Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN: 2550-0023

Vol 20, No 2, 2023, 280-294
Article available at *homepage presipitasi*

Regional Case Study

Determination of Strategy Planning of Domestic Wastewater Management System in a Commercial Area of Tasikmalaya City

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Abstract
The domestic wastewater in Cihideung and Tawang Subdistricts as central business district (CBD) areas in Tasikmalaya City is only served by an on-site domestic wastewater management system or Sistem Pengelolaan Air Limbah Domestik Setempat (SPALD-S) which could deteriorate the environment. This study aims to determine the most appropriate type, strategy, and development direction of SPALD based on the existing local conditions for the next 20 years in CBD areas in big cities such as Tasikmalaya. The two methods were used: the multicriteria decision analysis method which refers to the Regulation of the Minister of PUPR Number 04 of 2017, and the Quantitative SWOT analysis method refers to the Guidelines for Preparing a Wastewater Management System Plan. The results of the analysis show that integrated SPALD (SPALD-T) must be implemented aggressively in the two sub-districts based on the key parameters of the existing SPALD conditions, potential for soil contamination, potential danger to air receiving bodies, socio-economic characteristics of the community, public health conditions, education level, financial capability, and the availability of regulations regarding SPALD. The SPALD-T development is suggested to be carried out in stages by determining priority zones for every five years of the planning period.

Keywords: Domestic wastewater; SPALD type selection; multicriteria decision analysis; SWOT analysis

1. Introduction

Untreated or insufficiently treated wastewater in urban areas is one of the major environmental issues in Indonesia (Soemirat, 2011; Sururi et al., 2019; Sururi et al., 2020). A large proportion of the untreated or insufficiently treated wastewater is discharged directly into the nearest drainage channel or surface water body which is often used as the source of raw drinking water (Sururi et al., 2020; Dirgawati et al., 2023). This increases the number of waterborne disease cases in many urban areas or cities, resulting in issues of significant adverse human health. Waterborne diseases in Indonesia were estimated to be the cause of 3% of deaths of children under the age of 5 (Ministry of Health, 2020) and economic losses that reach 2.3% of the annual national gross domestic product (Dirgawati et al., 2021).

Domestic wastewater management in Indonesia comprises two systems: an on-site system, known as on SPALD-Setempat (SPALD-S), and a centralized or off-site system, known as SPALD-Terpusat (SPALD-T) which is distinguished based on the total number of houses served and the type of technology to treat the wastewater as stated in the Regulation of the Minister of Public Works and Housing (PUPR) No 04 /2017. The number of houses served by the SPALD-S is less than 10 houses, and the wastewater treatment is carried out on-site with typical sanitation technology in the form of concrete pits and either septic tanks or fabricated biofilters complemented with advanced processing systems such as wells or infiltration fields. The septage produced from SPALD-S is sucked and processed in the septage treatment plant. Whereas the SPALD-T is planned to serve more than 10 houses, wastewater treatment is centralized in a wastewater treatment plant, either on a regional scale or a city scale. In general, the biological treatment systems used in city-scale SPALD-T are anaerobic baled reactors, anaerobic filters, rotating biological contactors, and contact aeration (Widrayani et al., 2022). In 2022, only 12 out of 514 cities in Indonesia have city-scale SPALD-T.

Tasikmalaya City is considered one of the big cities in Indonesia, with a population number of 725,561 people in 2020, a population density of 3,948 people/Km², and a population growth rate of 12.80% from 2010 to 2020 (DISDUKCAPIL, 2021a; DISDUKCAPIL,2021c). Tasikmalaya City has an area of the trade business center, known as central business district (CBD). The CBD is a national strategic area in Tasikmalaya City that includes Cihideung, Tawang, and a small part of Cipedes subdistricts (PERDA Tasikmalaya No. 10, 2016). Therefore, in the future, Cihideung and Tawang subdistricts have the potential to experience accelerating urbanization and economic development, increasing population number and density, hence resulting in greater wastewater quantity and pollution load. Consequently, it is important to design proper infrastructure to sufficiently managed domestic wastewater in these urban areas.

The domestic wastewater in Tasikmalaya City is currently served by a decentralized wastewater management system or SPALD-S, comprising individual and communal septic tanks. However, most of these sanitation facilities and infrastructure did not meet the safe sanitation criteria because of insufficient or lack of septage treatment facilities hence the wastewater may not adequately away from human contact, and the waste is not properly treated before environmental discharge (BAPPELITBANGDA, 2016). The Cihideung and Tawang subdistricts are the two subdistricts with the lowest access to safe sanitation (latrines) in Tasikmalaya City in 2020. It was reported that 55.04% of the total households or 19,761 households out of 35,906 households in Cihideung and Tawang subdistricts have no access to proper latrine facilities (Ministry of Health, 2021). This contributes to the contamination of rivers located in the Cihideung and Tawang (CBD) subdistricts, such as the Ciloseh and Cikalang rivers. The water quality index (WQI) of these rivers was 66.47 in the Ciloseh River and 65.91 in the Cikalang River which is a moderately polluted river, with a high concentration of Escherichia Coli from domestic wastewater as the main pollutant parameter contributing to the contamination of these rivers (BAPPELITBANGDA, 2020).

The Cihideung and Tawang subdistricts are categorized as areas with a high risk for domestic wastewater sanitation (BAPPELITBANGDA, 2016). According to the World Health Organization (WHO), an appropriate domestic wastewater management system could reduce the incidence of diarrhea by 35% (Nurhayati, 2019; Sinum, 2021). Therefore, it is important to develop appropriate strategies for domestic wastewater management plan in Cihideung and Tawang subdistricts to prevent an unhealthy environment contaminated by human waste and the spread of many diseases/conditions that can cause widespread illness and death (Soemirat, 2011). The development strategy of the SPALD can be determined either through a standardized multicriteria decision analysis method which is guided by the Regulation of PUPR Number 04 of 2017 or a detailed quantitative SWOT analysis which is commonly used to determine municipal sanitation strategies. Sidiq and Sururi (2022) have reported that regional management systems in Bandung City, Bandung Regency, and Cimahi City through quantitative SWOT could determine different sanitation strategies due to differences in the characteristics of the existing areas. However, there has never been a comparison and/or integration between the two methods of the SPALD determination strategies in the CBD area of a big city such as Tasikmalaya. This paper describes the systematic stages to determine strategy plans for the future development, expansion, or upgrade of a wastewater management system that accommodates changing needs in the Cihideung and Tawang subdistricts of Tasikmalaya City.

2. Methods

2.1 Location

This study was conducted in Cihideung and Tawang subdistricts, the two subdistricts which function as a trade center or central business district (CBD) in Tasikmalaya City (PERDA Tasikmalaya No. 10, 2016). Cihideng District comprises six urban villages (Cilembang, Argasari, Nagarawangi, Yudanagara, Tuguraja, and Tugujaya urban villages), meanwhile Tawang District has five villages i.e. Lengkongsari, Empangsari, Tawangsari, Cikalang, and Kahuripan villages. The surface level of Cihideung and Tawang Districts is commonly flat, ranging from 340-365 meters above sea level (Tasikmalaya City in Figures, 2021). These two subdistricts' areas are the smallest in Tasikmalaya City, with a total area of 545 Ha for the Cihideung subdistrict, and 691 Ha for the Tawang subdistrict (BPS, 2021a; BPS,2021b; BPS,2021c). However, the population densities of these two subdistricts in 2020 were the highest in Tasikmalaya accounting for 134 people/Ha in Cihideung District, and 92 people/Ha in Tawang District (DISDUKCAPIL, 2021). As their functions as CBD areas, the population in Cihideung and Tawang Districts is projected to increase substantially for the next 20 years which further limits land for the placement of wastewater infrastructure and wastewater treatment facilities, suggesting the importance to upgrade the existing system from SPALD-S to SPALD-T.

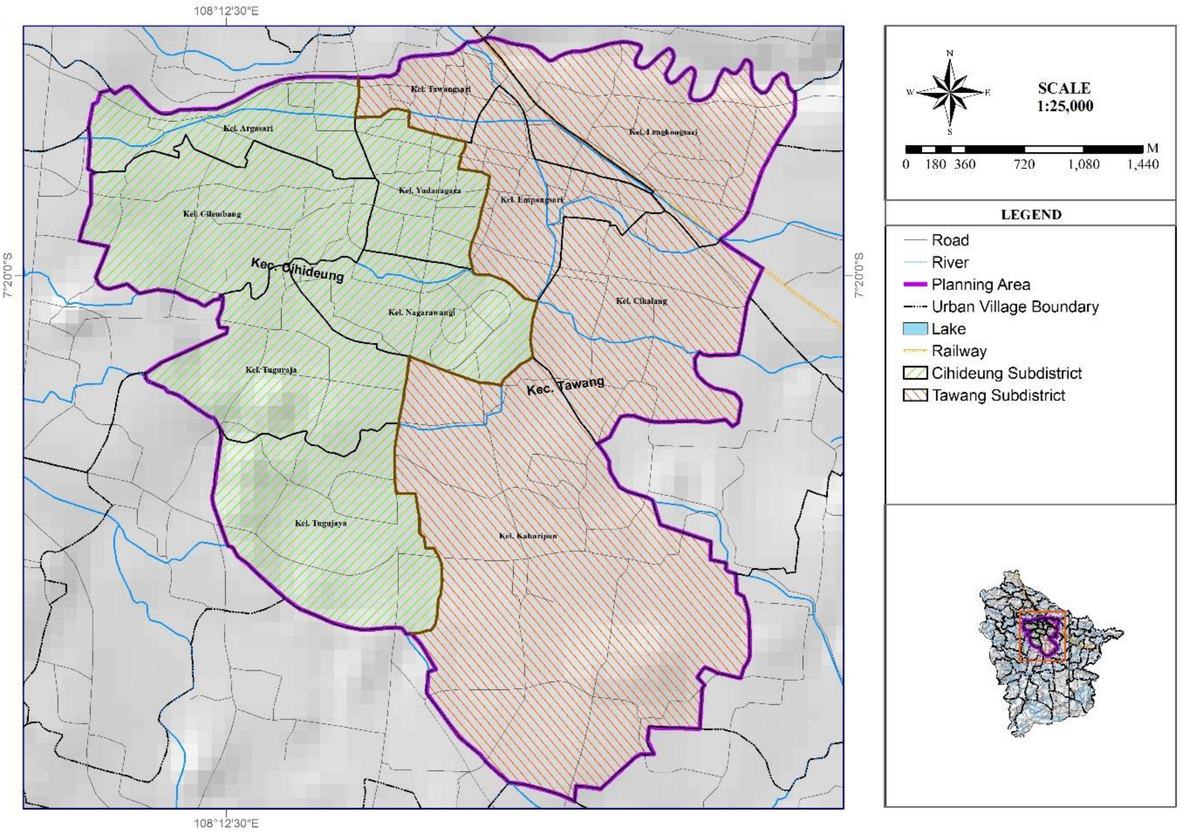

Figure 1. Administrative map of the planning area
Source: Urban Planning of Tasikmalaya City 2011-2031, 2012

2.2 Data

The collected data included: (1) institutions and regulations related to the waste water management system; (2) demographic data of Cihideung and Tawang Subdistricts such as population number, and population density; (3) education level to reflect the quality of human resources and their concern for environment quality; (4) ability to finance sanitation based on the budget plan related to domestic wastewater management; and (5) sanitation conditions such as sanitation risk areas, access to safe drinking water and proper sanitation in Cihideung and Tawang Subdistricts was derived from the regional health office and BAPPELITBANGDA of Tasikmalaya; (6) the quality of water body conditions and the number of water-borne diseases (diarrhea) cases from the regional health office and BAPPELITBANGDA Tasikmalaya, to indicate the environmental conditions and public health status; (7) physical and geographical conditions of Cihideung and Tawang Subdistricts which are important factors to determine the strategy of wastewater management system such as maps of groundwater depth, land slope, and soil type; and (8) spatial distribution of population densities in the two Subdistricts which was obtained from the Agency of Public Housing and Residential Areas of Tasikmalaya City. All data were obtained for all urban villages in these two subdistricts, as input data for the multicriteria decision analysis method and quantitative SWOT analysis.

2.3 Determination of SPALD Strategy

The strategy of SPALD was determined by two standardized methods: (1) multicriteria decision analysis method; and (2) quantitative strength weakness opportunity threat (SWOT) analysis method. The multicriteria decision analysis method refers to the regulation of the Ministry of Public Housing and Residential Areas (PermenPUPR No.04/2017) which is a common method used in municipal masterplan planning or any feasibility studies. The quantitative SWOT analysis method followed the guidelines for developing master plans for wastewater management systems (RISPAL) to determine strategies and directions for developing SPALD. The results of these two methods were then compared to obtain the most optimum strategy of the SPALD plan in these two subdistricts which represent the CBD area in a big city such as Tasikmalaya City.

2.3.1 Multicriteria Decision Analysis Method

The multicriteria analysis method was used as a decision tool to determine the type of SPALD: on-site or decentralised SPALD at the individual/communal scale; centralized SPALD (SPALD-T) at the residential area scale; SPALD-T at the municipal scale; or SPALD-T at the regional scale. In this method, key aspects or parameters for the centralization of wastewater treatment systems were used. These include population density, groundwater level, soil permeability, financial capability, land slope, and quality improvement ability. The analysis was conducted by comparing the criteria of the key parameters with the existing conditions of corresponding parameters in the planning area. As seen in **Figure 2**, this analysis was carried out in stages, following the standardized flowchart as suggested in PermenPUPR No.04/2017. A brief description of the required criteria for all key parameters in the multicriteria decision analysis is below (The Ministry of PUPR, 2017):

1. Population density**.** SPALD can be used for the area with a population density of at least 150 people/ha;
2. The depth of the groundwater level**.** The application of SPALD-S will be at risk of contaminating groundwater in the groundwater level is < 2 meters, therefore applying SPALD-T is preferable;
3. Soil permeability**.** The permeability of soil can affect the type of SPALD to be used, particularly for the SPALD-S which use latrines or septic tank with infiltration area;
4. The development and construction of the SPALD are influenced by the financial capacity of the local government for operating and maintaining the SPALD-T;
5. The distribution of domestic wastewater is required to be able to flow by gravity. The municipal scale SPALD-T with conventional systems (gravity flow) can be applied only if the land slope > 2%, while shallow and small bore sewers can be used on various slopes; and
6. The changes from SPALD-S to SPALD-T were conducted by reviewing the fulfillment of requirement criteria for specific parameters.

The population density parameter is the only dynamic parameter in this method which changes every year. The population density will affect land availability at the end of the planning year, because the higher the population density, the more limited land will be available for the placement of SPALD facilities (Tyas and Priyono, 2019). Thus, the selection of SPALD type by the multicriteria decision analysis method was carried out by only considering the population density at the beginning and the end of the planning year (2041).

2.3.2 Quantitative SWOT Analysis Method

The quantitative SWOT analysis method was used to determine relevant strategies to develop and improve the SPALD implemented in the planning area. In this method, a matrix containing a list of internal factors (strengths and weaknesses or SW), and external factors (opportunities and threats or OT) was developed. Similar parameters and their performance indicators that were used in the multicriteria decision analysis method were also used in the SWOT method. These parameters and indicators were determined based on the PUPR guideline for municipal domestic wastewater system development in Indonesia as well as based on the results of previous studies that show the performance of municipal SPALD was also influenced by non-technical aspects such as the financial capability, institutional availability, existing regulation on domestic wastewater management system, and education level of the local community in the service area. All parameters in each factor were scored (ranging from 1 to 4) based on 'how influential/important' the factor was. **Table 2** shows the parameters and the score for each performance indicator for the SPALD development.

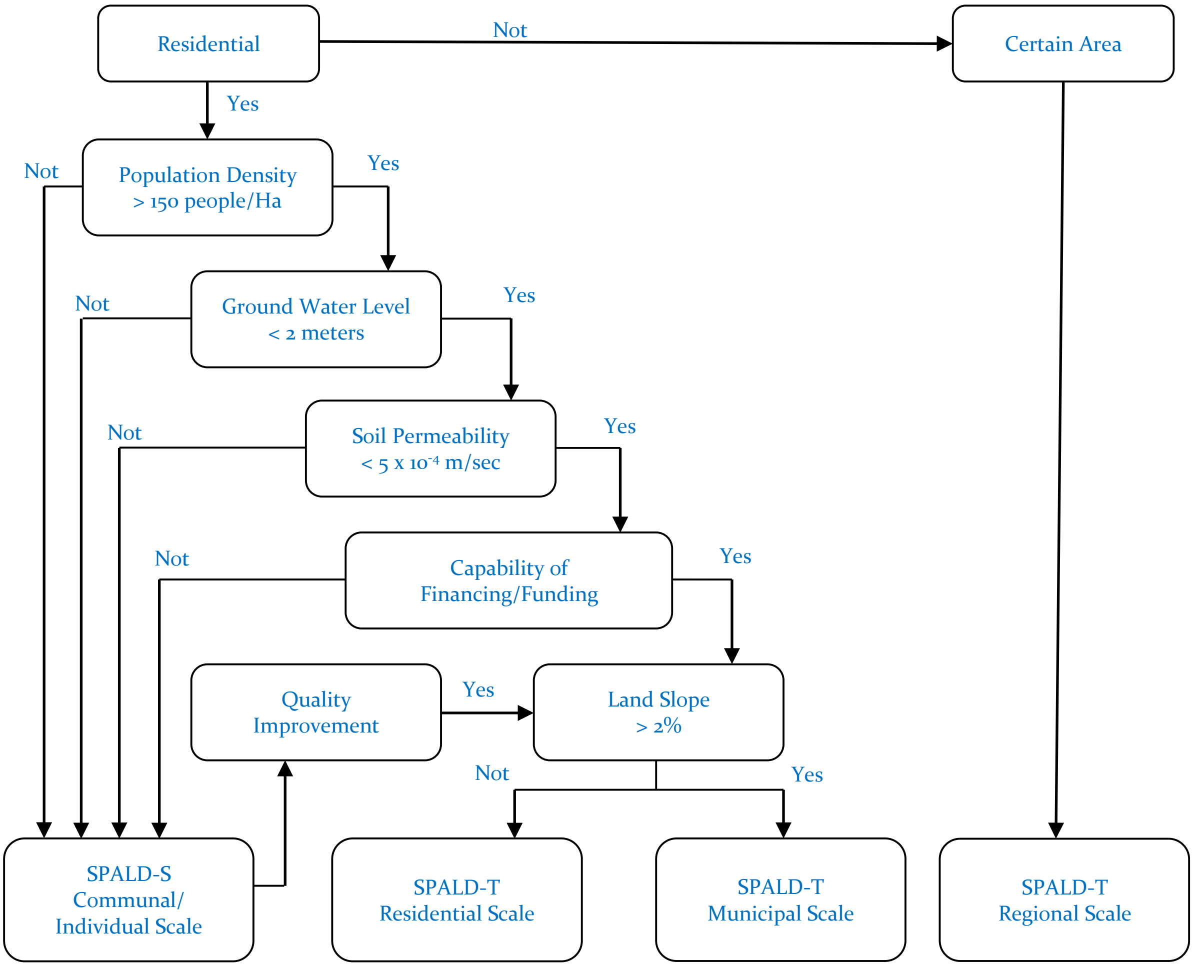

Figure 1. Selection stages of SPALD type based on the multicriteria decision analysis method
Source: Minister of PUPR Regulation Number 04, 2017

Table 1. Parameters' criteria and corresponding scores for internal and external factors in quantitative SWOT analysis method

Parameters[*)]	**Score**			
	1	**2**	**3**	**4**
A. **Internal Factors**				
S1 Population density meets the criteria to implement SPALDT (>150 people/Ha)	0 – 50	50 – 100	100 – 250	> 250
S2 Land slope meets the technical feasibility criteria of SPALDT (>2%)	0 – 2	2 – 5	5 – 15	15 – 40
S2 Proportion of households with access to drinking water (%)	< 72.04	72.04 – 78	78 – 99	100
S4 Proportion of households with access to safe sanitation (%)	< 67.89	67.89 – 69.27	69.27 – 90	90 – 100
S5 Soil permeability meets the technical feasibility criteria of SPALDT (cm/hour)	0.125 – <0.50	0.50 - <2.00	2.00 – <6.25	6.25 – <12.50
W1 Quality of surface water body based on water quality index	71-100	51-70	26-50	0-25
W2 Areas with a high risk of unsafe sanitation due to domestic wastewater	Very High	High	Low	Very Low
W3 Slum areas	High Slum	Moderate Slum	Low Slum	No Slum
W4 Groundwater level meets the technical feasibility criteria of SPALDT (m)	20-30	10- 20	5- 10	< 5
B. **External Factors**				
O1 Availability of the budget plan for the operation and maintenance of domestic wastewater management	no budget plan	The budget plan will be planned	budget plan is available for each city/district	budget plan is available for each sub-district
O2 Availability of institution/ taskforce for managing the SPALD	There is no wastewater management institution	A new wastewater management institution will be formed	There is a wastewater management institution, but no specific	There is a special institution for wastewater management
O3 Regional and/or local government considers waste management as an important issue and has issued some related regulations	There is no regulation on wastewater management	There is no regulation on wastewater management, but it refers to the PUPR Ministerial Regulation	There is no regulation on wastewater management, but it refers to the provincial regulation	There are regulations for wastewater management
O4 Highest education level of local people indicates the willingness to use and pay the cost of the SPALD	Without education	Elementary School	Junior or Senior High School	University
T	-			

*) Modified from Siddik and Sururi (2021), and A'isyah and Sururi (2021).

The SWOT analysis was carried out for each urban village in each subdistrict to determine a strategy that can be implemented in each location. The scoring results would indicate the priority aspects to be developed and become the basis for the SWOT analysis, hence the SWOT analysis could be categorized easily with quantitative data. The scoring results for each parameter were added up, then the difference in the scores of strengths and weaknesses (SO) was used as the X axis, while the difference in scores of opportunities and threats (OT) was used as the Y axis. The X and Y axis was plotted on the SWOT matrix, and their position in the coordinate plane indicate the possible development strategy based on internal and external factors in each urban village in the Cihideung and Tawang subdistricts.

Referring to the PUPR Guideline for the SPALD development strategy, the coordinate position in quadrant I indicate the selected development of the SPALD strategy is optimizing the existing on-site or decentralized system. Meanwhile, quadrant II is developing the centralized SPALD system (off-site system); quadrant III is developing a city-scale centralized system (off-site system); and the strategy for quadrant IV is developing an off-site system with advanced technology.

2.3.3 Determination of Domestic Wastewater Management Strategy

The results of quantitative SWOT analysis and multicriteria decision analysis methods were compared to determine the most appropriate type and development strategy of SPALD in both the Cihideung and Tawang Districts. These include comparing their results, advantages, and disadvantages. In addition, the future changes of both subdistricts such as the city spatial plan and the projected population number and density in the next 20 years were also considered important parameters to determine the most appropriate strategy for SPALD at the end of the planning period in both districts.

3. Results and Discussion

3.1 Overview of Planning Area

The general overview of Cihideung and Tawang subdistricts based on key parameters for SPALD selection and development can be seen in **Table 2.** The total population in Kecamatan Tawang is 136,528 people with an average population density of 110.46 people/Ha, at a range from 62.25 to 210.53 people/Ha (BPS, 2021b). Meanwhile, the Cihideung subdistrict has a smaller population of 73,065 people but a higher average population density (134.06 people/Ha) with a range between 68.85 and 178.48 people/Ha (BPS,2021a; BPS,2021c), with population densities in 2020 were in Cihideung Subdistrict, and 62.43 – 201.53 in Tawang Subdistrict (BPS,2021c). The higher population density in an area can affect the availability of land for local wastewater processing systems. Based on the business plan and BAPELITBANGDA data, both districts have indicated the capabilities to develop the SPALD in their area.

Table 2. General characteristics of study area

Parameter	Cihideung Subdistrict	Tawang Subdistrict
Demographic characteristics (population number (people); density (people/Ha))	Argasari (11,958 and 178.48) Cilembang (15,446 and 173.55) Yudanagara (4,513 and 128.94) Nagarawangi (6,716 and 126.72) Tuguraja (23,278 and 167.47) Tugujaya (11,154 and 68.85)	Kahuripan (21,975 and 62.25) Cikalang (13,965 and 87.83) Empangsari (7,248 and 151.00) Tawangsari (4,959 and 90.16) Lengkongsari (15,316 and 201.53)
Education level (%)		
- Basic education (≤ elementary school)	47.0	36.3
- Moderate education (junior-senior high school)	45.6	39.0
- Higher education (>university)	7.4	11.6
Sanitation conditions: risk of unsafe sanitation	- High risk: all villages - Moderate risk: - - Low risk: -	- High risk: Cikapalang, Empangsari, Cikalang, dan Lengkongsari villages

Parameter	Cihideung Subdistrict	Tawang Subdistrict
		- Moderate risk: - - Low risk: Kahuripan village
Slum Area (total area in Ha)	Argasari (3.8 Ha); Cilembang (35.8 Ha); Nagarawangi (22.8 Ha).	Lengkongsari (23.9 Ha); (Aragasari 3.8 Ha)
Groundwater level (m)	Cilembang, Argasari, Nagarawangi, Yudanagara, and Tuguraja: 3 – 5 m Tugujaya: <3m	Lengkongsari, Empangsari Tawangsari, Cikalang: 3 – 5 m Kahuripan: <3m
Soil permeability (m/sec)	Cilembang, Argasari, Tuguraja and Tugujaya: 1.14 – 1.44 x 10^{-5}; Nagarawangi and Yudanagara: 6.19 – 8.89 x 10^{-6}.	Kahuripan: 1.14 – 1.44 x 10^{-5} Lengkongsari, Empangsari, Tawangsari, and Cikalang: 6.19 – 8.89 x 10^{-6}
Financial capability	Capable	Capable
Land slope (%)	2 – 5%	2 – 5%

In 2021, around 55.04% of total households in both subdistricts either do not have access to proper sanitation facilities (latrines) or conduct open defecation. Compare to other subdistricts in Tasikmalaya city, both Cihideung and Tawang subdistricts have the lowest access to proper sanitation facilities (latrines). As shown in **Table 2**, almost all villages in both study areas have a high risk of unsafe sanitation, except the Kahuripan village. The data for the whole city of Tasikmalaya have shown a decrease in the number of diarrhea cases from 9371 cases in 2019 and 9884 in 2020, to 9123 cases in 2021 which is consistent with the percentage of households that have access to proper latrines i.e. 52.1% in 2019 and 2020, increasing to 60.6% in 2021.

There are two rivers in these areas: Ciloseh and Cikalang Rivers which were categorized as moderately polluted rivers in 2020 with a Water Quality Index (IKA) value of 66.47 for Ciloseh River and 65.91 for Cikalang River. The parameter of Escherichia Coli was high, possibly resulting from untreated domestic wastewater. The groundwater level in most villages was in range from 3 to 5 meters except for Tugujaya village in Cihideung Subdistrict and Kahuripan village in Tawang Subdistrict with a ground level <3 m. The shallower the groundwater table, the greater risk of groundwater contamination. Thus, areas with a groundwater depth of < 2 meters are not recommended to apply an on-site system or SPALD-S. The range of land slope was between 2 and 5 %. The regosol soil type dominates the Cihideung District and the latosol soil type is dominant in the Tawang District. The permeability rate of regosol type based on laboratory analysis was 1.44 x 10-5 m/sec, while the permeability rate based on the field measurements was 1.14 x 10^{-5} m/sec. The permeability rate of latosol was 8.89 x 10-6 m/sec based on the laboratory analysis and 6.19 x 10^{-6} m/sec based on field measurement results. These permeability values of regosol and latosol types are in the range of the medium permeability category (Chen, 2019).

3.2 SPALD Selection Based on the Multicriteria Decision Analysis Method

The summary of each screening stage based on the multicriteria method for both subdistricts can be seen in **Table 3**. Decentralized domestic wastewater management system or SPALD-S in urban villages would be more appropriate to be implemented in areas with a population density of fewer than 150 people/Ha such as Nagarawangi, Yudanagara, and Tugujaya villages in Cihideung subdistrict, and Tawangsari, Cikalang, and Kahuripan villages in Tawang Subdistrict. The parameter of land slope influences the system of sewer flow to be planned. The land slope in both subdistricts was> 2%, hence the sewer could be transmitted by gravity to support the sewerage system of the SPALD-T, this becomes the strength to apply the SPALD-T.

The risk level of unsafe sanitation represents the existing condition of sanitation facilities, personal hygiene behavior, and population density. As seen in **Table 2**, almost all villages except Kahuripan village were at high risk of unsafe sanitation and it was reported around 44,96% of total households have access to proper sanitation. The poor access to proper sanitation also implied poor access to clean water used for the flushing channel. Therefore, the condition of high risk to unsafe sanitation suggested that the SPALD-T would be more appropriate to be implemented in these areas than the SPALD-T. The low soil permeability indicates the poor ability of the soil to infiltrate water. The existing range of soil permeability in all urban villages of 6.25 - ≥12.50 cm/hour or 1.17×10^{-5} – 3.47×10^{-5} m/sec were below the minimum limit ($< 5 \times 10^{-4}$ m/sec), suggesting there was a potential of soil and groundwater water pollution from domestic wastewater. This condition was worsened by the open defecation practice. Therefore, it is important to improve the quality of the existing SPALD-S by upgrading the system to the SPALD-T. This was because a centralized management system or SPLAD-T can properly prevent environmental pollution due to untreated domestic wastewater in the future, hence SPALD-T development is preferable. The SPALD is planned to be implemented for 20 years period, from 2022 to 2041. It is predicted the population density in each area would have increased by 2041. Therefore, it is important to conduct a reanalysis of whether the selected SPALD type at the beginning of the plan period still can serve the domestic wastewater from all areas at the end of the plan period in 2041.

Table 3. Summary of SPALD selection for each village in Cihideung and Tawang Subdistricts based on the multicriteria decision analysis method

Urban Village	Population Density in 2022 (people/Ha)	Ground Water Level (m)	Soil Permeability (m/sec)	Financing Capability	Land Slope (%)
Area-1: Cihideung Subdistrict					
Cilembang	√	X	√	√	√
Argasari	√	X	√	√	√
Nagarawangi	X	X	X	√	√
Yudanagara	X	X	X	√	√
Tuguraja	√	X	√	√	√
Tugujaya	X	X	√	√	√
Area-2: Tawang Subdistrict					
Lengkongsari	√	X	√	√	√
Empangsari	√	X	√	√	√
Tawangsari	X	X	√	√	√
Cikalang	X	X	√	√	√
Kahuripan	X	X	√	√	√

√ = existing condition meets the criteria (”yes” answer); X = existing condition doesn’t meet the criteria (”not” answer).

Table 4. Improvement of SPALD quality based on population density at the end of the planning year

Urban Village	The population density in 2041 (people/Ha)	Selected SPALD at the beginning of the plan period (2022)	Selected SPALD at the end of the plan period (2022)
Area-1: Cihideung Sub-district			
Argasari	227.82	SPALD-S	SPALD-T
Nagarawangi	161.75	SPALD-S	SPALD-T
Cilembang	221.53	SPALD-S	SPALD-T
Nagarawangi	161.75	SPALD-S	SPALD-T
Yudanagara	164.59	SPALD-S	SPALD-T
Tuguraja	213.76	SPALD-S	SPALD-T
Tugujaya	87.89	SPALD-S	SPALD-S
Area-2: Tawang Sub-district			
Lengkongsari	257.24	SPALD-S	SPALD-T
Empangsari	192.74	SPALD-S	SPALD-T

Urban Village	The population density in 2041 (people/Ha)	Selected SPALD at the beginning of the plan period (2022)	Selected SPALD at the end of the plan period (2022)
Tawangsari	115.09	SPALD-S	SPALD-T
Cikalang	112.11	SPALD-S	SPALD-T
Kahuripan	79.69	SPALD-S	SPALD-S

SPALD-S: on-site system; SPALD-T: city-scale off-site system

2. SPALD Development Strategy Based on Quantitative SWOT analysis

The first step in the quantitative SWOT analysis method is to calculate the total score on internal and external factors to determine the position of the coordinate plane. An example of scoring the analysis of internal and external factors in Argasari and Tawangsari villages can be seen in the following **Table 5**. Whereas the summary of all factors' scores and the resulting quadrant position can be seen in the following table 6.

Table 5. Scoring analysis of internal and external factors for Cilembang and Lengkongsari Village

Parameters*)	Existing Condition		Score	
	Cilembang	**Lengkongsari**	**Cilembang**	**Lengkongsari**
A. **Internal Factors**				
S1 Population density meets the criteria to implement SPALDT (people/Ha)	173.55	201.53	3	3
S2 Land slope meets the technical feasibility criteria of SPALDT (%)	2 - 5	2 - 5	2	2
S3 Areas with a high risk of unsafe sanitation due to domestic wastewater	Very High	High	4	3
S4 Groundwater level meets the technical feasibility criteria of SPALDT (m)	3 – 5	3 – 5	4	4
Total			**13**	**12**
W1 Proportion of households with access to drinking water (%)	98.68	73.63	3	2
W2 Proportion of households with access to safe sanitation (%)	37.26	52.75	1	1
W3 Soil permeability meets the technical feasibility criteria of SPALDT (cm/hour)	4.12 - 5.20	2.23 – 3.20	3	3
W4 Quality of surface water body based on water quality index	66.47	66.47	2	2
W5 Slum areas	No Slum	Low Slum	1	2
Total			**10**	**10**
Deviation S-W			3	2
B. **External Factors**				
O1 Availability of the budget plan for the operation and maintenance of domestic wastewater management	budget plan is available for each city/district		3	3
O2 Availability of institution/ taskforce for managing the SPALD	UPTD SPALD		4	4
O3 Regional and/or local government considers waste management as an important issue and has issued some related regulations	Peraturan Daerah Kota Tasikmalaya Nomor 02 Tahun 2021		4	4

Parameters*)	**Existing Condition**		**Score**	
	Cilembang	**Lengkongsari**	**Cilembang**	**Lengkongsari**
O4 Highest education level majority of local people	Junior and Senior High School (33.344 people)	Junior and Senior High School (28.509 people)	3	3
Total			**14**	**14**
T	-	-	-	-
Total			**0**	**0**
Deviation O-T			**14**	**14**

Table 6. Summary of total scores and quadrant position for each Urban Village in Cihideung and Tawang Subdistricts

Urban Village	**Subtotal of strength parameters**	**Subtotal of weakness parameters**	**Score of internal factors (X) = S - W**	**Subtotal of opportunity parameters**	**Score of external factors (Y) = O - T**	**Quandrant position**
Area-1: Cihideung Sub-district						
Cilembang	15	8	7	14	14	Quadrant III
Argasari	14	8	6	14	14	Quadrant III
Nagarawangi	15	8	7	14	14	Quadrant III
Yudanagara	14	8	6	14	14	Quadrant III
Tuguraja	15	8	7	14	14	Quadrant III
Tugujaya	15	8	7	14	14	Quadrant III
Area-2: Tawang Sub-district						
Lengkongsari	13	9	4	14	14	Quadrant III
Empangsari	14	8	6	14	14	Quadrant III
Tawangsari	12	8	4	14	14	Quadrant III
Cikalang	13	8	5	14	14	Quadrant III
Kahuripan	11	8	3	14	14	Quadrant III

Based on the quantitative SWOT analysis as seen in Table 4, the internal factors score differences i.e. between the strength and weakness factors in all urban villages in the Cihideung Subdistrict ranged between +6, and +7. While the results obtained for the internal and external factors in all urban villages in the Tawang Subdistrict ranged between +3, and +6. The score difference between the opportunity and threats for the two subdistricts was +14. The increment trend of population number and density in both areas will reduce the available land for on-site systems (Awaluddin, 2021), hence strengthening the need to develop a centralized domestic wastewater system or SPALD-T. Moreover, the slum areas in both subdistricts have typically inadequate standardized buildings, high density of buildings, and poor access to safe water drinking and proper sanitation, causing contamination of the nearby water bodies. The depth of the groundwater table < 2 m has more potential to be contaminated and polluted, indicating the on-site system is not appropriate in all urban villages in both subdistricts. Therefore, it will be difficult to implement SPALD-S, and implementing SPALD-T would be more appropriate for these areas.

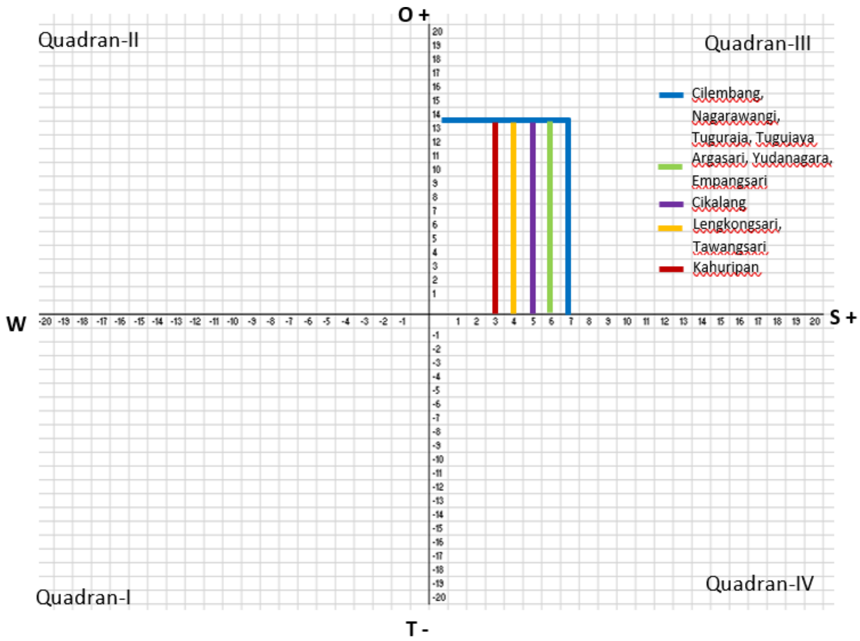

Figure 3. SWOT matrix plot results

The analysis for external parameters such as institutional, financial aspect, and local regulations has indicated the SPALD-T is preferable to be implemented in the Cihideung and Tawang subdistricts. Both subdistricts have a specific task force carrying out domestic wastewater management, known as Unit Pengelola Teknik Daerah (UPTD) SPALD, allocated annual budgets for investing, operating, and maintaining the SPALD, and developed local regulations of SPALD implementation. Moreover, a majority of the population has a higher level of education, and the higher willingness to connect the community to a centralized system. The highest education level of the community can reflect the quality of human resources and concern for environmental quality. Therefore, the higher the education level, the more concern for domestic wastewater management. The characteristics of both subdistricts were consistent with the resulting coordinate plane in the SWOT matrix for all urban villages in both subdistricts, each of which was located in quadrant III. Therefore, the strategy for developing SPALD in these areas is the aggressive development of a centralized system, because of the strong condition of existing SPALD and sufficient opportunities to develop the SPALD. This can be conducted by a gradual development of SPALD-T infrastructure at the municipal scale and gradual changes from the on-site (SPALD-S) to the off-site system SPALD-T at the end of the plan period in 2014.

3.3 Comparison of Multicriteria Decision Analysis and Quantitative SWOT Methods

The multicriteria analysis method in the PUPR Ministerial Regulation Number 04 of 2017 is a method that generally aims to screen the most suitable type of SPALD in a particular area. The screening of SPALD-type screening accounted for 5 key parameters/criteria such as demographic (population density), financial ability, and technical and environmental aspects. Nonetheless, the quantitative SWOT analysis method is a strategic planning tool to plan and set the direction development of wastewater facilities and infrastructure in the future. Compared to the multicriteria decision analysis method, the SWOT analysis method enables the SPALD development strategy makers to maximize the role of internal factors i.e. strength (S) and minimize weaknesses (W), and take advantage of external factors, i.e. opportunities (O) and able to suppress the impact of challenges (T) that must be faced. In addition, the quantitative SWOT method considered more detailed key parameters/criteria. These include the condition of the wastewater management system, the groundwater contamination level, the contamination degree of the receiving water body; socioeconomic characteristic of the community, public health, level of willingness to pay retribution based on education level, projection of investment funding capacity from APBD, as well as the available regulation on the domestic wastewater system. However, the multicriteria decision analysis method has more flexibility to improve the selected SPALD based on the condition at the end of the plan year period than that of the SWOT analysis method which was determined based on the beginning of the plan year period only.

The292omparisonn results suggest that these two methods can complement each other. The SPALD development strategy in the planning area can be determined by the quantitative SWOT analysis method as the first stage of planning. Subsequently, the multicriteria decision analysis method is then used to select the most appropriate SPALD type in a specific plan area or urban village.

3.4 Selected Domestic Wastewater Management Strategy

The domestic wastewater in Cihideung and Tawang Subdistricts is currently served by an inadequate on-site system or SPALD-S. In 2020, approximately 55% of households in the Cihideung and Tawang subdistricts did not have access to proper sanitation facilities (latrines) (Ministry of Health, 2021). Moreover, these two subdistricts are set as the central business districts and hence are projected to have high population density in the next 20 years. These conditions add to evidence of the importance to improve the quality of domestic wastewater management from the existing on-site systems or SPALD-S to the SPALD-T. Referring to the results of both multicriteria decision analysis and SWOT analysis methods, the selected strategy for urban villages in the Cihideung and Tawang Subdistricts is to develop a city-scale SPALD-T. The SPALD-T is planned to serve 80% of the total population in all urban villages in the Cihideung and Tawang Subdistricts. However, the investment, operation, and maintenance of a city-scale SPALD-T development are high costs. In Indonesia, only a few big cities in Indonesia can build and operate the system hence the number of cities operating a city-scale centralized system is very limited (Widyarani et al., 2022). Therefore, the SPAL development planning area in these two subdistricts must be divided into planning zones. The planning zones are then assessed to determine priority zones to support development planning in stages over a period of the next 20 years by considering the financial ability, the proportion of households with access to drinking water and proper sanitation facilities estimated pollution load that will be received by the environment if existing domestic waste water is not treated for the next 20 years. Furthermore, the SPALD screening result has shown that the implementation of the SPALD-T in Cihideung and Tawang Subdistricts should prioritize in those urban villages with a population density of > 100 people/ha at the beginning of the planning period. Accordingly, the Cilembang, Argasari, Nagarawangi, and Yudanagara in Cihideung subdistrict, and Tuguraja, Lengkongsari, and Empangsari urban villages in Tawang sub-district have the priority to develop the SPALD-T at the beginning of planning period.

4. Conclusion

The appropriate development strategy for every urban or CBD village in Cihideung and Tawang subdistricts is a centralized domestic wastewater management system or SPALD-T. This strategy could be directly determined through the multicriteria decision analysis method. However, with the application of SWOT, the strategies or step toward the SPALD-T can be determined. The priority zones for SPALD-T development particularly at the beginning of the planning period are the Cilembang, Argasari, Nagarawangi, and Yudanagara in Cihideung sub-district, and Tuguraja, Lengkongsari, and Empangsari urban villages in Tawang sub-district. Also, the selected area has a high population density, an area with a high risk of domestic wastewater, and is located in the city center as a central business district. The SWOT method considered more detailed key parameters or criteria including internal and external factors. Therefore, the sanitation management strategy can be carried out in a directed manner, while the multicriteria decision analysis method then can be used to select the most appropriate SPALD type in a specific plan area or an urban village.

Acknowledgement

I would like to acknowledge the BAPPELITBANGDA Tasikmalaya for providing the relevant data and important information to complete this study.

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