yes
6	Alignment Surveying	100.00%	0.00%	Yes
7	Installing PC Strand and Accessories	100.00%	0.00%	Yes
8	Permanent Stressing	100.00%	0.00%	Yes
9	Patching Works	80.00%	20.00%	Yes
10	Grouting Works	100.00%	0.00%	Yes
11	Resurveying for Bearing Installation	100.00%	0.00%	Yes

Almost all experts agree with the activities shown. It can be seen from table above that the total percentage of expert to agree is greater than 80%. However, some experts add suggestions by adding “preparation” activity at the beginning and “finishing” activity at the end. Thus, in the next stage the two activities are added to the survey and data analysis.

After finishing the data analysis from expert judgement, the respondent survey is conducted. There

were 30 respondents who were asked about their opinions regarding the box girder erection activities. Respondent categories are consisting of education, position and experience. There are 26 respondents who had bachelor degree, 2 respondents had master degree and 2 respondents had diploma degree. Most respondents are managers who are practitioners in their fields. And most respondents have 10 – 15 years work experience. The detail respondent category is shown in Table 4.

Table 4. Respondent category

No	Education	Total Sample	Position	Total Sample	Experience	Total Sample
1	Diploma Degree	2	Manager	26	10 - 15 Years	21
2	Bachelor Degree	26	Assistant Manager	1	16 - 20 Years	8
3	Master Degree	2	Staff / Engineer	3	> 20 Years	1
Total Sample		30		30		30

According to table 5 below, the total percentage of respondents to agree is greater than 90%. It means that almost all respondents agree with the activities which were asked in questionnaire. Additionally, preparation and finishing work activities which were proposed by the experts were also agreed by the respondents. Only two activities which have percentage of agreeing below than 100%. They are Position Setting and Patching Works. Although those two activities agreeing percentage is below than 100%, it still show more or equal to 90%. It means the activities are not having problem to be validated. The detail results of analysis are available in Table 5.

3.2. Discussion

Activities are important things to achieve project goals [4]. Activities are identified hence the project team can manage their project easily [13]. In standardized work breakdown structure, activity is level 5 after project name (level 1), work section (level 2), sub work section (level 3), and work package (level 4) [7]. In this case, box girder erection is at level 4 or work package level. The level of Box girder erection work package is developed by identifying activities under its level. The launching gantry method is also a determinant in activity identification because different construction method in work package level will determine different activities [10].

Table 5. Results of respondent survey

No	Validated Activity	Respondent Survey		
		Yes	No	Conclusion
1	Preparation	100.00%	0.00%	Yes
2	Delivery Box Girder	100.00%	0.00%	Yes
3	Lifting Box Girder Segment	100.00%	0.00%	Yes
4	Position Setting	93.33%	6.67%	Yes
5	Epoxy Gluing Works	100.00%	0.00%	Yes
6	Temporary PT Bar Stressing	100.00%	0.00%	Yes
7	Alignment Surveying	100.00%	0.00%	Yes
8	Installing PC Strand and Accessories	100.00%	0.00%	Yes
9	Permanent Stressing	100.00%	0.00%	Yes
10	Patching Works	90.00%	10.00%	Yes
11	Grouting Works	100.00%	0.00%	Yes
12	Resurveying for Bearing Installation	100.00%	0.00%	Yes
13	Finishing Works	100.00%	0.00%	Yes

According to the analysis results, the activities consisting of 13 activities starting from preparation, delivery box girder, lifting box girder segment, position setting, epoxy gluing works, temporary PT bar setting, alignment surveying, installing PC strand and accessories, permanent stressing, patching work, grouting work, resurveying for bearing installation and finishing work.

These activities are sequential activities according to a predefined construction method using the launching gantry. In other words, this sequence of activities can also be called the "span by span" method. Figure 1 shown detailed activities of box girder erection work in wbs tree diagram.

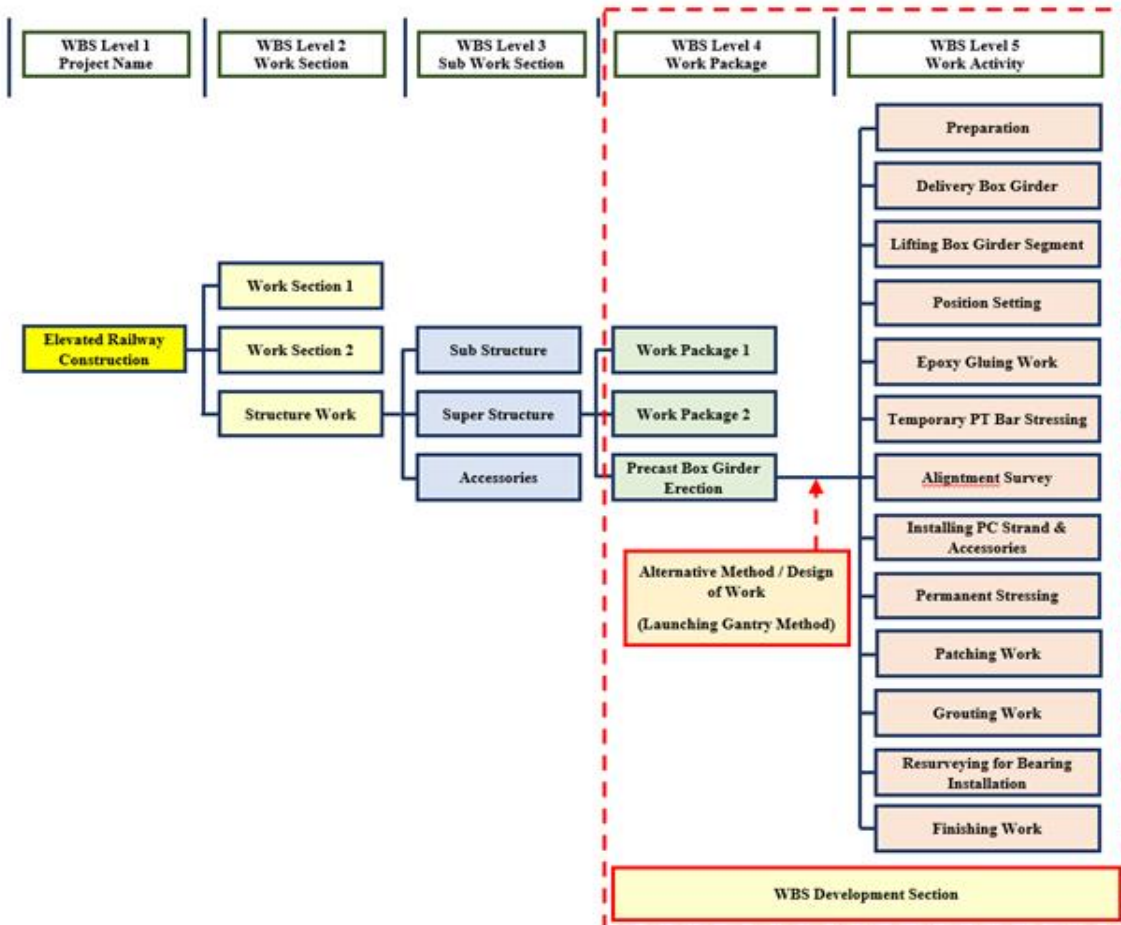


Figure 1 Detailed activities of box girder erection work in wbs tree diagram

The complex level of activity is generated by work breakdown structure [6] hence the identified activities are depicted in a work breakdown structure tree diagram in figure 1. above. In the diagram above, it can be seen that there is a work breakdown structure development starting from level 4 to level 5. This work breakdown structure development shows hierarchical levels ranging from general to specialized and complex, according to its definition [11]. Based on its function, this work breakdown structure is important thing to manage project scope [14], time or schedule, cost estimation, human resources, communication, risk, supervision, monitoring and control [11]. Thus, it will be useful for future similar project.

4. CONCLUSION

There are 13 activities in box girder erection starting from preparation, delivery box girder, lifting box girder, position setting, epoxy gluing work, temporary PT bar stressing, alignment surveying, installing PC strand and accessories, permanent stressing, patching work, grouting work, resurveying for bearing installation and finishing. The detailed activities on the precast erection box girder can be included as part of work breakdown structure and can be used as a reference standard for future similar projects. The results of this research can be developed into further research to calculate cycle times for erection girder, development of standard operational procedure of erection girders, development of safety plans, quality plans and building information management (BIM) integration.

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