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COMPARATIVE STUDY OF BILL OF QUANTITY PLANNING AND ACTUAL WORK MECHANICAL, ELECTRICAL AND PLUMBING CONSTRUCTION OF HOSPITAL BUILDINGS

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Keywords

BoQ, RKS, Security, Mechanical, Electrical, Plumbing, Hospital

ABSTRACT

One important aspect in the planning process of a project is the calculation of the volume of work or commonly known as the Bill of Quantity (BoQ). BoQ itself is a document detailing the type of work, volume and unit of measurement of all work items to be carried out to determine the final estimated value of a construction job. Calculation of the volume of work will be carried out based on the Work Plan and Conditions (RKS) and drawings that have been approved by the owner. In the construction industry, MEP or Mechanical, Electrical, and Plumbing is an important factor to realize a building or buildings whose installation system is safe and of good quality. MEP itself is the expertise to plan, design, and manage mechanical, electrical, and piping systems in a building. The actual BoQ results were 5.74% greater than the planned BoQ caused by changes in the work of installing the plumbing system. As well as the most influential factors were changes in design drawings that did not match the conditions in the field and incomplete design drawings.

INTRODUCTION

The development of knowledge and technology in the world of Civil Engineering is increasingly advanced and growing(Chen, Merrett, Liu, Fauzia, & Liem, 2022). In this Digital Era, there are many new discoveries in digital methodology and technology from planning to direct practice in the field(Hai, Van, & Thi Tuyet, 2021). In the construction industry, MEP or Mechanical, electrical, and Plumbing is one of the important factors to realize a building or building whose installation system is safe and quality (Osburn, Lee, & Gambatese, 2022).

MEP itself is an expertise to plan, design, and regulate mechanical, electrical, and piping systems in a building(Hietala, 2022). The operation of multi-storey buildings certainly requires considerable electrical power, therefore in the process of distributing electrical power must be calculated and done as well as possible to achieve maximum results(Ofetotse, Essah, & Yao, 2021). Coordination of mechanical electrical and plumbing system design planning specifically is critical to the success of the project (Tillmann, 2020).

The MEP system affects about 40 - 60% of the construction cost of a building, ranging from one floor to tall buildings(Molina Hutt et al., 2022). In general, the MEP system consists of vertical transportation systems, electrical systems, clean water networks, rainwater and waste disposal networks, venting systems, wifi networks, lightning protection systems, telephones, sound systems, fire protection, CCTV systems, computer networks and others.

The hospital is one of the buildings that has an important and critical role for the community(Angelakis, Antoniou, Yapijakis, & Tchobanoglous, 2020). In hospital buildings, MEP network installation is a mandatory and important factor for the functioning of the

hospital.(Alvanchi & Seyrfar, 2020) MEP's work on hospital construction is very complex looking at strict health regulatory standards, deadlines, coordination, and work costs(Blumhorst, 2021). For this reason, proper planning and execution are needed so that it can avoid rework, waste and delays that can result in project cost overruns and increase the value of efficiency in planning.(Yap, Lim, Skitmore, & Gray, 2022)

METHODS

The method used in this study is a quantitative / concrete method. Research procedures are carried out by collecting, analyzing, and processing data obtained in a study to understand research problems.

The quantative method is carried out by surveying questionnaires with respondents who have knowledge and experience in MEP work, so that factors that cause differences in the volume of work that occurs during planning can be determined with those realized in the field. As well as collecting data related to the calculation of the volume of work or BoQ as well as the calculation of the estimated cost of the General Hospital construction project. After that the data is processed and analyzed using conventional methods by means of manual calculations with the help of Microsoft Excel software, to identify comparisons between BoQ planning and those realized in the field, as well as comparisons of cost estimates.

RESULTS AND DISCUSSION

After comparing *BoQ,* MEP *work,* planning and actual work in the field, a difference of 5.74% was found with a price difference of Rp 571,816,261.08. Changes in the volume of work itself are most commonly found in wiring and piping work in SDP systems and power panels, lighting systems, air conditioning, telephone installations, cctv, matv, fire extinguishers and fire alarms, elevators, *lightning rods,* hydrants, sprinklers*, and* fire extinguishers*, as* well as piping systems.

Table 1. BoQ Comparison Table

MEP Jobs	***Bill of Quantity* Plans**	***Actual Bill of Quantity***
Other SDP & Power Panel Jobs	IDR 1,488,165,189.00	IDR 1,492,247,733
Lighting Work	IDR 1,213,415,650.00	IDR 1,216,143,250
Air Conditioning Works	IDR 2,481,560,101.37	IDR 2,481,310,200
Medical Gas Jobs	IDR 1,025,744,854.55	IDR 1,034,370,224
Sound Works	IDR 284,288,270.00	IDR 286,457,190
Phone & Data Installation Work	IDR 325,224,800.00	IDR 327,870,500
MATV Jobs	IDR 21,004,550.00	IDR 20,500,750
CCTV Jobs	IDR 207,764,850.00	IDR 209,350,700
Fire Extingusher & Fire Alarm Work	IDR 288,303,830.00	IDR 288,005,340
Elevator Works	IDR 625,000,000.00	IDR 625,000,000
Lightning Protection Work	IDR 51,945,000.00	IDR 51,250,000
Fire Hydrant, Sprinkler, and Fire Extingusher Work	IDR 121,718,765.00	IDR 128,315,115
Plumbing Work	IDR 1,264,509,791.33	IDR 1,809,640,910
Sum	IDR 9,398,645,651.25	IDR 9,970,461,912.33
	IDR 571,816,261.08	

As for determining the most influential factors in BoQ changes , planning and actual in the field, a questionnaire distribution was carried out by 30 respondents in project X(Alshihri, Al-Gahtani, & Almohsen, 2022). From the distribution of the questionnaire, the results of filling out the questionnaire were obtained as in table 4 below(Fauziati, Minovia, Muslim, & Nasrah, 2020).

Table 2. Results of 30 Respondents Factors and Independent Variables of Research

Code	BoQ Planning and Actual Change Factors on the Field	Correspondent Results
	Implementation Method	
X1	Implementation of methods in the field that are not in accordance with planning	4,6
X2	Lack of supervision of implementation methods in the field	4,2
X3	Improper use of tools	3,3
X4	Use of materials/materials that are not in accordance with the implementation method	3,3
X5	Planning implementation methods that are not in accordance with the field	3,2
	Human Resources	
X6	Lack of workers' job skills in doing a job	3
X7	Lack of accuracy of workers in doing a job	2,6
X8	Lack of knowledge of workers regarding implementation methods	3,2
X9	Lack of knowledge of workers regarding work drawings	4,4
X10	Lack of knowledge of workers regarding the use of work tools	2,3
	Design	
X11	Design / image that is not in accordance with the conditions in the field	4,8
X12	Obstacles in the distribution of updated images to all parts including in the field	3,3
X13	Incomplete design drawings	4,8
	Materials	
X14	Improper calculation of material requirements	3,2
X15	Lack of supervision of materials that have been used	3,3
X16	Damage to materials during the implementation process	3,1

After calculating the average value (*mean*) it was found that the most influential factors in BoQ changes in the sequence were *Design*, Implementation Method, Material, Human Resources factors(Negesa, 2022). Where the most influential variables in the change in order are:

1. Design / image that is not in accordance with conditions in the field
2. Obstacles in the distribution of updated images to all parts including in the field.
3. Incomplete design drawings
4. Implementation of methods in the field that are not in accordance with planning.
5. Lack of supervision of implementation methods in the field.
6. Improper use of tools.
7. Use of materials / materials that are not in accordance with the implementation method.
8. Planning implementation methods that are not in accordance with the field.
9. Improper calculation of material requirements.
10. Lack of supervision of the materials that have been used.
11. Damage to materials / materials during the implementation process.
12. Lack of workers' job skills in doing a job.
13. Lack of accuracy of workers in doing a job.
14. Lack of occupational knowledge regarding working drawings.
15. Lack of knowledge of workers regarding implementation methods
16. Lack of knowledge of workers regarding the use of work tools.

CONCLUSION

Based on the results of the analysis conducted, a comparison of the BoQ of MEP work planning with the Actual BoQ was obtained with a difference of 5.74% or IDR 571,816,261.08 caused by changes in plumbing system installation work And the most influential factor is changes in the design of the image that is not in accordance with conditions in the field and incomplete design drawings.

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