

DEVELOPMENT STANDARD MEASUREMENT METHODS BASED OF WBS FOR MECHANICAL AND ELECTRICAL WORK VOLUMES OF STADIUM AREA OF SPECIAL STATE BUILDING WITH INTEGRATED DESIGN BUILD CONTRACT TO INCREASE ACCURACY OF MECHANICAL AND ELECTRICAL WORK VOLUMES MEASUREMENT

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ABSTRACT

The construction of a stadium that has a fairly high level of complexity with the use of an integrated design and build contract demands an acceleration of execution time, the modernization of the job procurement system and easier project delivery. Not a few of these conditions trigger disputes one of the problems that arise due to the absence of standards in determining the calculation of the volume of work which causes different views from various parties regarding the measurement of the volume of work. This study was conducted to compile and develop a Standard Measurement Method (SMM) of the volume of mechanical electrical work in the stadium area based on Work Breakdown Structure (WBS) and to model the relationship between the method of measuring the volume of mechanical electrical work on the level of accuracy of calculating the volume of work using Structural equation modeling (SEM). The results of this study are expected to serve as a guide in measuring volume to create a consistent measurement method and produce a measurement method that can be accepted by various parties.

Keywords: *Stadium, dispute, standard measurement method (SMM), mechanical electrical, work breakdown structure (WBS)*

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INTRODUCTION

The construction of state buildings with design and build contracts in Indonesia is considered capable of responding to the challenge of accelerating project completion (Nurmandi & Kim, 2015), but in its implementation in the field, the implementation of integrated design and construction contracts still reaps many problems, such as in the construction of state stadiums, there are not a few disputes between the Supreme Audit Agency (BPK) with the implementing activities due to the absence of standardization of volume measurement methods nationally and internationally, causing differences in perceptions in determining the volume of work which results in the return of the state budget ceiling. Through the preparation of this thesis, the author tries to develop a method for calculating the volume of mechanical and electrical work in the stadium area, which is expected to minimize disputes (Katsaprakakis et al., 2019). The development of this method begins with developing a Work Breakdown Structure (WBS) standard with an integrated design and construction contract system then developed with the National (IQSI) and International measurement standards (Singapore, Hongkong, Malaysia, and RICS NRM) (Ghinea & Bena, 2008). The results of the development of the SMM method are expected to be used as a guideline that can help achieve consistency and standardization of information that will be used by various stakeholders in every stage and process of implementing stadium building construction so that the potential for disputes or disputes in project implementation can be minimized.

Work Breakdown Structure (WBS)

The measurement method developed is based on Work Breakdown Structure (WBS) with an integrated design and build contract system (Al-Kasasbeh et al., 2021), Work Breakdown Structure (WBS) is a hierarchical decomposition of the total scope of work that must be carried out by the project team to achieve project objectives and create the required deliverables Project Management Body of Knowledge (2017). Each level below in the hierarchy represents a greater level of detail for the deliverables and work required (Jung & Woo, 2004). WBS is a list that is top down and hierarchically describes the components that must be built and the work associated with it defines the tasks that can be completed separately from other tasks, facilitates the allocation of resources, assignment of responsibilities, measurement and control project (Ibrahim et al., 2009). The division of tasks into smaller sub-tasks in the hope that it will be easier to do and the estimated length of time Ervianto (2004).

Standard Measurement Method (SMM)

The Standard Measurement Method (SMM) is a document that contains things about how to take measurements, write descriptions and arrange building work. SMM is a guideline for Quantity Surveyors in compiling Volume List Documents. SMM provides a uniformity principle for the calculation of construction work and its accompanying. According to the definition given by Seeley and Winfield (1999), SMM is a document that contains details and explanations of ways to take measurements, write descriptions and contain building materials including units of measure. Its use is also not limited to work in progress, where this equivalent calculation can also be used for work in planning for the provision of Volume lists. More specifically, the main function of SMM is guidance when providing Volume lists.

Structural Equation Modeling – Partial Least Square

Based on (Sarstedt, Ringle, & Hair, 2017) the PLS-SEM approach, the structural model, and its measurements are referred to as the inner model and outer model. To develop path models, it is necessary to first describe the structural theory and measurement theory that specifies the relationship between elements in the path model.

METHOD

The development of the measurement method carried out is in the mechanical and electrical stadium area work where the development is carried out based on the Ministry of Public Works and Housing Republic of Indonesia Regulation No. 28 of 2016 concerning Guidelines for Analysis of Building Unit Prices obtained by WBS level 1 and 2 then developed into level 6 by adopting BoQ from various stadiums, the results of the WBS are used as inputs used to develop Standard Measurement Method (SMM) with content containing units, rules measurements, conditions and scope which are then modeled on the relationship between the WBS and SMM with an accuracy level of calculating the volume of work using statistical analysis of Structural Equation Modeling-Partial Least Square (SEM-PLS) Work Breakdown Structure (WBS).

Work Breakdown Structure (WBS)

The first research question in this study is what is the form of WBS for mechanical electrical work in the stadium area on an integrated design contract using inputs, namely the Bill of Quantity (BoQ) and RKS for previous stadium projects and the regulations adopted in the PUPR Ministerial Regulation 28 of 2016 research strategy in the form of literature study, benchmarking and survey. The research instrument is a questionnaire that is used to perform expert validation then the analysis is carried out so that the WBS standard for Mechanical and Electrical work in the Stadium Area is obtained.

Standard Measurement Method (SMM)

The second research question is how to develop a standard measurement method (SMM) for mechanical and electrical work in the stadium area where at this stage the validated WBS is used as an input with the standard existing measurement method (IQSI) then uses research strategies in the form of literature study, benchmarking and survey, the research instrument is a questionnaire then validated twice to the expert.

The relationship model of the WBS based mechanical and electrical work volume measurement method in the stadium area to the level of volume calculation accuracy

The third research question is how the WBS-based standard method of measuring work volume relates to the level of accuracy of volume calculation. In the study, the WBS Indicators for Mechanical Electrical Works, SMM Indicators for Mechanical Electrical Works, and Indicators of the Accuracy Level of Electrical Mechanical Work Volume were obtained through literature studies and surveys. volume calculation accuracy which is the independent variable and the dependent variable which consists of 15 indicators.

After being arranged, validation was carried out on 5 experts with the criteria of an educational expert with at least S1 and 10 years of work experience in project management and Quantity Surveyor (QS), after that a pilot survey was carried out to ensure that the statements in the questionnaire were easy to understand when distributing the questionnaire to respondents, after that the questionnaires were distributed. to respondents with a minimum respondent target of 52 respondents (Wong, 2013). After getting a response from the questionnaire, then data processing was carried out using SPSS and using SEM-PLS to determine the relationship between WBS-based SMM with the level of volume accuracy and which variable indicator had the greatest influence on the accuracy of the volume calculation.

RESULTS AND DISCUSSION

Work Breakdown Structure (WBS)

Based on this research, the Work Breakdown Structure (WBS) format for Mechanical Electrical works in the stadium area is obtained in the form of benchmarked results from BoQ (Bill of Quantity) from several stadiums. The six levels of the WBS include:

- WBS Level 0: Project Name
- WBS Level 1: Division Area
- WBS Level 2: Division Group
- WBS Level 3: Sub of Work,

Development Standard Measurement Methods Based of WBS for Mechanical and Electrical Work Volumes of Stadium Area of Special State Building with Integrated Design Build Contract to Increase Accuracy of Mechanical and Electrical Work Volumes Measurement

WBS Level 4: Work Package,
WBS Level 5: activities,
WBS Level 6: Resources.

WBS is obtained from expert validation results with criteria required to have a minimum educational background of S1 with a minimum of 10 years experience in the planning and implementation of construction projects, project management, and procurement of construction goods and services. The WBS of mechanical and electrical in the stadium area is illustrated in Table 1.

Table 1:

Validated Stadium WBS Standard for Mechanical and Electrical Works in Stadium Area

WBS Level 0	WBS Level 1	WBS Level 2	WBS Level 3	WBS Level 4	WBS Level 5	WBS Level 6	
Project Name	Division Area	Division Group	Sub of work	Work Package	Activities	Type of resources	Resources
Stadium	Area Stadium Development	Mechanical Work	VAC (ventilation air conditioning)	Air Conditioning Unit	Procurement and Installation AC Split Duct	Material	AC Split duct Labor - Foremen - Worker

The Standard Measurement Method (SMM)

Standard Measurement Method (SMM) was developed based on literature studies from national (IQSI) and international SMM (Singapore, Hong Kong, Malaysia, RICS NRM) SMM with additional information in the form of units, measurement rules, provisions and scope. Validation was carried out 2 times, namely expert validation I in the form of measurement units and rules and Expert validation II provisions and scopes which then obtained a standard Measurement Method (SMM) as shown in table 2.

Table 2:

Validated Standard Measurement Method (SMM) for Mechanical and Electrical Works in Stadium Area

(WBS Level 6) Resources	Unit Of Measure	Measurement Rules	Provision	Scope
AC Split duct	Number	Calculated based on number installed	Procurement of non-inverter types with a capacity of low static (1-2.5 PK), middle static (3-6 PK), or high static pressure (5-20 PK)	Equipment includes: (a) supporting framework (b) sound insulation when provided with the unit (c) controls and switches when supplied with the unit

Labor	Man-day	Calculated based on the number of working days	The person in charge of assisting the handyman in carrying out work which includes heat ventilation and air conditioning is proven by the minimum possession of a Mechanical Skills Certificate TM 055 (Mechanic Heating Ventilation and Air Condition (HVAC))	Wages are given based on the number of attendance per day which includes basic work equipment (tools) and meal costs
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The relationship model of the WBS-based mechanical and electrical work volume measurement method in the stadium area to the level of volume calculation accuracy.

The following are 15 indicators obtained from the results of the literature study as shown in table 3.

Table 3:

		Validated indicator	
Code	Variable	Code	Indicators
X1	Work Breakdown Structure (WBS)	X1.1	Hierarchical Decomposition/Description of Jobs
		X1.2	Bill of Quantity (BoQ)
		X1.3	Project Scope
		X1.4	Project Deliverables
		X1.5	Project Resources
		X1.6	Risk Identification
X2	Standard Measurement Method (SMM)	X2.1	Measurement method
		X2.2	Measurement Rules
		X2.3	Provisional items
		X2.4	Specification Information and Pictures
		X2.5	Job Classification
		X2.6	Professional Agreements and Practices
		X2.7	Bill of Quantity (BoQ)
Y1		Y1.1	The closeness of the estimated value to the actual value

Work Calculation Level	Volume Accuracy	Y1.2	Clarity of Job Scope Details
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Result of SEM – PLS:

Based on the results of SEM-PLS analysis, an r-square value of 0.654 for level of accuracy is acquired. after removing the provisional items indicator X2.3 because the sample has low correlation in the indicator. Furthermore, the result of the relationship model from the SEM-PLS analysis is as shown in the figure below:

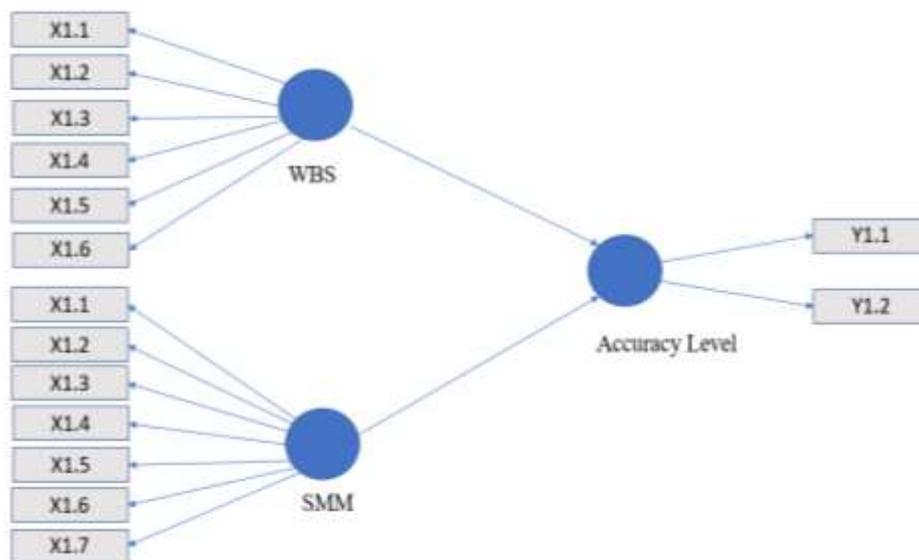


Figure 1: Model the relationship between variables using SEM - PLS

Table 3:

Analysis results on inter-variable relationships based on results from SEM-PLS

Hypothesis Test Results	T Statistics	P Values	Inter-Variable Relationship
WBS -> Accuracy	2.505	0.013	Significant
SMM -> Accuracy	4.060	0.000	Significant

CONCLUSION

Development of the Standard Measurement Method (SMM) based on Work Breakdown Structure (WBS), it was found that it was able to increase the accuracy of calculating the volume of mechanical and electrical work in the stadium area. With an R-square value of 0.654, the independent variables (WBS and SMM) can explain the dependent variable (accuracy of work volume calculation) with a moderate category (Hair, 2011).

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