Decision making analysis for water distribution improvement projects

by Dedi Purba

IOP Conference Series: Materials
Science and Engineering

Decision making analysis for water distribution improvement projects

To cite this article: Dedi Alfa Julian Purba *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **1007** 012011

Decision making analysis for water distribution improvement projects

Dedi Alfa Julian Purba, Wati Asriningsih Pranoto*, Mark Setiadi
Civil Engineering Department, Faculty of engineering
Tarumanegara University

*watip@ft.untar.ac.id

Abstract. Regional water utility company at Jakarta is determined to improve the quality of service to its customers. The water distribution system must have criteria for quantity, quality, and continuity of flow. To maintain the criteria of company, it continues to make improvements. Based on the evaluation of water utility company that they could decrease of non-revenue water was 1% per year with company target was 2% per year. Decision support systems increasingly play an important role in the area of area control that will be used as improvement project on pipes to customers. Some supporting methods that will be used are electre and linear programming (LP). Electre will be used in decision making analysis on determining the repair area. Based on the results of electre analysis, it can be seen that B01, B02, B13, and B20 have the highest priority that can be recommended for improvement projects. LP can be used as tools for selecting the project to get maximum profit from limited of budget. Based on the results of LP analysis, it can be seen that it selected 13 projects from 16 projects with the constraint's budget of maintenance is 16.7 BIDR.

1. Introduction

The Problem- As water distribution system that they had problems such as corrosion of the pipe and pipe leakage. Therefore preventive action is the most appropriate step that a history of maintenance can be used to produce maintenance standards on a regular basis. The purpose of these preventive action is an important objective for future water distribution maintenance planning. At the same time, steps to increase capital for the rehabilitation of the pipeline became a concern of the management. Maintenance management systems by integrating routine maintenance and capital improvement planning are important goals for future water distribution system.

2. Method and materials

This study provides an electre method and linear programming for the problem of water maintenance project. This study presents an approach for budgeting maintenance costs in water distribution networks. The decision making process starts to choose project which it will be plan by company in 2020. Rehabilitation and replacement of alternatives were evaluated for each pipeline, based on field study.

2.1. Object sample

The sample was selected at West Jakarta. Water utility company have divided 20 permanent service areas. Permanent services area can make it easy to find out what the value of water loss is for each area, so that priority can be made on data as shown below on **Table 1** and mapping area on **figure 1**.

Table 1. Permanent area of water distribution

PA	LOCATION	PA	LOCATION
B01	Kelapa Dua	B11	Teluk Gong
B02	Meruya Ilir	B12	Rawa Buaya
B03	Sukabumi Utara	B13	Permata Buana
B04	Perjuangan	B14	Semanan
B05	Tanjung Duren	B15	Jelambar
B06	Kedoya	B16	Perternakan
B07	Taman Kota	B17	Rawa Gabus
B08	Moneter	B18	Cengkareng Timur
B09	Puri Indah	B19	Cengkareng Barat
B10	Tosiga	B20	Kalideres

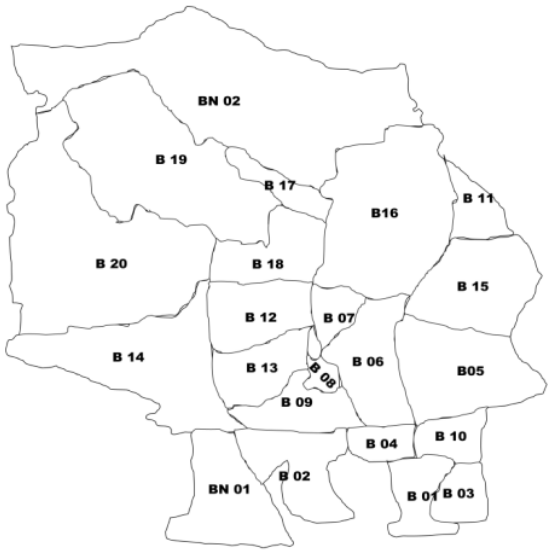

Figure 1. Permanent area

2.2. Method

The method in the decision making proses are electre and linear programming. The electre will use to select three permanent area which it will analysis on the field. The linear programming will use to choose projects with the objective target is maximum sales. The final result from this method are project decision maker and the cost of project. Its purposes is maximum profit for company with the constraint's budget.

2.2.1. Electre

Make a decision matrix based on consideration of making a decision and normalizing the values in the decision matrix. A set of categories must be a priority defined. The definition of a category is based on the fact that all potential action which are assigned to it will be considered further in the same way. In

sorting problematic, each action is considered independently from the others in order to determine the categories [3]. Then the best alternative is the alternative that dominates the other alternatives.

2.2.2. Linear Programming

Linear programming is a mathematical method that has a linear characteristic to find solution with the step of maximizing the objective function of an arrangement of constraints [1]. The models is binary problems. Binary problem, each variable can only take on the value of 0 or 1. This may represent the selection or rejection. The objective of target from linear programming is maximum sales in the potency sales of project.

3. Results

3.1. Evaluation of Water System Distribution

The evaluation data can show the root problems. The period of data is January 2018 until to August 2019. From **Figure 2,** it can show the average supply and sales. The value of NRW (non-revenue water) is 42.1%.

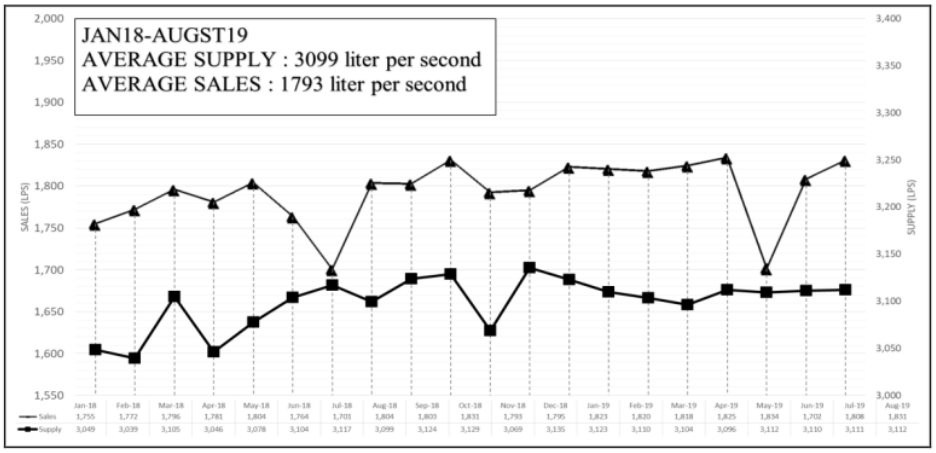

Figure 2. Supply VS Sales

3.2. Electre

The step in the decision making process used six criteria. The six criteria are supply, sales, non-revenue water, complaint, number of standard customers, and number of key account customers. The criteria is shown below on **Table 2**. The criteria will use to convert with the primary data and the result of conversion will be used by electre formula. The primary data can be shown on **Table 3** and the result of conversion can be show on **Table 4**.

Table 2 Criteria of electre

Supply	Sales	NRW	Average Complaint	∑ STD	∑ KA	Rating	Information
On below agreement 10%	Achievement 95-96% from target	NRW > 50%	Complaint > 70	> 15000	> 60	5	Very Bad
On below agreement	Achievement 97-99% from target	NRW 41-50%	Complaint 51-70	10001 - 15000	41 - 60	4	Bad
In the middle agreement	Achievement 100% from target	NRW 31-40%	Complaint 31-50	5001 - 10000	31 - 40	3	Enough
Above agreement	Achievement 101-102% from target	NRW 20-30%	Complaint 11-30	1001 - 5000	11 - 30	2	Good

Above Agreement 10%	Achievement 103-105% from target	NRW	< 20%	Complaint 10	< 1000	< 10	1 Well

Table 3. Primary data

PA	Supply (lps)	Sales (lps)	NRW (%)	Complaint (cust)	∑ STD (cust)	∑ KA (cust)
B01	63	16	74%	2	1959	7
B02	55	36	33%	17	4526	22
B03	38	10	75%	34	1611	1
B04	33	17	48%	8	462	9
B05	421	230	45%	181	19386	57
B06	198	121	39%	27	11599	15
B07	88	57	35%	9	5438	10
B08	17	14	15%	3	1080	2
B09	46	33	28%	17	2869	10
B10	31	12	61%	16	1679	5
B11	177	85	52%	61	9115	17
B12	135	95	30%	42	11604	11
B13	58	32	45%	7	3312	4
B14	186	133	28%	34	16302	9
B15	386	164	57%	105	21801	76
B16	263	134	49%	52	13854	34
B17	70	43	39%	15	6246	5
B18	250	141	44%	57	19794	25
B19	242	171	29%	1163	20550	33
B20	241	161	33%	1019	20394	40

Table 4. The result of rating data

PA	Supply	Sales	NRW	Complaint	∑ STD	∑ KA
B01	3	5	5	1	2	1
B02	3	1	3	2	2	2
B03	2	3	5	3	2	1
B04	2	3	4	1	1	1
B05	3	5	4	5	5	4
B06	3	2	3	2	4	2
B07	3	1	3	1	3	1
B08	3	1	1	1	2	1
B09	2	5	2	2	2	1
B10	3	3	5	2	2	1
B11	3	5	5	4	3	2
B12	3	1	2	3	4	2
B13	3	2	4	1	2	1
B14	3	3	2	3	5	1
B15	3	3	5	5	5	5
B16	1	2	4	4	4	3
B17	3	1	3	2	3	1
B18	1	2	4	4	5	2
B19	4	2	2	5	5	3
B20	3	5	3	5	5	3

The data processing in this research is the ranking of the water service areas for the recommendation of project area by using the electre formula. The process produces concordance and dis-concordance values for each alternative. Based on the results of electre, it can be seen that B01, B02, B13, and B20

have the highest priority that can be recommended for improvement projects. The result can be shown on **Table 5** and mapping area can be show on **Figure 3**.

Table 5. Result of electre

PA	B 1	B2	B 3	B 4	B 5	B 6	B 7	B 8	B 9	B 10	B 11	B 12	B 13	B 14	B 15	B 16	B 17	B 18	B 19	B 20	∑
B01	-	0	1	0	1	0	0	0	0	1	0	1	0	1	1	1	0	1	0	1	9
B02	1	-	0	0	0	1	0	0	1	1	0	0	0	1	0	0	1	0	0	0	6
B03	0	0	-	1	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	4
B04	0	0	0	-	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	4
B05	1	0	0	0	-	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	3
B06	0	0	0	0	0	-	1	0	1	1	0	0	0	0	0	0	0	0	0	0	3
B07	0	0	0	0	0	0	-	0	0	0	0	1	0	0	0	0	1	0	0	0	2
B08	1	0	0	0	0	0	0	-	0	0	0	0	1	0	0	0	0	0	0	0	2
B09	0	0	1	1	0	0	0	0	-	1	0	0	0	1	0	0	0	0	0	0	4
B10	1	0	0	0	0	0	0	0	0	-	0	0	0	0	1	0	0	0	0	0	2
B11	0	0	0	0	1	0	0	0	1	0	-	0	0	0	1	0	0	0	0	1	4
B12	0	0	0	0	0	0	0	0	0	0	0	-	0	1	0	0	0	0	0	0	1
B13	1	0	0	0	0	1	0	0	0	0	0	1	-	0	0	1	1	1	0	0	6
B14	0	0	1	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	1
B15	1	0	0	0	1	0	0	0	0	0	1	0	0	0	-	0	0	0	0	1	4
B16	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	-	0	1	0	0	3
B17	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	-	0	0	0	4
B18	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	-	0	0	3
B19	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	-	1	3
B20	1	0	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	-	5

Figure 3. Mapping area

3.3. Linear Programming

A total budget of 16.7 BIDR for maintenance and capital improvement measures is available in this year. The budget projections are given in **Table 6**. It is the outputs of the model. The first column

represents projects and third column represent capital required for the project. Examination of these results shows that the project in which implementation was most deferred are project B01-001, B01-002, B01-004, B01-005, B02-001, B13-001, B13-002, B13-003, B20-001, B20-002, B20-003, B20-004, and B20-005.

Table 6. Result of linear programming

PROJECTS CODE	PA	LENGTH (m)	CAPITAL REQUIRED BIDR	POTENSIAL SALES (M3)	PROJECT TAKEN/NOT
B01-001	B01	-	0.7	2,940	1
B01-002	B01	211	1.5	22,380	1
B01-003	B01	122	0.3	1,260	0
B01-004	B01	155	0.9	17,940	1
B01-005	B01	22	0.02	3,540	1
B02-001	B02	600	0.9	16,956	1
B13-001	B13	111	3.9	70,920	1
B13-002	B13	200	1.7	30,120	1
B13-003	B13	100	0.8	14,280	1
B13-004	B13	150	0.6	8,400	0
B13-005	B13	144	2.8	28,980	0
B20-001	B20	100	2.4	94,908	1
B20-002	B20	100	0.7	115,860	1
B20-003	B20	555	1.1	9,000	1
B20-004	B20	100	0.8	8,820	1
B20-005	B20	133	1.2	33,780	1
BUDGET			**16.74**	**441,444**	**13**
CAPITAL REQUIRED (BIDR)			**16.58**		

4. Conclusion

The decision making process is not decided by only one participant, but by many participants. This is because decision making covers the interests of many participants that must be considered, so that the decisions made can be satisfactory for all participants. In decision making there are many alternative decisions [3]. Often decision makers in making decisions use intuition, so the results of decision making are not always right. Based on the results of electre analysis, it can be seen that B01, B02, B13, and B20 have the highest priority that can be recommended for improvement projects. Examination of these results shows that the project in which implementation was most deferred are project B01-001, B01-002, B01-004, B01-005, B02-001, B13-001, B13-002, B13-003, B20-001, B20-002, B20-003, B20-004, and B20-005. Three permanent area and thirteen project were planned by model.

References

[1] Fadi A Karaa, A. M. 1987 *Budgeting Of Water Distribution Improvment Projects* Vol **113** 378-391
[2] Febriyanno Suryana *Elimination Et Choix Trasudiant La Realite 2016 Sistem Pendukung Keputusan Pemilihan Siswa Berprestasi Dengan Metode Electre* (Jakarta: Binus)
[3] José Figueria and Vincent Mousseau 2016 *ELECTRE Methods* (Portugal: Universidade de Coimbra) p16
[4] Pinem, A. P. 2017 *Implementasi Fuzzy ELECTRE Untuk Penilaian Kerusakan Akibat BencanaAlam* (Semarang: Universitas Semarang)

Decision making analysis for water distribution improvement projects

ORIGINALITY REPORT

4%	4%	1%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.proquest.com Internet Source	1%
2	www.scilit.net Internet Source	1%
3	iopscience.iop.org Internet Source	1%
4	m.moam.info Internet Source	1%
5	docplayer.org Internet Source	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		