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BASIC COST OF DOMESTIC WASTEWATER MANAGEMENT SERVICES

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ABSTRACT

Denpasar Sewerage Development Project (DSDP) is a domestic wastewater network development project that serves Denpasar City, Sanur Area, and Kuta Area. Built from soft loans from the Japanese Government, the State Budget, the Regional Revenue and Expenditure Budget for the Province of Bali, Denpasar City, and Badung Regency. The total cost is 11,404 million JPY and IDR 193.25 billion. There are Waste Water Treatment Plant (WWTP) in Suwung, the main network, pump houses in Sanur and Kuta. The domestic wastewater management system is a basic service provided by the government, but requires community participation in retribution payments for service rendered for its operation and maintenance. The amount of the levy is determined in the service tariff based on the basic cost, waste water source, type of activity, and customer classification according to the volume of wastewater generated, so that the service tariff is different for each customer classification. The base cost is determined from the previous year's actual costs and processing capacity. The average costs for 2017-2021 are IDR 14,465 billion. The capacity of the centralized wastewater treatment plant is 51,000 m^3/day. The Basic Cost to recover operational and maintenance costs for the centralized domestic wastewater treatment service is IDR 5,103/m^3.

Keywords: Wastewater, basic cost, management services

1. INTRODUCTION

The increase in population, changes in land use that are increasingly dense, the advancement of civilization and human behavior are the main factors that make domestic waste increase from time to time. Uncontrolled waste disposal causes a decrease in water quality (D.M. G. Rarasari et.al, 2018). It is necessary to strive for waste management according to the type and character of the waste itself, so that the environment becomes better (M. N. Azis et.al, 2019). Sanitation is one of the environmental problems that are still faced by many cities in Indonesia (M. S. Abfertiawan, 2019). The government's efforts are to provide sanitation infrastructure and facilities, one of which is the construction of a centralized wastewater treatment system. In Bali, the development is known as the Denpasar Sewerage Development Project (DSDP) which is managed by the Technical Implementation Unit for Wastewater Management.

In piping services or a Centralized Domestic Wastewater Management System, wastewater from customers will be channeled through a pipeline network to the Domestic

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Wastewater Treatment Plant. The wastewater effluent is channeled into the river in the mangrove forest which of course has met the quality standards of wastewater quality. The wastewater management system from influent to effluent consists of a service system, a collection system, and a centralized treatment system. Expenses on these systems include investment costs, labor, equipment, materials, vehicles, electricity, water, administration, and depreciation.

Denpasar Sewerage Development Project is a domestic wastewater network development project that serves Denpasar City, Sanur Area, and Kuta Area. It was built from soft loans from the Japanese Government, the State Budget, the Bali Province Regional Budget, Denpasar City and Badung Regency Budget. The total cost is 11,404 million JPY and IDR 193.25 billion in two stages of construction. The construction in phase I includes a Waste Water Treatment Plant in Suwung, the main network, and two pump houses in Sanur and Kuta, as well as house connections for phase I. The construction in phase II is an expansion of the service area for a centralized domestic wastewater management system.

The domestic wastewater management system is a basic service provided by the government, but requires community participation in the form of payment of user fees for services provided. The government provides infrastructure for domestic wastewater management and the community plays a role in meeting costs for sustainable operations and maintenance. Environmental costs need to be taken into account as the responsibility of protecting the environment (H. Jing and L. SOngqing, 2011). The amount of the levy is determined in the service tariff based on the basic cost, waste water source, type of activity, and customer classification according to the volume of wastewater generated, so that the service tariff is different for each customer classification. The base cost is determined from the previous year's actual costs and processing capacity. The basic fee for this domestic wastewater management service is used as a reference for setting tariffs. Cost-effective wastewater treatment systems are the choice for proper sanitation (G. Khurelbaatar et.al, 2021).

2. DOMESTIC WASTEWATER

Domestic wastewater is waste water that comes from the activities of daily human life related to water use, can come from settlements, restaurants, offices, commerce, apartments, and dormitories. Wastewater must be treated to meet wastewater quality standards before being discharged into the environment. Wastewater quality standard is a measure of the limit or level of pollutant elements and or the acceptable amount of pollutant elements in wastewater that will be disposed of or released into water sources.

Domestic wastewater is part of the waste water of human and natural activities (S. D. Strauss, 1986). Figure 1 shows the types of wastewater.

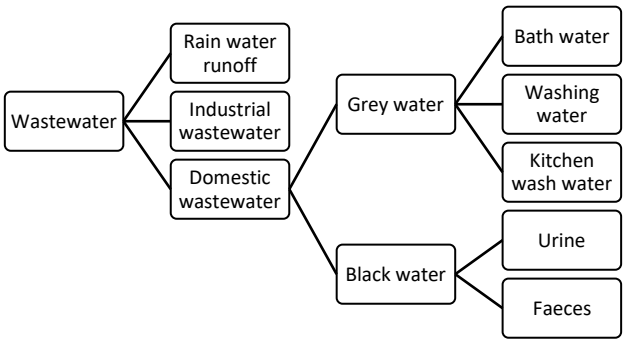

Figure 1 Types of Wastewater

Untreated or minimally treated wastewater that is discharged into the environment has the potential to have a negative impact on the ecosystem, especially on groundwater and nearby seawater. Addressing this problem requires a system that links land use for wastewater treatment with the nutrient load in groundwater which ultimately impacts aquatic habitats. The operation and management of the Wastewater Treatment Plant (WWTP) is very important to ensure the sustainability of water resources (V. Hernanddez-Chover et.al., 2020). Increased release of nutrients will increase the potential for harm to the marine environment (C. A. Wada et.al., 2021). Wastewater treatment plants are the main contributors to expanding environmental protection, supported by relevant technology and meeting cost requirements (T. H. Tsui et.al., 2022).

2.1. Domestic Wastewater Management System

The pattern of domestic wastewater services provided by domestic wastewater managers can be in the form of:

a. Decentralized Domestic Wastewater Management System (DDWMS)
   This system consists of sub-system components for local treatment, transportation, and sewage treatment. Of the three components of the DDWMS, domestic wastewater managers provide services in the form of desludging fecal sludge from the septic tank, which is then transported to the Sludge Treatment Plant to be processed until it meets the quality standards. In this system, customers are subject to operational expenses in the form of transportation and sewage treatment expenses. The burden on local processing is the responsibility of the customer.
b. Centralized Domestic Wastewater Management System (CDWMS)
   This system consists of components of a centralized service, collection and processing sub-system. Of the three components of CDWMS, domestic wastewater managers provide services starting from the collection sub-system where there is a domestic wastewater piping network including its supporting infrastructure (inspection holes, control holes/manholes, pump stations, etc.) domestic wastewater from customers to the Domestic Wastewater Treatment Plant), up to the centralized treatment sub-system. In this system, customers are subject to operational costs in the form of pipeline network loads and centralized processing loads. The success or failure of self-managed organizations in providing environmental services such as

wastewater management is critical to ensuring compliance with environmental laws (L. Van Karnenbeek et.al., 2021).

Cost is an important criterion in choosing a centralized or local wastewater treatment system. Local wastewater treatment is increasingly being considered as a substitute for centralized wastewater treatment because it can save on the provision of a canal network which is quite expensive to procure and maintain (L. Van Karnenbeek et.al., 2021). Wastewater treatment for disposal, reuse and recycling is a complementary approach to wastewater management. The target of treatment is to remove solids, salts, chemicals, and oils (S. D. Strauss, 1986).

3. RESEARCH METHODS

The object of research is the Regional Technical Implementation Unit for Wastewater Management of Bali Province, the waste water management network covers the areas of Sanur, Kuta, Denpasar, and the Wastewater Treatment Plant. Secondary data was obtained by conducting interviews, observations, and document studies at the Bali Province.

The initial step is the collection and processing of operational and maintenance cost data for 2017-2021, calculation of asset depreciation, influent debit, and inflation. After processing the data, the basic cost analysis is carried out. Operational and maintenance costs include costs for service sub-systems, collection, centralized processing, and other operations. The sum of these costs and the depreciation of the assets results in the cost of managing the entire system. The cost of managing the entire system divided by the influent discharge yields an annual fee. Annual costs for the previous 5 years are averaged taking inflation into account to produce the base cost. This calculation stage is made in accordance with the 2019 CDWMS Retribution Tariff Guidelines.

4. RESULT AND DISCUSSION

In terms of its technical components, the Centralized Domestic Wastewater Management System at the Bali Province Regional, Wastewater Treatment Technical Implementation Unit has three sub-systems, namely service sub-systems, collection sub-systems, and centralized treatment sub-systems. According to the Guidelines for Compiling the CDWMS Levy Tariff to find operational and maintenance costs at the CDWMS, it is divided into three components, namely, the piping network load (consisting of service and collection sub-systems), centralized processing expenses, and other operational expenses (loads outside the piping and processing network).

4.1 Operational and Maintenance Costs of CDWMS Bali Province

Operational and maintenance costs are divided into three components: pipeline network, centralized processing and other operational, as in Figure 2.

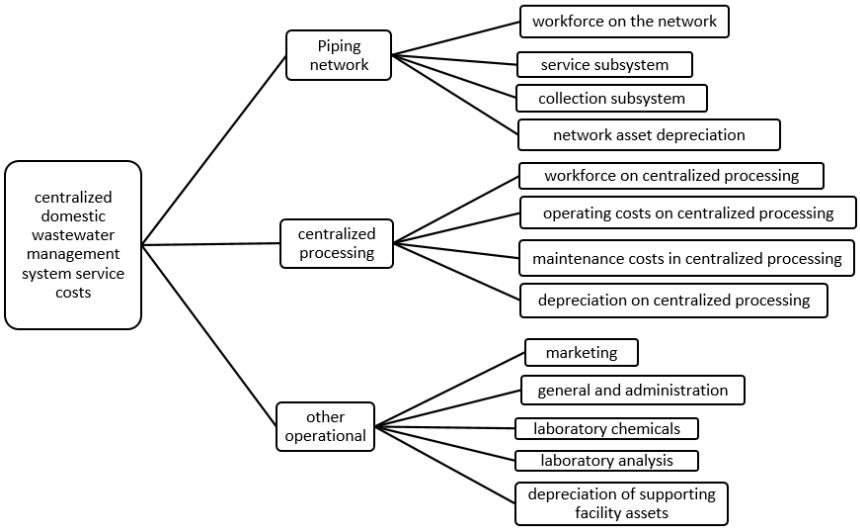

Figure 2 Centralized Domestic Wastewater Management System Service Costs

In general, operational costs are broken down as follows:

1. Labor Costs
   The workforce at the Bali Province consists of 85 people. 12 civil servants, 73 contract workers. In its implementation, there are several honorariums for several activities that require extra personnel, such as consulting services for drafting BLUD regulations, consulting services for making wastewater customer applications, consulting services for the preparation of WWTP sedimentation pond engineering studies, assistance for implementing PPK BLUD, assistance for online payment operations.
2. Office Administration Expenditure
   Covers the burden of office stationery, printing, procurement, photocopying, religious ceremony offerings, as well as the burden of eating and drinking meetings.
3. Vehicle and Genset Fuel Load
   Covers fuel costs for 2, 4, 6 wheeled vehicles and generators to carry out operational and maintenance activities.
4. Material Costs
   This includes the purchase of chemicals, laboratory equipment, electronic goods, reagents, personal protective equipment, medicines, work safety equipment, and pipe network accessories.
5. Electricity Consumption Costs
   Covers the use of electricity on the network, processing and in the office. In processing electricity consumption in the form of aerators, pumps in pump houses, pumps in the wetpit and electricity use at the UPTD PAL Office and Suwung Office.
6. Water Costs, Telephone, Internet
   Includes flushing load, communication load, and connectivity load used for the continuity of centralized domestic wastewater treatment system.
7. Office Cleaning/Cleaning Service

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Covers the burden of cleaning staff and cleaning tools in the office and in the yard of wastewater treatment plant.

8. Land Rent Expenses for Tahura
   The Bali Province UPTD PAL leases an area of 10 hectares of tofu land. Based on Bali Provincial Regulation Number 7 of 2021 concerning the Third Amendment to Regional Regulation Number 3 of 2011 concerning Business Service Retribution (2021), every 1 hectare rental is subject to a tariff of IDR 40,000,000/year.
9. Domestic and Outside Business Travel Expenses
   Conducted to conduct studies related to the management of similar waste water outside Bali and inside Bali.
10. WWTP Maintenance Expense
    Covering the burden of cleaning and dredging ponds that occur in sedimentation, maintenance and procurement of spare parts for WWTPs, maintenance of roads and parks in the WWTP environment, maintenance of WWTP buildings, maintenance of aeration ponds and sedimentation ponds.
11. Maintenance Expenses for Pipeline Networks, Pumping Stations, Wetpit
    Covers the burden of maintaining the pipeline network, maintaining the bar screen at the pump house, maintaining the pump at the pump house and wetpit, maintaining the generator set, and cleaning the wet pit on a regular basis.
12. Operational Vehicle Maintenance Expense
    Includes vehicle service, replacement of spare parts, vehicle delivery, renewal of vehicle registration, as well as oil and lubricant loads.
13. Equipment/Office Equipment Maintenance Expenses
    Includes maintenance of items such as air conditioners, computers, printers, other electronic equipment, and machine tools.
14. Building Maintenance Expense
    Covers the burden of repairing buildings that are damaged and must be repaired, as an example of repairing leaky roof tiles, replacing leaking doors, and so on related to repairing building supporting components.

The overall costs of these operational and maintenance expenses are shown in Table 1.

Table 1 Recapitulation of Operational and Maintenance Costs for 2017-2021

No	Description	Expenses (IDR)				
		2017	2018	2019	2020	2021
1	Labor Costs	6,698,591,043	7,631,602,178	7,757,230,224	6,654,923,996	5,726,570,781
2	Office Administration Expenditure	161,684,070	187,624,879	136,745,700	139,277,300	102,317,650
3	Vehicle and Genset Fuel Load	204,928,000	270,150,000	149,942,400	189,660,000	254,836,000
4	Material Costs	191,893,252	568,466,800	800,550,750	486,080,650	316,644,100
5	Electricity Consumption Costs	3,233,933,594	3,244,188,419	3,255,255,446	3,170,235,880	3,347,347,754
6	PDAM Water Costs, Telephone, Internet	125,528,883	118,004,024	114,209,697	130,193,060	126,016,613

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7	Office Cleaning/Cleaning Service	89,881,000	98,285,000	109,411,500	124,383,270	123,090,000
8	Land Rent Expenses for Tahura	400,000,000	400,000,000	400,000,000	400,000,000	400,000,000
9	Domestic and Outside Business Travel Expenses	242,791,400	293,130,650	219,124,938	22,082,600	6,840,000
10	WWTP Maintenance Expense	718,741,650	866,995,710	1,006,855,410	920,093,050	561,226,900
11	Maintenance Expenses for Pipeline Networks, Pumping Stations, Wetpit	366,852,870	2,070,057,474	1,828,129,935	1,458,182,060	1,178,526,479
12	Operational Vehicle Maintenance Costs	305,023,200	422,520,200	317,817,846	391,305,744	307,312,900
13	Equipment/Office Equipment Maintenance Costs	84,225,000	102,575,960	97,959,433	39,295,238	100,557,050
14	Building Maintenance Costs	99,968,000	190,135,000	71,133,150	0	0
	Amount	12,924,041,962	16,463,736,294	16,264,366,429	14,125,712,848	12,551,286,227

4.2 Asset Depreciation

Assets whose depreciation value is calculated are transportation equipment, workshop equipment, large equipment, office and household equipment, medical equipment, laboratory equipment, weaponry equipment, studio and communication equipment, and computer assets. The calculation of asset depreciation uses the straight-line depreciation method. Infrastructure asset management includes System, Function, Supply-Demand, Operating System, Deterioration, Maintenance, and Life-Cycle (A. C. Septaprasetya et.al., 2019). The results of the calculation of asset depreciation from 2017-2021 can be seen in Table 2.

Table 2 Asset Depreciation in 2017-2021

No.	Year	Depreciation Value (IDR)
1	2017	27,317,119,832
2	2018	27,519,659,391
3	2019	28,036,230,470
4	2020	28,002,318,377
5	2021	27,759,146,167

4.3 Processing Capacity

The Suwung WWTP is planned to be able to treat waste water of 51,000 m^3/day 18,615,000 m^3/year. The discharge recording is done by reading the numbers listed on

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the flow meter tool, which is carried out daily to determine the amount of waste water entering the treatment plant. The influent discharges that entered the Suwung WWTP in 2017-2021 are shown in Table 3.

Table 3 Influent Discharge In 2017-2021

No	Year	Debit (m^3/year)		
		Average	Maximum	Minimum
1	2017	10,179,401	14,772,952	6,553,334
2	2018	9,971,369	13,712,937	6,757,698
3	2019	9,156,856	13,102,358	5,817,418
4	2020	7,760,592	12,813,194	4,976,925
5	2021	12,007,709	16,726,301	7,640,765

4.4 Annual Total Expense (Tn)

Total Year Expense (Tn) is the total cost of wastewater treatment expenses incurred for treatment purposes. Tn is obtained by adding operational and maintenance costs to past depreciation costs, divided by the influent discharge obtained from the Bali Province data. Then Tn will be analyzed by adding inflation to get the essential cost for the next 5 years. Table 4 shows the calculation of Total Year Expense (Tn).

The following formula for Total Year Expense (Tn) is as follows:

$$Tn = \frac{O\ \&\ M\ Costs + Depreciation}{Influent\ discharge}$$

Table 4 Annual Total Expenses (Tn)

Year	Annual Total Expenses IDR/ m^3		
	Average	Minimum	Maximum
2017	3,953	2,724	6,141
2018	4,411	3,207	6,509
2019	4,838	3,381	7,615
2020	5,428	3,288	8,465
2021	3,357	830	5,276
Average	4,398	2,686	6,801

Total Year Expense (Tn) used is IDR 4,398, which is the average value of the average Tn.

a. Basic Cost

Basic Costs are costs that are used as the basis for determining the levy rate. According to the Guidelines for Compiling Tariffs of the Ministry of Public Works and Public Housing (2019), after getting the value of operational and maintenance

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costs or called total year expenses (Tn), the Basic Cost (BC) calculation is carried out by multiplying Tn by the inflation factor (5-6% per year).

b. Inflation

According to Natsir (2014) inflation is a tendency to increase the prices of goods and services in general and continuously. Meanwhile, according to Bank Indonesia, inflation is a general and continuous increase in prices. An increase in just one or two goods cannot be called inflation unless the increase is widespread or results in an increase in the price of other goods.

The inflation rate is obtained from the website of the Central Statistics Agency, the data obtained are as shown in Table 5.

Table 5 Inflation Rate in 2012-2021

Inflation Rate			
Year	**Denpasar (%)**	**Singaraja (%)**	**National (%)**
2021	2.01	2.39	1.87
2020	0.55	2.48	1.68
2019	2.37	2.42	2.72
2018	3.4	1.88	3.13
2017	3.31	3.38	3.61
2016	2.94	4.57	3.02
2015	2.7	2.97	3.35
2014	8.03	10.32	8.36
2013	7.35	-	8.38
2014	4.71	-	4.3

Sources: Badan Pusat Statistik (2022)

According to inflation data for the last 10 years, the average inflation rate for the Denpasar area is 3.7%, the Singaraja area is 3.8%, and the National is 4.0%. According to Table 6, there was a decrease in the percentage of inflation from 2019-2021 in the Denpasar area, and this was due to the Covid-19 pandemic, which caused a decline in inflation that year. The economic situation is not expected during the Covid-19 period. Based on the Guidelines for Compiling Retribution Tariffs from the Ministry of Public Works and Public Housing (2019), the average annual inflation is 5-6%. So in analysis, the primary cost used is 5%. It is assumed that the next 5 years will be the situation under normal conditions.

15. Basic Costs for The Next 5 Years

The base cost for the next 5 years (2022-2026) can be predicted by multiplying the base cost by the annual inflation rate. The essential cost for the next 5 years is used as an illustration to consider the number of levy rates for the following years. The projected increase in total expenses is carried out for the next 5 years, considering that the tariffs are valid for 5 years. After getting the projected value, it is averaged to get a fixed rate valid for the next 5 years.

The following is the calculation of the essential cost of domestic management service for the next 5 years, from 2022 to 2026:

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Total expenses for the next 1 year: $T_{n+1} = T_n x\ (1+i)^1$=4,398 x (1+5%)^1 = 4,617
Total expenses for the next 2 year: $T_{n+2} = T_n x\ (1+i)^2$=4,398 x (1+5%)^2 = 4,848
Total expenses for the next 3 year: $T_{n+3} = T_n x\ (1+i)^3$=4,398 x (1+5%)^3 = 5,091
Total expenses for the next 4 year: $T_{n+4} = T_n x\ (1+i)^4$=4,398 x (1+5%)^4 = 5,345
Total expenses for the next 5 year: $T_{n+5} = T_n x\ (1+i)^5$=4,398 x (1+5%)^5 = 5,612

Average total expenses in the next 5 years or basic costc for the next 5 years:

$$\text{Basic Cost (BC)} = \frac{T_{n1}+T_{n2}+T_{n3}+T_{n4}+T_{n5}}{5} = \frac{4{,}617+4{,}84+5{,}91+5{,}345+5{,}612}{5} = 5{,}103$$

5. CONCLUSION

Wastewater management services require the fulfillment of costs for the piping network, wastewater treatment, and other operations. The annual fee is affected by inflation. This fee is calculated as the basic cost in determining service rates for each customer group and classification of each so that wastewater management can be sustainable.
The average cost per 5 years in 2017-2021 is IDR 14,465,828,752. Base Cost for 2022-2026 is IDR 5,103/m^3. The basic cost is obtained from the total average burden for 2017-2021, which is IDR 4,398 with an inflation factor of 5%.

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