

POTENTIAL FOR ECO-EFFICIENCY OF WATER RESOURCES IN THE SCHOOL ENVIRONMENT

Ana Yustika, Wahjoe Handini

STIKES HAKLI Semarang Environmental Health Study Program

Jl. Doctor Ismail No.27, Bongsari, Kec. West Semarang, Semarang City, Central Java 50148

e-mail: anayustika13@gmail.com

Article Info

Article history:

Received October 4, 2022

Revised October 5, 2022

Accepted January 01, 2023

Keywords:

adiwiyata school
eco-efficiency
environment
SMA N 1 Ambarawa
water

ABSTRACT

Potential for Eco-efficiency of Water Resources in The School Environment. Water is a natural resource that humans and other living things need. Along with population growth, water consumption in Indonesia has increased. That is inversely proportional to water availability, which is decreasing. To overcome these problems, the concept used in this study is eco-efficiency. Eco-efficiency is a concept that seeks to increase economic and environmental efficiency when carrying out activities. This study aims to analyze the opportunities for enhancing the eco-efficiency of water resources in the school environment, specifically at SMA N 1 in Ambarawa. This type of research is known as descriptive research. The SWOT analysis method is used for data analysis. SMA N 1 Ambarawa's average total water consumption is in the wasteful category, at 20,898 liters daily. The potential for implementing eco-efficiency in SMA N 1 Ambarawa regarding water consumption is high. The volume of water consumed in SMA N 1 Ambarawa is efficient, at 7,326 liters daily. However, there are significant leaks of technical and non-technical water, amounting to 13,572 liters. Several efforts can be implemented through no-cost, middle-cost, and high-cost recommendations to increase the eco-efficiency potential in water at SMA N 1 Ambarawa.

This is an open access article under the [CC BY-SA](#) license.



INTRODUCTION

Based on Law No. 17 of 2019, water resources are defined as water, water sources, and the waterpower contained therein. Meanwhile, water is defined as all water found on, above, or below the surface of the land, including surface water, ground water, rainwater, and sea water [1]. Water is an essential resource for both humans and other living creatures. Water can be used by various sectors, such as households, industry, agriculture and infrastructure [2]. Apart from that, water can also be used for fisheries, tourism and hydropower [3].

Clean water availability is still an environmental issue around the world, including Indonesia [4]. The need for clean water, which is increasing from time to time, is in contrast to the decreasing availability of clean water [5]. It seems that high population growth has had an impact on decreasing the availability of clean water [6]. High population growth in the Central Java region causes the community's consumption of clean water to increase from year to year [7]. In addition to this, factors such as the increasingly narrow catchment areas, excessive development that disregards natural balance, and the exploitation of raw water sources

without considering their sustainability also contribute to the reduction of clean water availability [8].

The emergence of various problems related to ever-increasing water consumption indicates that the implementation of sustainable development in Indonesia, as mandated in Law No. 32 of 2009 concerning Environmental Protection and Management, seems to be experiencing serious problems [9]. Various efforts have been made by the government to support the implementation of sustainable development principles in Indonesia. One of these efforts is the implementation of policies in various sectors of life, which prioritize the concept of eco-efficiency and promote appropriate resource management.

Eco-efficiency is a concept commonly used by entrepreneurs in the business world to increase economic and environmental efficiency when running their businesses. Eco-efficiency serves as a business strategy that benefits both economic and ecological aspects equally [10]. In principle, the concept of eco-efficiency includes aspects of natural resources that minimize the use of raw materials, water, energy, and environmental impacts [11]. The scope of the eco-efficiency concept is so broad that its principles can be adopted in every sector of life. One of them is in the education sector. In this case, the efficiency of clean water in the school environment not only saves water use, but also aids in water management and conservation [12].

SMAN 1 Ambarawa is a school located in Ambarawa District, Semarang Regency, Central Java, with a land area of 18,854 m² and a total number of school residents of around 1,100 people. Given the large number of school residents, it appears that the school also consumes a significant amount of clean water. Therefore, this research was conducted to determine clean water consumption and opportunities for eco-efficiency of water resources that can be implemented in the school environment.

MATERIALS AND RESEARCH METHODS

This research is being conducted at SMA N 1 Ambarawa, which is located on Jln. Yos Sudarso No. 46, Ambarawa District, Semarang Regency, Central Java. This research is descriptive in nature, with the aim of examining and analyzing the potential for implementing eco-efficiency at SMA N 1 Ambarawa and providing appropriate recommendations to enhance this potential. The research commenced with the collection of relevant data from SMA N 1 Ambarawa. The data in question includes information about the building area, number of school residents, number and type of buildings, teaching and learning process (PBM) activities, and average daily clean water consumption. Apart from that, researchers also conducted observations and interviews. These data are then analyzed for the purpose of assessing clean water use. The results of this evaluation will then be used to identify opportunities to save on clean water use. This will ultimately result in a detailed account of the water eco-efficiency implementation at SMA N 1 Ambarawa. This research uses SWOT analysis as the data analysis method.

RESULTS OF RESEARCH AND DISCUSSION

Clean Water Consumption at SMA N 1 Ambarawa

Currently, the clean water used in the SMA N 1 Ambarawa environment comes from a drilled well with a depth of 80 m. The volume of clean water used is influenced by whether there is a lot of activity or additional activities in the school community. However, the average water consumption in the school reaches 20,898 liters, or 20,898 m³ per day.

The amount of clean water consumption obtained in schools is compared with the standard amount of clean water issued by the Ministry of Health in Minister of Health Regulation Number 1429/MENKES/SK/XII/2006 concerning Guidelines for Implementing School Environmental Health [13]. According to the Minister of Health's regulation, the need for clean water in schools is 15 liters per person per day. Thus, if the total school population at SMA N

1 is 1100 people, then the maximum use of clean water at the school that meets environmental health standards is only around 16,500 liters per day.

The deviation in the amount of clean water consumption at SMA N 1 Ambarawa was apparently caused by water leaks in the network pipes. The total leakage in the two-water network pipe lines is estimated at 557.70 liters/hour for the east route and 573.30 liters/hour for the south route. According to these calculations, school residents at SMA N 1 Ambarawa consume only 7,326 liters of clean water per day. This means that if there is no water leak in the network pipes, then it can be said that water use in the school is classified as efficient because it does not exceed the standards of Minister of Health Regulation Number 1429/Menkes/SK/XII/2006.

Clean Water Mass Balance at SMA N 1 Ambarawa

The mass balance is a precise calculation of all materials that enter, accumulate and leave within a certain time ^[14]. A clean water mass balance is a balance that shows the amount of input and output from the use or consumption of clean water in a place or the activities that occur there.

Areas & Activities that uses clean water			Output:
Inputs: 7326 liters/day →	Canteen	Cook, wash dishes →	6 canteens x 300 kg/day = 1800 kg/day
	Kitchen	Cook, wash dishes →	100 kg/day
	Prayer room	Ablution →	(366 students + 53 teachers/employees) x 3 kg/day = 1257 kg/day
	Park	Watering the plants →	3 x 30 minutes with interval = 540 kg/day
	Toilet	Flush the toilet →	(328 students + 71 teachers/employees) x 6 kg/day = 2394 kg/day
	Labchemistry	Practice →	(10 buckets x 15 kg x 19 practicals)/6 days = 475 kg/day
	Labphysics	Practice →	(8 buckets x 15 kg x 24 practicals)/6 days = 480 kg/day
	Labbiology	Practice →	(8 buckets x 15 kg x 14 practicals)/6 days = 280 kg/day

Table 1 shows that the order of areas that use the largest to smallest amount of clean water is toilet, canteen, prayer room, garden, physics laboratory, chemistry laboratory, kitchen biology laboratory.

School Residents' Response to Eco-Efficiency of Clean Water

There were 258 samples of school residents selected randomly, which were then used in carrying out a response questionnaire survey on the eco-efficiency of clean water at SMAN 1 Ambarawa. The results show that the entire sample has a total score of 31.992. According to the criteria presented in Table 2, the residents of SMA N 1 Ambarawa have a very strong response to the implementation of eco-efficiency in the clean water sector.

Table 2. Response Questionnaire Criteria for Clean Water Eco-efficiency

No	Score	Criteria
1	0 – 7,740	Very low
2	7,741 – 15,480	Low
3	15,481 – 23,220	Currently
4	23,221 – 30,960	Tall
5	30,961 – 38,700	Very high

SWOT analysis

An appropriate planning strategy is needed to determine the steps that will be taken by a person or agency to achieve the desired goals. In this regard, SWOT analysis is a popular analysis for formulating planning strategies.

Through SWOT analysis, a person or agency can examine complete information regarding internal and external conditions that are occurring within and outside themselves. There are four keywords in the SWOT analysis, namely strengths, weaknesses, opportunities, and threats. Thus, a SWOT analysis matrix can be formulated, which consists of four types of planning strategies, namely SO, WO, ST, and WT [15].

Table 3. SWOT Analysis

Internal factors External Factors	Strengths: - Schools have a large number of human resources - Schools have special officers who are responsible for water matters - Availability of adequate cleaning facilities - The curriculum used in schools prioritizes student character education. One of them is about water saving behavior	Weakness: - <i>Environmental leadership</i> which is not yet strong - There is no involvement from student organizations (OSIS) in environmental issues - The school does not have a water pipe network plan - The school does not have a water meter - There are still leaking or damaged taps or water network pipes - Schools do not have policies/regulations equipped with strict sanctions regarding water eco-efficiency - lack of commitment from the school community regarding efforts to save water - supervision over the use of clean water is still weak
	Opportunities: - The source of funding comes from the state - was appointed by the Semarang Regency Education Service to represent the Regency in the Adiwiyata competition at the Central Java Province level - was appointed by the Semarang District Education Department to take part in the Energy & Water Efficiency Competition organized by the Central Java Province ESDM Department	WO: - Make a water pipe network plan - Collaborating with the Semarang Regency Education Department and BLH to always provide outreach and assistance to school residents regarding water eco-efficiency, as well as providing direction and assistance to school principals regarding environmental leadership - Using water meters as a means of controlling clean water consumption - Replace leaking or damaged faucets or water pipes - Added tools to control water savings. The control device in question can be a human or a sensor
	Threats: - Scarcity of water resources - Degradation of environmental quality - Environmental health continues to decline	WT : - The school makes a firm policy regarding water eco-efficiency - The school carries out outreach regarding the importance of saving clean water
	ST: - Incorporating eco-efficiency principles in the learning curriculum - Check and repair problematic water pipe networks - Make efforts to reuse water	

Clean Water Saving Opportunities at SMA N 1 Ambarawa

The recommendations offered are divided into three levels, namely no-cost, middle-cost, and high-cost.

1. No-cost recommendation

The research results show that, in fact, a water pump that flows automatically for just 8 hours per day is enough to meet the clean water consumption needs at SMA N 1 Ambarawa. The total amount of clean water that can be saved reaches 2,524 liters per day. Thus, from an economic perspective, the costs that can be saved are IDR 404,786.5/month for water

quantity, IDR 196,560/month for electricity consumption, and IDR 1,666,667 for the life of the water pump. This calculation is based on the cost of a water pump, which is IDR 5,000,000.

2. Middle-cost recommendation

With an average volume of clean water used for ablutions in prayer rooms of 1,257 liters per day, 100% of the wastewater produced from ablution activities can be reused to water plants and replace water circulation in fishponds. However, additional costs must be incurred by the school to support the implementation of water reuse efforts, such as adding hoses or water pipe networks to channel used ablution water to parks and ponds.

The reuse scheme offered can save water consumption used to water plants by up to 100% and 5–10% to replace the water cycle in fish ponds every day. Thus, as much as 540 liters of water per day produced from used ablution water can be reused for water plants, while 717 liters of water per day produced from used ablution water can be reused to replace water circulation in fishponds. Viewed from an economic perspective, the total value of money that can be saved by implementing efforts to reuse used ablution water to water plants and replace water circulation in fish ponds at SMA N 1 Ambarawa, respectively, is IDR 86,602.5, -/month and IDR 114,989,-/month.

3. High-cost recommendation

There are four schemes included in the recommendations for implementing clean water eco-efficiency at SMA N 1 Ambarawa. The first scheme is to check and replace $\frac{1}{4}$ of the entire water pipe network in the school that is leaking so that the leak target is reduced by 25%, or 3,393 liters per day. Thus, based on local PDAM clean water price standards, the costs that can be saved from implementing the first scheme are IDR 544,152.4/month. The second scheme is to check and replace $\frac{1}{2}$ of the leaking water pipes in the school so that the leakage target is reduced by 50%, or 6,787 liters per day. Thus, the cost savings from implementing the second scheme are IDR 1,088,305/month. The third scheme, namely checking and replacing $\frac{3}{4}$ of the entire water pipe network in the school that is leaking, is to reduce the leak target by 75%, or 10,179 liters per day. Thus, the cost savings from implementing the third scheme are IDR 1,632,457/month. The fourth scheme is to check and replace all leaking water pipes in the school so that the leakage target is reduced by 100%, or 13,572 liters per day. As a result, the costs of implementing the fourth scheme can be reduced by IDR 2,176,610 per month.

CONCLUSIONS AND RECOMMENDATIONS

The average total clean water consumption at SMA N 1 Ambarawa is in the wasteful category, namely 20,898 liters/day. The potential for implementing eco-efficiency in terms of clean water consumption at SMAN 1 Ambarawa turns out to be quite high. At SMAN 1 Ambarawa, the volume of clean water actually consumed is quite efficient, namely 7,326 liters per day. However, there is a very large amount of clean water leakage, namely 13,572 liters per day, both technical and non-technical. We can increase the potential for eco-efficiency in terms of clean water at SMAN 1 Ambarawa through no-cost, middle-cost, and high-cost recommendations

REFERENCES

1. Republik Indonesia. 2019. Undang-Undang Republik Indonesia Nomor 17 Tahun 2019 tentang Sumber Daya Air. Sekretariat negara : Jakarta.
2. Zuhilmi, Efendy, I., Syamsul, D., & Idawati. 2019. Faktor yang Berhubungan Tingkat Konsumsi Air Bersih pada Rumah Tangga di Kecamatan Peudada Kabupaten Bireun. *Jurnal Biology Education*. 7(2) : 110-126.
3. Novianti, Badrus, Z., & Anik, S. 2022. Kajian Status Mutu Air dan Identifikasi Sumber Pencemaran Sungai Cidurian Segmen Hilir Menggunakan Metode Indeks Pencemaran (IP). *Jurnal Ilmu Lingkungan*. 20(1) : 22-29.
4. Suratmi. 2017. Studi Mengenai Kebutuhan Air Bersih di Wilayah Cakupan Pelayanan PDAM Cabang Loa Kulu Kecamatan Loa Kulu Kabupaten Kutai Kartanegara. *Jurnal Media Sains*. 10(1) : 82-90.
5. Yanti, R.M.K., & Ajeng, N.D. 2022. Proyeksi Kebutuhan Air Bersih Jangka Pendek dan Menengah Kecamatan Penajam Kabupaten Penajam Paser Utara. *Jurnal Konstruksia*. 13(2) : 113-124.
6. Alihar, F. 2018. Penduduk dan Akses Air Bersih di Kota Semarang. *Jurnal Kependudukan Indonesia*. 13(1) : 67-76.
7. Badan Pusat Statistik (BPS) Jawa Tengah. 2019. Statistik Air Bersih Provinsi Jawa Tengah 2019. BPS Jawa Tengah.
8. Suheri, A., Cecep, K., Moh.Yanuar, J.P., & Yudi, S. 2019. Model Prediksi Kebutuhan Air Bersih berdasarkan Jumlah Penduduk di Kawasan Perkotaan Sentul City. *Jurnal Teknik Sipil dan Lingkungan*. 4(3) : 207-218.
9. Republik Indonesia. 2009. Undang-Undang Republik Indonesia Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup. Sekretariat negara : Jakarta.
10. Prasad, P., R. Pagan, M. Kauter, & N. Price. 2004. Eco-efficiency for the Dairy Processing Industry. The UNEP Working Group for Cleaner Production in the Food Industry, Australia.
11. Rifa'atussa'adah & Bulan, P. 2017. Analisis Eko-Efisiensi pada Usaha Kecil dan Menengah (UKM) Batik Tulis Bakaran (Studi Kasus pada Batik Tjokro). *Diponegoro Journal of Social and Politic*. pp. 1-6.
12. Rizki, R. 2022. Pengaruh Efisiensi Energi dan Air pada Bangunan dalam Penerapan Eco-Green. *SINEKTIKA : Jurnal Arsitektur*. 19(2) : 120-128.
13. Kementrian Kesehatan RI. 2006. Keputusan Menteri Kesehatan Nomor 1429/Men.Kes/SK/XII/2006 tentang Pedoman Penyelenggaraan Kesehatan Lingkungan Sekolah. Kementrian Kesehatan : Jakarta.
14. Alexander, M.A. 2018. Neraca Massa dan Neraca Energi Pengelolaan Sampah Terpadu – Penujah Kabupaten Tegal. 8(3) : 129-138.
15. Tyas, S.K. & Chriswahyudi. 2017. Perencanaan Strategi Pemasaran dengan Pendekatan Matrik IE, SWOT, dan AHP untuk Mendapatkan Alternatif Strategi Prioritas. Seminar Nasional Sains dan Teknologi Fakultas Teknik Universitas Muhammadiyah Jakarta.