Water Supply Management System And Social Capital

Volume 4

Kiyoshi KOBAYASHI
M. Saleh PALLU
Suharman HAMZAH (Editors)

Water Supply Management System And Social Capital Vol. 4
Kiyoshi KOBAYASHI, Muhammad Saleh PALLU, Suharman HAMZAH

ISBN : 978-602-203-411-7

Distribution :
Laboratory of Planning and Management Systems
Department of Urban Management
Graduate School of Engineering
Kyoto University
615-8540, Japan

In collaboration with :
Department of Civil Engineering
Faculty of Engineering
University of Hasanudin, Makassar
90245, South Sulawesi, Indonesia

Published by :

Universitas Brawijaya Press (UB Press)
Jl. Veteran, Malang 65145 Indonesia
Telp: 0341-551611 psw. 376
Fax: 0341-565420
e-Mail: ubpress@gmail.com
http://www.ubpress.ub.ac.id

Cover : Waipokol Beach, Central Moluccas, Indonesia 2012
(courtesy of Ismu Rini Dwi Ari, design by Erwin Badateng)

Content

Part 3 Case Study on Water Supply Provision and Management

Chapter 8

Efficiency of Communal and Public Water Supply System

Sri Maryati, and Heru P.H Putro

8.1 INTRODUCTION

Condition of water supply provision in Indonesia cannot fulfill the demand of community. As a figure, in 2009 only 43.96% of community in urban area had access to public water supply, whereas in rural area only 11.54% (Directorate Generale of Cipta Karya, 2011).

Some effort have been done by government and community in order to increase access to public water supply, among others are PAMSIMAS programme. PAMSIMAS or WSLIC-3 (The Third Water Supply and Sanitation for Low Income Community) is water supply provision and sanitation programme based on community participation. The programme is directed for low income community in rural area or peri-urban area. The objective of the programme is to increase access of community to water and sanitation. The programme was started in 2007. Besides programme from government such as PAMSIMAS, there were also some communal system initiated by community purely. The community plan, construct, and operate the system without intervention from government. Such system usually exist in urban area. Sometimes housing developers also constructed water supply system in order to fulfill the demand of community. Water system from PAMSIMAS programme or the system which did not plan, construct, and operate by government to serve community in urban area in this paper is called as communal system.

The scale of communal system is smaller compared to public scale. Evidence in Indonesia, especially in West Java Province shown that there was economies of scale in water supply provision. The bigger the system, the cheaper the cost (Maryati *et al.*, 2009). The fact related to the scale of communal system and evidence of economies of scale in Indonesia raise a question concerning efficiency of communal system compared to public system. The objective of this paper was to identify level of efficiency of communal system and public system. Although the scale of communal system was smaller compared to public system, communal system especially in rural area should be efficient in order to fulfill the need of low income community. By knowing the level of efficiency of respective system and some possible condition that influence the level of efficiency, some recommendation can be proposed to improve the system.

8.2 EFFICIENCY OF WATER SUPPLY SYSTEM

Efficiency is defined as how much output produced by using certain input, or how much input needed to produce certain output. Input and output to measure the level of efficiency could be more than one respectively. There are two methods used to measure level of efficiency, they are DEA (Data Envelopment Analysis) and Stochastic Frontier. These methods are applied if more than one input and more than one output used to measure the level of efficiency. DEA is a non-parametric method and does not require assumption about functional form, while Stochastic Frontier Analysis is based on relationship between input and output in the form of function.

Efficiency could vary based on condition of environment. If cost used as output to measure the level of efficiency, it could be affected by factors which affect variation in cost. Several empirical studies related to efficiency of water supply found that raw water quality and customer density affecting efficiency of water supply system. Another study in Indonesia found that scale, source of water, distribution system, (topography), and density influence the level of efficiency (Maryati *et al*., 2009).

Source of water affects treatment cost. The greater the deviation between raw water quality with the quality standard, the higher the treatment costs. Quality of water depends on physical, chemical, and microbiological composition of the water.

Topography influences the distribution system, pumping or gravity system. This condition influences energy cost. Energy cost in pumping system is higher compared to gravity system. Customer density affects energy cost and depreciation cost on distribution process. The higher the density, the lower the distribution cost.

8.3 METHOD

In this study efficiency was calculated based on one input and one output. This was because the limitation of data. Input was measured based on operational cost per year, and output was measured based on the number of household served. Since it was very simple calculation, neither DEA no stochastic frontier analysis were used. Efficiency was measured based on Formula (1) as follows:

$$e = OC / Customers \quad (1)$$

where e is level of efficiency, OC is operational cost per year, *customers* is number of customers

Since the objective of this study was to compared the level of efficiency between communal and public system, level of efficiency was calculated for both communal system and public system. Furthermore, they will be arranged together in order to know level of efficiency as a whole. Based on Formula (1) the level of efficiency in this study can also be defined as operational cost per year for one customer or one household. Consequently, the lower the value, the more efficient the system.

In order to achieve the research objective, case studies were used. For communal system, case studies were the system which were developed by developer, community, or government through PAMSIMAS Programme. Communal system chosen were the system located in rural, urban, and peri urban area. Case studies as representation of public system were PDAMs (Local Government Public Water Supply). PDAMs chosen as case studies were located in West Java and Banten Province. PDAMs chosen as case studies showed the variation on water source, distribution system, and number of customers. In order to know the effect of form of the system, communal and public, variable

influencing cost, such as source of water and distribution system should be the same among the system. The difference between system should be only on their scale and management. Nevertheless it was very difficult to find the system with the criteria. To overcome this problem, descriptive statistics analysis will be used to explain the implication.

Operational cost per year for communal system were difficult to find. It was therefore tariff were used in order to predict operational cost. Tariff structure applied in communal system usually was fixed charge per month. Number of customers for communal system were estimated based on the number of households served by the communal system.

8.4 CASE STUDIES

8.4.1 Communal system

Communal systems used as case studies consist of communal system in rural, urban, and peri-urban areas. For communal systems in rural areas, water supply system from PAMSIMAS programme in Kabupaten Subang was used as case studies. Rural system consists of system in Desa Legonwetan, Batusari, and Ponggang. For communal systems in urban areas, system developed by community or developer in certain housing areas were used as case studies. They were Griya Bukit Mas, Villa Bukit Mas, Awiligar, Parmindo and Melong Green. They are located in Kota and Kabupaten Bandung and Kota Cimahi. Ciburial system was used as representative of peri-urban area. Description of the case studies was as follows.

System in Desa Legonwetan. Communal water supply system at this location was built in 2008. The village is located in District Legon Kulon, Kabupaten Subang. The village is located in the coastal areas directly adjacent to the Java Sea. Total area of the village was 715 ha and 98 ha was settlement. The population of the village in 2008 was as many as 1,849 people. Most of the community worked as farmers and farm workers, and educational level was elementary to junior high school. The system serve 417 households. Tariff system used was fixed rate, ranging from Rp.10,000 to 15,000 per household per month.

System in Desa Batusari. Communal water supply system at this village was started from 2008. The village is located in District Dawuan, Kabupaten Subang. The population of the village in 2008 was as many as 3,123 people. The existing system served 360 households. Tariff system used was fixed rate system, the amount was Rp 10,000/households/month. Water sources used was shallow well, distributed by using public taps.

System in Desa Ponggang. Communal water supply system at this location was started since 2009. The village is located in District Serangpanjang, Kabupaten Subang. Desa Ponggang is located in hilly area with sufficient rainfall. The population of the village in 2009 was as many as 3,512 people or 1,153 households. Sources of water used was spring water, distributed by gravitation. The system served approximately 430 households. Tariff structure was fixed tariff, the amount was Rp 1,000/household/month

System in Griya Bukit Mas II. Griya Bukit Mas is settlement located in Bojong Koneng, Kabupaten Bandung. There is no public water supply in this area. The system was developed by housing developer, and operated and managed by organization which was paid by community. The source of water

was groundwater. The system served 180 households. Tariff structure applied was fixed rate, and the amount was Rp. 35,000/household/month.

System in Villa Bukit Mas. The system originally developed by developer, but later operated and managed by community. The system used groundwater as source of water and served 40 households. Tariff structure applied was uniform tariff, the amount was Rp 2,500/m^3 and the load tariff was Rp 27,500/month.

System in Awiligar. Awiligar is a residential located in Awiligar, Kabupaten Bandung. The residential was built in 1981. In the beginning community used individual well as source of water. Later the quality and quantity of individual well decrease, and community decided to construct communal system. The system served 253 households. The structure of tariff applied was increasing block tariff. The usage of water between 0-15 m^3 was costed Rp 27,500/household/month, the usage between 16-20 m3 costed Rp 2,000/m3, between 21-25 m^3 costed Rp 3,000/m^3, and more than 25 m^3 costed Rp 3,500/m^3.

System in Parmindo. Parmindo settlement is a residential located in Desa Cibeureum Kota Cimahi. There was no connection to the area, so community decided to construct communal system. The source of water was groundwater. The system served 184 households. Tariff structure applied was incerasing block tariff. The usage of water between 0-10 m^3 was costed Rp 15,500/household/month, the usage between 11-20 m^3 costed Rp 1000/m^3, between 21-30 m^3 costed Rp 1200/m3, 21-40 m^3 costed Rp 1400/m^3, 41-50 costed Rp 1600/m^3 and more than 50 m^3 costed Rp 2000/m^3.

System in Melong Green. Melong Green is a residential area located in Desa Melong, Kota Cimahi. Previously community used individual well as source of water. Later quantity and quality of water decrease, and community decided to make communal system. The system used groundwater as source of water. The system served 403 households. The tariff structure used was increasing block tariff. The load tariff was Rp 10,000/household/month, the usage between 0-10 m^3 was costed Rp 1,000/m^3, 11-20 m^3 costed Rp 1,200/m^3, 21-25 m^3 costed Rp 1,500/m^3, and more than 25 m^3 costed Rp 2,500/m^3.

System in Ciburial Village. Ciburial Village is a peri-urban area. The system used spring as a source of water. The system served 630 households. The tariff system applied was increasing block tariff. The cost of water varied between Rp 1,000-2,000/m^3. The revenue of the system was Rp 13,000,000/month. The condition of communal system is shown in Table 8.1, Table 8.2, and Table 8.3.

Table 8.1 Number of customer, source of water and distribution system of communal system

Communal System	Number of Customer	Source of Water	Distribution System
Desa Legonwetan	417	DW	Pumping, Public Hydrant
Desa Batusari	360	DW	Pumping, Public Hydrant
Desa Ponggang	430	S	Gravitation, Public Hydrant
Griya Bukit Mas	180	DW	Housing Connection
Villa Bukit Mas	40	DW	Housing Connection
Parmindo	184	DW	Housing Connection
Awiligar	253	DW	Housing Connection
Melong Green	403	DW	Housing Connection
Ciburial	630	S	Housing Connection

Note: DW: Deep Well, S: Spring
Source: Mustika (2007), Sastavyana (2010), and Lestari (2011)

Table 8.2 Tariff structure of communal system

Communal System	Tarif Structure
Desa Legonwetan	Fixed Charge
Desa Batusari	Fixed Charge
Desa Ponggang	Fixed Charge
Griya Bukit Mas	Fixed Charge
Villa Bukit Mas	Uniform Charge
Parmindo	Increasing Block Tariff
Awiligar	Increasing Block Tariff
Melong Green	Increasing Block Tariff
Ciburial	Increasing Block Tariff

Source: Mustika (2007), Sastavyana (2010), and Lestari (2011)

Table 8.3 Production volume and operational cost of communal system

Communal System	Production Volume (m^3/hh/month)	Operational Cost/month (Rp)
Desa Batusari	NA	3,600,000
Desa Ponggang	NA	430,000
Griya Bukit Mas	21.24	6,300,000
Villa Bukit Mas	24	2,427,500
Parmindo	18	4,324,000
Awiligar	21.3	11,340,725
Melong Green	17.7	11,783,720
Ciburial	10.04	14,000,000

Source: Mustika (2007), and Lestari (2011)

8.4.2 Public system

There were 18 public water supply systems used as case studies. PDAMs used as case studies were located in West Java and Banten Province. The scale of the service of these systems was varied widely from 2,361 in Kota Cirebon to 150,236 customers in Kota Bandung.

Sources of water used was also varied, consisting of surface water, spring, deep well, and dams. In general, PDAMs used more than one source of water. PDAMs which used river as main source of water were Kota Banjar, Kota and Kabupaten Bandung, Kota and Kabupaten Sukabumi, Kota and Kabupaten Bogor, Kota and Kabupaten Tangerang. PDAM which used spring as main source of water were Kota Cirebon, Kabupaten Garut, Kabupaten Kuningan, and Kabupaten Majalengka. PDAM which used dam as main source of water was PDAM Kota Bekasi. There was no PDAM which used groundwater as main source of water.

The type of distribution system mainly consists of combination between pumping and gravitation system. Some PDAMs used only gravitation system, such as Kota Bogor, Kota Cirebon, and Kabupaten Majalengka. PDAMs which used only pumping system were Kabupaten Karawang, Kota Bekasi, Kota and

Kabupaten Tangerang. The condition of PDAMs can be seen in Table 8.4 and Table 8.5.

Table 8.4 Number of customers, source of water and distribution system of public system

Public System	Number of Customers	Source of Water and Quantity (l/s)	Distribution System
Kab Subang	26,986	R: 84, S: 135, DW: 99	PG
Kab Karawang	45,721	R: 558, S: 18, DW: 20	P
Kota Bogor	94,995	R: 1,114, S: 336	G
Kota Cirebon	2,365	S: 1,061	G
Kota Bandung	150,236	R: 2,316, S: 100, DW: 95	PG
Kab Bandung	56,486	R: 522.68, S: 87.60, D: 10, DW: 49,50	PG
Kab Garut	29,115	R: 20, S: 276, DW: 45	PG
Kab Sukabumi	20,431	R: 226, S: 193, DW: 58	PG
Kab Kuningan	19,740	S: 163, D: 40	G
Kota Bekasi	12,289	D: 275	P
Kab Bogor	126,540	R: 1062, S: 693.6, DW: 81.8	PG
Banjar	8,131	R: 120	PG
Kab Cirebon	26,957	R: 78, S: 166, DW: 27	PG
Kab Sumedang	25,567	R: 87, S: 99, DW: 20	PG
Kota Sukabumi	18,030	R: 170, S: 112, DW: 20	PG
Kab Majalengka	14,286	R: 20, S: 102, DW: 25	G
Kota Tangerang	17,586	R: 328	P
Kab Tangerang	103,420	R: 4,461	P

Note: R: River, S: Spring, D: Dam, DW: Deep Well, PG: pumping and gravitation, G: Gravitation, P: Pumping
Source: www.perpamsi.or.id

Table 8.5 Distributed water, sold water, and operational cost of public system

Public System	Distributed Water (m^3/y)	Sold Water (m^3/y)	Operational Cost (Rp/y)
Kab Subang	7,714,614	5,985,805	14,867,445,696
Kab Karawang	6,585,587	3,999,618	23,962,517,785
Kota Bogor	NA	NA	36,041,123,902
Kota Cirebon	25,116,283	19,691,098	28,804,426,169
Kota Bandung	70,226,348	43,617,254	153,791,909,155
Kab Bandung	18,820,189	11,503,318	40,316,052,913
Kab Garut	7,487,949	5,680,044	12,168,817,927
Kab Sukabumi	8,671,736	4,773,392	13,503,292,915
Kab Kuningan	6,402,691	4,079,332	8,384,327,765
Kota Bekasi	8,722,209	6,985,439	8,974,808,108

Public System	Distributed Water (m^3/y)	Sold Water (m^3/y)	Operational Cost (Rp/y)
Kab Bogor	56,635,542	38,409,158	117,997,150,937
Banjar	3,343,056	2,317,176	3,328,886,282
Kab Cirebon	6,407,643	4,827,934	16,594,290,080
Kab Sumedang	7,044,988	4,738,909	11,360,716,525
Kota Sukabumi	6,945,264	4,590,576	14,116,158,753
Kab Majalengka	4,002,144	2,953,933	6,149,862,633
Kota Tangerang	9,901,496	8,303,779	28,044,587,665
Kab Tangerang	136,134,538	121,956,572	260,639,665,075

Source: www.perpamsi.or.id

8.5 ANALYSIS

8.5.1 Efficiency of communal system

As defined in Formula (1), efficiency was measured based on operational cost per year and number of customers. Based on calculation, it was known that the most efficient communal system was Desa Ponggang and the most unefficient system was Villa Bukit Mas. Desa Ponggang was located in Kabupaten Subang and the system in this village used spring as source of water and gravity system as distribution system. Water supply system using spring and gravity system is the cheapest system (Maryati *et al.*, 2009). Villa Bukit Mas was the most unefficient communal system due to the scale which was the smallest.

Based on the pattern of the efficiency value, it can be concluded that system located in rural area was more efficient compared to those in urban area, The more urbanized the area, the more unefficient the system. Ciburial system which was located in periphery of urban area was more efficient compared to others in urban area. Unefficient condition of the system located in urban area could be related to the condition of source of water and distribution system. Source of water in urban area was very limited. The easiest source to be found was deep well, but the quantity of deep well tend to decrease by the time, and consequently pumping cost increase. Distribution system in urban area usually in the form of housing connection. The value of efficiency of communal system can be seen in Table 8.6.

Table 8.6 Efficiency of communal system

Communal System	Efficiency (Rp/hh/year)
Desa Legonwetan	180,000
Desa Batusari	120,000
Desa Ponggang	12,000
Griya Bukit Mas	420,000
Villa Bukit Mas	728,250
Parmindo	282,000
Awiligar	537,900
Melong Green	350,880
Ciburial	266,667

8.5.2 Efficiency of public system

Level of efficiency for public system was measured in the same way as communal system. The most efficient public system was Kota Bogor and the most unefficient system was Kota Cirebon. Kota Bogor was public system using river and spring as source of water and gravity system for distribution system. Gravity system was cheaper compared to pumping system (Maryati *et al.*, 2009). Kota Cirebon was the most unefficient system due to the scale which was only 2,365 customers. Table 8.7 showed the efficiency of public system.

Table 8.7 Efficiency of public system

Public System	Efficiency (Rp/hh/year)	Public System	Efficiency (Rp/hh/year)
Kab Subang	550,932	Kota Bekasi	730,312
Kab Karawang	524,103	Kab Bogor	932,489
Kota Bogor	379,400	Banjar	409,407
Kota Cirebon	12,179,461	Kab Cirebon	615,584
Kota Bandung	1,023,669	Kab Sumedang	444,351
Kab Bandung	713,735	Kota Sukabumi	782,883
Kab Garut	417,957	Kab Majalengka	430,482
Kab Sukabumi	660,922	Kota Tangerang	1,594,711
Kab Kuningan	424,738	Kab Tangerang	2,520,206

Table 8.8 Efficiency of communal and public system

System	Efficiency (Rp/hh/yr)
Desa Ponggang	**12.000**
Desa Batusari	**120.000**
Desa Legonwetan	**180.000**
Ciburial	**266.667**
Melong Green	**350.880**
Kota Bogor	379.400
Banjar	409.407
Kab Garut	417.957
Griya Bukit Mas	**420.000**
Kab Kuningan	424.738
Kab Majalengka	430.482
Kab Sumedang	444.351
Kab Karawang	524.103
Awiligar	**537.900**
Kab Subang	550.932
Kab Cirebon	615.584
Kab Sukabumi	660.922
Kab Bandung	713.735
Villa Bukit Mas	**728.250**
Kota Bekasi	730.312
Kota Sukabumi	782.883
Kab Bogor	932.489
Kota Bandung	1.023.669
Kota Tangerang	1.594.711

System	Efficiency (Rp/hh/yr)
Parmindo	**1.956.000**
Kab Tangerang	2.520.206
Kota Cirebon	12.179.461

Note: bold face was for communal system

If level of efficieny of communal and public system was compared, it was known that public system was not always the most efficient system due to their scale. Communal system in rural area and periphery of urban area were the most efficient system, although their scale were relatively smale compared to public system. There were some reasons for this condition. Source of water, distribution system, and the condition of the whole system were the explanation for the condition. According to source of water, the system using spring and gravity system has lower operational cost and consequently most efficient compared to other system. According to the system as a whole, communal system in rural area usually use public hydrant instead of housing connection and they do not have any employee who have to be paid regularly. The employee was the member of community who work voluntarily. Efficiency of communal and public system altogether can be seen in Table 8.8.

8.6 CONCLUSION AND RECOMMENDATIONS

From the analysis it can be concluded that public system was not always more efficient compared to communal system. Communal system in rural area in fact were more efficient compared to public system. Source of water, distribution system, and the management of the system influenced the level of efficiency, besides the scale. Although communal system is small scale system, it could be more efficient compared to public system if it uses spring water, gravity system, and managed by community voluntarily.

The level of efficiency of communal system in urban area varied compared to public system. System used in communal system in urban area were almost the same as those in public system. The only difference was on the management of the system. Since in urban area the system were almost the same between communal and public, role of scale was very important.

Some recommendations can be proposed based on the result of the studies. Better efficiency of water supply system can be achieved by increasing the scale and cheaper management. One example of cheap management is management by community voluntarily. If there are more than one source of water that can be used, priority should be given in the following order: spring, surface water, and deep well.

ACKNOWLEDGMENT

The authors would like to thank to Directorate of Higher Education, Ministry of Education and Culture for funding a part of this research through PENPRINAS MP3EI 2012 and Institute of Technology Bandung for funding this research through Riset Inovasi KK 2012. The authors also would like to thank to Handini Pradhitasari for final touch of this paper.

REFERENCES

Directorate Generale Cipta Karya. (2011), Salutu Mawangun Cimahi bersama RPIJM. *Buletin Cipta Karya Edisi 04/Tahun IX/ April 2011*. Ministry of Public Work.

Lestari, J. (2011), *Identification of Factors Influencing the Sustainability of Water Supply System in Desa Ciburial, Kecamatan Cimenyan, Kabupaten Bandung*. Thesis in Magister Programme of Urban and Regional Planning. Bandung : Institute of Technology Bandung.

Maryati, S., Notodarmojo, S., Chatib, B., and Widiarto. (2009), *Environmental Condition and Cost of Water Production and Distribution*, Proceeding the 1st International Conference on Sustainable Infrastructure and Built Environment in Developing Countries; Bandung, 2-3 November.

Mustika, S. (2007), *Influence of Tariff, Household Size, Income, and Alternative of Water Source on Water Consumption in Communal System*. Final Project in Study Programme of Urban and Regional Planning. Bandung: Institute of Technology Bandung

Nauges, C., Van den Berg, C. (2008), Economies of Density, Scale, and Scope in the Water Supply and Sewerage Sector: a Study of Four Developing and Transition economies, *Regional Economics*, **34**: 144-163.

Sastavyana, S. (2010), *Identification of Sustainable Rural Water Supply by Using Analytic Network Process.* Final Project in Study Programme of Urban and Regional Planning. Bandung: Institute of Technology Bandung.

www.Perpamsi.or.id , accessed June 6, 2012