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APPROPRIATENESS OF A MULTI-CRITERIA RATING MODEL: THE CASE OF ESTABLISHING RESCUE POLICIES FOR REGIONAL DRINKING WATER COMPANIES (PDAM) IN INDONESIA

Kirti Peniwati
PPM Graduate School of Management
Jl. Menteng Raya 9, Jakarta 10340, Indonesia
kirti@indo.net.id

Werner Brenner
The Indonesian Association of Water Companies (PERPAMSI)
Jl. Penjernihan II/27B, Pejompongan, Jakarta, Indonesia.
wbrenner@dnet.net.id

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Summary: *Fresh water is in abundance in Indonesia, but it has not been evenly distributed within the country. Only about 20% out of more than 200 millions of Indonesian population have access to clean water supplied by the 306 Regional Drinking Water Companies (PDAMs). The poor performance of most PDAMs is due to high level of debt, lack of investment, and inefficient operations. On one hand, the PDAMs need to increase its coverage capacity but on the other hand they have been operating under unfavorable regulated tariff policies. Indonesia's Water Enterprise Association (PERPAMSI) has been participating in a task force to propose financial policies to rescue the industry by rating and grouping the PDAMs using a multi-criteria framework. This paper proposes improvements to the model by maintaining the original priority judgments. Model-1 is the AHP representation of the original model, Model-2 is similar to Model-1 with the principle of hierarchic composition is satisfied, and Model-3 is a framework for multi-decisions decision making by clustering the PDAMs based on their business performance. Model-2 does not improve its usefulness for identifying specific group policies that fit the need of every PDAM in a given group. Model-3 enables one to identify a specific policy applicable for either the whole PDAMs or those grouped in a certain cluster, and rate the PDAMs based on a set of criteria that is relevant to that policy. The results of the three models are evaluated and some examples of using Model-3 framework to rate the PDAMs, each with a specific policy in mind, are provided.*

1. Introduction

Fresh water is in abundance in Indonesia, but it has not been evenly distributed within the country. Provision of clean water still needs to be enhanced to meet people's basic needs especially in rural areas. It has been reported that at the beginning of the new millennium, only about 20% out of more than 200 millions of Indonesian population have access to clean water supplied by the 306 Regional Drinking Water Companies (PDAM) around the country . The poor performance of PDAM is due to high level of debt, lack of investment, and inefficient operations. On one hand, PDAMs need to increase its coverage capacity but on the other hand they are operated under unfavorable regulated tariff policies. The number of PDAM with long term liabilities are close to 70%, with more than 90% of them have been penalized for not paying their debt as scheduled.

The government established a task force, in which representations from the Indonesia Water Enterprise Association (PERPAMSI) and other institutions have been collaborating in a program to rescue and increase the efficiency of the PDAMs. Some of the objectives of the program are increasing government's financial support and introducing full cost recovery to water service without compromising the need to serve the low-income communities. The team has established a rating model to prioritize the PDAMs with respect to how much they need financial support or/and management interventions to survive. The PDAMs are then grouped based on their scores and debt solution policies are recommended for each group. Thirty PDAMs were then selected for more detailed study, partly because the proposed policies are too broad with no clear distinction between policies for different groups.

The purpose of this paper is to show the original model and two alternative improvements after converting the original framework into an AHP model (Model-1). Model-2 is similar to Model-1, but ensuring that the principle of hierarchic composition is satisfied by removing internal dependency among criteria through a correlation test. Model-3 clusters the PDAMs based on their financial performance, making it useful to identify an appropriate policy and rate the PDAMs with that policy in mind using only criteria that are relevant for the purpose.

2. Model 1: The Original Model

The original rating model contains 13 criteria grouped into external factors and internal factors. The external factors are those considered as uncontrollable by the PDAMs, i.e., Water Source Bottleneck, Chemical and Electricity Costs, Idle Capacity, Tariff Ratio, Arrears to Short Term Debt for Loans Ratio, and Debt to Equity Ratio. The internal factors are controllable by the PDAMs, i.e., Non Revenue Water, Employees per 1000 Connections, Working Ratio, Collection Period, Current Ratio, Solvability Ratio, Coverage Ratio. A range of discrete points between 2 and 10 or between 2 and 20 are assigned for each factor, to be used in representing judgments regarding the quality of a PDAM with respect to that particular factor [Brenner, 2005]. External factors and internal factors are judged to be equally important and expressed by having the same total of maximum scores of the external as the internal set of criteria. As many as 167 PDAM were evaluated by assigning discrete points for each criterion to obtain overall scores that were then used to divide the PDAMs into five groups and recommend alternative policies for each group.

The model can be directly converted into an AHP model as shown in Fig.1, with the points represent intensity ratings of the AHP's absolute measurement approach. This implied an assumption that the discrete points used to represent judgments come from ratio scales.

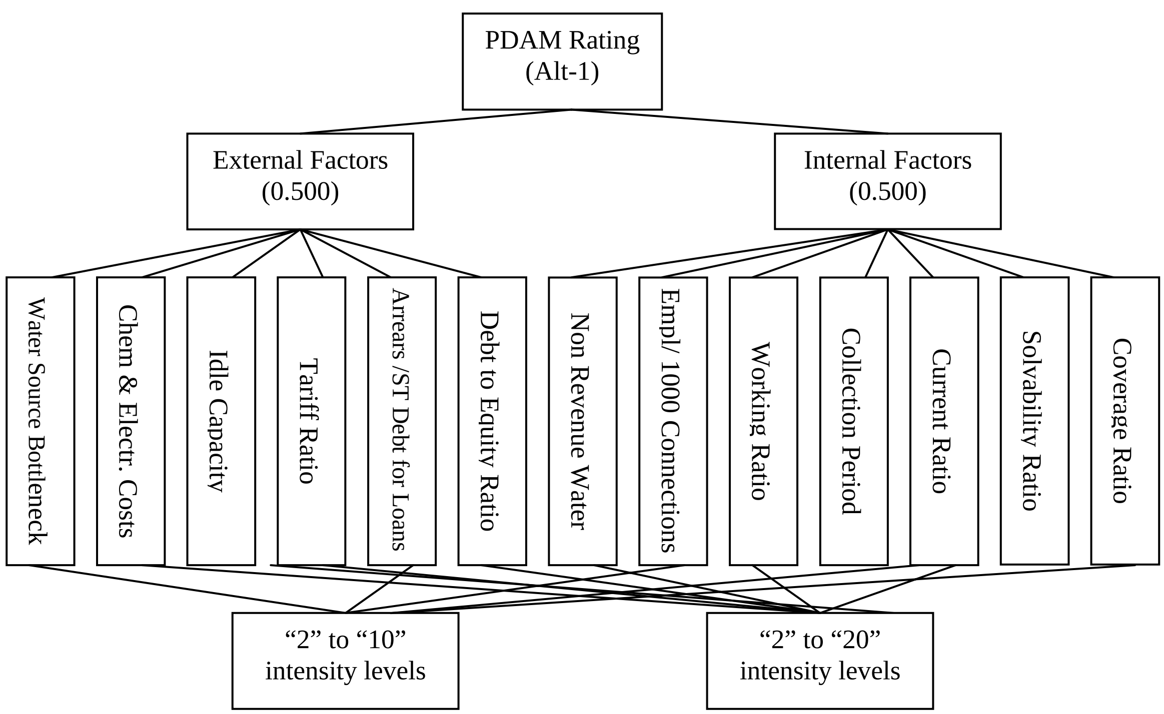

Figure 1. The AHP Representation of the Original Rating Model (Model-1)

The AHP representation of the original model is a four level hierarchy with external factors and internal factors as the main criteria, judged as equally important. Sub-factors or criteria with maximum scores of 20 are judged as twice as important as those with maximum scores of 10. Intensity ratings are noted using the numbers used, i.e., “2”, “4”, …, “10”, …, “20”, each associated with a range of quantitative measures for each criterion. The numbers represent relative priority of the intensity ratings. The alternatives are evaluated by assigning a number from the set of intensity ratings, assumed to be ratios, hence can be normalized to get the AHP’s (0,1) priority scales. By entering the same intensity judgments, Model-1 produces the same overall PDAM rating scores as those of the original model. The scoring is such that the higher the number, the more troubled the PDAM is, hence the higher the priority for receiving government financial support. The global relative priorities of the criteria are a normalization of the maximum points of Model-1, as shown in Table 1 below:

Table 1. Points vs Relative Priorities of the Factors/Criteria (with dependency)

Factors/Criteria	Maximum Points (original model)	Global Priority (AHP)
External factors (uncontrollable by PDAM)		
Water Source Bottleneck	10	0.050
Chemical and Electricity Costs	20	0.100
Idle Capacity	20	0.100
Tariff Ratio	20	0.100
Arrears to Short Term Debt for Loans Ratio	10	0.050
Debt to Equity Ratio	20	0.100
Total	100	0.500
Internal factors (controllable by PDAM)		
Non Revenue Water	20	0.100
Number of Employees per 1000 Connections	10	0.050
Working Ratio	20	0.100
Collection Period	10	0.050
Current Ratio	20	0.100
Solvability Ratio	10	0.050
Coverage Ratio.	10	0.050
Total	100	0.500

Table 2. The Original Grouping and Proposed Policies

Group	Total Points	Proposed Policy	Number of PDAM
1 Very Weak	86 - 100	• Write off all unpaid interest, debt, and commitment fee. • Debt restructuring / write off unpaid principal.	4 (2.4 %)
2 Weak	71 - 85	• Write off all unpaid interest and debt. • Debt restructuring / write off unpaid principal	46 (27.5 %)
3 Inadequate	56 - 70	• Write off all unpaid interest and debt. • Write off unpaid principal.	64 (38.3 %)
4 Adequate	41 – 55	• Write off all unpaid penalty • Debt restructuring	45 (27.0 %)
5 Strong	13 - 40	• Debt restructuring	8 (4.8 %)

The PDAMs are categorized into 5 groups based on the scores obtained from the model, ranging from very weak to strong. The five categories of PDAMs with the recommended policies for each group are shown in Table 2 above.

3. Model-2 : A Hierarchy that Satisfies the Principle of Hierarchic Composition

The outcome of Model-1 is valid only if the Principle of Hierarchic Composition (Saaty, 1994) is satisfied, i.e., the factors are independent. We conducted a correlation test for the set of factors in the original model (Model 1) and the result is shown in Table 3 below:

Table 3. Results of Correlation Test for Model 1

Criteria as Variables	Degree of Correlation
Current Ratio	No significant correlation
Solvability Ratio	No significant correlation
Water Source Bottleneck	No significant correlation
Idle capacity	No significant correlation
Debt to Equity Ratio	No significant correlation
Non Revenue Water and Collection Period	Significant at the 0.05 level (2-tailed)
Coverage Ratio and Arrears to Short Term Debt for Loan Ratio	Significant at the 0.01 level (2-tailed)
Coverage Ratio and Tariff Ratio	Significant at the 0.01 level (2-tailed)
Employees per 1000 Connections and Working Ratio	Significant at the 0.01 level (2-tailed)
Employees per 1000 Connections and Collection Period	Significant at the 0.01 level (2-tailed)
Working Ratio and Chemical and Electricity Costs	Significant at the 0.01 level (2-tailed)
Collection Period and Chemical and Electricity Costs	Significant at the 0.01 level (2-tailed)
Collection Period and Tariff Ratio	Significant at the 0.01 level (2-tailed)

The presence of significant correlations between criteria indicates that Model 1 violates the principle of hierarchic composition (axiom of independence), which may lead to invalid outcome. Taking into consideration only significant correlations at the 0.01 level, we obtained nine (assumed) independent factors as follows: Non Revenue Water, Collection Period, Coverage Ratio, Working ratio, Current Ratio, Solvability Ratio, Water Source Bottleneck, Idle Capacity, and Debt to Equity Ratio. When there is a significant correlation between an internal factor and an external factor, we chose the internal factor to make the improved model creates a sense that the PDAMs is more in control of their companies' future. We propose Model-2 to improve Model-1 such that the principle of hierarchic composition is satisfied.

To maintain the equivalency between Model-2 and the original model regarding judgments of relative priorities, the relative priority of the External Factors and Internal Factors must be maintained to be proportional to the total maximum points of the new set of criteria which represents relative priorities.the External Factors and Internal Factors elements. In this case, the relative priorities of External and Internal Factors elements become 0.357 and 0.643 respectively. The AHP model for Model-2 with the global priorities associated with the points assigned by the team are shown in Fig. 2 and Table 3 below.

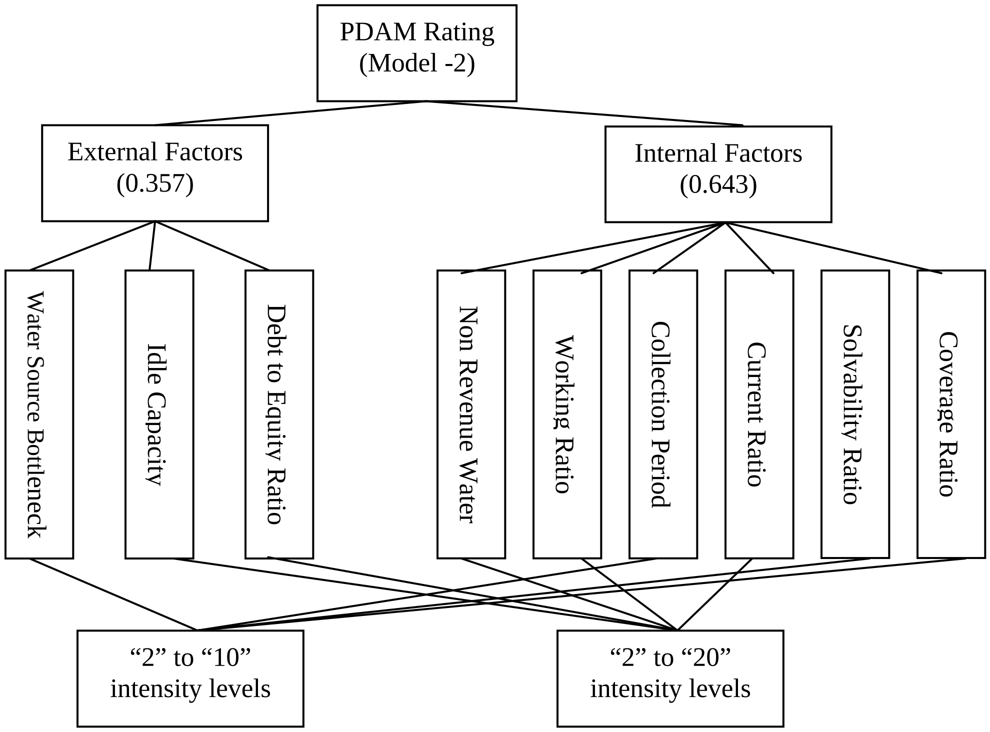

Figure 2. AHP Representation of the Original Model with Independent Criteria

Table 4. Points vs Relative Priorities of the Factors/Criteria (significant dependency removed)

Factors/Criteria	Maximum Points (original structure)	Global Priority (AHP)
External factors (uncontrollable by PDAM)		
Water Source Bottleneck	10	0.071
Idle Capacity	20	0.143
Debt to Equity Ratio	20	0.143
Total	50	0.357
Internal factors (controllable by PDAM)		
Non Revenue Water	20	0.143
Working Ratio	20	0.143
Collection Period	10	0.071
Current Ratio	20	0.143
Solvability Ratio	10	0.071
Coverage Ratio.	10	0.071
Total	90	0.643

4. Model 3: A Model with Clustering Based on Business Performance

Model-1 and Model-2 take all PDAMs as one population, and group them in increasing order based on their scores. Applying a multi-criteria rating model like this does not seem to help in designing a common rescue policy that is applicable for each group. We would argue that financial policies need to be based on business performance using financial indicators. For this reason, the appropriate framework would be one that clusters the PDAMs based on those indicators. The process can be done with the line of thinking as described below, that can also be represented in a diagram shown in Figure 3:

- PDAMs with negative equity but continuously show working ratio below 100% do not have a business justification to operate anymore. Maintaining their operation means that they are subsidized operations for public service. From a purely business perspective, they are in a bankruptcy status and need to be liquidated. They are grouped in Cluster A.
- PDAMs with negative equity but working ratio more than 100% are also technically bankrupt, but still have the capacity to continue their operation as long as they are not burdened with depreciation cost and interests. They are grouped in Cluster B.
- PDAMs with positive equity but continuously show working ratio below 100% are approaching bankruptcy. It is just a matter of time, and they are grouped in Cluster C.
- PDAMs with positive equity, working ratio above 100% but tariff ratio below 100% do not have the capacity to maintain their fixed assets. They are not profitable businesses and grouped as Cluster D.
- PDAMs with positive equity, working ratio above 100%, and tariff ratio above 100%, are profitable businesses. They are grouped as Cluster E.

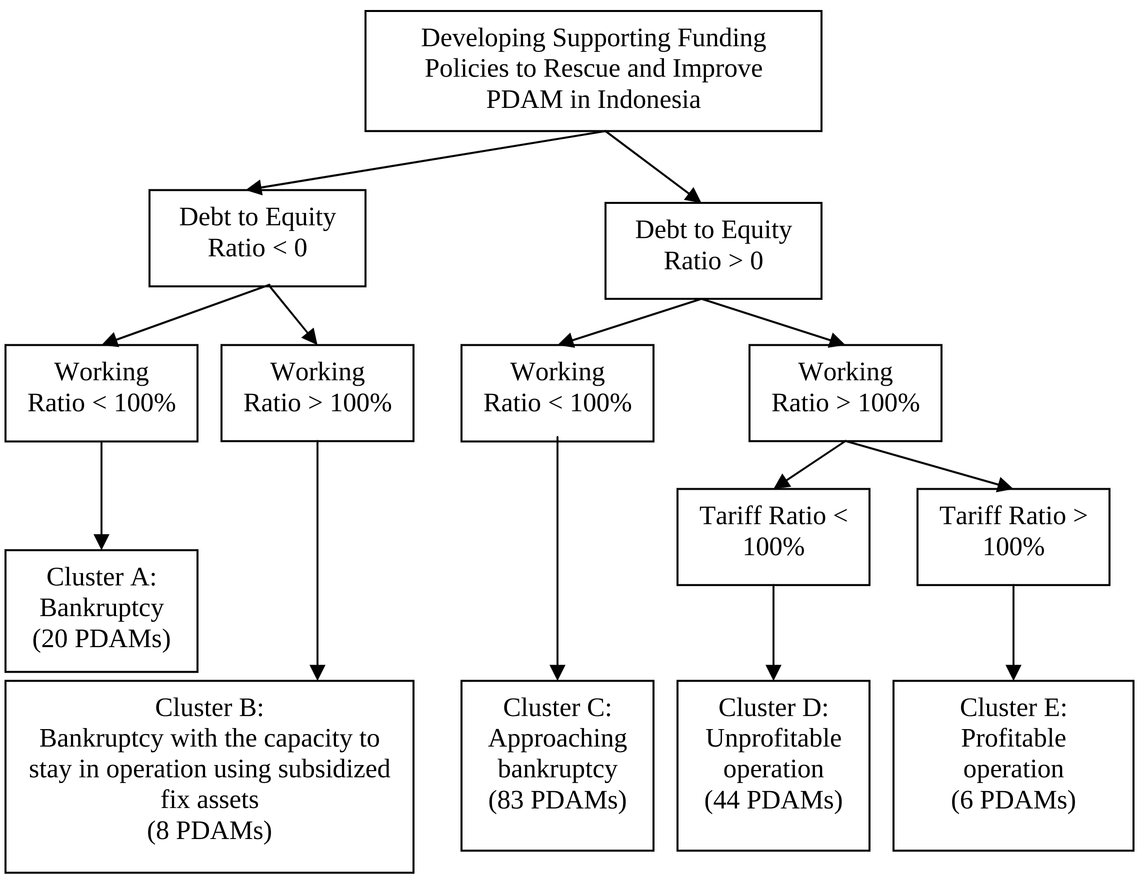

Figure 3. Clustering of PDAMs Based on Business Performance

5. Analysis of the Different Models

Model-1 and Model-2 put all PDAMs in one population while Model -3 groups them in clusters based on their business conditions. While Model-1 and Model-2 use a range of rating scores to indicate an appropriate rescue policy, Model-3 allows rating to prioritize PDAMs in a given group with a specific policy in mind.

5.1 Model-1 and Model-2 are Significantly Correlated

A correlation test between PDAM's groupings as shown by Model-1 and Model-2 outcomes gives a Pearson Correlation of 0.859, which is significant at the 0.01 level. The difference in grouping, uswing the same cut-off points, is never more than 1 as shown below:

- 112 (68 %) PDAMs grouped the same.
- 12 (7 %) PDAMs grouped lower (worse) by Model-2 than by Model-1
- 43 (26 %) PDAM grouped higher (better) by Model-2 than by Model-1

This finding must not lead to a conclusion that satisfying the principle of hierarchic composition is not necessary for a hierarchy. It is true, however, that improvement in Model 2 does not add to its usefulness for designing rescue policies. Model 1 and Model 2 give different numbers of PDAM in each group as shown in Table 5 below. Despite its significant correlation, it is interesting to observe that Model-1 rated only 8 PDAMs as strong while Model-2 rated as many as 24 PDAMs in this top group.

Table 5. Grouping of PDAMs Using Model 1 and Model 2

Group	Total Points	Number of PDAM			
		Model 1		Model 2	
		Number	%	Number	%
1 Very Weak	86 - 100	4	2.4	5	29.9
2 Weak	71 - 85	46	27.5	40	24.0
3 Inadequate	56 - 70	64	38.3	57	34.1
4 Adequate	41 – 55	45	27.0	41	24.6
5 Strong	13 - 40	8	4.8	24	14.4

5.2 Model-3 Facilitate Purposeful Ratings

Model-3 uses a decision tree structure to cluster the PDAMs into homogeneous groups. The different numbers of PDAMs in each group by the three models are shown in Table 6 below. The total number of PDAMs in this table is only 157 instead of 167 because of incomplete data. This table shows the significant difference between the outcome of Model-3 and Model-1 or Model-2. For example, PDAMs in Cluster C (those approaching bancruptcy) are scattered in all groups from the worst (Group 1) to the best (group 5) by Model-1 and Model-2. We have 20 PDAMs in Cluster A (those in a bancruptcy state), but only four of them fall in Group 1 (very weak) with Model 1 and Model 2.

These results show the problematic nature of using a single multi-criteria rating model for the whole population of PDAMs with a wide range of business performance levels. Such a rating model does not facilitate the identification of a unique policy for each group that represents their different positions in the rating process.

Table 6. Different Groupings of PDAMs by Different Models

Model 3	Model 1					Model 2				
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 1	Group 2	Group 3	Group 4	Group 5
Cluster A 20	4	12	4	1	-	4	12	4	1	-
Cluster B 8	-	3	4	1	-	-	4	3	1	-
Cluster C 83	1	23	33	23	1	1	19	32	21	8
Cluster D 44	-	6	19	12	6	-	4	13	14	12
Cluster E 4	-	-	-	3	1	-	-	1	1	2

6. Purposeful Rating with Model-3

The purpose of a rating assessment dictates what criteria to use in the model. Hence, a rating model needs to be constructed with a specific purpose in mind to be useful. In this PDAM case, it seems obvious that the different business conditions would need different interventions, be it financial or managerial policies. In this case, rating by cluster may be more helpful. Below are some examples of policies with their appropriate rating with the Model-3 basic structure.

Capacity to Pay Debt

The PDAMs are not fully accountable for their situation of deeply in debt because it was more the central government who made the foreign loan decisions in the past. For this reason, many PDAMs do not seem to feel obliged to pay their debt even when they have the financial capacity to do so. Rating based on Current Ratio is useful to see the PDAMs relative financial liquidity, indicating their level of capacity to pay their short term debt. There are 62 PDAMs with Current Ratio higher than 100%, 37 of them are rated the best by this criterion (scored “2”). The 37 most liquid PDAMs are spread in Groups 3, 4, 5 by Model-1 and Clusters C, D, E by Model-3 as follows

Table 7. Distribution of PDAMs Rated the Best in Current Ratio

	Number of PDAMs		
	Group 3	Group 4	Group 5
Cluster C	7	12	1
Cluster D	5	3	5
Cluster E	-	-	1

PDAMs in Cluster C by Model-3 are those with Working Ratio less than 100%, which are expected not to be able to pay their debt because of liquidity problem. The fact that their financial conditions are highly liquid may indicate that the Working Ratio problem is just temporary, so they may not really approaching bancruptcy. PDAM Kab. Jombang is clustered in C but curiously not only is the most liquid of all but also has extremely high Current Ratio. This PDAM is deeply in debt, with debt penalty almost half of its capital loan. Assuming that the data is accurate, this PDAM may not belong to this cluster and has some capacity to pay its debt but is not willing to do so. This PDAM belongs to the Adequate Group 4 by Model-1. The two PDAMs from Cluster E, PDAM Kota Malang and PDAM Kota Payakumbuh, have no interest payable, indicating discipline in paying short term debt.

Not only that PDAM Kota Malang and PDAM Kota Payakumbuh have no interest payable, they also are free of debt penalty. They can be considered as the best PDAM from the financial performance, but only PDAM Kota Payakumbuh belongs to the strong Group 5 by Model-1. PDAM Kota Malang is rated as adequate (Group 4) by this model. The two PDAMs obtain good rating under solvability ratio.

One may want to rate PDAMs with respect to their overall capacity to pay debt by using Current Ratio and Solvability Ratio. There are 28 PDAMs rated the best, but only 15 of them free of interests and debt penalty payables. The government may need to financially rescue 30 PDAMs that are rated the worst in both criteria.

<u>Tariff Increase</u>

Tariff increase is under the control of local government, a decision that is heavy with social and political considerations. This policy would improve PDAM's survival ability through increasing Working Ratio or Tariff Ratio. Tariff increase can be applied to all PDAMs, but priority may be given to those PDAMs which this policy could move them from Cluster A to Cluster B or from Cluster D to Cluster E.

PDAMs in Cluster A have no business justification to exist anymore, however the government may not want to close them because provision of clean water around the country still needs to be enhanced. In this situation, implementing a rescue intervention to move the PDAMs from Cluster A to Cluster B may be preferable rather than liquidate them. One way to do it is by increasing tariff, but cannot be too significant for obvious reasons. This means that tariff adjustment would work only for PDAMs with Working Ratio relatively close to 100%. For example, reasonable tariffs increase in PDAM Kab. Purbalingga or PDAM Kota Blitar with working ratio 99% and 92% respectively is likely to make a difference, but it may not be for PDAM Kab. Rembang whose Working Ratio is 37%.

With the same line of reasoning, a reasonable tariff increase for PDAMs in Cluster D whose Tariff Ratio is close to 100% will be enough to move them to Cluster E. Tariff increase for PDAM Kota Balikpapan, PDAM Kab. Temanggung, PDAM Kota Palembang, and PDAM Yogyakarta with Tariff Ratio higher than 90% will be likely to move them to Custer E. PDAM Kota Semarang, PDAM Kab. Kutai, or PDAM Kota Makasar are the worst with Tariff Ratio of 11% or less.

Here, even a simple rating model with only a single criterion (Working Ratio or Tariff Ratio) is appropriate and useful to identify PDAMs whose business status can be significantly improved by tariff increase.

<u>Management Intervention to Improve Operational Efficiency</u>

Similar to increasing tariff, management intervention to improve operational efficiency is applicable to all PDAMs. The independent criteria indicating opportunity for improvements are Non Revenue Water, Collection Period, and Coverage Ratio. Here the government may want to prioritize PDAMs based on their relative leverage for such intervention. It is assumed that the highest absolute rating for any of these criteria means most opportunity for improvement. Five PDAMs are top rated in all three criteria, implying the highest leverage for management intervention. They are PDAM Kota Pekan Baru (Cluster A), PDAM Tirta Nciho Kab. Dairi (Cluster A), PDAM Kab. Sumbawa (Cluster C), PDAM Kab. Rejang Lebong (Cluster D), and PDAM Kab. INHU (Cluster D). PDAM Kab. Takalar (Cluster D) is rated the best in all criteria, implying the lowest leverage or relatively no opportunity for improving operational efficiency.

The government may particularly want to move PDAMs from Cluster A to B or from Cluster D to Cluster E by improving operational efficiency. PDAM Kota Pekan Baru and PDAM Tirta Nchico Kab. Dairi are top rated for all criteria, providing the best leverage for management intervention to move them from Cluster A to Cluster B, while PDAM Kab. Wonosobo is rated the lowest.

<u>Rating for Cluster E</u>

PDAMs in Cluster E are profitable businesses, which may not need government financial support. The four PDAMs in this category do not have outstanding debt penalty, indicating that they all have the discipline to pay the debt. PDAM Kab. Purwakarta has the lowest Current Ratio of 42% with no debts in interests and penalty – indicating an excellent discipline in paying debt but may create other problems due to the poor liquidity.

and PDAM Kota Pare-Pare have inadequate Current Ratio with Only two of the four PDAMs in this category have current ratio above 100%, but all four have or its support to increase their capacity to pay debt. There are several alternative policies that can be implemented, such as debt restructuring, tariff increase, or management intervention to increase operational efficiency. We have more than one way to rate the PDAMs in this cluster.

6. Conclusion

It is important to develop a model that is an appropriate representation of the decision at hand. This paper shows that treating a multi decisions problem as a single decision problem could lead to useless outcome, as has been shown by Model-1 and Model-2. Multi decisions problem may take the form of a list of independent set of decision problems, in which AHP can be used to prioritize them. Model-3 is an example of how AHP can be applied in Multi Decisions Decision Making with dependency. The framework of Model-3 is recommended to be used in this context, to facilitate designing appropriate policies for a number of PDAMs with similar situation.

Robert C. G. Varley, a Staff Consultant, Asian Development Bank (Manila) does not seem to be alone when he suggests that "*The best way of addressing chronic and intractable deficiencies in PDAM management and governance is privatization, and a sound regulatory framework.*" However, we should define *privatization* more as managing PDAMs the way private companies do, rather than allowing private investors control this business.

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