Development of Dictionary and Checklist Based on WBS (Work Breakdown Structure) of Air Side Facilities in Airport Construction Works for Quality Planning

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Abstract

The air side facilities in airport construction works consist of a series of complex works so needs many procedures in planning stages to fulfill the standardization, requirement, and user expectation. Therefore, the planning for air side facilities in airport construction works should be built detailed to make the job assignments become more structured and clear in fulfilling various criteria that have determined by breaking down the work into important work elements by using a Work Breakdown Structure (WBS). This research aims to development of dictionary and checklist based on WBS and to know dominant risk factors that influence on project quality performance. The methodology used was expert validation with interviewed using questionnaire and then analyzed using descriptive statistics with mode data characteristics and non-parametric inference statistics (Kendall's Tau Method). The results of this research indicate WBS dictionary and checklist for air side facilities in airport construction works consisting eight dominant risk factors on the performance of project quality hat can provide preventive and corrective actions as a risk response to produce project scope requirements (description, deliverables, and acceptance criteria) as well as a list of stakeholders responsible for overcoming negative impacts will happen.

Keywords
Air side facilities in airport construction works, Work breakdown structure, WBS dictionary, Checklist and Quality planning

1. Introduction

The economic growth increasing the development of infrastructure including the air transportation. If this is not anticipated as early as possible, it can be worrying because it will cause an imbalance between the facilities and the available and adequate infrastructure. Aiport is one example of infrastructures that plays an important role in an air transportation system. The work of an airport is included in the high risk category with a complex work activities which are limited by time and selection of appropriate work methods. Effective project management of these complex work activities depends on the development of WBS (Work Breakdown Structure) (Perry and Hayes 2015). WBS becomes an important part of project planning, begins with a hierarchy of tasks that can help identify and define tasks on projects within a designed timeline (Devi and Reddy 2012). Therefore, the project must be decomposed into WBS because the scope of work on the project can be defined and detailed into important components to be controlled. It can prevent delays in project results and helps in clarifying tasks so that they are always focused on the project objectives (Project Management Institute 2017).

If the results of the construction work do not meet the standards, requirements, or user expectations, the work must often be reworked which can affect the performance and productivity of the construction project (Alwi et al. 2002). Rework is the process of correcting and re-completing items to fit the original requirements that have been set at the planning stage. To manage rework, the first thing to do is identify and classify the causes (Hwang et al. 2009). So the rework carried out has an influence which always leads to a budget that can exceed limits and deadlines will be exceeded from the schedule that was set at the beginning of the project. There have also been several cases as a result of rework that will have an effect on various other aspects such as loss of reputation (Kumar and Swain 2011).

The cause of problems in the field work that has an impact on the quality of the project is the lack of planning on work activities including work methods related to resources (labor and equipment). Existing planning becomes

unstructured and assignments also become unclear in fulfilling all the criteria specified in the project scope while the actual planning is made to achieve high effectiveness and efficiency of the use of resources to be used during the duration of project implementation in order to obtain costs and time optimal project but still with quality that matches the criteria. This lack of planning is related to WBS components that have not been well-defined or developed poorly or even don't exist. Even though, the use of WBS can provides important input to the project management process, such as defining activities, scheduling projects, and analyzing the risks that might occur so that the planning stages become more structured (Eric et al. 2008).

A WBS certainly needs to be supported by documents in the form of a WBS dictionary and checklist. The WBS dictionary is a document that can also provide details on each work package relating to work methods, activities, and scheduling information on each component contained in WBS (Palaneeswaran 2006). The WBS dictionary is continuously described along with the planning process. Among the information in the WBS dictionary can include: account identification code, description of work packages, assumptions and constraints, organization or person responsible, milestone list, schedule of activities, resource requirements, cost estimates, quality requirements, acceptance criteria, technical information or references, and agreement information. Each WBS item needs to be documented in the WBS dictionary to ensure an accurate understanding of the scope of work (Project Management Institute 2006). The checklist is a tool that functions to measure the suitability between WBS that contains inspection guidelines from each level of WBS but only to the work package. This check refers to the breakdown of activities that exist at each WBS level from the WBS diagram and based on the description of each activity in the WBS dictionary (SU 2012).

2. Literature Review

2.1 Air Side Facilities in Airport Construction Works

The air side in airport is part of the airport with all supporting facilities that are not non-public areas and means that every person, goods, or vehicle that enters it is required to conduct a security check or have a permit. These facilities include runways, taxiways, aprons, and other facilities such as access road, vehicle parking, GSE (Ground Support Equipment) and visual landing aids (Airfield Lighting System) that related to the safety, security, and smoothness of aircraft flights during takeoff. The air side facilities in airport need to be built and maintained to serve arrivals, departures, movements including aircraft ground services in order to move efficiently (Horonjeff 2010).

2.2 Work Breakdown Structure (WBS)

WBS is a total decomposition of the work scope in a hierarchy to achieve project objectives. WBS levels are decomposed into smaller components named work packages and provide various component relationships to project work. Besides that, WBS provides a framework for what needs to be done and becomes more manageable (Palaneeswaran 2006). Work packages that are the lowest level of WBS can provide appropriate details and focus to support the project management process, such as developing schedules, cost estimates, resource allocation, and risk assessment (Haugan 2013). If WBS is not well formed, it can produce adverse project outcomes such as the project definition being incomplete, assignments, goals, objectives, or work results being unclear, project scope often changes, exceeds the budget limit, and missed deadlines. Among the initial steps to get the components that will be input in the preparation of WBS are plan and define scope, gather requirements, and identify companies more specific (Postula 1991).

2.3 Quality Performance

Quality performance is the result of performance attributes on a job in meeting all needs to be achieved for an acceptable period of time. Therefore, effective quality management is needed to communicate that focuses on customer satisfaction throughout the organization. The main activity that needs to be carried out in quality management is quality planning. In quality planning activities are needed to anticipate the situation and prepare various actions to produce everything that has been predetermined (Palaneeswaran 2006).

2.4 WBS Dictionary

The WBS dictionary is a document that provides detailed information about each work package in WBS by creating a summary description of each work package in WBS to make it easier to understand when completing work. It helps identify and explain each work package (the lowest level) in WBS and then minimizes the existence of scoop creep (additional scope or uncontrolled changes in the project scope) as a result of the weak definition of the project's

scope (Postula 1991). The WBS dictionary is described progressively as the planning process. This means that the WBS dictionary is the result of iteration techniques in the planning process (Palaneeswaran 2006).

2.5 Checklist

A checklist is a structured tool that verifies a series of activities required to complete a job have been completed. In other words the checklist is used to ensure the project that the project has completed activities related to Work Breakdown Structure (WBS). The checklist explains the complexity of all work to be done to reduce the uncertainties that often occur in projects and there is no work left to do (Palaneeswaran 2006).

2.6 Risk Factors on WBS Dictionary and Checklist

Risk is considered as an unfavorable probability in decision making. In construction project, risk will be apparent at all stages of the project life (Perry and Hayes 2015). If these risk factors occur, then it can cause the project objectives are not achieved so it needs to manage risk throughout the project implementation process. In managing the risk of a construction project it is necessary to determine risks based on their type and group them into groups. This is called risk identification. Early risk identification ensures that efforts can be concentrated in critical areas and focus the project's attention on key risk exposures (Kumar and Swain 2011).

3. Research Methodology

To identify the standardized WBS of air side facilities in airport construction works, the data were collected from standard specifications, regulations (primary data), and airport project data reports in Indonesia and abroad (secondary data) which produced WBS consisting of 6 levels. The result was validated to 3 competent experts in the field of airport construction works with a minimum of 25 years of work experience using checklist questionnaire then analyzed using descriptive statistics (mode characteristics) to produce a standardized WBS.

The standardized WBS that has been obtained will then be input in creating a WBS dictionary and checklist according to the template. The WBS dictionary is based on each work package of air side facilities in airport construction works, while checklist is made for each different work division. The WBS dictionary and checklist will also be validated to the same 3 competent experts as WBS validation and analyzed using descriptive statistics (mode characteristics).

However, there are standardized WBS levels included in the supporting documents, which are WBS dictionary and checklist that need to be controlled in relation to project performance, that is risk, such as at the level of work packages related to implementation methods, activity level, and resources level (material, labor, tools). The risk identification derived from each WBS level (work packages until resources) and the variables were obtained from literature analysis then rating scale questionnaires were distributed to 10 respondents with a minimum of 5 years experiences in the ai side facilities of airport construction works. The data obtained will be analyzed using non-parametric inference statistics (Kendall's Tau Method) with SPSS *software* to produce a dominant risk factor in the WBS dictionary and checklist that can affect the quality performance.

4. Data Analysis

4.1 Standardized WBS of Air Side Facilities in Airport Construction Works

Work package is the lowest level of WBS. But this decomposition process can continues to an appropriate level so that project management is achieved. The level of decomposition can vary depending on the level of maturity of the project organization in producing final results. The team must ensure that all work that must be completed on the project has been identified and accounted (Eric et al. 2008).

Because of the air side facilities in airport construction works consist of several building constructions, the WBS level starts from 0 which contains the name of the project that is the air side facilities in airport construction works then proceed with WBS level 1 until level 6. So, the standardized WBS level based on the results of the validation from 3 competent experts consists of:

1. Level 0: Project Name
2. Level 1: Sub-project Name
3. Level 2: Work Division
4. Level 3: Sub of Work/ Section
5. Level 4: Work Package
6. Level 5: Activity
7. Level 6: Resources

The air side facilities in airport construction works were categorized into 7 facilities (sub-projects) that consist of access road, runway, taxiway, apron, airfield lighting system, motorized vehicle parking, GSE and perimeter road. The example of WBS from one of the sub-projects such as taxiway can be seen in Figure 1 below.

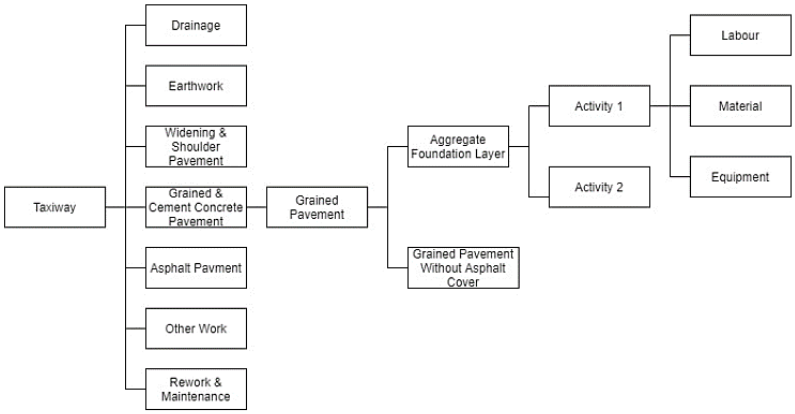

Figure 1. WBS of Taxiway (Air Side Facilities in Airport Construction Works)

4.2 WBS Dictionary of Air Side Facilities in Airport Construction

An appropriate WBS dictionary must also be developed in support of the WBS created for the project. The WBS Dictionary can defines, details, and clarifies the various elements of the WBS. This will provides critical information for everyone in the project (Eric et al. 2008).

The first validation was carried out for 3 competent experts is the WBS dictionary format and the second one is the content of the WBS dictionary itself. Each work package of the air side facilities in airport construction works were described in the form of this layout as in Table 1 below.

Table 1. Validated WBS Dictionary of Air Side Facilities in Airport Construction Works - Example

WBS DICTIONARY OF AIR SIDE FACILITIES IN AIRPORT CONSTRUCTION

GRAINED PAVEMENT

Agregate Foundation Layer

D	Sub of Project	:	Taxiway
D.5	Work Division	:	Grained and Cement Concrete Pavement
D.5.1	Sub of Work/ Section	:	Grained Pavement
D.5.1.1	Work Package	:	Agregate Foundation Layer
	Person in Charge	:	
	Deskripsi	:	Work which includes supplying, processing, transporting, laying, wetting and compaction of aggregates on prepared and received surfaces in accordance with the details shown in the drawings or in accordance with work directors' orders and maintaining the finished aggregate foundation layer as required
	Deliverable	:	Agregate Foundation Layer
	Reference	:	1. BOQ 2. RKS/ Material Specification Document 3. Expert Validation

Code	Activity	Resources		
		Labour	Material	Equipment
D.5.1.1.1	Material procurement	1. Foreman 2. Workman	1. Base A aggregate (according to spec.) 2. Base B aggregate (according to spec.)	Tools
D.5.1.1.2	Making gutters and drains	1. Foreman 2. Workman	1. Brick 2. Cement 3. Sand	Tools

Some of the findings obtained in the WBS dictionary are based on the results of validation:

1. In airport project preparation work, it consists of a variety of work packages including preparing project work plans, topographic studies and soil tests, field technical studies, etc.
2. In airport project preparation work, there are many activities related to direct costs and indirect costs
3. On access roads and parking of motorized vehicles will utilize the land contained in the existing land if it is only made for the development of the existing airport
4. In runway, taxiway, apron, GSE and perimeter road work, the most labor-intensive work is pavement before asphalting because each layer of pavement must be safe enough to ensure the work load of the aircraft will not damage the pavement underneath
5. In airfield lighting system work, installation, placement, and configuration of equipment for airport lighting installation systems must comply with applicable international and national standards.

4.3 Checklist of Air Side Facilities in Airport Construction Works

The checklist validation produces a format that consists of breaking down each level of WBS, starting from the name of the sub-project, work division, sub of work, to the work package. This is useful for measuring the suitability of WBS by including inspection guidelines that refer to details at each level of WBS (Haugan 2002).

Same as the WBS dictionary, the first validation was carried out for 3 competent experts is the checklist format and the second one is the content of the checklist itself. In the end, the final results obtained as in Table 2 below.

Table 2. Validated Checklist of Air Side Facilities in Airport Construction - Example

CHECKLIST OF AIR SIDE FACILITIES IN AIRPORT CONSTRUCTION
GRAINED AND CEMENT CONCRETE PAVEMENT

WBS Level 1 : Sub of Project
WBS Level 2 : Work Division
WBS Level 3 : Sub of Work/ Section
WBS Level 4 : Work Package

WBS LEVEL	CODE	DESCRIPTION	
1	D	Taxiway	Name of sub-project being worked on
2	D.5	Grained and Cement Concrete Pavement	Grained Pavement and Concrete Pavement include Grinding Pavement and Cement Concrete Pavement Work
3	D.5.1	Grained Pavement	In grained pavement work consisting of aggregate material that has been selected from an approved source material in accordance with technical specifications.
4	D.5.1.1	Agregate Foundation Layar	Work which includes supplying, processing, transporting, laying, watting and compaction of aggregates on prepared and received surfaces in accordance with the details shown in the drawings or in accordance with work directors' orders and maintaining the finished aggregate foundation layar as required
4	D.5.1.2	Grained Pavement without Asphalt Cover	Work includes supplying, transporting, laying, and compacting the material for a temporary surface layer on the surface of the subgrade or prepared underfloor and road foundation layers without asphalt cover. The supply of materials will include, if necessary, breaking, sifting, mixing, and operating to obtain materials that meet the requirements of the specifications

Some of the findings obtained in the checklist are based on the results of validation:

1. In airport project preparation work, the type of site facilities work is only temporary because these facilities are needed during the period of work following the maintenance of cleanliness and will be demolished if there is an order to dismantle after the work is completed
2. The description of access road and parking of motor vehicles work are sufficiently concise, concise and clear so that it is easier to understand. The work is not as complex as other jobs because it does not require planning for the application of pavement that needs to be carried out by special review
3. The description of runway, taxiway, apron, GSE and perimeter road work are made in detail because there is a need for special reviews relating to pavement work before paving
4. In the work of airfield lighting systems, the description needs to focus on providing an explanation in terms of installation, placement, and configuration of equipment in the airport lighting installation system

4.4 Dominant Risk Factors That Can Influence Quality Performance

There is a standardized WBS level included in the supporting documents (WBS dictionary and checklist) that need to be controlled in relation to project performance called work package. In identifying risks, risks are identified based on the categorization of WBS starting from the work package, method, activity, and resources (labor, material, equipment) that can affect quality performance. This risk identification is obtained from a literature study that will be validated content and construct to 10 respondents with min. 5 years work experience in the air side facilities of airport construction works. Respondents also need to fill in how the quality performance of each project is being undertaken by them based on the available rating scale questionnaire.

The variable relationship between risk identification at each level of WBS (X Variable) and project quality performance (Y Variable) are searched using one of the non-parametric inference statistics analysis named Kendall's Tau using SPSS *software*. There are several interpretations in the test results.

1. Significance of Relationships
   In testing a relationship between variables a hypothesis is used as below.
   - H0 = There is no relationship between risk factors and project quality performance
   - H1 = There is a relationship between risk factors and project quality performance

   Furthermore, the guidelines used to accept or reject the proposed null hypothesis (H0) are as follows.
   - If the significance value < 0.05, then H0 is rejected and H1 is accepted
   - If the significance value > 0.05, then H0 is accepted
2. Direction of Relationship
   The direction of the relationship is known by the correlation coefficient. The magnitude of the correlation coefficient ranges from +1 to -1. The correlation coefficient will show the strength of the linear relationship and the direction of the relationship between the two random variables. If the correlation coefficient is positive, then the two variables have a direct relationship. This means that if the value of variable X is high, then the value of variable Y will be high too. Conversely, if the correlation coefficient is negative, then the two variables have an inverse relationship. This means that if the value of variable X is high, then the value of variable Y will be low and vice versa. However, in perfect correlation there is no need to test hypotheses regarding the significance of the correlated variables because the two variables have a perfect linear relationship. This means that variable X has a very strong relationship with variable Y. If the correlation is equal to zero (0), then there is no relationship between the two variables.
3. Strength of Relationship between Two Variables
   To facilitate the interpretation of the strength of the relationship between two variables, the following criteria are shown in the Table 3 below.

Table 3. Strength of Relationships between Two Variables

Coefficient Interval	Relationship Level
0	No Relationship
>0 – 0.25	Very weak
>0.25 – 0.5	Enough
>0.5 – 0.75	Strong
>0.75 – 0.99	Very strong
1	Perfect

After being analyzed using the Kendall's Tau Test between risk factors and project quality performance, it can be seen that there are eight dominant risk factors that affect project quality performance as summarized in the Table 4 below.

Table 4. Kendall's Tau Test Results Using SPSS *Software* Relating to Risk Factors that Influence Project Quality Performance

WBS LEVEL	X VARIABLE			Y VARIABLE	INFORMATION	RANK
Work Package	X.1.1.6 X.2.1.6	Image details are inadequate and unclear	Correlation Coefficient	0.566	Direct and strong relationship	5
			Sig. (2-tailed)	0.036		
			N	12		
Sub of Work	X.1.2.6 X.2.2.6	Errors in planning construction methods	Correlation Coefficient	0.647	Direct and strong relationship	2
			Sig. (2-tailed)	0.015		
			N	12		
Sub of Work	X.1.2.7 X.2.2.7	There is a mismatch of the construction method applied to the planning	Correlation Coefficient	0.555	Direct and strong relationship	7
			Sig. (2-tailed)	0.038		
			N	12		
Activity	X.1.3.3 X.2.3.3	Installation does not match specifications or drawings plans or work rejected (reject)	Correlation Coefficient	0.664	Direct and strong relationship	1
			Sig. (2-tailed)	0.013		
			N	12		
	X.1.3.6 X.2.3.6	A technical error occurred by the contractor due to negligence in implementation	Correlation Coefficient	0.571	Direct and strong relationship	4
			Sig. (2-tailed)	0.035		
			N	12		
Resource (Material)	X.1.4.1 X.2.4.1	Scarcity of material according to specification	Correlation Coefficient	0.537	Direct and strong relationship	8
			Sig. (2-tailed)	0.045		
			N	12		
Resource (Equipment)	X.1.4.8 X.2.4.8	The amount of equipment planned is not according to need	Correlation Coefficient	0.560	Direct and strong relationship	6
			Sig. (2-tailed)	0.036		
			N	12		
Resource (Labor)	X.1.4.17 X.2.4.17	Labour productivity is lower than demand	Correlation Coefficient	0.608	Direct and strong relationship	3
			Sig. (2-tailed)	0.025		
			N	12		

The eight risk factors have a direct and strong relationship to quality performance. Direct relationship has the understanding that if the greater the risk occurs, it can reduce project quality performance. While a strong relationship means the eight risk factors have a big influence (impact) on quality performance. And below is an analysis of the eight risk factors.

1. Work Package
   a. Image Details are Inadequate and Unclear
      Work drawings are reference drawings that are used to realize design ideas into physical form. Work drawings that are truly accurate and detailed will greatly help realize a project correctly. Completing the quality system requirements to get the best quality standards on the final product can be done by making detailed and accurate work drawing. If an error is discovered at the project implementation stage due to a lack of detailed working drawings, the design will automatically change to cover up the drawing errors. Thus, this risk results in a non-maximum quality in work processes that affect the results of work obtained (Dharsika et al. 2017).
2. Sub of Work
   a. Errors in planning construction methods
      The implementation method has a big role to improve the project quality performance. Planning the implementation method will be the key to the implementation of the construction project work because it will provide clarity at the project implementation stage. If the method is not given enough attention during

planning, the opposite can happen, the implementation of the project becomes unclear which can have an impact on the decline in quality performance (Djukardi and Semiawan 2018).

b. There is a mismatch of construction methods that are applied with planning
Implementation of work on some work items that do not refer to planning documents and affect the method of carrying out the planned work can result in the quality of the work being not in accordance with the objectives or specifications (Kalangit et al. 2009).

3. Activity
   a. Installation does not match to specifications or drawing plans or work rejected
   Installation according to specifications and drawings is a way to control the quality of the project so that the work carried out is in accordance with the requirements and plans in quality planning (Dharsika et al. 2017).
   b. A technical error occurred by the contractor due to negligence in implementation
   The success of a project that is measured based on the resulting performance is very dependent on the activities of implementing organizations that are coordinated in one management item. Preventive solution that can be done is the selection of a competent contractor.
4. Resources
   a. Material: Scarcity of material according to specifications
   If the material used is not in accordance with the desired quality, the final result is not in accordance with the project specifications. Material has a direct impact on quality performance so obtaining material that conforms to specifications both based on project provisions and applicable standards is the main thing in determining material criteria (Djukardi and Semiawan, 2018).
   b. Equipment: The amount of equipment planned is not according to need
   The number of tools according to the required specifications is an indicator of construction equipment that has a significant effect on the quality of the project so that comprehensive handling and management needs to be done. Construction equipment is an important factor that cannot be separated from the construction. The quality of a construction is strongly influenced by the ability and availability of tools at the time of construction activities (Permono and Mulyono, 2006).
   c. Labor: The amount of equipment planned is not according to need
   Performance that is measured in terms of quality depends on the productivity of human resources who do it because the work results of an employee can be seen directly and have a direct effect on quality performance (Djukardi and Semiawan, 2018). To get the level of productivity as needed by minimizing all the risks that might occur and prioritizing occupational safety and health, leaders must understand the capabilities and limitations caused by project site conditions (Rini, 2017).

This can thus prove the hypothesis: "If the risk in the WBS dictionary and checklist is not managed, it can reduce project quality performance".

Identifying and analyzing risk factors will produce dominant risks that occur and can have a significant impact on project quality performance. This is important to do because if it is not analyzed and the results of the work produced will be less precise then it will affect the overall planning, including quality planning. This quality planning is concerned with identifying quality requirements and/or project standards and documenting how a project can demonstrate compliance with relevant quality requirements so that direction is generated on how the quality will be managed and validated by the project. The list of risks obtained from the results of the risk analysis will then be input to obtain preventive and corrective actions in response to the risks that may occur in overcoming project problems. WBS activities that are arranged based on risk responses can become a new element of WBS, namely on work items and activities or become additional points in the project RKS. Thus, after the dominant risks are known, an analysis of risk activities in the project can be carried out by considering the scope of the project. The relationship between risk and quality is the standard requirements. The project scope requirements then contain a description, deliverables, and acceptance criteria. This information will be used to develop a quality management plan in the project management plan.

Then potential support for impacts on each stakeholder can be developed in the form of a stakeholder list and classified for strategy development plans. Stakeholders are then assessed about how they react or respond to various situations in increasing their support and anticipating negative impacts that may arise. In the end, this project quality management plan and stakeholder list will then be input into quality planning. Such information is also listed in the WBS dictionary and checklist.

5. Conclusion

Standardized WBS of air side facilities in airport construction works consist of 7 facilities (sub-projects): access road, runway, taxiway, apron, airfield lighting system, motorized vehicle parking, GSE and perimeter road. Because

of all work that must be completed on the project needs to be identified and recorded, WBS certainly needs to be supported by documents in the form of a WBS dictionary and checklist. WBS dictionary will provides critical information for every element in WBS, while the checklist is useful for measuring the suitability of WBS by including inspection guidelines. However, the WBS included supporting documents such as the WBS dictionary and checklist, there are risks that need to be identified and controlled. After the risk is identified and analyzed using non-parametric inference statistics analysis named Kendall's Tau, there are eight dominant risk factors that affect project quality performance. Risk factors that may arise in work activities such as installation that is not in accordance with specifications are ranked first. Identification and analysis of risk factors are useful to produce a dominant risk then becomes an important thing to do because it can provide preventive and corrective actions as a risk response to produce project scope requirements (description, deliverables, and acceptance criteria) as well as a list of stakeholders responsible for overcoming negative impacts will happen. Such information can also be found in WBS dictionaries and checklists that are useful in making quality planning more structured.

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