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The Application of Green Technology in Clean Water Treatment Installation: A Case Study of Batuah Village

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Abstract

The purpose of this study is to assess the impact of the technology on the efficiency and effectiveness of clean water treatment processes. Through the deployment of sustainable water treatment systems, the research aims to evaluate the technology's performance in enhancing water quality, accessibility, and sustainability. The study explores the strengths and weaknesses of the existing system, suggests potential enhancements, and evaluates the implications of implementing these green technologies on the socio-economic structure of the village. The insights gained can provide value for similar contexts striving to ensure clean water availability within community environments. The research methodology employs a collaborative strategic planning program, involving Batuah Village Government, Samarinda State Polytechnic/academics, and the community in planning and sharing knowledge regarding the Clean Water Provision Program, based on data and installation. This is accomplished through the establishment of the Pamsimas Water Treatment Installation (IPA) Karya Makmur. This community-managed program, guided and supported by the government, educational institutions, and businesses, operates based on a model akin to that of a Public Drinking Water Company (PDAM). This integrated approach aims to effectively implement and sustain clean water provision programs, while assessing their impact on enhancing clean water accessibility. This research provides an overview of the products that are most in demand at sharia pawnshops.

Keywords: Green Technology, Clean Water, Water Treatment Installation, Sustainable Water Systems, Socio-economic Impact

Introduction

Based on Maslow (2017), as cited by Ni Wayan Rosmalawati and NS. Kasiati, human basic needs exist at various levels, encompassing physiological needs, the need for safety, the need for love and belonging, the need for esteem, and the need for self-actualization. This indicates that humans inherently share common needs. However, when individuals are situated within different cultures, variations in needs arise, causing humans to adapt and prioritize the fulfillment of these requirements. Within Maslow's Hierarchy of Needs, the highest or primary need is physiological, as these fundamental necessities are crucial for human survival—fulfilling the prerequisites for sustaining life. This includes the provision of oxygen, essential nutrients for bodily well-being, necessary fluids for consumption (such as beverages and clean water), as well as addressing natural human sexual needs and the requirement for sleep and rest.

Calvin S. Hall and Gardnen Lindzey (1993: 33) classified types of needs into four categories. The first category is primary needs (viscerogenic), which includes food, clean water/beverages, air/oxygen, sex, lactation, and waste elimination. The secondary category encompasses psychogenic needs, covering achievements, recognition, honor, among others. The second classification distinguishes between overt needs, which stimulate motor behavior, and covert needs, relating to individuals' dreams or fantasies about desires. The third classification pertains to focal needs and diffuse needs, which are closely tied to changes based on an objective to be achieved. The fourth classification encompasses proactive needs and reactive needs: needs for resources and consequences, exclusively focusing on desired outcomes or states.

According to Abdurahman Shaleh (2004), human interests are differentiated by two factors. The first factor is primitive interest, arising from humans' biological needs, such as food, beverages, freedom in activities, comfort, safety, and sexuality. The second factor is cultural or social interest, stemming from a desire to learn. In society, there is a perception that individuals with education or high achievements are highly esteemed. Hence, this encouragement compels them to learn and strive for the highest possible education or accomplishments. Water is an integral part of human life, conferring numerous benefits to plants/flora and fauna in our environment. Humans themselves rely heavily on water; it's estimated that the human body consists of 70% water/liquid. To meet this requirement, individuals are obliged to consume about 2.5 liters of water per day, equating to drinking between 6 to 8 glasses over a 24-hour period (Ranteallo, 2015). This substantial need for water contradicts the common misconception that people should only drink water when they feel thirsty.

As an essential human need, water must embody health and sanitation value. According to Juli Soemirat Slamet (2011), healthy water isn't solely characterized by being tasteless, colorless, or free from germs. It also necessitates that water is devoid of chemical particles. Interactions between chemical particles and our body can result in organ dysfunction. This underscores the necessity for clean, sanitized drinking water to maintain proper bodily functions in alignment with metabolism. In Law Number 11 of 1974, water resources and their origins, encompassing surface and subsurface water, as well as other resources like reservoirs, are mandated to be managed by the state and utilized for the welfare of all strata of society, irrespective of socioeconomic status. Such legislation ensures that access to clean, safe water is a universal right, transcending socio-economic or cultural barriers. This institutional approach is a testament to the recognition of water not merely as a commodity but as a basic human right essential for societal welfare and individual well-being. Therefore, this paper aims to explore how varying types and categories of needs intersect and diverge across different cultural and individual contexts, with a particular focus on the essential role of water in fulfilling these complex, multifaceted human needs.

The Impact of Clean Water Crisis

Clean water crises, whether in Batuah Village or elsewhere, can have profound repercussions on the environment, society, and economy. Based on Gamawan (2008), the following are potential impacts arising from a clean water crisis:

a. Public Health: A clean water crisis can lead to serious health problems for the local population. Contaminated water can contain various pathogens, hazardous chemicals, and pollutants that may cause stomach ailments, skin infections, respiratory disorders, and even fatalities if not properly addressed.
b. Ecosystem Disruption: Insufficient clean water supply can disrupt freshwater ecosystems and their surroundings. The rivers, lakes, and other water sources can be contaminated by industrial, agricultural, and domestic waste, resulting in the death of aquatic organisms, disruptions in the food chain, and loss of biodiversity.

c. Agriculture and Food Production: Limited access to clean water can adversely affect the agricultural sector. Plants require adequate water for growth and development. A water crisis can hinder agricultural productivity, reduce harvest yields, and potentially threaten local food security.

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d. Economic Disruption: Industries reliant on clean water supply, such as processing, mining, and energy, can face disruptions. Decreased production and economic activity can negatively impact employment opportunities and local community income.
e. Social Conflict: Water scarcity can trigger conflicts among communities, especially in situations where the remaining water resources need to be shared among many. Competition for clean water can lead to social conflicts, intergroup disputes, and heightened tensions.
f. Long-Term Environmental Losses: If not adequately addressed, an unmanaged clean water crisis can have long-term impacts on water quality and ecosystems. Contamination and damage can be difficult to rectify, and ecosystem recovery may take considerable time.

International attention has also been directed towards addressing these issues through the Sustainable Development Goals (SDGs). Goal six specifically emphasizes the human right to water. It highlights the guarantee of availability and management of clean water and sanitation facilities, aiming to establish sustainable programs accessible to local communities. Population-related concerns, as outlined by Hunter (2001), underscore the impact of population dynamics on ecosystems, particularly regarding water availability. Population density growth influences the access to clean water for surrounding communities. This is where collaborations between local communities and academic institutions, such as Samarinda State Polytechnic, come into play, to provide technological solutions and facilities for managing clean water availability, impacting the socioeconomic aspects of the local community (Mujiyani, Hidayati & Rachmawati, 2006).

According to Rustan, Sriyani, and Talanipa (2019), calculations regarding daily water consumption needs per person by the Department of Public Works (PU) indicate the following requirements: 12 liters per person per day for bathing, washing, and toilet use; 2 liters for drinking; 10.7 liters for laundry; as well as additional activities.

Water Management in General

Clean water management, as defined by Kadek, Lelono, and Arifin (2010), involves technical efforts to safeguard various water resources in the surrounding environment by enhancing the quality of raw water to meet the expected standards of quality. This ensures that the water can be utilized or consumed by the community. Regarding the management of raw water sourced from surface water, as indicated by Fitria S (2015), the process involves the following steps:

a. Intake Structures

Intake structures are designed and constructed to collect water from natural sources such as rivers, lakes, or reservoirs for processing and providing clean water to the community. Intakes play a pivotal role in water supply systems, particularly for drinking water, irrigation, or industrial purposes. Their main functions encompass filtration, collection, flow regulation, protection, and redirection of water. Positioned strategically along water sources, intakes have varied designs based on geographical and hydrological conditions, as well as water supply needs in the area (Paranoan, Arnold. 2018). Given their significance, proper planning, design, and maintenance of intakes are crucial to ensure adequate and quality water for both the community and the environment.

b. Pre-Sedimentation

Pre-sedimentation is a step in the clean water treatment process aimed at removing large particles and suspended materials present in raw water before further treatment. The primary goal of pre-sedimentation is to reduce the load of particles and suspended substances in raw water, facilitating subsequent treatment processes. Common pre-sedimentation steps include initial settling, removal of sludge layers, coarse screening, separation of sludge, and discharge of pre-sedimentation water (Huisman, L. 2004).

c. Coagulation Process

Coagulation is an initial stage in water purification that involves adding chemical coagulants to raw water. Its purpose is to eliminate colloidal particles, sludge, and dissolved materials in water that are difficult to remove solely through simple filtration (Alfiandri A, 2016). This process is vital in ensuring safe drinking water. It includes coagulant addition, mixing, flocculation, settling, and filtration. By removing these particles through coagulation and settling processes, water quality significantly improves before proceeding to the next stages of clean water treatment. Coagulation is essential in removing physical contaminants from raw water and ensuring the safety and quality of water for human consumption.

d. Flocculation Process

According to Alfiandri A (2016), flocculation is a step in clean water management involving the addition of flocculant chemicals to polluted water. The objective is to agglomerate small particles present in water into larger, dense flocs, making them easier to settle or remove through sedimentation. The associated process includes flocculant addition, mixing, settling, floc removal, and advanced purification.

e. Sedimentation Process

Sedimentation is a stage in clean water management aimed at removing solid particles that settle in water. Typically conducted prior to filtration and further treatment, its purpose is to eliminate heavier, insoluble solid materials such as sand, mud, and other particles from the water (Darmayani, Riska, 2021). The sedimentation process involves allowing water containing solid particles to stand in a structure known as a sedimentation tank. During this period, heavier solid particles settle at the bottom of the tank due to gravity, forming sediment that can be easily removed. The associated processes include coagulation, sedimentation, sediment disposal, and advanced treatment.

f. Filtration Process

Filtration is a critical step in clean water management, separating solid particles and dissolved substances from water using filtering media such as sand, activated carbon, or porous membranes. The primary goal of filtration is to remove contaminants, including bacteria, viruses, organic particles, chemicals, and others that can render water unfit for consumption. Rahmawati Anis (2013) states that filtration can be part of the pre-treatment stage or the main stage in clean water treatment, depending on the treatment facility's design and type. Common types of filtration used in clean water management include slow sand filtration, rapid sand filtration, activated carbon filtration, microfiltration, ultrafiltration, nanofiltration, and reverse osmosis.

g. Disinfection Process

Disinfection entails the implementation of measures to eliminate or deactivate pathogenic microorganisms like bacteria, viruses, and parasites, which can induce diseases upon human consumption. The primary objective of the disinfection process is to render water safe for drinking and communal use. Ali M (2010) and HS, H. S. (2021) underscore that a pivotal goal in clean water management is to guarantee the absence of harmful contaminants in water entering the clean water distribution system. While water treatment encompasses diverse stages such as sedimentation, filtration, and coagulation, disinfection is imperative to ensure the absence of pathogenic microorganisms in water supplied to households and public areas. Disinfection methods encompass chlorination, ozonation, ultraviolet (UV) treatment, and hydrogen peroxide treatment.

h. Reservoir Process

A reservoir represents a water storage facility, frequently in the form of an artificial lake or expansive pond, meticulously designed for accumulating, storing, and regulating water supply. Anrianisa Sudiran (2015) emphasizes its primary role of stockpiling sufficient water to meet the clean water requisites of the community, agriculture, industry, and diverse other purposes.

Modern Clean Water Treatment Technology

There are many modern technologies used in clean water treatment to ensure safe and quality drinking water. The following are some modern clean water treatment technologies:

a. Membrane Filtration: Membrane filtration includes technologies such as ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO). This technology uses a porous membrane to filter particles, bacteria, viruses, and chemicals from the water, resulting in exceptionally clean water.
b. Ozonation: The ozonation process involves the use of ozone (O3) to remove bacteria, viruses, and organic substances dissolved in water. Ozone is usually used as a pre-treatment before filtration processes or other disinfection measures.
c. UV (Ultraviolet) irradiation: Ultraviolet light is used to destroy pathogenic microorganisms in water by damaging their DNA. This technology is effective in killing bacteria, viruses and protozoa without leaving chemical residue.
d. Control of Chemical Contaminants: The use of various chemical methods such as coagulation, flocculation, settling, and activated carbon adsorption are used to remove chemical contaminants from drinking water.
e. Advanced Treatment: Some modern water treatment systems use advanced technologies such as ion purification, removal of hazardous chemicals (such as arsenic or heavy metals), and removal of pharmaceutical chemicals or other chemicals that may be found in the water.
f. Integrated Water Treatment: Integrated water treatment systems combine some of the above technologies to achieve higher levels of purification and better efficiency in energy and resource use.
g. Intelligent Monitoring and Control System: The use of sensor technology, automation and remote monitoring enables more efficient operation and better maintenance of water treatment systems. It also helps in detecting potential problems early.
h. Desalination: Desalination technology is used to convert seawater into fresh water. The main desalination methods involve reverse osmosis, multi-effect evaporation, and high-pressure desalination.
i. Use of Renewable Energy: Some modern clean water treatment facilities use renewable energy sources such as solar energy or wind power to reduce their environmental impact.
j. Data-Driven Water Quality Monitoring: Use of data analytics and artificial intelligence to more accurately monitor and predict water quality, enabling fast and efficient action to address potential problems.

The use of this technology in modern water treatment helps ensure that the drinking water produced is safe, clean and complies with water quality standards set by health and environmental authorities. This technology also helps reduce environmental impact and improve resource use efficiency.

Furthermore, Batuah is a village housing approximately 11,266 inhabitants (as of July 2022). Its residents are engaged in a range of occupations, including farming, pepper cultivation, animal husbandry, trading, entrepreneurship, ornamental plant cultivation, and geographically, Batuah's landscape features undulating terrain without natural surface water or rivers to underpin the requirements of clean water. Consequently, some residents depend on rainwater collection. It's noteworthy, however, that as per Regulation of the Minister of the Environment of the Republic of Indonesia No. 17 of 2009, Batuah cannot be classified as prosperous due to the insufficient availability of clean water. Access to clean water is restricted, and the support framework for clean water is inadequate. This scenario will pose a challenge for Batuah as its burgeoning population will necessitate escalated water supply. In Batuah, residents rely on numerous local wells, and some have even drilled groundwater wells. Nonetheless, these water sources have yet to prove entirely hygienic, frequently exhibiting taste, odor, and color anomalies, with pH levels below 6 (alkaline) upon testing. These issues can lead to skin irritations, turbid appearances, and water quality unfit for consumption. Consequently, some residents opt to purchase clean water, with prices at 80,000 IDR for 1,200 liters or 66,666 IDR for 1,000 liters.

Consequently, the significance of procuring clean water is paramount to the community's health. Ensuring access to safe and clean water can effectively stave off diseases such as gastroenteritis, typhoid fever, worm infections, diarrhea, and various skin ailments stemming from the inadequate hygiene and sanitation of raw water. Conversely, although the government-operated water facility, the Public Water Supply (PDAM), remains inaccessible to the area, an initiative is underway to devise clean water management systems. Once clean water necessities are fulfilled, this initiative will bolster the overall well-being of the Batuah community, thereby impacting their socioeconomic status. Initiatives encompass the establishment of clean water treatment facilities employing processes such as aeration, sedimentation, and filtration, which have the potential to yield clean water that is beneficial for the residents of Batuah Village.

Research Method

Metode The adopted methodology employs a collaborative strategy achieved through deliberation and knowledge sharing, utilizing data shared among the Batuah Village Government, the State Polytechnic of Samarinda, and local companies. This collaboration has led to the formulation of diverse programs tailored to the execution of respective initiatives. Currently, a substantial amount of government funding has been allocated for the establishment of clean water treatment facilities. As a result, this endeavor is closely monitored by both companies and the village government, ensuring the effective implementation of the water treatment process and culminating in the creation of a Clean Water Treatment Facility (CWT) to address the water needs of the Batuah Village community. The research methodology's execution proceeds as follows:

a. Knowledge Sharing: This phase entails the exchange of experiences, ideas, perspectives, and information among the Batuah Village Government, the State Polytechnic of Samarinda, and local companies. This knowledge sharing encompasses insights gained from work experiences, research, and social interactions. As highlighted by Tobing (2007: 22), knowledge sharing is an effective method in organizational program development. It aligns competencies among available human resources, thus enhancing the organization's productivity. Furthermore, Setiarso (2006: 1) underscores that sharing outcomes enables employees to contribute their expertise within their teams, fostering critiques, ideas, and open opinions among team members. This transparent exchange of ideas promotes innovation, ultimately elevating the company's reputation on an international scale.

b. Effective Communication: Effective communication plays a pivotal role in knowledge sharing. Individuals must articulate their ideas clearly and comprehensibly to others Sabherwal, R., & Becerra-Fernandez, I. (2003). In this context, the group collaborates to devise implementation plans with each responsible party, monitoring execution outcomes through direct meetings. According to Sangkala as cited by Nawawi (2012: 86), obstacles in knowledge sharing activities often arise from cultural barriers known as friction or conflicts. When conflicts emerge, the knowledge sharing process is impeded due to the lack of acceptance of transferred knowledge, which could even lead to the erosion of transferred knowledge. Thus, a shared perception and open-mindedness are essential to facilitate the transfer and implementation of acquired knowledge.
c. Technology: In this digital era, technology and platforms play a pivotal role in facilitating knowledge sharing. Equipment as part of the installation, online collaborative platforms for design planning, and social media platforms ease access and distribution of information. Hence, the work group takes the initiative to construct the clean water treatment facility, designing its layout in accordance with literature on simplified clean water treatment processes, while also tailoring cost estimates to the government's funding allocation.
d. Data Analysis: Laboratory tests are conducted to assess the viability of the clean water treatment process and sanitation data, aligning with the Ministry of Health of the Republic of Indonesia's Regulation No. 32 of 2017. This regulation outlines the standard quality criteria for environmental health and health requirements for water used in hygiene and sanitation. The output from the Clean Water Treatment Facility (CWT) adheres to these standards, ensuring no adverse health impacts on the residents of Batuah Village.
e. Monitoring and Observation: The community's utilization of the Clean Water Treatment Facility (CWT) is continually monitored, along with an assessment of the program's impact on the Batuah Village community.

Implementation

The involvement of external parties in executing the construction of this Clean Water Treatment Facility, aside from the Batuah Village Government, State Polytechnic of Samarinda, and local companies, encompasses the following elements as significant contributors to the implementation of the facility:

a. Local Government: The local government, especially Kutai Kartanegara, plays a crucial role in the planning and development of the clean water treatment facility. They are responsible for permitting, land acquisition, regulations, and oversight related to this undertaking.
b. Planning Team: Comprising engineers, environmental specialists, chemists, and various technical experts, this team designs the clean water treatment facility. This includes selecting appropriate treatment technologies aligned with the local conditions and the needs of the Batuah Village community.
c. Building Contractor: The building contractor is responsible for physically implementing the construction of the clean water treatment facility based on the designed plan and budget. They manage construction work, equipment procurement, treatment system installation, and connections to several customers, namely the residents around Batuah Village.

d. Planning Consultant: Appointed by the company, the planning consultant provides expert advice on technical, environmental, and project management aspects. They ensure that the clean water treatment facility adheres to applicable standards and regulations, while offering technical insights based on on-site implementation.

e. Local Community: Involving the local community in this participation is crucial to designing the clean water treatment facility. Engaging the community in the planning process helps identify more specific needs and ensures project acceptance, ultimately leading to long-term benefits for the community.

f. Regulatory Authorities: Environmental regulatory institutions, such as the Environmental Agency (DLH) or similar bodies, play a role in granting approvals, licenses, and overseeing compliance of the clean water treatment facility with environmental regulations. They provide considerations regarding legal aspects.

g. Monitoring Institutions: Monitoring institutions conduct inspections after the clean water treatment facility is operational. Environmental monitoring bodies, research institutions, or other independent entities can be involved to ensure the facility functions well and doesn't have adverse effects on the environment.

h. Financing Entities: The construction of the clean water treatment facility requires substantial funding. Entities involved in financing, such as banks, financial institutions, or international donors, also contribute to the success of the project.

i. Operators and Technicians: After the facility is operational, skilled personnel are essential to operate and maintain the clean water treatment system. This includes operators, technicians, and personnel responsible for maintaining the quality of the produced water.

j. Non-Governmental Organizations (NGOs): Environmental or public health-focused NGOs can also participate in the development process. These NGOs can offer input, conduct independent oversight, or assist in public education about the importance of clean water and proper water treatment.

From the agreed-upon implementation sequence, the collaborative team (Batuah Village Government, State Polytechnic of Samarinda, and companies) has established a series of design programs, budgets, and project execution plans for the construction and installation of the Clean Water Treatment Facility. The cost breakdown has also been prepared in the initial plan after the design phase. The design or flow chart that has been created is as follows:

Figure 1. *Flowchart of the Clean Water Treatment Process in Batuah Village*

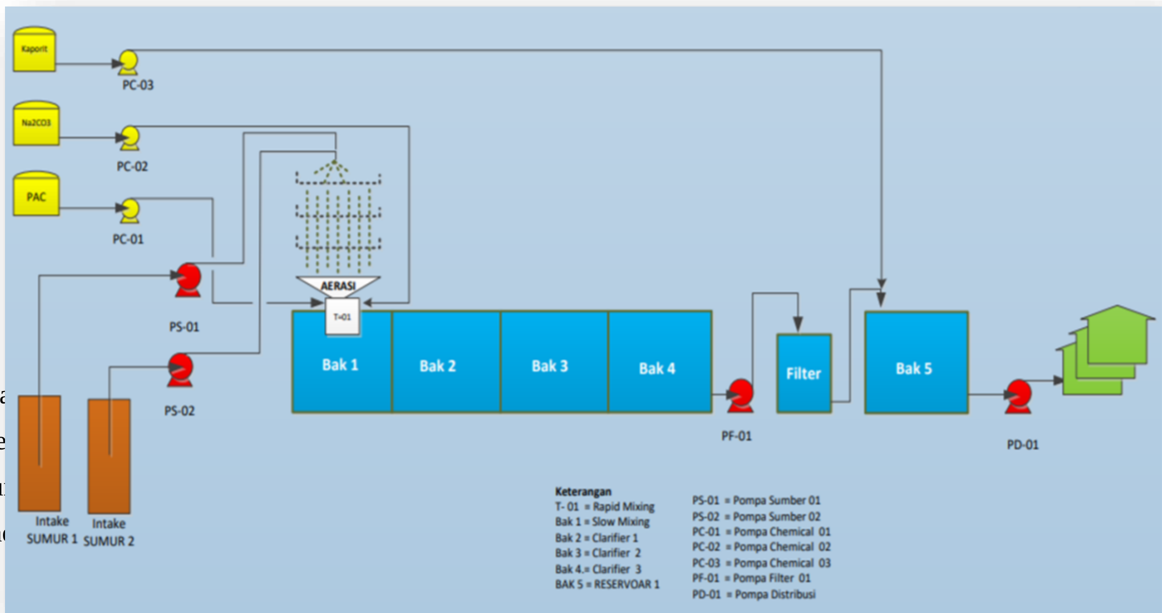

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Table 1*. Results of the Clean Water Examination Test at the Clean Water Treatment Facility in Batuah Village*

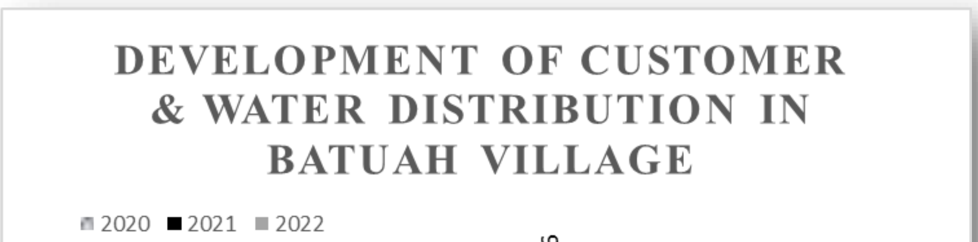
No	Parameter	Test Result	Maximum Standard	Units
Physical				
1.	Colour	1	50	Skala TCU
2.	Taste	Tidak Berasa	Tasteless	-
3.	Odor	Tidak Berbau	Odorless	-
4.	Turbidity	0.25	25	Skala NTU
5.	Total Dissolved Solid (TDS)	153	1,000	mg/L
Chemical				
6.	pH Value (pH)	7.0	6.5 – 8.5	-
7.	Total Hardness	102.34	500	mg/L
8.	Chloride (Cl)	18.40	-	mg/L
9.	Manganese (Mn)	< 0.048	0.5	mg/L
10.	Iron (Fe)	< 0.155	1	mg/L
11.	Zinc (Zn)	< 0.080	15	mg/L
12.	Nitrile by N	< 0.004	1.0	mg/L
13.	Nitrate by N	2.051	10	mg/L
14.	Organic matter by KMnO	2.42	10	mg/L
15.	Sulfate (SO)	42	400	mg/L
16.	Cyanide (CN)	< 0.028	0.1	mg/L
17.	Fluoride (F)	< 0.15	1.5	mg/L
18.	Chromium (VI) (Cr)	< 0.023	0.05	mg/L
No	**Parameter**	**Test Result**	**Maximum Standard**	**Units**
Microbiological				
19	Coliform Total	0	50	mg/L
20	Escherichia Coli	0	0	mg/L
Standart Baku Mutu Air untuk keperluan higienis Sanitasi Permenkes No. 32 Th 2017				

Source: Results from laboratory testing of the Clean Water Treatment Facility

3. Result and Discussions

After the installation in Batuah Village, which was carried out in three hamlets, namely Tani Jaya, Tani Makmur, and Karya Makmur (the most recently constructed water treatment facility), the total number of customers benefiting from the Clean Water Treatment Facility is as follows:

Graph 1. Customer Development in Karya Makmur Hamlet & Volume of Clean Water (m3)



From the graph above, it is evident that there has been a significant surge in the number of customers from 2010 to July 2022. This increase can be attributed to growing awareness and the decreasing cost of obtaining clean water. The public's enthusiasm for clean water has increased because, where previously the cost was 66,666 IDR for every 1,000 liters, it now stands at 8,000 IDR per 1,000 liters for customers of IPA (Clean Water Management Installation). This implies a cost reduction of up to 12% to access clean water from IPA. Additionally, heightened community awareness about health and hygiene standards has also propelled the use of IPA services. On average, an individual in Batuah village requires approximately 25.5 liters of clean water daily. The percentage of registered customers utilizing IPA (Clean Water Management Installation) services is presented as follows:

Table 2. Number of Batuah residents using IPA and clean water production capacity per day.

	Total Population	**Residents who Use IPA**	**Percentage**	**IPA Production Capacity**
Batuah Village	11,266	6,116	54%	1,390 m^3
Karya Makmur Hamlet	862	480	56%	463 m^3

From the table above, it is explained that currently, the total population of Batuah Village using clean water from the Clean Water Treatment Installation, or referred to as IPA customers, is about 54% of the total population. From Karya Makmur hamlet, it has reached 56%. Therefore, the target for the following year is 46% of the Batuah Village population or 44% from Karya Makmur hamlet. Observing the clean water production capacity directly managed by the Clean Water Treatment Installation, which is 1,390 m^3, only 150 m^3 is currently used. This means that only 10.8% of the production capacity is utilized, while 89.2% of the produced water is not maximally used. This presents an opportunity for distribution to neighboring villages or those within the scope of Batuah Village.

4. Conclusions

The research provides several noteworthy conclusions:

a. Increased Utilization and Economic Benefits : There has been a significant rise in the number of customers of the Clean Water Treatment Installation in Batuah Village, marking a 47% increase between 2021 and 2022, from 3,272 residents to 6,116. This increased uptake may be attributed to the cost-saving advantages of utilizing the facility—water costs were reduced from 66.66 IDR to 8 IDR per liter. As a direct consequence, this affordability factor has elevated the socio-economic conditions of the residents. The excess production capacity also presents a lucrative commercial opportunity to extend services to neighboring villages. Given that only 10.8% of the total production is utilized, there is scope for capitalizing on the remaining 89.2% to further economic development in the region.
b. Impact on Prosperity and Well-being: The findings align with the Environmental Minister Regulation of the Republic of Indonesia, Number 17 of 2009, which underscores the positive correlation between easy access to clean water and community prosperity. Therefore, enhancing water accessibility is likely to result in improved health and overall prosperity for the residents of Batuah Village.
c. SROI Value and Environmental Impact: The Social Return on Investment (SROI) value, is a method used to measure the social and economic impact of a program or project. This method is designed to help organizations, governments, and non-profits identify, measure, and communicate the social value generated by their investments. SROI tries to go beyond just measuring financial results and focus on the resulting social impact. In general, SROI has a positive scale, meaning that a higher SROI value indicates that the investment or project is more efficient in producing positive social impacts. Therefore, there is no definite minimum or maximum number for SROI. A good SROI will vary depending on the goals, resources, and context of the project or investment, as of July 2022, stands at 7.44. This metric is crucial for evaluating the efficiency and effectiveness of the clean water program in delivering social benefits per unit of investment. The high SROI value indicates that the project has significantly exceeded initial investment expectations, positioning it as a model for sustainable development.
d. Opportunities for Future Development: The data suggest that there is room for enhancing water quality through technologies such as Reverse Osmosis, aimed at upgrading it to Drinking Water standards. This could serve as an additional revenue stream by facilitating the supply of bottled drinking water in the broader East Kalimantan area. Implementing such technologies could improve both the economic prospects and the quality of water, thereby serving as a model for sustainable community development.
e. Regional Impact and Policy Recommendations: Given the underutilized capacity, there is a case for policymakers to consider extending the infrastructure to cater to neighboring villages or other regions within Batuah Village. Such an expansion could improve water accessibility and may create economies of scale, potentially further reducing the cost per liter for all residents, thereby resulting in a win-win situation for all stakeholders.
f. Sustainability Concerns: As plans for expanding the facility are considered, it is prudent to examine the long-term sustainability of the water source. Implementing sustainable water management practices is essential to ensure that increased usage does not lead to resource depletion or contamination.

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In conclusion, the research clearly indicates that the Clean Water Treatment Installation has significantly improved the quality of life for residents of Batuah Village. Moreover, it offers promising avenues for future development and expansion, with the potential for broad social, economic, and environmental benefits.

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