Development of risk-based standardized work breakdown structure for quality planning of airport construction project

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Abstract. Airport project construction can be successful if the definition of project scope in accordance with the requirements. Although each airport project is unique, it can be standardized in their activities to enable the provision of a stronger forecast for project management. In fact, Airport project construction in Indonesia are still many that are not in accordance with the planning in terms of quality so that can affect the quality of the project. In consequence, the development of risk-based WBS (Work breakdown Structure) is proposed. The objective of the study was to develop risk-based WBS standard for airport project that can be a reference in airport construction projects to achieve project quality. The research consisted of several stages with qualitative risk analysis method. The methodology used is expert validation, respondent survey and interview and analyzed using risk analysis. The results of this study are WBS standards, implementation methods, activities, risks, and quality planning using risk-based WBS standards.

1. Introduction

Since its beginning in the early twentieth century, civil aviation has become one of the most fascinating, important, and complex industries in the world. The civil aviation system, particularly its airports, has come to be the backbone of world transport and a necessity to twenty-first-century trade and commerce. The magnitude of the impact of the commercial air transportation industry on the world economy is tremendous, contributing more than $2.6 trillion in economic activity, equivalent to 8 percent of the world gross domestic product, and supporting 29 million jobs [1]. PT Angkasa Pura II (Persero), state-owned airport services company operating in western part of Indonesia state that Soekarno-Hatta International Airport received 63 million airline passengers throughout 2017, up by 8 percent from 58.2 million in 2016. The number of international-bound passengers jumped to 14.71 million. This was a 12 percent increase from 2016, the airport wrote in a press statement. Meanwhile, the number of domestic passengers also increased by 7 percent to 48.3 million. In line with the rise in passenger numbers, aircraft movements also went up by 8 percent to 447,390 [2]. In an airport project that is so complex, compliance with quality specifications is very important. An airport every day serves thousands of passengers who use their services in need of a good construction quality standard so that service to passengers is not disrupted. Construction activities are highly predictable and there are consistent rules that governs the selection of activities, so it is feasible to develop standard activity [3].

Regarding project quality performance, compliance with quality specifications is an important measurement of the performance of each construction project [4]. If the conformity of specifications is
not achieved then rework will appear or work something more than once due to incompatibility with the request [5]. Measurements of the level of rework can be used by management to assess how quality has been managed and to identify problem areas within a construction organization [6]. To overcome or avoid problems as above, in realizing the achievement of a successful project, good project management is needed. Particularly in the construction of airports, a detailed item of work is needed in detail so that during the construction period it can be carried out properly. One of the most basic things in planning or controlling the quality of a project, is either using the WBS (Work Breakdown Structure) analysis method. WBS is a breakdown of deliverable and project works into smaller components so it can be better managed and measured against the ultimate completion [7]. The WBS organizes and defines the total scope of the project, and represents the work specified in the current approved project scope statement. Instead of developing WBS for each project, it is sometimes appropriate to develop a general WBS for typical project, then the necessary segment can be modified. It is suitable for organizations which perform similar projects [8]. The planned work is contained within the lowest level of WBS components, which are called work packages. The planned work is contained within the lowest level of WBS components, which are called work packages. A work package can be used to group the activities where work is scheduled and estimated, monitored, and controlled [9]. So that the WBS of the Airport Construction work can be defined as a hierarchical description / decomposition of work in the construction of the airport with the results measured from each detail of the work package in the project up to the details of material, labor and equipment resources, which can be measured and controlled by project team to achieve project objectives. The WBS standardization framework is also recommended to support integrated planning and supervision [10].

The foundation in forming WBS is the project requirements which if done will produce deliverables that are in line with the expectations of all stakeholders [11]. Initial input for the development WBS of airport is done by reviewing the regulations in the form of guidelines related to the implementation of airport construction such as Peraturan Menteri Perhubungan No. PM 69 tahun 2013 tentang Kebandarudaraan Nasional, Undang – Undang No. 1 Tahun 2009 tentang Penerbangan, Surat Keputusan Menteri Perhubungan No. KM 48 tahun 2002 tentang Penyelenggaraan Bandar Udara Umum, Peraturan Pemerintah No. 70 tahun 2001 tentang Kebandarudaraan, Peraturan Menteri Perhubungan No. PM 77 tahun 2013 tentang Standarisasi dan Sertifikasi Fasilitas Bandar Udara, Peraturan Rirektur Jenderal Perhubungan Udara KP 590 Tahun 2014 tentang Pedoman Teknis Pembuatan rencana Induk bandar Udara, Surat Keputusan No. 347 Tahun 1999 Tentang Standar Rancang Bangun dan/atau Rekayasa Fasilitas dan Peralatan Bandar Udara, to see the structure of airport components, FAA (Federal Aviation Administration) Advisory Circular no 150/5370-10G, Law No. 1 of 2009 on Aviation and various Bill Of Quantity of airport construction projects.

The output of the WBS manufacturing process is a work package, which is a collection of related work that lies in the lowest structure of the work details, making it easy to control by the project team. Based on these matters, it is necessary to develop WBS standardization on risk-based airport works for quality control. So the research objective in this study are to create WBS standards for airport, to identify the risk that come from work packages, activities and resources that affect the quality performance of airport construction work, to develop of risk-based WBS standards used to develop quality plans for airport construction work.

2. Research method

This research was conducted with a qualitative approach to answer the research objectives. Surveys and interviews were conducted using a structured questionnaire for airport construction experts with more than 20 years of experience. The research flow diagram can be seen in Figure 1.
3. Results and discussion

3.1. Standardization WBS of airport project (RQ1, RQ2, RQ3, RQ4)
Based on a literature review on airport construction and 10 (ten) previous project data it was found that airport construction work was categorized into 6 (six) facilities, that is airside facilities which consist of Runway, Taxiway, Apron, RESA, Stopway, Clearway, Visual Landing Equipment, Markings and Signs. Aviation Communication Facility which contains Aviation Communication System Equipment. Flight Navigation Facility that contains the Aviation Navigation System Equipment. Landside Building Facilities containing Passenger Terminal Buildings, Cargo Terminal Buildings, Aviation Operational Buildings, Air Traffic Control Towers (ATC), Meteorological Systems, Access Roads Depots on Airfuel Refueling, Administrative Buildings and Offices, Parking of motorized vehicles, Markings and Signs, Power House, Pump House and Water Tank, Waste Processing Building, Clean Water Supply System Equipment, Electrical Energy Supply System Equipment. Airport Support Facilities. Each of these categories has a WBS. In Figure 2, one of the occupational categories is shown, namely the Runway.

Figure 1. The research flow diagram.
Figure 2. Work breakdown structure diagram.

Level 1 is for the project name, level 2 is the Work Section which consists of Drainage, Earthwork, Widening and shoulder pavement, Grained and cement concrete pavement, Hotmix Pavement, Other Work, Rework and Maintenance. Level 3 is the Work Sub-Section. Level 4 is a Work Package which consist of prime coat/ tack coat and hot mixed asphalt. Level 5 is an Activity and level 6 is a resources which consist of material, equipment and labour.

3.2. To answer RQ 2
Project risk management is a systematic process of project risk identification, analysis, response, and control. Risk management is aimed at increasing the probability and / or impact of positive risks and to decreasing the probability and / or impact of negative risks in order to optimize the project’s success [12]. In risk management, risk assessment is very influential in determining the consequences or exposure of potential hazards, because through risk assessment, the accident can be prevented or eliminated [12]. Therefore, to be able to identify risks, the categorization of WBS starts from the Work Package, Method / Design, Activity, Material Resources, Tools, and Labor as well as the environment as a category of risk events that can affect the objectives of quality performance. Identify any potentially hazardous risks in airport construction obtained from literature studies that are then verified, clarified and validated for content and constructs to experts. Experts are asked whether they agree or disagree with such risk factors and input on each of the risk factors, impacts and causes. In addition, experts are required to provide additional risk factors. Once the probability and impact are determined, the risk score can be calculated by following:

\[ R = P \times I \]

Where \( R \) = Risk Factor, \( P \) = Probability and \( I \) = Impact

| Risk Variables That Affect Project Performance | score | Rank | Level of risk |
|---------------------------------------------|-------|------|---------------|
| X50 Workers are not ready for new methods    | 0.176 | 1    | High          |
| X6 Misunderstanding in reading pictures      | 0.172 | 2    | High          |
| X21 Control and monitoring of projects with high complexity is not good | 0.169 | 3    | High          |
| X33 The quality of the material used is not in accordance with the planning specifications | 0.168 | 4    | High          |
3.3. To answer RQ 3
To develop risk-based standardized WBS, the highest ranked risk variables are analysed for their preventive and corrective actions through pattern recognition. In order to avoid mismatch with the quality planning which can cause cost and time overrun, and dissatisfaction from the project’s stakeholders it is important to control the quality of project work [13]. Quality in the projects is on the one hand about ensuring the right quality intermediate services or products delivered specific to the project. On the other hand, it is about ensuring that quality processes are well implemented throughout the project. A quality plan must determine all procedure and measurement (tests, inspections, etc.) to assess progress towards goal requirements [12]. WBS can be used as a planning approach to improve project performance, the practice was reported to reduce rework on quality performance mostly associated with reduced change of scope on work, and increased control on site for industrial construction projects [14]. The purpose of managing the quality is to plan and guarantee the quality requirements and standards applicable to the project and project deliverable. Planning of the quality includes determining and agreeing with the project sponsor/owner and other key stakeholders on the quality objectives to be achieved. It includes defining indicators and setting quality target values for those indicators in the project at hand. It includes the monitoring and assessment of the tasks defined in the plan and closing the quality tasks, like all others in the project [15]. Result of the risk responses is used to develop the standardized WBS. There are some experts interviewed using questionnaire. Not every risk responses can be adopted directly into related WBS structure. Risk-based standardized WBS can be utilized for quality planning, to help project executor identifies project works to the smallest items and set quality objective for each items in greater accuracy as a tool to ensure every work has considered the requirements to respond quality-related risks.

| No. | Action | Category | Recommendation | Action | Category | Recommendation |
|-----|--------|----------|----------------|--------|----------|----------------|
| X49 | Qualifications and workforce specializations are not according to planning | 0.168 | 5 | High |
| X36 | Bad tool condition | 0.164 | 6 | High |
| X47 | Labor productivity is lower than needs | 0.160 | 7 | High |
| X44 | Lack of expert workers (technical personnel) in the field | 0.160 | 8 | High |
| X32 | Error in material use | 0.160 | 9 | High |
| X43 | Supervisor are less experience | 0.157 | 10 | High |

4. Conclusion
Based on the process of making this WBS standard of the airport can be concluded that this construction work is categorized into 6 (six) facilities, that is air facilities which consist of Runway,
Taxiway, Apron, RESA, Stopway, Clearway, Visual Landing Equipment, Markings and Signs. Aviation Communication Facility which contains Aviation Communication System Equipment. Flight Navigation Facility that contains the Aviation Navigation System Equipment. Land-side Building Facilities containing Passenger Terminal Buildings, Cargo Terminal Buildings, Aviation Operational Buildings, Air Traffic Control Towers (ATC), Meteorological Systems, Access Roads Depots on Airfuel Refueling, Administrative Buildings and Offices, Parking of motorized vehicles, Markings and Signs, Power House, Pump House and Water Tank, Waste Processing Building, Clean Water Supply System Equipment, Electrical Energy Supply System Equipment. Airport Support Facilities. WBS airport standard for each category work divided into 6 Level, Level 1: Project Name, Level 2: Work Section, Level 3: Sub Work Section, Level 4: Work Package, Level 5: Activity and Level 6: Resources. Risk-based standardized WBS can be used for quality planning. With development that considers risk response, it produces risk-based WBS in addition to the WBS structure. Furthermore, it can also be a control tool to ensure that work has considered the requirements to respond risks related to its quality. The benefit of developing the WBS standard for quality planning is to ensure that no work items are missed until the smallest part of the process of identifying and setting quality targets in quality planning.

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