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ANALYSIS OF THE PRIORITY ZONE OF SPAM IN THE EAST AND NORTH BINJAI REGIONS

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ABSTRACT
Currently, PDAM Tiratasari is facing significant challenges in providing optimal drinking water services to the residents of Binjai City. The main issues stem from the low level of service caused by limited production capacity and an inadequate distribution pipeline network. This situation arises because PDAM Tiratasari relies solely on a single Water Treatment Plant (IPA), namely IPA Marcapada, which is insufficient to meet the growing demand for clean water in line with population growth and regional development. As a strategic effort to increase production capacity and expand the distribution network, the Regional Drinking Water Supply System (SPAM) Program for the Mebidang area—covering Medan, Binjai, and Deli Serdang—has become an essential solution. The Mebidang SPAM, sourced from the Bingei River in Binjai City, has been inaugurated and is designed to serve up to 88,000 household connections or approximately 440,000 people, with a production capacity of 1,100 liters per second. This program is the result of synergy between the central, provincial, and local governments, and is expected to significantly improve access to safe drinking water, particularly in the priority development areas of Binjai Utara and Binjai Timur subdistricts. This study aims to determine the priority areas for the development of the Main Distribution Network (JDU) of the Mebidang SPAM in Binjai City, in order to support improved water service delivery amidst the government's policy of budget efficiency as stipulated in Presidential Instruction Number 1 of 2025. The analysis employed includes a technical hydraulic scheme analysis using the EPAnet application to model water distribution, as well as the SMART (Simple Multi Attribute Rating Technique) method to determine area priorities based on technical criteria, community needs, and budget efficiency. Through this approach, it is expected that the JDU development can be implemented effectively, efficiently, and accurately, in accordance with community needs and government policies.

INTRODUCTIONS

Raw water sources consist of springs, surface water (rivers, lakes, reservoirs, etc.), groundwater (dug wells, borewells) and rainwater. Managing raw water sources in accordance with the quality standards that have been determined is called the Drinking Water Supply System (SPAM) as the provision of clean water for the community. The Regional SPAM development policy is the right step in utilizing the potential of raw water that can be used

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together to overcome the limitations in the quantity and quality of surface water used as a source of raw water in several districts/cities. (Safitri et al., 2023) (Sudarmadji et al., 2016)

In Binjai City, drinking water management is managed by Regionally Owned Enterprises, hereinafter referred to as BUMD, which is a business entity formed specifically to carry out activities to implement a drinking water supply system whose entire or most of the capital is owned by the Region (Regulation of the Minister of Home Affairs, 21 2020), namely PDAM Tirsari. At this time, PDAM Tiratasari is faced with a low level of service due to the lack of production capacity and limited distribution pipeline network. The areas that have received Binjai city SPAM network services to date are all regions (five sub-districts in Binjai City). However, not all areas can be supplied by PDAM Tirtasari considering that PDAM Tirtasari only has one IPA, namely Marcapada IPA. (Wardhani & Rais, 2023)

The Regional Drinking Water Supply System (SPAM) program that is a priority for development development in Indonesia is the Regional SPAM Mebidang (Medan, Binjai and Deli Serdang). Based on Government Regulation No. 26 of 2008, the Mebidangro area (Medan, Binjai, Deli Serdang and Karo) is designated as a National Strategic Area (KSN) which of course has an impact on increasing the need for drinking water services. The development of the Mebidang Regional Drinking Water Supply System is prepared for a long term of 10 years (2016-2025), especially for the Sei Bingei river project with a capacity of 2,100 lt/s which will be supplied to Binjai City, Medan City and Deli Serdang Regency. (Feasibility Study of Regional SPAM Development in Mefieldang, 2017)

In the Amendment Document on the Synergy of Planning and Development Implementation (SP3) concerning the Implementation of Regional SPAM Mebidang in North Sumatra Province, in this case the Regional Government of Binjai City approved the implementation of the development of SPAM Mebidang by providing information data and purchasing bulk water from the implementation of the Regional Mebidang SPAM which meets the quantity requirement of 150 lt/s from the East Binjai Off Taker Reservoir to be given to the service area of East and North Binjai City, In this case, the implementation of the implementation of the development of SPAM in Binjai City will be carried out by the Binjai City Public Works Office and/or PDAM Tirtasari Binjai City, This party is required to build a service unit consisting of a distribution network to serve ≤ 16,000 SR, as well as carry out counseling to the people of Binjai City to subscribe to PDAM Tirtasari drinking water.

In order to realize the SP3 document in the utilization and development of SPAM clean water in accordance with Presidential Instruction Number 1 of 2025 concerning Expenditure Efficiency in the Implementation of the State Revenue and Expenditure Budget and Regional Expenditure in 2025, the Binjai City Government and PDAM Tirtasari need to make development priorities with the right target in the development area of clean water/drinking water utilization with budget limitations. According to Lynch (1981), A Theory of Good City City Planning must prioritize strategic location decisions for public facilities to ensure equitable access and improve quality of life.

According to Prioritization in project management or decision-making can be done by using several methods and criteria to ensure effective resource allocation. In the study, the method used in this study is the SMART method (Simple Multi Attribute Rating Technique). The use of the SMART method is due to its simplicity in responding to the needs of decision-makers and the analysis used is transparent, thus providing a high understanding of the problem and easy to accept by decision-makers. The weighting technique used to give a value or score to each parameter was carried out by a hydrolysis analysis test, in the study and Epanet was able to simulate the hydraulic behavior and water quality in the pipeline network by describing the simulation of the hydrolytic and the tendency of the quantity of water flowing within the pipeline. Brianorman (2021) Elia et al. (2022) Yusnitha et al. (2019) Ramana et al. (2015)

In an effort to support the sustainable and equitable provision of drinking water, it is necessary to conduct an in-depth study of the condition of the water distribution network in urban areas that continue to grow. East Binjai and North Binjai Districts as part of the Mebidang Drinking Water Supply System (SPAM) development area have a strategic role in supporting the community's clean water needs. However, to ensure the effectiveness and efficiency of services, it is necessary to know what the existing condition of the distribution network in the two sub-districts is. Therefore, this study formulates several main problems that will be answered, namely: (1) how the existing condition of the distribution network in East Binjai and North Binjai Districts uses the Epanet application; (2) how to determine priority areas for the development of Mebidang SPAM in the two sub-districts using the SMART Method; and (3) how is the most appropriate water distribution network investment priority strategy to be implemented in East Binjai and North Binjai Districts. (Triayudi et al., 2023)

In line with the formulation of the problem above, this study aims to provide a comprehensive overview of the water distribution system in the research area and its future development direction. The objectives to be achieved include: (1) identifying the existing condition of the water distribution network in East Binjai and North Binjai Districts to determine the current system performance level; (2) analyze areas that have priority for the development of SPAM by applying the SMART Method, so that the areas that need the most improvement in drinking water services can be identified; and (3) analyze the priority investment strategy of the water distribution network in the two sub-districts so that existing resources can be utilized optimally and sustainably. With the achievement of these goals, it is hoped that the results of the research can be the basis for making the right decisions for the development of drinking water systems in the Binjai area and its surroundings.

This research is expected to provide benefits both theoretically and practically. Theoretically, the results of this study will enrich scientific studies in the field of water resource management, especially related to the analysis of real drinking water needs and the identification of the economic feasibility of PDAM Tirtasari in the context of distribution network development. Practically, this research is expected to be a valuable input for local governments, PDAMs, and related business entities in formulating policies and strategies for more efficient, fair, and sustainable drinking water management. Thus, this research can contribute to improving drinking water services to the community and support the achievement of basic infrastructure development targets oriented towards public welfare.

As a basis for reference, this study refers to several official documents, including the 2017 North Sumatra Province Regional SPAM Development Feasibility Study Document, which serves as a technical and conceptual guideline in understanding the initial conditions and development plans for drinking water systems in the region. In addition, the Amendment Document on the Synergy of Development Planning and Implementation (SP3) concerning the Implementation of Regional SPAM in accordance with Decree Number 188.45-191/K/Year 2021 dated March 8, 2021, which affirms coordination between regions in the provision of regional-based drinking water.

At the level of national regulations, this study also pays attention to Presidential Instruction Number 1 of 2025 concerning Expenditure Efficiency in the Implementation of the State Revenue and Expenditure Budget and Regional Expenditure, which is the foundation of efficiency in financing public infrastructure, including SPAM projects. In addition, there are also technical references in the form of Regulation of the Minister of Public Works Number 18 of 2007 concerning the Implementation of the Development of Drinking Water Supply Systems, as well as the Regulation of the Minister of Public Works and Spatial Planning Number 27/PRT/M/2016 concerning the Implementation of Drinking Water Supply Systems, which regulates the technical, institutional, and operational aspects of the implementation of drinking water systems in Indonesia.

The scope of this research is limited only to the assessment of the priority needs of Phase I of SPAM Mebidang in Binjai City, so the focus of the research is directed to identify and determine priority areas for development in the early stages of system implementation. Non-technical aspects, such as political, socio-cultural, and policy dynamics outside the technical realm of infrastructure planning, are not included in the scope of this study. With these restrictions, the research is expected to be more directed in providing in-depth and relevant analysis results to the needs of water distribution network development in the study area.

METHOD

This research methodology is prepared as a systematic guideline in carrying out the entire series of research activities so that the goals that have been formulated can be achieved effectively. Each stage of research is designed in a flowchart that describes the implementation process starting from data collection, processing, to analysis of results. This flowchart serves as a guide in the implementation of research activities and ensures that the entire process runs in a directional manner and according to the previously set goals. (Rasyid, 2022)

This research was carried out in East Binjai District and North Binjai District located in Binjai City, North Sumatra Province. These two areas were chosen because they are included in the Mefield Regional Drinking Water Supply System (SPAM) development area, which includes Medan City, Binjai City, and Deli Serdang Regency. As part of the regional system, the two sub-districts have an important role in providing and distributing drinking water for the community, so a thorough analysis of the condition of the existing network and its potential development in the future is needed.

The type of data used in this study is secondary data, obtained from various agencies and official documents, both from government agencies and online publications. The data includes information from PDAM Tirtasari Binjai City regarding the existing condition of the water distribution network in 2020-2025, the work plan for the 2025 fiscal year, and the results of the Real Demand Survey (RDS). In addition, the study also uses data from the Binjai City PUPR Office and the Central Statistics Agency (BPS) of Binjai City, as well as various supporting documents such as the 2017 Mebidang Regional SPAM Development Feasibility Study, the Master Plan for the Drinking Water Distribution Network of East Binjai and North Binjai Districts, the North Sumatra Province Drinking Water Achievement Report, and the Medan City Drinking Water Supply System (RISPAM) Master Plan for 2022. Additional data in the form of the number of population, number of family cards, per capita income, and Presidential Regulation of the Republic of Indonesia Number 18 of 2020 concerning the National Medium-Term Development Plan 2020–2024 were also used as the basis for the analysis.

RESULT AND DISCUSSIONS

Drinking Water Construction Guidelines of the Director General of Cipta Karya Ministry of PUPR

Referring to the Technical Guidelines for Community-Based Drinking Water Supply issued by the Directorate General of Cipta Karya of the Ministry of Public Works and Public Housing (PUPR), there are several technical provisions that are a reference in the planning of drinking water transmission and distribution systems. These provisions are listed in Table 1 and Table 2 below.

Table 1. Transmission Pipe Criteria

No	Description	Notation	Criterion
1	Discharge planning	Q	The plan discharge is set based on the maximum daily water requirement.
2	Maximum day factor	F_{max}	The maximum daily water requirement is calculated by the formula: $Q_{max} = F_{max} \times Q_{average}$, with a value of F_{max} ranging from 1.10 – 1.25.
3	Channel type	-	Open pipes or channels.
4	Water flow speed in the pipeline (minimum and maximum)	V_{min} / V_{max}	Minimum speed: 0.3 m/sec. Maximum speed: -PVC pipe: 3.0 m/sec - DCIP pipe: 1.5 m/sec.
5	Water pressure in the pipe (minimum and maximum)	H_{min} / H_{max}	Minimum pressure: 10 meters. Maximum pressure: -PVC pipe: 80 meters - DCIP pipe: 100 meters.
6	Flow rate on open channels (minimum and maximum)	V_{min} / V_{max}	Minimum speed: 0.6 m/sec, maximum speed: 1.5 m/sec.
7	Open channel slope	S	The slope is between 0.5 – 1.0‰ (per mile).
8	Open channel free height	H_w	Minimum free height of 15 cm.
9	Slope of the cliff against the bottom of the channel	-	45° tilt angle for trapezoidal channel shapes.

Table 2. Distribution Pipeline Criteria

Yes	Description	Notation	Criterion

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1	Discharge planning	Q	The planned discharge is determined based on peak hour water needs.
2	Peak hour factor	F_{pincak}	Peak hour water needs are calculated by the formula: Q_{peak} = F_{peak} × Q_{average}, with a value of F_{peak} between 1.5 – 2.0.
3	Speed of water flow in pipes	V_{min} / V_{max}	Minimum speed: 0.3 m/sec. Maximum speed: -PVC or ACP pipe: 3.0 m/s - Steel pipe or DCIP: 6.0 m/sec.
4	Water pressure in the pipe	H_{min} / H_{max}	The minimum pressure at the farthest service point (house connection) is 10 – 15 meters, while the maximum pressure is: -PVC or ACP pipe: 80 meters - Steel pipe or DCIP: 100 meters.

The provision indicates that in the planning of a drinking water transmission and distribution system, factors such as discharge, flow speed, water pressure, and the type of pipeline material must be carefully taken into account so that the system can function optimally and sustainably. In transmission pipelines, the aspects that are considered include the calculation of the maximum daily water requirement, the type of channel (closed pipe or open channel), as well as speed and water pressure limits so as not to cause network damage. (Wardhani & Kamil, 2023)

Meanwhile, in the distribution pipeline, calculations are focused on peak hour water needs, flow speed in the network, and water pressure at the furthest point of service. A minimum flow rate is required to avoid sedimentation within the pipeline, while a maximum speed is set to prevent excessive pressure loss and potential leakage. The minimum and maximum pressure values are adjusted to the characteristics of the pipe material used, such as PVC, ACP, or DCIP, to ensure the long-term durability of the system. (Bastrianto et al., 2024; Tanjung & Adawiyah, 2018)

Data Analysis

EPANET App. The analysis was carried out with 3 (Three) Distribution Pipeline Connection Modeling Schemes as follows:

1. Analysis of existing Main Distribution Network (JDU) hydraulics with active customer data demand.
2. Analysis of the existing Main Distribution Network (JDU) hydraulics with the demand for population data.
3. Hydrolysis analysis of the Main Distribution Network (JDU) plan with population data demand.

The first step is to form a main distribution network (JDU) pipeline on Google Earth Image Map to get pipe tapping, regional elevation, and coordinates at the tapping location. The analysis with the EPANET 2.2 program requires data input from the results of google earth network modeling and demand from the secondary data of each node of each village as well as the planned pipeline roughness value. The results of the hydrolytic analysis of the piping network using EPANET produced water pressure figures and analysis of the length of the pipes used in the planning.

First analysis of existing major distribution network (JDU) connections with existing demand

The analysis of the Main Distribution Network (JDU) was carried out by analyzing the existing JDUs in North Binjai District and East Binjai District. The first hydraulic analysis was carried out to analyze the feasibility of the existing pipeline owned by PDAM Tirtasari with existing demand, namely PDAM Tirtasari customers in North Binjai District and East Binjai District with the discharge of the phase I plan of the Mebidang SPAM Offtaker 150lt/sec using the Epanet 2.2 Application, the following analysis:

1. Modeling of the Existing Main Distribution Network (JDU) in the Google Earth Application in Figure 1 and Figure 2 to obtain data needed in Hydrolysis Analysis, namely network coordinates and elevation data.

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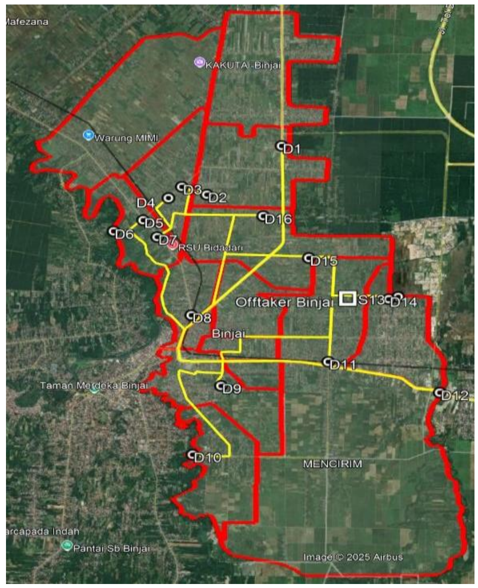

Figure 1. Google Earth Existing Network

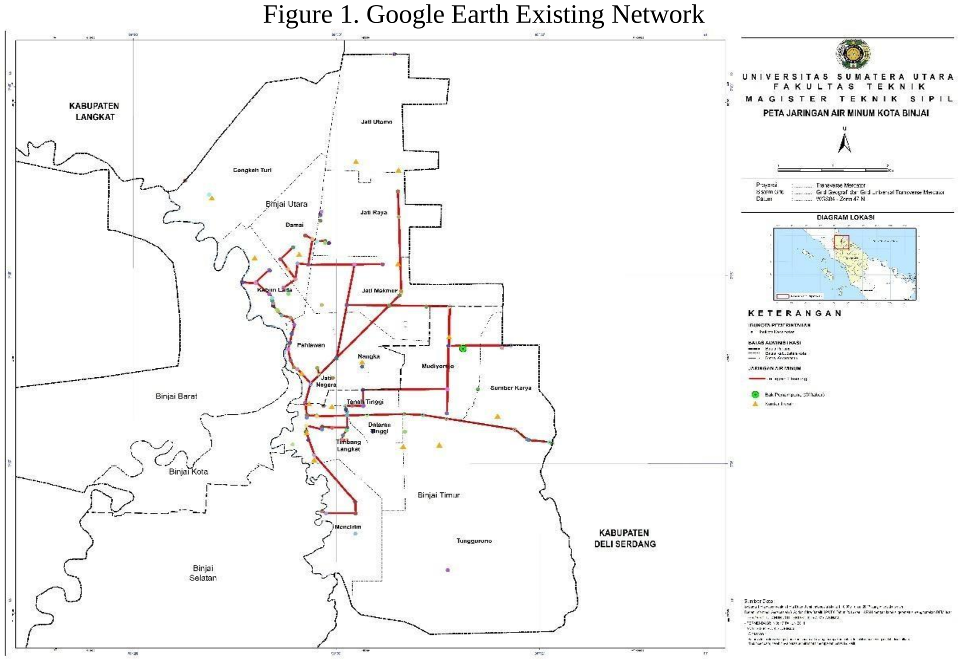

Figure 2. Existing JDU map of North Binjai and East Binjai sub-districts

2. After modeling was carried out on Google Earth, it was followed by the EPANET 2.2 application in Figure 3 using secondary customer data in Table 3 as existing demand data in hydraulic analysis. The following are the results of the analysis of the Existing JDU hydraulics with Existing Demand.

Table 3. Number of Customers of PDAM Tirtasari

Yes	Village/Village	SR Existing
1	Hero	498

2	Jatinegara	272
3	Jackfruit	194
4	Düsseldorf	372
5	Peace	557
6	Kebunlada	201
7	Squirt	400
8	Fingers	586
9	Jatiutomo	80
10	Mencirim	118
11	Tunggurono	343
12	Plateau	0
13	Weight Loss	274
14	Highlands	466
15	Sumbermulyorejo	800
16	Source	83

Figure 3. Epanet 2.2 Modeling Existing JDU

Node ID	Demand LPS	Head m	Pressure m

1	0	76.29	55.69
2	0	76.29	53.59
3	0.13	76.29	51.29
4	0.13	76.29	52.59
5	0	75.2	53.8
6	2.59	75.02	47.32
7	0	72.74	49.94
8	0	69.23	43.23
9	1.21	69.16	46.56
10	0	68.57	41.57
11	0	68.57	41.77
12	0	68.36	41.76
13	0.6	68.35	45.05
14	0	68.2	40.9
15	0	68.16	41.16
16	0.9	68.16	43.76
17	0	68.16	41.56
18	0	68.16	40.56
19	0	68.16	40.36
20	0.95	68.16	40.16
21	0	68.19	41.59

22	0	68.18	42.98
23	0	68.17	41.17
24	0.9	68.17	43.17
25	0.3	68.18	39.98
26	0	68.34	41.24
27	0	67.65	37.95
28	3.12	67.65	37.45
29	0	67.6	36.6
30	0	67.6	37.5
31	0	67.59	37.09
32	0	67.59	34.79
33	0	67.59	38.09
34	0	67.58	39.28
35	0	67.58	39.28
36	0	67.58	35.58
37	0	67.58	37.88
38	0	67.57	38.67
39	0	67.57	34.37
40	0	67.57	32.97

Table 4. Results of the hydrolytic analysis of the epanet 2.2

Based on the results of the analysis using the Epanet application, the following data in Table 5 states that the Existing Main Distribution Network (JDU) with Existing Demand can accommodate the discharge of the Mebidang SPAM plan, with the provision that the average does not reach a maximum pressure of 80 meters and a minimum of 10 meters in accordance with the provisions of the Pocket Book of Drinking Water Construction Instructions of the Director General of Cipta Karya of the Ministry of PUPR in Table 5

Table 5. Distribution Pipeline Criteria

No	Uraian	Notasi	Kriteria
1	Debit Perencanaan	Q puncak	Kebutuhan air jam puncak Q peak = F peak x Q rata-rata
2	Faktor jam puncak	F. puncak	1,5 – 2
3	Kecepatan aliran air dalam pipa	V min	0,3 m/det
	a) Kecepatan maksimum - Pipa PVC atau ACP - Pipa baja atau DCIP b) Kecepatan minimum	V max	3,0 m/det 6,0 m/det
4	Tekanan air dalam pipa	h min	(10 - 15) meter, pada titik jangkauan pelayanan terjauh. (Pada titik sambungan rumah/ konsumen terjauh)
	a) Tekanan minimum	h max	80 meter
	b) Tekanan maksimum - Pipa PVC atau ACP - Pipa baja atau DCIP	h max	100 meter

Analysis of the two existing main distribution network (JDU) connections with the demand plan

The second hydraulic analysis was carried out by modeling using the existing JDU pipeline with the demand plan, namely the population number per village, the second analysis was carried out to analyze the feasibility of the existing pipeline with the discharge of the phase I plan Offtaker SPAM Mebidang 150lt/dt using the Epanet Application 2.2 The results of the modeling analysis of the existing main distribution network (JDU) pipeline with the demand plan produced errors in the application that indicated the existing pipeline with the demand of the plan was not can be used with the results of pressure on each node not in accordance with the table of the drinking water network guidebook of the Director General of Cipta Karya of the Ministry of PUPR.

No.	Node ID	Demand (LPS)	Head (m)	Pressure (m)
1	1	0.0	86.6	66.0
2	2	0.0	85.12	62.42
3	3	5.56	85.1	60.1
4	4	5.56	85.03	61.33
5	5	0.0	45.81	24.41
6	6	11.52	42.93	15.23
7	7	0.0	-57.57	-80.37
8	8	0.0	-205.07	-231.07
9	9	15.63	-213.99	-236.59
10	10	0.0	-227.94	-254.94
11	11	0.0	-227.91	-254.71
12	12	0.0	-231.79	-258.39
13	13	4.46	-231.98	-255.28
14	14	0.0	-234.11	-261.41
15	15	0.0	-234.62	-261.62
16	16	2.98	-234.65	-259.05
17	17	0.0	-234.65	-261.25
18	18	0.0	-234.71	-262.31
19	19	0.0	-234.73	-262.53

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20	20	4.64	-234.76	-262.76
21	21	0.0	-234.21	-260.81
22	22	0.0	-234.39	-259.59
23	23	0.0	-234.47	-261.47
24	24	2.98	-234.53	-259.53
25	25	2.47	-234.42	-262.62
26	26	0.0	-240.91	-268.01
27	27	0.0	-272.5	-302.2
28	28	21.51	-272.84	-303.04
29	29	0.0	-275.17	-306.17
30	30	0.0	-275.59	-305.69
31	31	0.0	-275.67	-306.17
32	32	0.0	-275.84	-308.64
33	33	0.0	-276.08	-305.58
34	34	0.0	-276.19	-304.49
35	35	0.0	-276.22	-304.52
36	36	0.0	-276.42	-308.42
37	37	0.0	-276.62	-306.32
38	38	0.0	-276.79	-305.69
39	39	0.0	-276.97	-310.17
40	40	0.0	-277.08	-311.68
41	41	0.0	-277.13	-312.03
42	42	0.0	-277.24	-310.74
43	43	0.0	-277.3	-310.6
44	44	0.0	-277.36	-310.06
45	45	0.0	-277.42	-309.72
46	46	0.0	-277.51	-308.51
47	47	0.0	-277.9	-307.5
48	48	0.0	-277.88	-307.78
49	49	2.47	-277.9	-297.0
50	50	11.82	-278.2	-304.7
51	51	0.0	-277.59	-308.59
52	52	0.0	-277.82	-309.92
53	53	0.0	-277.98	-308.98
54	54	0.0	-278.0	-309.5
55	55	0.0	-278.49	-310.89
56	56	0.0	-278.52	-308.52
57	57	0.0	-278.54	-308.44
58	58	0.0	-278.57	-309.17
59	59	0.0	-278.62	-309.62
60	60	0.0	-278.69	-311.89
61	61	0.0	-278.81	-310.81
62	62	0.0	-279.39	-305.89
63	63	0.0	-280.0	-303.1
64	64	4.46	-280.16	-303.16
65	65	0.0	-280.4	-312.1
66	66	0.0	-280.44	-312.34
67	67	0.0	-280.77	-309.87
68	68	0.0	-280.98	-311.98

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69	69	0.0	-281.05	-310.25
70	70	0.0	-281.41	-313.41
71	71	0.0	-281.54	-314.14
72	72	0.0	-282.12	-316.12
73	73	0.0	-283.56	-320.86
74	74	0.0	-283.82	-320.62
75	75	0.0	-284.47	-320.57
76	76	8.34	-284.57	-316.77
77	77	0.0	-280.51	-313.51
78	78	0.0	-280.64	-311.64
79	79	0.0	-280.75	-312.55
80	80	14.95	-280.87	-312.57
81	81	0.0	-278.52	-309.52
82	82	0.0	-278.55	-306.05
83	83	0.0	-278.61	-309.11
84	84	0.0	-278.62	-306.62
85	85	9.44	-278.64	-303.54
86	86	-128.79	23.0	0.0

Table 6. Results of epanet 2.2 jdu existing and demand plan

The JDU planning plan was formed due to the results of the analysis of the existing JDU cannot accommodate the amount of pressure on the pipeline with population demand per sub-district BPS 2024 data in North Binjai and East Binjai Districts in phase I of 150lt/s with a coverage of 4 (four) people per house connection (sr). The results of the hydrolis analysis showed that it is necessary to create a new pipeline connection network for the Main Distibusi Network (JDU) of SPAM Mebidang so that the target of minimum service standards (SPM) in North Binjai and East Binjai Districts is met. The analysis used in the new pipeline connection plan at JDU is to use PVC pipe materials with a value of C=140 in accordance with the provisions with a diameter that is in accordance with the designation of each demand in each sub-district and by including the discharge of the phase I plan at the Mebidang SPAM offtaker in Binjai City of 150 liters/second.

Analysis of the three main distribution network connections (JDUs) of the plan with the demand of the plan

The third analysis was carried out by modeling using the JDU pipeline plan with the demand plan, network planning was planned using the Google Earth application in determining the pipeline tappings and pipeline planning lines in the JDU Planning plan was formed because the results of the analysis of the existing JDU could not accommodate the amount of pressure on the pipeline with population demand per village in North Binjai and East Binjai Districts in phase I of 150lt/s with a coverage of 4 (four) people per Home connection (SR).

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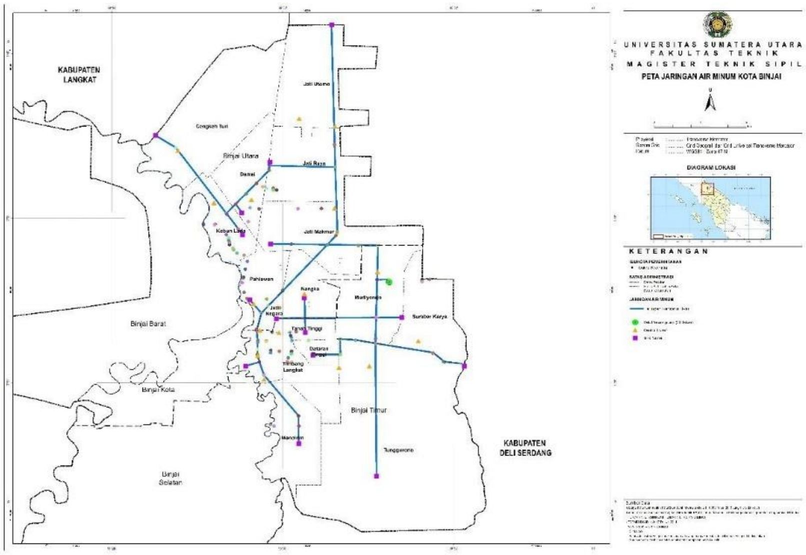

Figure 3. JDU map of North Binjai and East Binjai sub-districts

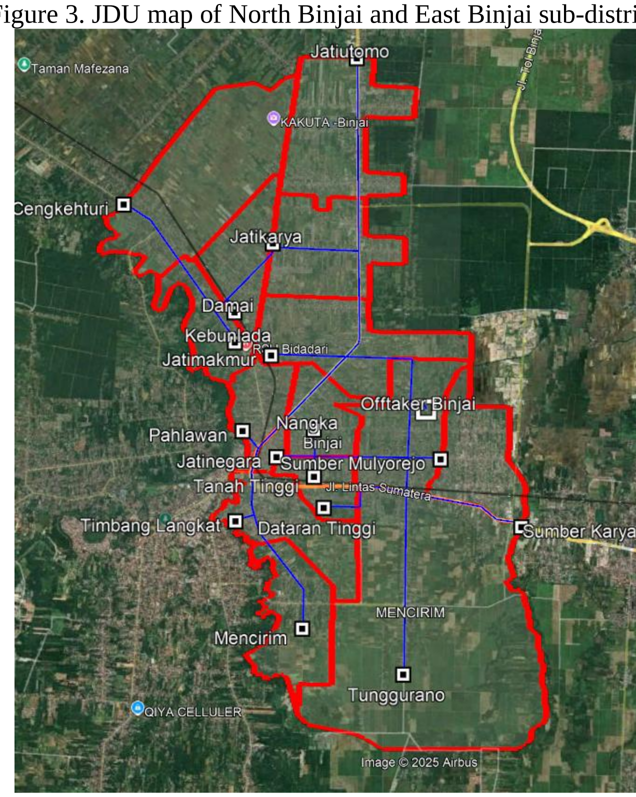

Figure 4. JDU planning Google Earth plan

Figure 4 is the modeling of the Main Distribution Network (JDU) pipeline connection plan for SPAM Mebidang which covers 16 (sixteen) villages in North Binjai and East Binjai Districts. In this modeling, it was tested on the EPANET 2.2 application.

Table 7. Results of the JDU Pressure Node Plan – Demand Plan

Node ID	Demand (LPS)	Head (m)	Pressure (m)	Quality
14	0.00	34.87	7.87	0
15	4.74	34.77	8.57	0
16	0.00	33.58	6.88	0
17	0.00	29.22	3.32	0
18	12.03	28.00	2.20	0
19	4.90	33.31	5.21	0
20	0.00	65.52	38.32	0
21	0.00	60.21	29.21	0
22	9.22	59.65	29.65	0
23	0.00	59.01	27.01	0
24	0.00	58.22	26.62	0
25	0.00	57.40	24.70	0
26	0.00	56.90	22.90	0
27	4.42	56.78	22.48	0
28	0.00	56.44	22.44	0
29	0.00	54.76	17.66	0
30	9.17	53.86	17.36	0
32	2.30	74.28	43.18	0
33	0.00	80.92	54.22	0
34	10.21	79.94	55.74	0
35	0.00	74.35	42.35	0
36	9.48	73.66	43.96	0
37	4.75	74.22	40.82	0
38	0.00	74.74	47.24	0
39	0.00	74.52	47.32	0
40	0.00	74.35	43.35	0
41	0.00	74.18	44.48	0
42	5.19	73.89	41.69	0
43	0.00	71.56	41.06	0
44	0.00	70.75	44.45	0
45	12.41	69.80	43.90	0
46	9.52	70.19	28.49	0
47	-127.87	21.90	0.00	Reservoir

Results of Technical Aspect Analysis

The results of the Piping Network Analysis using 3 (three) different modeling analysis schemes with the trial in the Epanet 2.2 application. The results of the hydrolis analysis showed that it is necessary to create a new pipeline connection network for the Main Distibusi Network (JDU) of SPAM Mebidang so that the target of minimum service standards (SPM) in North Binjai and East Binjai Districts is met. The analysis used in the new pipeline connection plan at JDU is to use PVC pipe materials with a value of C=140 in accordance with the provisions of the diameter in accordance with the designation of each demand in each sub-district and by including the discharge of the phase I plan on the offtaker of SPAM Mebidang in Binjai City of 150 liters/second.

Real Demand Survey (RDS) / Interest

PDAM Tirtasari as a BUMD in charge of managing drinking water and wastewater in Binjai City has conducted an RDS survey in Binjai City to see the interest in the community to become a violation of PDAM with the existence of SPAM Mebidang. The results of the survey are described in each sub-district and each sub-district. In the aspect of this interest category, the level of interest of residents to become customers of PDAM Tirtasari is very low, because

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the service before SPAM Mebidang is very lacking in terms of water services to customers and because it is still in the process of building a pipeline connection so that the direct positive effect/impact has not been felt by residents who are already customers (existing) and potential customers.

Simple Multi Attribute Rating Technique (SMART) Method

The priority study of the construction of pipeline connections for the main distribution network of SPAM Mebidang was carried out using the Simple Multi Attribute Rating Technique (SMART) Method. The SMART method is a multi-criteria decision-making method used to handle problems with various alternatives and assessment criteria. The basic principle of this method is to give weight to each criterion according to its level of importance, then calculate the total value of each alternative to determine the best alternative. (Sibyan, 2020; Taherdoost & Mohebi, 2024)

The stages of applying the SMART method in this study are described as follows:

1. Determine alternatives and criteria. The first step is to determine the alternatives to be evaluated as well as the criteria that are the basis for the assessment in determining the priority for the development of the water distribution network.
2. Give weight to each criterion. Each criterion is weighted based on its level of importance, using a scale of 1 to 100. The more important a criterion is, the greater the weight given.
3. Normalize the weight of the criteria. After all criteria are weighted, a normalization process is carried out to obtain a balanced weight proportion using the following equation:

$$W_{\text{normalisasi}} = \frac{W_i}{\sum_{i=1}^{n} W_i} (4.1)$$

Information:

- $W_{\text{normalisasi}}$= weight of the criteria for the result of normalization to j
- W_i= value of the weight of the J criterion
- n= total number of criteria

4. Determine the value of the criteria for each alternative. Each alternative is evaluated based on predetermined criteria. If the criterion data is qualitative, then the data is converted into quantitative form (numbers) so that it can be calculated mathematically.
5. Determine the utility value. Utility values are calculated to standardize the criteria values of each alternative so that they can be objectively compared.
   - For the benefit criteria, the formula is used:

$$U_i(a_i) = \frac{C_{\text{out}} - C_{\text{min}}}{C_{\text{max}} - C_{\text{min}}} \times 100\% (4.2)$$

   - For the cost criteria, the formula is used:

$$U_i(a_i) = \frac{C_{\text{max}} - C_{\text{out}}}{C_{\text{max}} - C_{\text{min}}} \times 100\% (4.3)$$

6. Information:
   - $U_i(a_i)$= Utility value of criterion i for alternative i
   - C_{max}= maximum criterion value
   - C_{min}= minimum criterion value
   - C_{out}= actual value of criterion i
7. Calculate the total utility of each alternative. The final value of each alternative is obtained by multiplying the normalization weight of each criterion by its utility value, then summing it up in its entirety. The formula used is:

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$$U(a_i) = \sum_{j=1}^{n} W_j \times U_j(a_i)(4.4)$$

Information:

- $U(a_i)$= total value of the first alternative
- W_j= weight of the criteria for the result of normalization to j
- $U_j(a_i)$= the utility value of the Jth criterion for the Ith alternative

The results of this SMART calculation stage will produce an alternative priority sequence, which is then used to determine the priority areas for the development of SPAM Mebidang based on the technical and non-technical criteria that have been set.

Final score

Table 8. Final Score Results

Alternative	C1	C2	C3	C4	C5	Result (U)
A1	0.370	0.259	0.185	0.111	0.074	1.000
A2	0.000	0.000	0.014	0.108	0.007	0.129
A3	0.232	0.130	0.000	0.000	0.000	0.363
Weight (Wj)	0.37	0.26	0.19	0.11	0.07	

The final value calculation is done using the following equation:

$$U(a_i) = \sum_{j=1}^{n} W_j \times U_j(a_i)$$

Table 9. Final Result Ranking

Alternative	**U Grade**	**Rank**
A1	1.000	1
A3	0.363	2
A2	0.129	3

Interpretation of Results:
Based on the results of the ranking in Table 4.26, it can be concluded that the location of A1 (eastern region) is the best alternative and is the main priority for the construction of the Main Distribution Network (JDU) of SPAM Mebidang in Binjai City, especially in North Binjai and East Binjai Districts.

CONCLUSION

Based on the results of the analysis carried out, it can be concluded that the hydraulic condition of the existing Main Distribution Network (JDU) in North Binjai and East Binjai Districts has not met the technical criteria set out in the Drinking Water Construction Instruction Pocket Book by the Directorate General of Cipta Karya of the Ministry

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of PUPR. This is shown by the results of pressure simulations on each pipe and node that produce values above 80 meters, so they do not conform to the recommended standards for drinking water distribution systems.

The results of the analysis using the SMART Method show that the priority area for the development of SPAM Mebidang in Binjai City is the eastern part of North Binjai and East Binjai Districts, which includes several urban villages. This area was selected based on the assessment of various aspects, including financial aspects with a total cost requirement of Rp 45,317,107,953, a total population of 66,799 people, the number of existing customers of 8,632 customers, hydraulic pressure of 321.01 meters, and the level of public interest of 43% based on the results of field surveys.

The strategy for developing the main distribution network of drinking water in this priority area is planned in two stages of implementation. The first phase includes the construction of JDU in Sumbermulyorejo Village and continues to Tanah Tinggi Village, which functions as an integration point between Nangka Village and Jatinegara Village, with an estimated cost of Rp 24,229,436,820 and the number of people served is around 35,805 people. Meanwhile, the second phase includes the construction of JDU in Sumber Karya Village, Dataran Tinggi Village, and Tunggurono Village, with an estimated cost of Rp 21,087,671,133 and the number of people served reaches 30,994 people. Overall, the results of this study emphasize the importance of adjusting the network hydraulic design and determining the priority of the SPAM Mebidang development area in stages to achieve investment efficiency and equitable distribution of drinking water services for the people of Binjai City.

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