

The Factor Analysis That Has Significant Influence on The Timing of Implementation of Infrastructure Development LRT (Light Rail Transit) Projects in Jabodebek

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Abstract—Jakarta Bogor Depok Light Rail Transit or abbreviated as LRT Jabodebek is a Mass Transit system with light rail (LRT) which is planned to be built in Jakarta, Indonesia and connecting Jakarta with surrounding cities like Bekasi and Bogor. One of the most important problem in the construction of this Jabodebek LRT is the delay in implementation time.

This study aims to determine the factors that have a significant influence on the timing of the implementation on Jabodebek LRT. This research used descriptive method. The instruments that used in data collection is through questionnaire technique (questionnaire). This research will discuss about the application of the TOPSIS method in classifying which factors are the most significant to the time of construction on Jabodebek LRT. The weighting criteria and the classification criteria using Topsis.

The results of this study indicate that land handover aspect is the first rank to be considered as the main factor causing project delay with preference value 0.9. The second aspect is the preparation of a good work plan with a preference value of 0.82. The third aspect is the selection of improper construction methods with the preference value of 0.8 and the fourth aspect which is not less important to be considered is the funding aspect of the project activity with the preference value 0.79. The author recommends that the decision makers should consider these aspects so that project implementation time can be well controlled so that there is no delay to know which factor is the most significant with respect to time in the implementation time of the project Jabodebek LRT.

Keywords—Implementation Time; Light Rail Transit (LRT) Jabodebek; TOPSIS.

I. INTRODUCTION¹

Light Rail Transit or abbreviated LRT is one of the environmentally friendly rail-based mass transportation modes. The LRT construction is carried out elevated above the space belonging to toll roads and non-toll roads. This LRT tool is widely applied in various countries in the world, because it is considered as one good means to meet the mass movement in each country. The government, through the Ministry of Transportation of the Republic of Indonesia, is conducting the development of LRT as a means of mass transportation which is expected to improve and improve quality in various aspects (transportation, city planning, economy and other aspects), especially in the capital city of Jakarta.

Light Rail Transit Jabodebek or abbreviated LRT Jabodebek is a Mass Transit system with light rail (LRT) planned to be built in Jakarta, Indonesia and connect Jakarta with surrounding cities such as Bekasi and Bogor [1].

Some construction projects often experience delays due to their complexity. Timing of implementation is an important factor in project management in addition to cost and quality. In a project must have a certain time limit.

Project demands must be completed on time to be a challenge in itself. There are several time factors for the implementation of the work of a project that can be a barrier to the achievement of targets. Therefore, it is necessary to study the time factor of the project implementation and the ways that can maximize project execution time, so there will be no delay.

The development of LRT in Jakarta is divided into several trajectories that have been listed in the General Plan of Railway Network in Jabodetabek area of 2014-2030 as stipulated in Regulation of the Minister of Transportation of RI [2]. This regulation is strengthened by Perpres No 98 Tahun 2015 which was then updated by Perpres No 65/2016[3].

The Phase I construction will build the Cibubur - Cawang (Cross Service - 1) route, Cawang - Kuningan - Dukuh Atas (Cross Service-2) and Cawang - East Bekasi (Lintas Pelayanan-3).

While Phase II will build the Cibubur - Bogor, Dukuh Atas - Palmerah - Senayan and Palmerah - Grogol lines.

LRT lines and stations will use toll lanes that have been granted a principal license from the Minister of Public Works and People's Housing number TN.13.03- Mn / 408 dated May 19, 2015. The main constraint with the determination of this path is the limited window time work so it is necessary Analysis of working methods of each job so that the implementation time is not too late

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This mode is built with elevation of height between 9-12 meters above ground level. The total funds needed for this phase I LRT project reached Rp 23.3 trillion. Of that amount, it will be financed through state capital participation (PMN) of Rp 9 trillion, each granted to Adhi Karya of Rp 1.4 trillion and PT KAI amounting to Rp 7.6 trillion through Government Regulation No. 28 of 2015 The remaining Rp 18 trillion from bank loans.

The purpose of this study to express the research problems as follows:

1. Identify what are the key factors affecting the timing of the construction work of the Jabodebek LRT construction project
2. Provide inputs on ways to be taken in account of project delays, so that good implementation can be done to avoid delay in LRT project implementation in Jakarta.

The benefits of this research are:

1. For the authors, this study is expected to expand knowledge and insight in the field of project time management.
2. For the agency, can be used as consideration in decision making in the future.
3. For others, this research can be presented as one of the reference/as a comparison material for further research, especially issues related to time management of project implementation

II. METHOD

In the management process of construction project implementation, various types of project delays are classified into 6 aspects of study according to Proboyo as below[4]:

1. Aspects of planning and scheduling work
2. Aspects of scope and work documents
3. Aspects of organizational systems, coordination and communication
4. Aspects of readiness / preparation of resources
5. Aspect of inspection system, control and evaluation of work
6. Miscellaneous aspects

Decision Support System is a system tool that is able to solve problems efficiently and effectively, which aims to help decision making choose various alternative decision which is result of information processing obtained by using decision model. In this research for determination factor of delay and for category ranking used TOPSIS method.

TOPSIS is an abbreviation of Technique for Order Preference by Similarity to Ideal Solution. TOPSIS Is one of the multi-criteria decision-making methods first [5]. The basic idea of the TOPSIS method is that the chosen alternative has the closest distance to a positive ideal solution and has the farthest distance from the ideal solution. The positive ideal solution is defined as the sum of all the best values that can be achieved for each attribute/criterion, whereas the ideal negative solution consists of all the worst values achieved for each attribute/criterion. This method is widely used to solve practical decision making. This is because the concept is

simple and easy to understand, and has the ability to measure the relative performance of decision alternatives.

A. TOPSIS Method Procedure

Steps for the preparation of TOPSIS [6] in general as follows:

- a. Make a decision matrix for alternatives (m) and criterion (n) into a matrix, where x_{ij} is a choice measurement of the i-th alternative and the j-th criterion. This matrix can be seen in the equation below:

$$D = \begin{bmatrix} x_{11} & x_{12} & x_{13} \\ x_{21} & x_{22} & x_{23} \\ x_{i1} & x_{i2} & x_{i3} \end{bmatrix} \quad (1)$$

- b. Calculates a normalized decision matrix (r_{ij})

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (2)$$

with $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$

- c. Calculates a weighted normalized decision matrix (y_{ij})

$$y_{ij} = w_{ij}r_{ij} \quad (3)$$

w_{ij} is a weight for every alternative

- d. Determine the ideal positive solution and the ideal negative solution (V^+ dan V^-)

$$\begin{aligned} V^+ &= (y_1^+, y_2^+, \dots, y_n^+) \\ V^- &= (y_1^-, y_2^-, \dots, y_n^-) \end{aligned} \quad (4)$$

with $y_j^+ = \max y_{ij}$ and $y_j^- = \min y_{ij}$

- e. Determine the distance of the ideal positive solution and the ideal negative solution distance (S_i^+ dan S_i^-)

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_i^+ - y_{ij})^2} \quad (5)$$

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij} - y_i^-)^2} \quad (6)$$

- f. Specifies the preference value for each alternative

The preference value for each alternative is given as follows:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (7)$$

Greater V_i values indicate that a better A_i alternative is to be chosen.

This research is one of the application of Multi Criteria Decision Making method (MCDM) which already exist, that is by using TOPSIS method. The differences of this study with previous research among others:

1. This study only uses TOPSIS method to rank the alternatives that become the main factors affecting the performance of the implementation time in the construction project LRT Jabodebek.
2. This research makes the respondent's position as sub criteria of alternative points to be studied.

III. RESULT AND DISCUSSION

A. Variables and Research Instruments

1) Research Variables

The research variables are factors that become indicators of a study. The research variables were obtained from literature studies (books, journals) as well as from

interviews with related sources. In this study using 45 variables that are divided into 6 classifications:

TABLE 1.
RESEARCH VARIABLES[7]

No	Overview of Aspects and Causes of Delay
A Aspects of Planning and Scheduling	
1	A very tight schedule of projects by the owner
2	No full identification of the type of work that should be there
3	Unstructured/unified work sequence plan
4	Determination of the duration of working time is not thorough
5	The owners work plans are often changing
6	Method of construction/implementation of work is wrong or not right
B Aspects of Scope and Work Document (contract)	
1	Incorrect/incomplete (image/specification) planning
2	Change of design/detail of work at time of execution
3	Change the scope of work at the time of execution
4	The process of creating a working drawing by a contractor
5	Request process and approval of work draw by owner
6	Understanding the rules of drawing work
7	There are many (often) added jobs
8	A request for changes to the completed work
C. Aspects of Organization, Coordination and Communication Systems	
1	Limited authority of owner owners in decision making
2	Qualified personnel/owners who are not professionals in their field
3	How to inspect and control the bureaucratic work by the owner
4	The failure of the owner coordinates the work of many contractors / subcontractors
5	The owner's failure to coordinate the handover/use of land
6	Delays in the supply of tools/materials etc. Provided by the owner
7	Poor technical and managerial qualifications of personnel in contractor work organization
8	Poor coordination and communication between parts of the contractor's work organization
9	Occurrence of work accident
D Aspects of Resilience/Resource Preparation	
1	Resource Mobilization (materials, tools, labor) is slow
2	Lack of skills and skills and work motivation of the workers directly on the site
3	The number of workers who are inadequate/in accordance with existing work activities
4	The unavailability of the material is fairly certain/appropriate as needed
5	Unavailability of equipment/equipment work quite adequate/as needed
6	Negligence/Delays by sub-contractors work
7	Funding of unplanned project activities (funding difficulties in contractors)
8	Non-payment of contractor appropriately in accordance with its rights (difficulty of payment by owner)
E Aspects of the Inspection, Control and Evaluation System	
1	Submission of materials by unscheduled contractors

No	Overview of Aspects and Causes of Delay
2	Process of request and approval of sample material by the old owner
3	Testing process and evaluation of material test from irrelevant owner
4	The process of approving work permits is long-winded
5	Failure of the contractor to carry out the work
6	Many results of work that must be repaired/repeated because of defects/not true
7	The process and procedure of evaluating the progress of the old work and through the agreed schedule
F Other Aspects (Force Majeure/Beyond The Ability of Owner and Contractor)	
1	The condition and environment of the tread was not in accordance with the allegations
2	Transportation to difficult project location
3	Occurrence of unexpected events such as fire, flood, storm/hurricane, earthquake, landslide,
4	The existence of labor strikes
5	The existence of riot/riot, war
6	The occurrence of damage/destruction due to negligence or acts of third parties
7	Changes in government policy/economic situation or policy

2) Profile of Respondents

The hierarchy of decision-making is done by distributing questionnaires to the stakeholders of the Jabodebek LRT development project. Selection of respondents is based on the consideration that the respondents directly related to the construction process and decision making in the construction of LRT Jabodebek.

Information on the respondent and the weight of each respondent based on the relevant position as Table 2.

3) Research Instrument

After knowing the variable of risk factor, in this research used tool to carry out research, in the form of questionnaire. Questionnaire to be performed as Table 3.

The scale used in the preparation of the questionnaire is the interval from 1-5 Frequency Occurrence of the factor:

- 1. Very Not Determine : 1
- 2. Not Specifying : 2
- 3. Neutral / Not Know : 3
- 4. Determine : 4
- 5. Very Determine : 5

B. Calculation Discussion of TOPSIS

1) TOPSIS begins by constructing a decision matrix.

In the decision matrix, the matrix column represents the attributes of the criteria, while the matrix row states alternatives ie the factors that affect the performance of the execution time to be compared.

2) Determine the weight of each criterion as needed

Criteria of respondents in the sampling is divided into categories and results group discussion weighting criteria can be seen in the following table:

TABLE 2.
WEIGHT FOR EACH RESPONDENT CRITERIA (WJ)

No	Respondent	Person	Factor
1	Owner	2	20 %

2	Contractor Top Management	7	25 %
3	Project Manager	8	35 %
4	Second Level Management	7	30 %
5	Staff	4	15 %

3) *Decision Matrix*

The decision matrix is the result of the conversion of questionnaire data with predefined values. Appendix-1 represents the table between factor alternatives and criteria in which X_{ij} = the i-th alternative and the j th criterion or can be called the criterion value.

4) *A normalized decision matrix*

Table of normalized decision matrix as in appendix -2

5) *Weighted average decision matrix (Yij)*

Table of normalized decision matrix as in appendix -3

6) *Calculates a positive ideal solution and an ideal negative solution*

After obtaining a weighted normalized decision matrix, then the value of the positive ideal solution and the negative ideal solution corresponds to equation 6. Table 3 and Table 4 are positive ideal solution values and the ideal solutions of the calculation results

TABLE 3.
POSITIVE IDEAL SOLUTIONS

OE1	OE2	GM	KDV	KDV	MD1	MD2	MD3	MD4
PM1	PM2	PM3	PM4	PM5	PM6	PM7	PM8	
MP1	MP2	MP3	MP4	MP5	MP6	MP7		
STF	STF	STF	STF					
0.03	0.03	0.04	0.05	0.05	0.05	0.04	0.04	0.04
0.06	0.06	0.06	0.07	0.06	0.07	0.06	0.06	
0.05	0.05	0.05	0.05	0.05	0.05	0.05		
0.03	0.02	0.03	0.03					

TABLE 4.
NEGATIVE IDEAL SOLUTIONS

OE1	OE2	GM	KDV	KDV	MD1	MD2	MD3	MD4
PM1	PM2	PM3	PM4	PM5	PM6	PM7	PM8	
MP1	MP2	MP3	MP4	MP5	MP6	MP7		
STF	STF	STF	STF					
0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03
0.01	0.04	0.05	0.03	0.04	0.03	0.01	0.02	
0.04	0.01	0.03	0.04	0.01	0.03	0.04		
0.01	0.01	0.01	0.02					

7) *Determine the distance between the value of each alternative.*

Determine the distance between the value of each alternative with a matrix of positive ideal solutions and the ideal ideal solution matrix of positive ideal solutions and negative ideal solutions

The distance between an alternative value with a positive ideal solution $D_i +$ is calculated by the formula of formula 5, where $D_i +$ = positive ideal solution vector (Y +) in computing the difference with the attribute value of each element in the Y matrix to find the distance of the ideal positive Any alternatives.

a. From that distance calculate the relative proximity of each alternative of the main factors most influential with

the ideal solution (V_i) with the equation formula 6
b. By sorting the choice of the most decisive factor can be ranked in the order of V_i . Therefore, the best alternative of the shortest one to the ideal solution and furthest away with the ideal negative solution

C. *Analysis and Discussion*

This section describes the analysis of retrieval and data processing that has been done. The analysis is a sequential factor analyzing the cause of project delay from the calculation result by TOPSIS method.

The results of the calculation of preference values using TOPSIS when ranked are obtained as follows:

TABLE 5.
RANKING VALUE PREFERENCE ANALYSIS RESULTS

No	Preference	Code	Aspect	Factor
1	0.90	C5	The owner's failure to coordinate the handover/use of land	Aspects of Organizational Systems, Coordination and Communication
2	0.82	A3	Unstructured/unified work sequence plan	Aspects of Planning and Job Scheduling
3	0.80	A6	Method of construction/ implementation of work is wrong or not right	Aspects of Planning and Job Scheduling
4	0.79	D7	Funding of unplanned project activities (funding difficulties in contractors)	Aspects of Resilience/Resource Preparation

D. *Sensitivity Analysis*

The application of sensitivity analysis in multi criteria decision making process is very important to ensure consistency of final decision. With sensitivity analysis, several scenarios can be visualized so it is helpful to know the impact of the weighting of the criteria on the sequence or the alternate ranking, in this case the main factor affecting the performance of the project execution time.

In this study, the simulation of sensitivity analysis is done by gradually changing the weight of each respondent from owner classification, top management, division/department manager, project manager, project manager and staff.

Sensitivity analysis is done by changing the greatest weight in other respondents. The result of sensitivity analysis can be researched in the following figure:

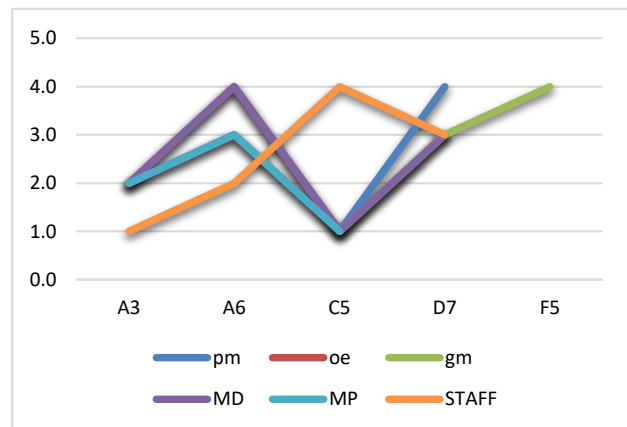


Figure 1. Priority-Level Changes on Sensitivity Analysis

From Figure above, it can be seen that the change of the criteria of the respondent criteria generally does not affect the priority of the factors affecting the performance of the implementation time in which the land acquisition aspect still ranks first. Therefore, it can be concluded that this aspect is consistent and reliable.

From Figure 1 it is seen that although the overall analysis results show that this decision is still consistent and reliable, but recommendations for future research, staff positions should not be taken as respondents. The results of the main factor analysis causing project delays from the standpoint of staff appear to deviate compared to other respondents.

The result of further study on the land acquisition aspect is carried out further analysis on those aspect groups, which is part of the organization system aspect, coordination and communication.

The results of analysis on aspects of the organization system, coordination and communication by using TOPSIS can be seen as follows:

TABLE 6.
RANKING OF THE PREFERRED VALUE OF THE HIGHEST ASPECT OF ORGANIZATION, COORDINATION AND COMMUNICATION SYSTEM

No	V_i Value	Code	Aspect
1	0.89	C5	The owner's failure to coordinate the handover / use of land
2	0.73	C9	Occurrence of work accident
3	0.63	C8	Poor coordination and communication between parts of the contractor's work organization
4	0.54	C2	Qualified personnel / owners who are not professionals in their field

The result of analysis shows that the C5 aspect (owner failure to coordinate the handover / land use) occupies the highest position.

E. Conformity of Analysis Results with actual / empirical conditions in the field

Light Rail Transit (LRT) development progress of Jabodebek has been running 15 percent since the ground-breaking conducted on September 9, 2015, the cause of the slow development of LRT Jabodebek due to land acquisition. This shows the appropriateness of the analysis results with the actual conditions in the field, where the constraints of owner failure to coordinate the handover/land use are the dominant factors.

IV. CONCLUSIONS

Based on the series of research process above can be concluded as follows:

1. Criteria of land acceptance aspect is the first rank that must be considered as the main factor causing project delay with value 0.9, second aspect is aspect of compilation of work plan well with value 0,82, third aspect is the choice of construction method which is not right with value 0,8 and aspect The fourth that is not less important to be considered is the funding aspect of project activities with a value of 0.79. This indicates that the respondent and the project management are aware of the factors that will affect the time of implementation of the work.

2. It is recommended from the results of this research that decision makers should hold on to these matters in order to avoid delay in the construction of infrastructure projects LRT Jabodebek.

The author realizes that this research is far from perfect. Therefore, the authors would like to suggest things as follows for further research.

1. Advanced analysis of the sequence of job implementation and the selection of work methods of each work to be carried out is not too late.
2. The choice of construction methods to be part that must be evaluated further, because it is very influential on the stages of preparation work plan.
3. It is necessary to conduct more specific research on the application of precast system method to the performance of the implementation time

In order to get a more comprehensive picture and can provide maximum benefits to the company, it is necessary to do the same research on prioritizing land acquisition so that the targeted work plan is achieved.

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Appendix -1

Tabel 4. Matriks Keputusan

Alternatif	KRITERIA																													
	O1	O2	M1	M2	M3	M4	M5	M6	M7	P1	P2	P3	P4	P5	P6	P7	P8	R1	R2	R3	R4	R5	R6	R7	S1	S2	S3	S4		
A1	4	4	4	5	5	5	5	5	4	2	5	5	5	5	5	4	5	5	5	5	5	5	5	5	5	1	4	4	5	
A2	4	5	5	4	4	3	5	5	4	2	4	4	4	4	4	4	5	5	5	5	5	5	5	5	5	2	4	5	3	
A3	4	5	5	5	5	4	5	4	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	5	2	5	5	5	
A4	4	5	4	3	3	5	4	5	5	5	4	5	3	5	4	5	5	5	5	5	4	4	5	5	5	2	5	3	4	
A5	4	4	5	3	3	5	5	5	5	5	4	5	3	5	4	5	4	5	5	5	4	4	5	5	5	2	5	2	5	
A6	5	5	5	3	5	5	5	5	5	5	3	5	5	4	5	5	5	5	5	5	5	5	5	5	2	5	5	4	5	
B1	5	4	5	3	3	5	5	4	5	5	4	5	4	4	4	5	5	5	5	5	5	5	5	5	1	5	5	4	5	
B2	5	3	5	5	5	5	4	4	5	5	4	5	4	4	4	5	4	4	5	4	4	4	5	5	1	5	5	4	4	
B3	5	3	5	5	5	5	4	5	3	5	4	5	3	4	4	5	5	4	4	4	4	5	5	3	5	2	5	3	4	
B4	3	3	4	4	4	3	3	5	3	5	4	4	4	5	5	4	4	4	5	5	4	4	4	4	4	1	5	5	2	5
B5	4	3	4	4	4	4	4	4	4	4	4	4	2	5	5	4	4	4	1	5	5	5	5	2	4	1	5	3	3	
B6	4	5	4	4	4	3	5	5	3	4	4	4	2	5	5	4	5	5	1	5	5	5	5	2	4	2	5	5	4	
B7	5	5	5	5	5	5	5	5	5	2	4	5	2	4	4	2	5	4	1	5	5	5	3	4	5	2	5	4	4	
B8	5	5	5	5	5	5	5	5	5	2	4	4	2	4	2	2	5	4	1	5	5	5	1	4	4	2	5	5	5	
C1	4	5	4	2	2	4	4	4	4	5	4	4	2	4	2	3	5	4	1	5	5	5	1	4	4	2	5	3	4	
C2	4	4	4	2	2	5	5	5	5	4	4	4	2	4	4	4	4	5	5	4	4	5	5	5	4	2	5	4	4	
C3	5	5	5	2	2	3	5	5	5	4	4	5	3	4	4	3	4	4	1	4	4	4	1	4	4	2	5	4	5	
C4	5	4	5	3	3	5	5	5	5	1	4	4	4	4	4	3	5	5	5	5	5	5	1	5	4	1	4	4	5	
C5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	1	5	4	4	
C6	4	5	5	4	4	4	4	4	4	1	4	5	4	4	4	1	5	5	5	5	5	5	3	5	5	1	4	3	4	
C7	4	5	4	3	3	3	4	4	4	2	4	4	2	4	5	4	4	5	4	4	5	4	5	3	4	4	1	5	5	4
C8	5	5	4	3	3	4	4	4	4	4	4	4	4	5	4	4	4	5	4	4	4	4	4	4	4	1	4	5	4	
C9	3	2	4	5	5	5	5	5	4	5	4	4	5	5	5	5	4	4	5	4	4	4	4	4	4	2	5	4	4	
D1	4	5	4	4	4	4	4	4	4	5	4	4	3	4	4	5	5	5	5	4	4	5	5	5	4	1	5	5	5	
D2	4	4	4	5	5	5	5	3	5	5	4	5	3	4	4	5	4	4	5	4	4	5	5	4	2	5	5	4	4	
D3	5	5	4	5	5	3	5	3	5	5	4	5	3	3	3	5	5	5	5	5	5	5	5	5	1	5	5	4	3	
D4	5	5	4	4	4	4	4	4	4	5	4	5	3	3	4	5	4	5	5	4	4	5	5	5	5	1	5	5	4	
D5	5	5	4	4	4	4	4	4	4	5	4	5	3	4	4	5	4	4	5	4	4	5	5	4	4	1	5	5	4	
D6	4	4	4	4	4	4	4	4	4	5	4	5	4	4	4	5	4	4	5	4	4	5	5	5	1	5	5	4	5	
D7	4	5	4	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	3	5	1	5	5	5	
D8	5	5	4	4	5	5	5	5	5	4	5	5	5	5	5	4	4	5	4	4	5	5	5	3	5	1	5	5	4	
E1	3	3	4	4	3	3	3	3	4	4	4	4	2	4	4	5	5	4	1	5	5	5	5	1	4	1	5	3	3	
E2	4	4	4	3	3	3	3	3	4	4	4	4	2	4	2	4	4	5	5	5	5	5	2	2	5	4	1	3	3	
E3	4	4	4	3	3	3	4	3	4	4	4	4	2	4	4	4	4	5	1	4	4	5	5	4	1	3	3	4	4	
E4	4	5	5	4	4	4	4	3	4	4	5	5	3	4	4	5	5	4	5	5	5	5	5	5	2	5	5	5	4	
E5	5	5	3	3	5	5	4	4	4	4	5	5	3	5	3	5	5	5	5	5	5	5	4	4	1	5	5	3	5	
E6	5	5	5	4	4	4	4	4	5	5	4	5	3	4	4	4	2	5	5	4	4	5	5	5	2	5	5	4	4	
E7	5	5	5	5	4	4	4	5	5	5	4	5	2	4	4	5	4	4	5	5	4	4	1	5	5	1	5	4	4	
E11	5	4	5	5	5	5	4	4	4	4	4	4	3	5	5	3	4	4	5	4	4	5	5	4	2	5	5	3	3	
E2	5	5	5	5	4	4	5	5	5	2	5	4	3	5	3	2	4	4	5	3	3	5	5	5	4	1	5	5	3	
E3	5	5	5	5	5	5	5	5	4	2	5	5	2	4	5	3	4	4	5	4	4	5	5	4	4	2	5	5	5	
E4	5	5	4	4	4	3	5	4	3	2	4	4	2	4	4	4	4	5	4	4	4	4	5	4	4	2	4	5	4	
E5	5	5	5	3	3	5	3	4	4	4	5	5	3	5	5	4	4	5	5	5	5	5	5	5	1	5	5	3	5	
E6	5	5	5	4	4	4	4	4	5	4	4	5	3	4	4	4	2	5	5	4	4	5	5	5	2	5	5	4	4	
E7	5	5	5	5	4	4	4	5	5	5	4	5	2	4	4	5	4	4	5	5	4	4	1	5	5	1	5	4	4	
F1	5	4	5	5	5	5	4	4	4	4	4	4	3	5	5	4	4	4	5	4	4	5	5	4	2	5	5	3	3	
F2	5	5	5	5	5	5	4	4	5	5	5	4	3	5	3	2	4	4	5	3	3	5	5	5	4	1	5	5	3	
F3	5	5	5	5	5	5	5	5	4	2	5	5	2	4	5	3	4	4	5	4	4	5	5	4	4	2	5	5	5	
F4	5	5	4	4	4	3	5	4	3	2	4	4	2	4	2	2	4	4	5	4	4	4	5	4	4	2	4	5	4	
F5	5	5	5	3	3	5	3	3	5	5	5	4	3	5	5	4	4	5	5	4	4	5	5	5	2	4	5	5	4	
F6	5	5	5	3	3	3	3	3	5	5	5	5	2	5	5	2	3	5	1	4	4	5	5	1	5	1	4	5	3	
F7	5	5	5	5	5	5	4	4	5	5	5	4	4	5	5	4	3	5	5	5	5	5	5	5	4	2	5	3	3	
200	202	200	176	180	174	204	193	209	179	190	205	150	197	188	184	193	207	173	198	214	169	199	204	66	214	188	186			

Appendix-2

Tabel 5. Normalisasi Matriks Kepuasan

Alternatif	O1	O2	M1	M2	M3	M4	M5	M6	M7	P1	P2	P3	P4	P5	P6	P7	P8	R1	R2	R3	R4	R5	R6	R7	S1	S2	S3	S4
A1	0.13	0.13	0.13	0.19	0.18	0.19	0.16	0.17	0.13	0.07	0.18	0.16	0.21	0.17	0.20	0.14	0.17	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.10	0.12	0.14	0.18
A2	0.13	0.16	0.17	0.15	0.15	0.11	0.16	0.17	0.13	0.07	0.14	0.13	0.17	0.13	0.16	0.14	0.17	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.19	0.12	0.17	0.11
A3	0.13	0.16	0.13	0.19	0.18	0.15	0.16	0.14	0.16	0.18	0.14	0.16	0.21	0.13	0.20	0.18	0.14	0.16	0.18	0.17	0.16	0.18	0.13	0.19	0.16	0.17	0.18	
A4	0.13	0.16	0.13	0.11	0.11	0.19	0.13	0.17	0.16	0.18	0.14	0.16	0.13	0.17	0.16	0.18	0.17	0.16	0.18	0.13	0.12	0.18	0.17	0.16	0.19	0.16	0.10	0.14
A5	0.13	0.13	0.17	0.11	0.11	0.19	0.16	0.17	0.16	0.18	0.14	0.16	0.13	0.17	0.16	0.18	0.14	0.16	0.18	0.13	0.12	0.15	0.17	0.16	0.19	0.16	0.07	0.18
A6	0.17	0.16	0.17	0.11	0.18	0.19	0.16	0.17	0.16	0.18	0.11	0.16	0.17	0.17	0.20	0.18	0.17	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.19	0.16	0.17	0.14
B1	0.17	0.13	0.17	0.11	0.11	0.19	0.13	0.14	0.16	0.18	0.14	0.16	0.17	0.13	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.10	0.16	0.14	0.18
B2	0.17	0.10	0.17	0.19	0.18	0.15	0.16	0.10	0.16	0.18	0.14	0.16	0.13	0.13	0.12	0.18	0.17	0.13	0.18	0.13	0.12	0.18	0.10	0.16	0.16	0.10	0.14	0.14
B3	0.17	0.10	0.17	0.19	0.18	0.15	0.16	0.10	0.16	0.18	0.14	0.16	0.13	0.13	0.12	0.18	0.17	0.13	0.18	0.13	0.12	0.18	0.10	0.16	0.16	0.10	0.14	0.14
B4	0.10	0.10	0.13	0.15	0.15	0.11	0.16	0.10	0.16	0.14	0.14	0.13	0.08	0.17	0.08	0.14	0.14	0.13	0.18	0.13	0.12	0.18	0.13	0.10	0.16	0.16	0.07	0.18
B5	0.13	0.10	0.13	0.15	0.15	0.15	0.13	0.14	0.13	0.07	0.14	0.13	0.08	0.17	0.08	0.07	0.17	0.13	0.04	0.17	0.16	0.07	0.13	0.10	0.16	0.10	0.11	0.11
B6	0.13	0.16	0.13	0.15	0.15	0.11	0.16	0.10	0.13	0.14	0.14	0.16	0.13	0.08	0.17	0.14	0.17	0.16	0.04	0.17	0.16	0.07	0.17	0.13	0.19	0.16	0.17	0.14
B7	0.17	0.16	0.17	0.19	0.18	0.08	0.16	0.17	0.16	0.07	0.14	0.13	0.08	0.13	0.08	0.07	0.17	0.13	0.04	0.17	0.16	0.04	0.13	0.13	0.19	0.16	0.14	0.14
B8	0.17	0.16	0.17	0.19	0.18	0.08	0.16	0.17	0.16	0.07	0.14	0.13	0.08	0.13	0.08	0.07	0.17	0.13	0.04	0.17	0.16	0.04	0.13	0.13	0.19	0.16	0.17	0.18
C1	0.13	0.16	0.13	0.07	0.07	0.15	0.13	0.14	0.13	0.18	0.14	0.13	0.08	0.13	0.08	0.18	0.17	0.13	0.04	0.17	0.16	0.04	0.13	0.13	0.19	0.16	0.10	0.14
C2	0.13	0.13	0.13	0.07	0.07	0.19	0.16	0.17	0.16	0.14	0.14	0.13	0.08	0.13	0.08	0.14	0.14	0.16	0.18	0.13	0.12	0.18	0.13	0.19	0.16	0.16	0.14	0.14
C3	0.17	0.16	0.17	0.07	0.07	0.11	0.16	0.17	0.16	0.14	0.14	0.16	0.13	0.13	0.12	0.14	0.14	0.13	0.04	0.13	0.12	0.04	0.13	0.16	0.19	0.16	0.17	0.18
C4	0.17	0.13	0.17	0.19	0.11	0.19	0.16	0.17	0.16	0.04	0.14	0.16	0.17	0.13	0.16	0.11	0.17	0.16	0.04	0.17	0.16	0.04	0.17	0.13	0.10	0.16	0.14	0.18
C5	0.17	0.16	0.17	0.19	0.18	0.19	0.16	0.17	0.16	0.18	0.18	0.16	0.21	0.17	0.20	0.18	0.17	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.10	0.16	0.14	0.14
C6	0.13	0.16	0.17	0.15	0.15	0.15	0.16	0.14	0.16	0.04	0.14	0.16	0.17	0.16	0.20	0.18	0.17	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.10	0.12	0.10	0.14
C7	0.13	0.16	0.13	0.11	0.11	0.11	0.13	0.14	0.13	0.07	0.14	0.13	0.17	0.17	0.16	0.07	0.14	0.13	0.18	0.13	0.16	0.11	0.13	0.13	0.10	0.16	0.17	0.14
C8	0.17	0.16	0.13	0.11	0.11	0.15	0.13	0.14	0.13	0.14	0.14	0.13	0.17	0.17	0.16	0.14	0.14	0.16	0.18	0.13	0.16	0.15	0.13	0.13	0.10	0.12	0.17	0.14
C9	0.10	0.07	0.13	0.19	0.18	0.15	0.13	0.14	0.13	0.18	0.14	0.13	0.21	0.17	0.20	0.18	0.14	0.13	0.18	0.13	0.12	0.15	0.13	0.13	0.19	0.16	0.14	0.14
D1	0.13	0.16	0.13	0.15	0.15	0.15	0.13	0.14	0.16	0.18	0.14	0.16	0.13	0.13	0.12	0.18	0.17	0.16	0.18	0.17	0.16	0.18	0.17	0.13	0.10	0.16	0.17	0.18
D2	0.13	0.13	0.13	0.19	0.18	0.11	0.16	0.10	0.16	0.18	0.14	0.16	0.13	0.13	0.12	0.18	0.14	0.13	0.18	0.13	0.16	0.18	0.13	0.16	0.19	0.16	0.14	0.14
D3	0.17	0.16	0.13	0.19	0.18	0.11	0.10	0.10	0.16	0.18	0.14	0.16	0.13	0.10	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.10	0.16	0.17	0.14
D4	0.17	0.16	0.13	0.15	0.15	0.15	0.16	0.17	0.16	0.18	0.14	0.16	0.13	0.10	0.16	0.18	0.14	0.16	0.18	0.13	0.16	0.18	0.17	0.16	0.10	0.16	0.17	0.14
D5	0.17	0.16	0.13	0.15	0.15	0.19	0.16	0.17	0.16	0.18	0.14	0.16	0.13	0.13	0.12	0.18	0.14	0.16	0.18	0.13	0.16	0.18	0.13	0.16	0.10	0.16	0.17	0.14
D6	0.13	0.13	0.13	0.15	0.15	0.11	0.13	0.14	0.16	0.18	0.14	0.16	0.17	0.13	0.16	0.18	0.14	0.16	0.18	0.13	0.16	0.18	0.10	0.16	0.10	0.16	0.14	0.18
D7	0.13	0.16	0.13	0.19	0.18	0.19	0.16	0.17	0.13	0.18	0.18	0.16	0.21	0.17	0.20	0.18	0.17	0.16	0.18	0.17	0.16	0.18	0.10	0.16	0.10	0.16	0.17	0.18
D8	0.17	0.16	0.13	0.19	0.18	0.11	0.13	0.14	0.16	0.14	0.18	0.16	0.21	0.17	0.20	0.14	0.14	0.16	0.18	0.13	0.16	0.18	0.10	0.16	0.10	0.16	0.17	0.14
E1	0.10	0.10	0.13	0.11	0.11	0.11	0.13	0.14	0.13	0.18	0.14	0.13	0.08	0.13	0.08	0.18	0.17	0.13	0.04	0.17	0.16	0.04	0.13	0.13	0.10	0.16	0.10	0.11
E2	0.10	0.13	0.13	0.11	0.11	0.19	0.16	0.17	0.16	0.14	0.14	0.13	0.08	0.13	0.08	0.14	0.17	0.13	0.04	0.17	0.16	0.04	0.17	0.13	0.10	0.09	0.10	0.11
E3	0.13	0.13	0.13	0.11	0.11	0.11	0.13	0.10	0.13	0.14	0.14	0.13	0.08	0.13	0.08	0.14	0.14	0.16	0.04	0.13	0.16	0.07	0.17	0.13	0.10	0.09	0.10	0.14
E4	0.13	0.16	0.17	0.15	0.15	0.11	0.13	0.14	0.13	0.18	0.14	0.16	0.13	0.13	0.12	0.18	0.17	0.13	0.18	0.17	0.16	0.18	0.13	0.16	0.19	0.16	0.17	0.14
E5	0.17	0.16	0.10	0.11	0.18	0.15	0.13	0.14	0.13	0.18	0.18	0.16	0.21	0.10	0.20	0.14	0.07	0.16	0.18	0.17	0.16	0.18	0.13	0.16	0.10	0.16	0.10	0.18
E6	0.17	0.16	0.17	0.15	0.15	0.19	0.16	0.17	0.16	0.14	0.14	0.16	0.13	0.13	0.08	0.18	0.14	0.16	0.18	0.17	0.16	0.18	0.17	0.16	0.10	0.16	0.14	0.14
E7	0.17	0.13	0.17	0.19	0.18	0.15	0.13	0.14	0.13	0.14	0.18	0.13	0.13	0.17	0.12	0.14	0.14	0.13	0.18	0.13	0.12	0.04	0.17	0.16	0.10	0.16	0.14	0.14
E8	0.17	0.13	0.17	0.19	0.18	0.15	0.13	0.14	0.13	0.14	0.18	0.13	0.13	0.17	0.12	0.14	0.14	0.13	0.18	0.13	0.12	0.04	0.17	0.16	0.10	0.16	0.14	0.14
E9	0.17	0.16	0.17	0.15	0.15	0.19	0.16	0.17	0.16	0.07	0.18	0.13	0.13	0.17	0.12	0.07	0.10	0.16	0.18	0.10	0.16	0.18	0.17	0.13	0.10	0.16	0.17	0.11
F3	0.17	0.16	0.17	0.19	0.18	0.11	0.13	0.14	0.13	0.07	0.18	0.16	0.21	0.17	0.20	0.11	0.14	0.13	0.18	0.13	0.12	0.04	0.13	0.16	0.19	0.16	0.17	0.18
F4	0.17	0.16	0.13	0.15	0.15	0.11	0.13	0.10	0.13	0.07	0.14	0.13	0.08	0.13	0.08	0.07	0.14	0.13	0.04	0.13	0.12	0.04	0.13	0.13	0.19	0.12	0.17	0.14
F5	0.17	0.16	0.17	0.11	0.11	0.11	0.16	0.17	0.16	0.18	0.18	0.13	0.21	0.17	0.20	0.14	0.14	0.16	0.18	0.13	0.12	0.18	0.17	0.13	0.19	0.16	0.17	0.14
F6	0.17	0.16	0.17	0.11	0.11	0.15	0.16	0.17	0.16	0.14	0.18	0.16	0.08	0.17	0.08	0.14	0.10	0.16	0.04	0.10	0.16	0.04	0.17	0.16	0.10	0.12	0.17	0.11
F7	0.17	0.16	0.17	0.19	0.18	0.15	0.16	0.17	0.16	0.18	0.18	0.13	0.17	0.17	0.16	0.18	0.10	0.13	0.18	0.10	0.16	0.18	0.13	0.13	0.19	0.16	0.17	0.18
F8	0.17	0.16	0.17	0.19	0.18	0.15	0.16	0.17	0.16	0.18																		

