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USE OF EPANET SOFTWARE IN DRINKING WATER SUPPLY SYSTEM NETWORK PLANNING IN BALIKPAPAN CENTRAL DISTRICT AND BALIKPAPAN KOTA DISTRICT

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ABSTRACT

Clean water is a primary need for everyone. The need for clean water will increase over time as well as the increase in population, this makes it necessary to carry out an assessment related to water demand in the future up to 10 years in the future. Therefore, considering the raw water source whose availability cannot be predicted so that it can be calculated the need for clean water for the District of Balikpapan Tengah and Balikpapan City, the water demand value is obtained, namely the debit in the District of Central Balikpapan is 352 liters/second and the District of Balikpapan Kota is 295 liters/second. After that, an analysis of the drinking water distribution routing network was carried out using the Hardy-Cross method and the use of EPANET 2.0 software. Then calculations are carried out by entering data in the form of needs data such as maps of the main pipeline network, 24-hour flow patterns, and data related to contours or elevation. In terms of speed and accuracy of analysis using EPANET 2.0 software for drinking water supply systems is considered more fulfilling.

Reseach Paper

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Keywords: Clean water, EPANET 2.0, Supply, System.

INTRODUCTION

Water is an element that has a very important role in sustaining the sustainability of all living things on earth. It is undeniable, air is an important element especially in human life which is not only for consumption, but supports many other human activities. Clean water holds the main position in meeting basic human needs, one example is used for domestic or household purposes as drinking water. Sources of clean water can be obtained in various ways, some of which can come from groundwater or directly from the processing carried out by the local Regional Drinking Water Company (PDAM) (Heston & Pascawati, 2021).

The rise of water pollution cases today makes it difficult for many people, especially those in rural and urban areas, to get clean water. The need for clean water will also increase over time due to population developments and an increase in people's living standards. Responding to various problems and developments that have occurred, of course, clean water also has certain qualifications in order to meet the drinking water needs of the community. So to achieve the fulfillment of the need for clean water, it is not only about the processing, but also about the distribution network that needs to be planned (Ross, 2004).

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In the City of Balikpapan, the availability of clean water to meet the needs of the community is predominantly obtained from surface water in the form of artificial reservoirs. All areas of service and clean water supply systems in Balikpapan City are managed by the Regional Drinking Water Company (PDAM) Tirta Manggar. However, the service for the clean water needs of the community in Balikpapan City is still considered to be less than optimal in fulfilling it because there are frequent air outages and the quality of the air being channeled is sometimes cloudy and smells.

Therefore, it is necessary to plan a drinking water supply system in Balikpapan City, especially in Balikpapan Tengah District and Balikpapan City so that the need for clean water can be met for the surrounding community. The purpose of this study is to plan a drinking water distribution network system from the Drinking Water Treatment Plant (IPAM) reservoir to consumers in Balikpapan City, Central Balikpapan District and Balikpapan City using the EPANET 2.0 program (Fahrizal, 2016).

LITERATURE REVIEW

EPANET 2.0 programs

The EPANET 2.0 program is a computer program package created by the U.S. Environmental Protection Agency. EPANET 2.0 can identify the flow or discharge of each pipe, the pressure at each node, the water level in the reservoir, and changes in the concentration of chemical compounds added to the network in a distribution during the simulation period. computer program that describes hydraulic simulations and trends in the quality of water flowing in pipelines, (Machell & Boxall, 2014).

The network itself consists of pipes, nodes (pipe connection points), pumps, valves, and water tanks or reservoirs. EPANET tracks the flow of water in each pipe, the condition of the water pressure at each point and the condition of the concentration of chemicals flowing in the pipe during the flow period. In addition, water age and source tracking can also be simulated, (Goode, 1996). In the operation of EPANET 2.0, it is necessary to know what data must be entered (input) and what data will be produced (output) for the purposes of analyzing the drinking water distribution network system.

Drinking Water Distribution System

The distribution of drinking water to consumers with enough quality and pressure will require a good piping system, reservoirs, pumps, and other equipment. The distribution of water uses a method that depends on the topographical conditions of the water source and the position of the consumers. Water supply through the main pipe has two kinds of systems (Alshukri et al., 2021).

Distribution Piping System

Several types of pipes that generally exist and will be used in planning drinking water distribution systems include the following, (Lee & Schwab, 2005). Primary pipe or main pipe which is a pipe that functions to carry drinking water from the main processing installation or distribution reservoir to a service area. This primary pipe has a relatively large diameter. Secondary pipe, which is a pipe that is directly connected to the primary pipe and has a diameter equal to or less than the diameter of the primary pipe. Tertiary pipe, this pipe can be connected to the secondary pipe. Service pipe which can be connected to the house (consumer) connection, this pipe has a relatively small diameter, (Dalla Rosa et al., 2012).

METHODS

Based on the background of the problems that have been described, this study aims to analyze the planning of the drinking water distribution network system in Balikpapan Tengah and Balikpapan City using the EPANET program and the Hardy-Cross method, then the needs method based on area and the Hazen William equation. The following are the stages in the research method, (Gelling, 2015).

Study of literature

Literature study aims to collect data prior to conducting the research including reviewing the update of this research. At the stage of the literature study it was found that this research would be able to provide great benefits for academics and stakeholders related to the need for data on the drinking water distribution system in Balikpapan.

Data collection

Collecting data related to the planning of the drinking water distribution system including secondary data and primary data, such as population data, data on the area of the planning area.

Data processing

Data processing is carried out after all the necessary data has been collected, so that calculations and analysis can be carried out using the EPANET 2.0 program. In the operation of EPANET 2.0, it is necessary to know what data must be entered (input) and what data will be produced (output) for the purposes of analyzing the drinking water distribution network system, (Milan et al., 2022).

RESULTS AND DISCUSSION

The clean water component of the raw water source for PDAM Balikpapan City is the Manggar Reservoir located in Karang Joang Village, North Balikpapan District, Klandasan River, Kampung Damai Drilling Well. In addition, there are also Water Treatment Plants (IPA) located in areas such as Batu Ampar, Kampung Air, Gunung Sari, and Mount Shoot. The volume of water that can be accommodated by the Manggar Dam/Reservoir is greatly influenced by the season. In the dry season the water volume capacity will drop drastically, (Aditjondro, 1993) .

The distribution pipeline network still does not cover all urban areas, especially areas that are far from activity centers. Clean water distribution system is done by means of pumping and gravity. At the time of minimum use, the reservoir is filled and during peak use, the water demand is met from the reservoir which is flowed by gravity (Richter & Thomas, 2007).

Service Block

Central Balikpapan District and Balikpapan City are divided into several service blocks, where these service blocks are locations that will be passed from the drinking water distribution system route, (Geldreich, 2020).

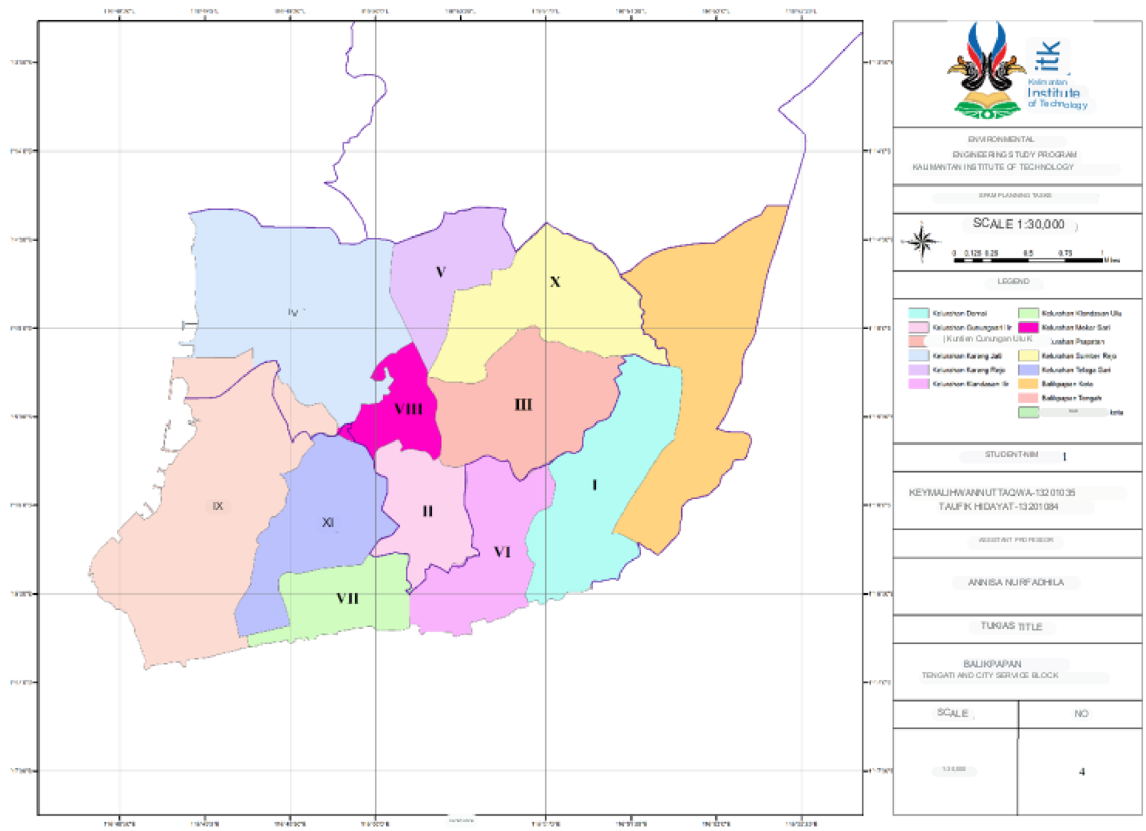


Figure 1 Map of Service Blocks of Central Balikpapan District and City

Calculation of Clean Water Needs

Considering that the need for clean water continues to increase from year to year, the existing clean water supply facilities or systems may not be able to serve the water needs in the future, (Malmqvist & Rundle, 2002). Meanwhile, to plan and build clean water supply facilities requires quite a long time. Therefore, it is necessary to estimate the need for clean water in the future, so that we can prepare everything needed to produce clean water according to future needs. The calculation of water needs is based on calculating several things which include the following, Domestic Needs, Non-Domestic Needs, Water Needs for Leakage, (Seyedzadeh et al., 2020).

Table 1 Non-Domestic Water Needs in Central Balikpapan District

Subdistrict	Unit	Amount of Non-Domestic Water Needs in Central Balikpapan				
		2019	2022	2025	2028	2031
Central Balikpapan	Liters/day	1392940	1409404	1423980	1461056	1473232
	Liters/second	16	16	16	17	17

Table 2 Non-Domestic Water Needs in Balikpapan City District

Subdistrict	Unit	Number of Non-Domestic Water Needs in Balikpapan City				
		2019	2022	2025	2028	2031
Balikpapan City	Liters/day	1670298	1683426	1692892	1714620	1743048
	Liters/second	19	19	20	20	20

Calculation of water needs in Central Balikpapan District can be seen in **Table 1** where the non-domestic water demand is 17 liters/s for the coming 2031. In **Table 3** where the non-domestic water demand in the Balikpapan City District is 20 liters/s for 2031.

Table 3 Recapitulation of Projected Water Needs in Central Balikpapan District

Description	Ward	2019	2022	2025	2028	2031
Maximum Discharge (110%)	Gunung Sari Ilir	3165878	3413611	3771518	4197559	4645870
	Gunung Sari Ulu	2216172	2386504	2632011	2925658	3228408
	Mekar Sari	1710227	1877002	2100583	2378524	2662534
	Karang Rejo	3277284	3567564	3984859	4496071	5019830
	Karang Jati	1836195	2001447	2240409	2518202	2812871
	Sumber Rejo	2581996	2803438	3121653	3507196	3908787
	Amount (L/day)	**14787752**	**16049565**	**17851033**	**20023209**	**22278300**
	Amount (L/sec)	**171**	**186**	**207**	**232**	**258**
Peak Discharge (150%)	Gunung Sari Ilir	4317106	4654924	5142979	5723944	6335277
	Gunung Sari Ulu	3022053	3254323	3589106	3989534	4402375
	Mekar Sari	2332127	2559548	2864431	3243442	3630728
	Karang Rejo	4469023	4864860	5433899	6131006	6845223
	Karang Jati	2503902	2729246	3055103	3433912	3835733
	Sumber Rejo	3520904	3822870	4256800	4782540	5330164
	Amount (L/day)	**20165116**	**21885771**	**24342318**	**27304376**	**30379500**
	Amount (L/sec)	**233**	**253**	**282**	**316**	**352**

Table 4 is a recapitulation of the results of calculating water needs, both non-domestic and domestic for the Central Balikpapan District, so that the discharge during peak hours for six (6) Kelurahan in Central Balikpapan District is 352 liters/s.

Table 4 Recapitulation of Projected Water Needs in the District of Balikpapan City

Description	Ward	2019	2022	2025	2028	2031
Maximum Discharge (110%)	Prapatan	2322665	2474484	2695651	2962365	3237143
	Telaga Sari	2404083	2608916	2902050	3249939	3632792
	Klandasan Ulu	2608425	2797976	3056868	3374196	3700805
	Klandasan Ilir	2993303	3265911	3654741	4117534	4615756
	Damai	2289458	2499292	2795100	3150787	3522633
	Amount (L/day)	12617933	13646578	15104409	16854820	18709128
	Amount (L/sec)	146	158	175	195	217
Peak Discharge (150%)	Prapatan	3167270	3374297	3675887	4039588	4414286
	Telaga Sari	3278294	3557612	3957341	4431735	4953807
	Klandasan Ulu	3556944	3815421	4168456	4601176	5046552
	Klandasan Ilir	4081776	4453514	4983738	5614819	6294212
	Damai	3121988	3408125	3811500	4296528	4803591
	Amount (L/day)	**17206273**	**18608970**	**20596922**	**22983846**	**25512448**
	Amount (L/sec)	**199**	**215**	**238**	**266**	**295**

In **Table 4**, the same calculation is carried out, namely the recapitulation of non-domestic and domestic water needs for the Balikpapan City District, so that the discharge during peak hour use for five (5) Kelurahan in the Balikpapan City District is 295 liters/s, (Dexter & Tinker, 1995).

Main Pipe Network Analysis

Analysis of the main pipeline network can be carried out using 2 (two) methods, namely the Hardy Cross method and the second, namely using the EPANET 2.0 program. The Hardy Cross method is used to analyze the suitability of the design diameter to flow the minimum discharge (Qmin) with speed control. While using the EPANET 2.0 program to get the right dimensions, efficient and economical according to the planning criteria used or used later. **Figure 2** shows the main pipe network that will become the drinking water distribution system in Balikpapan Kota and Balikpapan Tengah Districts. This main pipeline network is then analyzed related to the discharge requirements in each service block, (Tullis, 1989).

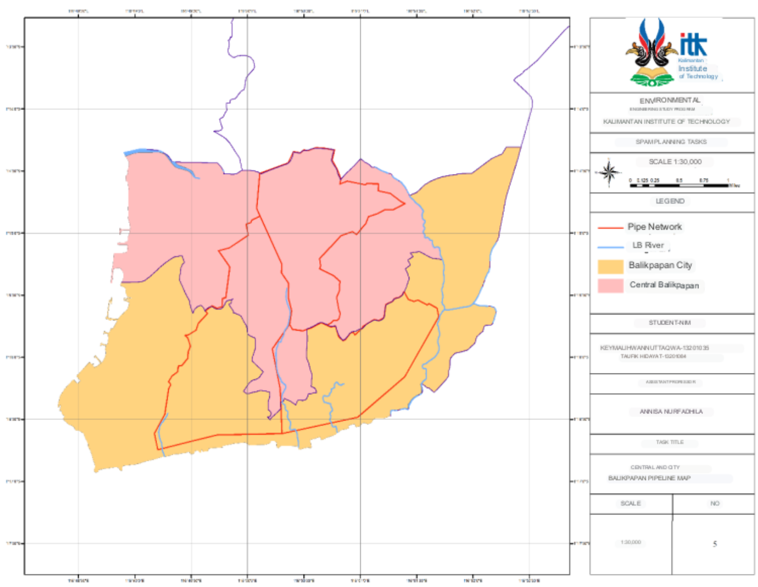


Figure 2 Main Pipe Network Map

Main Pipe Network Analysis using EPANET 2.0

Several stages of work carried out to start the analysis with the EPANET 2.0 program include, (Reca & Martínez, 2006). Creation of a new project, program settings, drawing of a clean water distribution network scheme, input of clean water distribution network component data, input of data on water demand patterns, and program simulation. The technical data for the network is the same as the existing conditions. The difference in the data included in EPANET 2.0 is on the water requirement for the service block junction. The water demand data is adjusted to the projected water demand in 2031. The running results are shown in **Figure 3**.

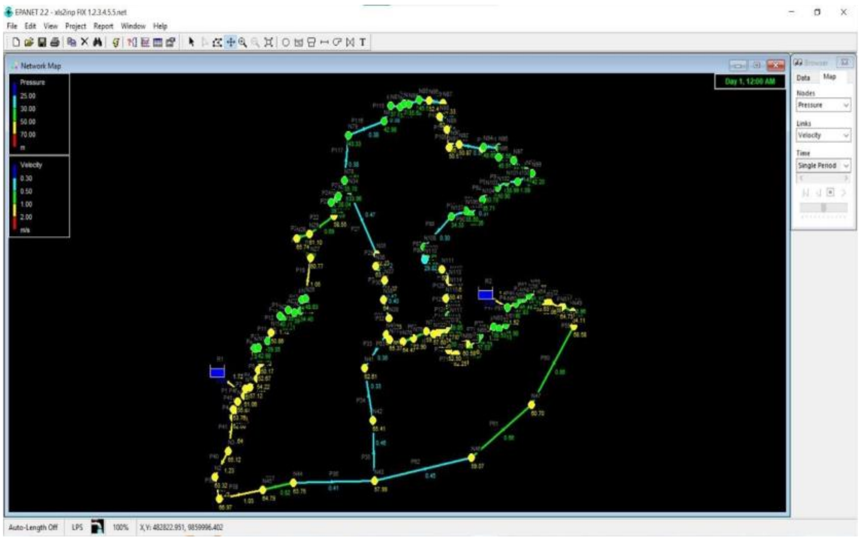
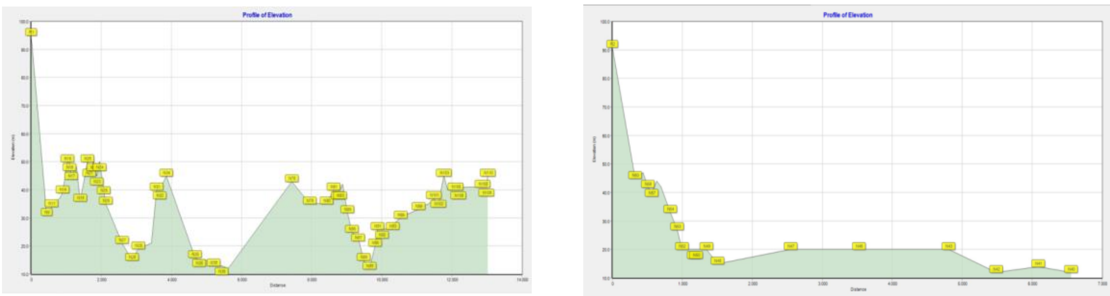


Figure 3 Results of Running EPANET 2.0

Figure 3 shows the pressure generated from the simulation at 25, 30 and 50 m. while the velocity of the resulting simulation is at 0.50 m/s, 1.00 m/s and 2.00 m/s.



(a) **(b)**

Figure 4 Results of Running EPANET 2.0 (Reservoir 1-Elevation) and Results of Running EPANET 2.0 (Reservoir 2-Elevation)

Figure 4 shows the simulation results from the EPANET 2.0 program where reservoir 1 (R1) is in the elevation range of 90.0 to 98.0 m. Reservoir 1 is planned to be at a high elevation. It is intended that the distribution of drinking water from R1 to consumer homes can be carried out mostly by gravity. **Figure 4** shows the simulation results from the EPANET 2.0 program where reservoir 1 (R1) is placed in the elevation range of 90.0 to 94.0 m. Reservoir 2 elevation can be seen in the figure which is higher than the elevation to the service area, (Nandalal & Bogardi, 2007).

CONCLUSION

From the results of the analysis that has been carried out, it can be concluded that the need for clean water in the Central Balikpapan District is 352 liters/second and the Balikpapan Kota District is 295 liters/second, this water need is calculated until the upcoming 2031 period. And based on the simulation results of the planned pipeline network, the network can serve the needs of clean water in the Balikpapan Kota and Balikpapan Tengan Districts until the upcoming 2031 period according to the elevation of each planned reservoir.

Author's declaration

Authors' contributions and responsibilities

The authors made substantial contributions to the conception and design of the study. The authors took responsibility for data analysis, interpretation and discussion of results. The authors read and approved the final manuscript.

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Availability of data and materials

All data are available from the authors.

Competing interests

The authors declare no competing interest.

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