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Analysis Selection Formwork Systems of Building Project Using AHP and Smart Methods

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ABSTRACT: In the work of reinforced concrete structures, the material and equipment needed to facilitate the work process is needed especially in the formwork work. Therefore required a method to selection of materials and equipment effective and efficient. The decision-making process is basically choosing a best alternative. The methods that can be used in decision making are Simple Multi Attributes Rating Technique (SMART) and Analytic Hierarchy Process (AHP). Both are methods by taking many criteria as the basis of decision making.

The purpose of this study was to compare two types of formwork namely conventional formwork and table form system on the work of beams and floor plates using AHP method and SMART method, so that the best formwork alternative was obtained. This research uses quantitative method, which data obtained from questionnaires and project data. The following criteria are cost, job schedule, quality, and human resources. Result of calculation analysis using SMART method got final weight for conventional formwork alternative equal to 0,16 and for alternative formwork table form that is equal to 0,84. While the results of analysis using AHP weights obtained comparison of the use of conventional forming that is equal to 0.460 and for alternative formwork table form that is equal to 0,540. Both methods show alternatives that meet the criteria to be chosen ie formwork table table system.

KEYWORDS: Formwork, Decision making, SMART, AHP

I. INTRODUCTION

Formwork is an auxiliary tool for printing concrete with the size, shape or position and the desired alignment (Muis, 2013). The allocation of a good formwork will determine the effective use of the equipment. The problem is very interesting from the point of view of engineering and implementation management to discuss the allocation of type of formwork so that it can assist the executor in solving one of the real problems that occurred in the handling of the project. Generally reinforced concrete work using conventional formwork type. However, at this time has been developed a different formwork system that is the table form system. the needs of materials and equipment used to facilitate the process of work is needed by the executor of the construction, therefore required a method of pemiihan material and equipment effective and efficient.

Decision-making is a process of selecting the best alternative from several alternatives systematically to be followed up (used) as a way of solving problems. Simple Multi Attribute Rating Technique (SMART) and Analytic Hierarchy Process (AHP) is a method used to make decisions from many alternatives based on multiple criteria.

The purpose of this research is to compare two work of formwork plates and beams on each floor to get the formwork which is more feasible to be applied by using AHP method and SMART method.

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II. THEORY

Decision-making

Decision (decision) literally means choice. The choice here is a choice of two or more possibilities, or it can be said to be a decision reached after consideration by choosing one possible choice (Gito Sudarmo, 2000).

SMART method

Simple Multi Attribute Rating Technique (SMART) is a multi-criteria decision-making method developed by Edward in 1977. This multi-criteria decision-making technique is based on the theory that each alternative consists of a number of criteria that have values and each criterion has a weight describes how important he is compared to other criteria. This weighting is used to assess each alternative in order to obtain the best alternative.

AHP Method

Analytic Hierarchy Process AHP is one of the models for decision making that can help the framework of human thinking. This AHP method was developed around 1970 by Thomas L. Sabaat (Faizal, 2012). The AHP method is a decision making technique that incorporates double criteria both real and unreal, quantitative or qualitative which takes into account the differences of opinion.

Formwork

According to Alfalah (2013) Formwork or formwork is a temporary construction on the execution of concrete work that serves to form the concrete in accordance with the size and place of its position or can also be called a construction that is a mold or mall.

1. Conventional System

Conventional system formwork is usually used one-time use. The materials used may be organic, artificial, and / or combined material. The depreciation of this type of formwork is very high, as the volume of material is wasted in the manufacturing process and requires considerable volume of labor and experience.

2. Table FormSystem

The latest developments in the use of formwork reference is the design of aluma system formwork to facilitate the use in various forms of structural components. Table Form is a formwork table system in the form of truss series. Table Form allows assembled using various supporting components together with Aluma Beams.

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III. METHODOLOGY

The research method that is done is a quantitative method. In general, the implementation of this research is illustrated in the following picture Flowchart.

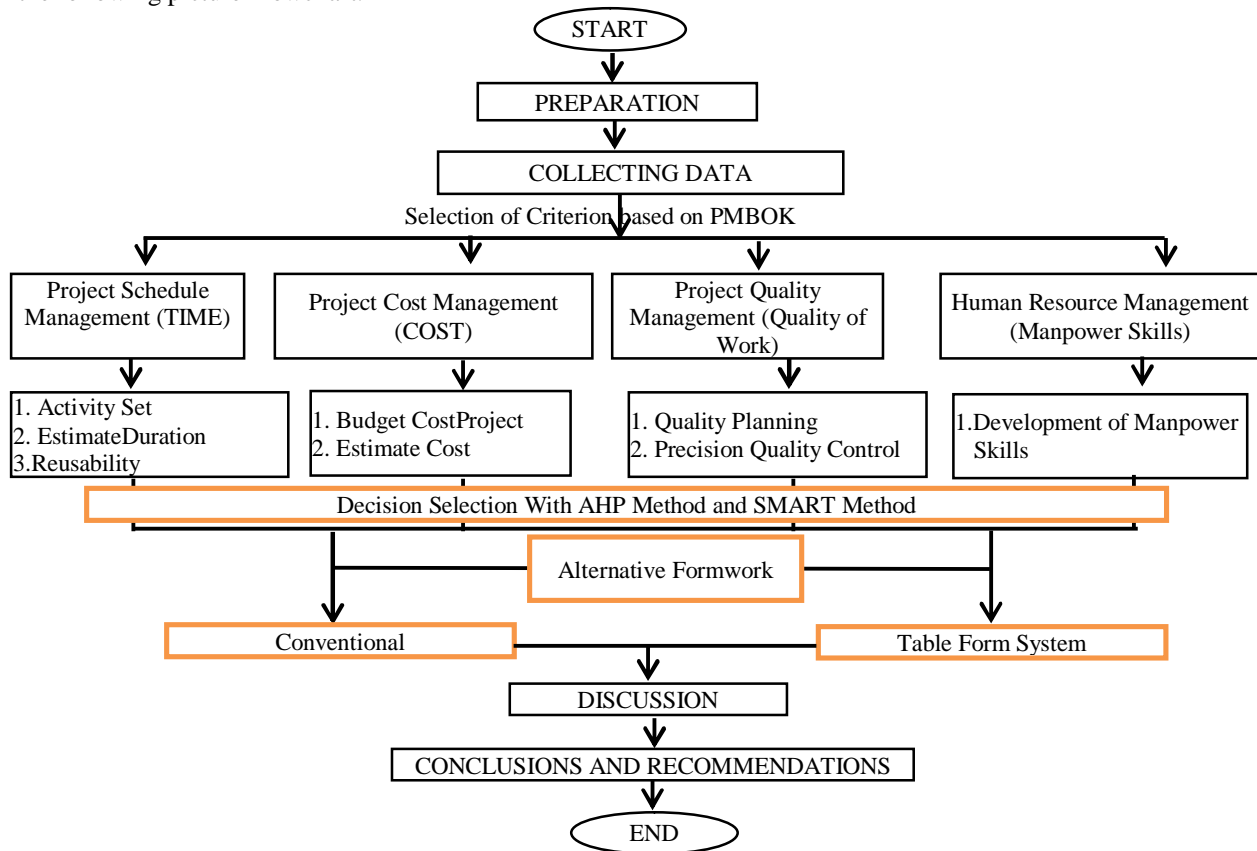


Figure 1. Flowchart Research Methodology

Data collection technique

The data collection procedure that will be used in this research is by doing questionnaires to 30 staffs who work on the project flats Pemda DKI Jakarta. The questionnaire is aimed at determining the priority comparison of each criterion where the value is determined as follows.

Tabel 1: Scale assessment of the relative importance (Saaty, 1988)

Inportance	Definition
1	Equal important
3	Week importance of one over another
5	Essential or strong importance
7	Very strong or demonstrated importance
9	Absolutly more importance
2,4,6,8	Intermediate value between adjacentscale values

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AHP and SMART Method

step analysis with Simple Multi Attribute Rating Technique (SMART) method and *Analytical Hierarchy Process* (AHP) method can be described in the flow diagram like Figure 2 and Figure 3.

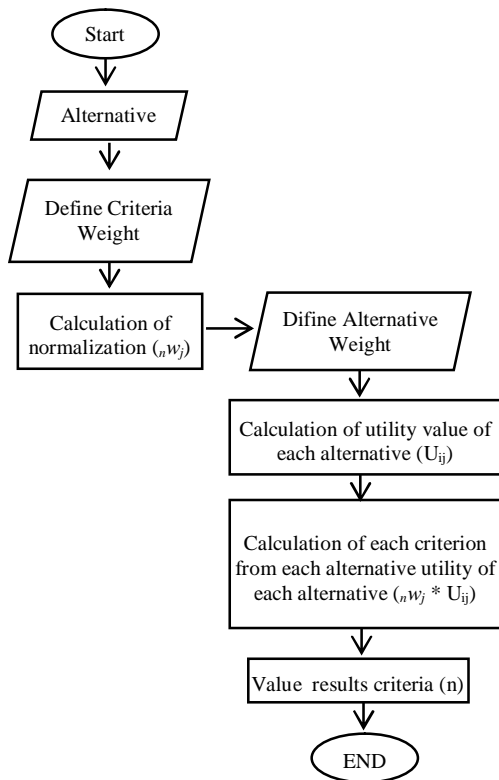


Figure 2. SMART Method Flowchart

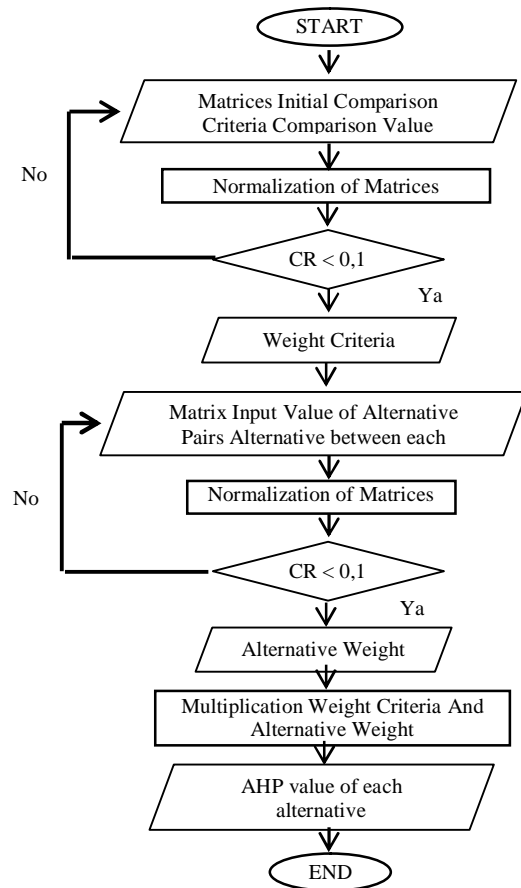


Figure 3. AHP Method Flowchart

IV. DISCUSSION

Calculation Value Each Criteria based on project data can be seen in the following recap table:

Table 2. Comparative Matrix Criteria To the formwork system

Criteria with Alternative	Conventional	System Table Form
Time	14 Day / zone	11 Day / zone
Cost	Rp 2.609.739.200	Rp2.160.233.210
Quality	5	5
Human Resources (labor skills)	2,434 m ² /Day/person	4,463 m ² /Day/person

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Analysis of SMART methods

Determining the assessment criteria, weighting criteria and normalization of criteria weight.

Table 3. Criteria , Weight and normalization

NO	Criteria	Weight	Relative Weights (wj)
1	Cost	100	0,4
2	Quality	80	0,32
3	Time	50	0,2
4	Human Resources (labor skills)	20	0.08

Provide parameter value criteria on each criterion for each alternative

Table 4. Alternative weight

NO	Criteria	Value	Weight
1	Cost	Lower	3
		Same	2
		Higher	1
2	Quality	Better	3
		Same	2
		Less	1
3.	Time	Faster	3
		Same	2
		Longer	1
4	Human Resources (labor skills)	Less than	3
		Same	2
		More than	1

Determining the value of utility by converting the criterion value on each criterion to the criterion value.

Table 5. Utility Values of each Alternative

Alternatif	Criteria	Value	Bobot	Utility weight
Conventional	Cost	Higher	1	0
	Quality	Same	2	0,5
	Time	Longer	1	0
	Human Resourrse	More than	1	0
Table Form System	Cost	Lower	3	1
	Quality	Same	2	0,5
	Time	Faster	3	1
	Human Resourrse	Less than	3	1

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Final Value of each alternative

Table 6. Final Value

Decision Formwork	Final Value
Conventional	0.16
Table Form System	0.84

Analysis of AHP methods

Determination of Comparative Matrix Between Criteria based on the results of questionnaires from 30 respondents who have been collected.

Table. 7. Comparative Matrix Criteria To the formwork system

Criteria	Time	Cost	Quality	Human Resources (labor skills)
Time	1	0,1111	0,1428	2
Cost	9	1	3	7
Quality	7	0,3333	1	5
Human Resources (labor skills)	0,5	0,1428	0,2	1
Total	17,5	1,5872	4,3428	15

Calculating eigen values Criteria and Testing Consistency by:
Normalization of Criteria Matrix and Calculating Eigen values Criteria

Table. 8. Normalization of Criteria Matrix

Criteria	Time	Cost	Quality	Human Resources (labor skills)	Average
Time	0,0571	0,07	0,0329	0,1333	0,0733
Cost	0,5143	0,63	0,6908	0,4667	0,5755
Quality	0,40	0,21	0,2303	0,3333	0,2934
Human Resources (labor skills)	0,0286	0,09	0,0460	0,0667	0,0578
Total	1	1	1	1	1

Based on the table, then calculate the value of CI and CR:

$$n = 4, RI = 0,89$$

$$CI = 0,0715$$

$$CR = 0,0803 \quad \text{Based on CR value} < 0.10, \text{ it can be concluded that the data entered is valid.}$$

Determination of an Alternative Interview Matrix for Each Criteria

Based on the calculation of data in table 2. Obtain an alternative matrix anatar each criteria.

For Criteria that are "more desirable of smaller values", such criteria are usually in the form of cost or time therefore an inverse comparison is used.

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Calculating eigen values Criteria and Testing Consistency with Normalization of Criteria Matrices

1. Matrix of Schedule (Time) criteria against Alternative

Table 9. Schedule criteria against Alternative

C1	Schedule 1 (Day/Zone)	Conventional	Table Form System
	Conventional	1	0,786
	Table FormSystem	1,273	1
Total		2,273	1,786

Table 10. Normalization Matrix Schedule Criteria

Schedule (Hr/Zone)	Conventional	Table Form System	Average
Conventional	0,440	0,440	0,440
Table Form System	0,560	0,560	0,560

2. Matrix of Cost criteria against Alternative

Table 11. Cost criteria against Alternative

C2	Cost	Conventional	System Table Form
	Conventional	1	0,828
	System Table Form	1,208	1
Total		2,208	1,828

Table 12. Normalization Matrix Cost Criteria

Cost	Conventional	System Table Form	Average
Conventional	0,453	0,453	0,453
System Table Form	0,547	0,547	0,547

3. Matrix of Quality criteria against Alternative

Table 13. Quality criteria against Alternative

C3	Quality	Conventional	System Table Form
	Conventional	1	1
	System Table Form	1	1
Total		2	2

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Table 14. Normalization Matrix Quality Criteria

Quality	Conventional	Table Form System	Average
Conventional	0,5	0,5	0,5
Table Form System	0,5	0,5	0,5

4. Matrix of Human Resources criteria against Alternative

Table 15. Human Resources criteria against Alternative

C4	Human Resources (labor skills)	Conventional	Table Form System
	Conventional	1	0,545
Table Form System	1,834	1	
Total		2,834	1,545

Table 16. Normalization Matrix Human Resources Criteria

Human Resources (labor skills)	Conventional	Table Form System	Average
Conventional	0,353	0,353	0,353
Table Form System	0,647	0,647	0,647

Calculating Eigenvalues Criteria

Table 17. Eigenvalues Criteria for Alternatives

	Time	Cost	Quality	Human Resources
Conventional	0,440	0,453	0,500	0,353
Table Form System	0,560	0,547	0,500	0,647

Final Weight

From the results of criteria analysis in the previous discussion, then get the final result of alternative formwork selection as below.

Table 18. Priority of Weight

Criteria	Priority of Weight
Time	0,073
Cost	0,575
Quality	0,293
Human Resources (labor skills)	0,058

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Multiplication of eigen matrix with priority weight matrix, so we get the final weight value.

$$\begin{pmatrix} 0,440 & 0,453 & 0,500 & 0,353 \\ 0,560 & 0,547 & 0,500 & 0,647 \end{pmatrix} \times \begin{pmatrix} 0,073 \\ 0,575 \\ 0,293 \\ 0,058 \end{pmatrix}$$

Table 19. Final Weight

Alternative	Final weight
Conventional	0,460
Table FormSystem	0,540

Total

1

V. CONCLUSION

The conclusions can be drawn from the results of the analysis as follows:

1. The results of analysis using Simple Multi Attributes Rating Technique (SMART) for conventional alternative weight of 0.16 and for alternative table form value 0.84. While the results of Analytical Hierarchy Process (AHP) obtained conventional alternative weight of 0.460 and for alternative table form of 0.540.
2. From the results of the analysis Both methods show an alternative that meets the criteria to be selected is the forming of table form system.
3. Based on the implementation of both methods, the SMART method is faster in the execution process than the AHP method.

SUGGESTION

Suggestions that can be submitted by the author to develop decision-making system Selection of the next formwork is:

1. In the next research is expected to be added other assessment criteria as a decision making materials selection decision.
2. Another suggestion is the comparison can be added using other Decision-making methods.

REFERENCES

- [1] S. Honggowibowo. 2015. Sistem Pendukung Keputusan Penerimaan Calon Mahasiswa Baru Jalur Prestasi Di Sekolah Tinggi Teknologi Adisutjipto Menggunakan Simple Multi Attribute Rating Technique. Jurnal Angkasa, Vol. VII, No. 2, November, Hal. 31-38.
- [2] Bagus, Ida, Ludfi D, dan Sugeng P.B. 2012. Studi Perbandingan Biaya Bekisting Semi Moderen Dengan Bekisting Konvensional Pada Bangunan Gedung. Jurnal Rekayasa Sipil Vol., No.3, hal 237-239.
- [3] Destyarini, Arum. 2016. Analisis Perbandingan Penggunaan Perancah Baja Konvensional Dan Perancah Baja Modifikasi. E-Jurnal MATRIKS TEKNIK SIPIL September 2016, hal 714-722.
- [4] Fitriyani, Theresia. 2011. Penentuan Skala Prioritas Proyek Pembangunan Jalan di Kabupaten Banggai Kepulauan Dengan Menggunakan Proyek Hirarki Analitik. Jurnal Ilmiah MEDIA ENGINEERING Vol. 1, No. 1, hal 38-46.
- [5] Muis, Trijeti. 2013. Analisis Bekisting Metode Semi Sistem dan Metode Sistem Pada Bangunan Gedung. Jurnal Konstruksia Volume 4 Nomer 2, hal 27-38.
- [6] Pan, Nang-Fei. 2008. Fuzzy AHP approach for selecting the suitable bridge construction method. Department of Civil Engineering, National Cheng Kung University, No. 1 University Road, hal 958-965.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 6, June 2018

- [7] Saaty, T.L. (1980) The Analytic Hierarchy Process, New York: McGraw Hill. International, Translated to Russian, Portuguese, and Chinese, Revised editions, Paperback (1996, 2000), Pittsburgh: RWS Publications.
- [8] Shapira, Aviad. 2005. AHP-Based Equipment Selection Model for Construction Project. Journal of Construction Engineering And Management © Asce / December 2005, hal 1263-1273.
- [9] Suryanto, M. Safrizal. 2015. Sistem Pendukung Keputusan Pemilihan Karyawan Teladan dengan Metode SMART (Simple Multi Attribute Rating Technique). Jurnal CoreIT, Vol. 1, No.2 Desember, Hal. 25-29.
- [10] Trijeti. 2011. Studi Perbandingan Bekisting Konvensional Dengan PCH (Perth Construction Hire). Jurnal Konstruksia Volume 3 Nomer 1, hal 45-55
- [11] Utami , Anggraeni. 2015. Analisis Perbandingan Zoning dan Siklus Bekisting Table Form System Pada Proyek Pembangunan Prima Orchard Apartement. Jurnal skripsi Universitas Mercu Buana, hal 1-7.
- [12] Valli, P. 2012. Analytical Hierarchy Process Based Equipment Selection Method For Construction Project Using Matlab Tool. International Journal of Advanced Technology in Civil Engineering, ISSN: 2231 –5721, Volume-1, hal 18-22.