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UNIVERSITI TEKNOLOGI MARA

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2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

SUSTAINABLE RURAL WATER SUPPLY: EFFECTIVENESS OF MINI WATER TREATMENT PLANT, A CASE STUDY OF SMK BONGKOL, PITAS, SABAH

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Abstract: Access to safe and clean drinking water remains a pressing concern in rural Sabah, where infrastructural and environmental challenges often result in serious health risks. SMK Bongkol, a rural secondary school in Pitas, faced a surge of skin-related infections among hostel students, prompting concerns over the quality of water used for daily hygiene and consumption. An investigation by the District Health Office (BA&KAS Pitas) revealed severe microbial contamination in the school's water supply, with *Escherichia coli* measured at 78 MPN/100 mL and Total Coliform at 3500 MPN/100 mL. The contamination was traced to a leaking toilet septic tank that discharged into a rainwater collection pond, used by students for bathing. In response, a solar-powered mini water treatment plant was installed to ensure consistent access to safe and treated water. This study evaluates the performance of the installed treatment system by collecting and analyzing water samples from six locations along the treatment line, including the source (reservoir pond) and final distribution points at the male and female hostels. Post-installation results demonstrated complete elimination of *E. coli* and Total Coliform in all treated water samples, while the raw source water remained highly contaminated (*E. coli*: 90 MPN/100 mL; Total Coliform: 240 MPN/100 mL). Informal interviews with school staff indicated no new complaints of skin-related infections following the treatment plant's operation. These findings highlight the plant's effectiveness in microbial removal and its role in reducing public health risks, demonstrating the value of decentralized, sustainable water treatment solutions for underserved rural schools.

***Keywords*:** *Escherichia coli, microbial contamination, total coliform, rural water supply, skin-related infections*

INTRODUCTION

Access to clean and safe drinking water is a crucial worldwide health issue, particularly in rural and remote communities. The World Health Organization (WHO, 2017) estimates that roughly 2.2 billion people globally do not have access to clean drinking water. Rural areas in Sabah, Malaysia, continue to struggle with access to safe drinking water due to geographic remoteness and poor infrastructure (Ministry of Health Malaysia, 2021). Schools in such areas are especially susceptible since polluted water sources can cause waterborne infections and harm students' health and academic performance (Bartram & Cairncross, 2010). Poor water quality was connected to recurrent skin diseases among dormitory students at SMK Bongkol in Pitas, Sabah. Microbial contamination, including *Escherichia coli* and total coliforms, exceeded national water quality limits, according to investigations conducted by the District Health Office (Ministry of Health Malaysia, 2021). Contamination was traced to a leaking septic tank affecting the rainwater collection pond used by students. In response, a solar-powered mini water treatment plant was installed to improve water safety. This study evaluates the plant's effectiveness in reducing microbial contamination and its impact on student health, contributing to sustainable water solutions for rural schools.

MATERIALS AND METHODS

Study Area

This study was conducted at Sekolah Menengah Kebangsaan (SMK) Bongkol, a rural secondary school situated in the Pitas district of Sabah, Malaysia. The school operates on a boarding system, accommodating approximately 140 students in on-site hostels. The students rely heavily on locally sourced water for daily hygiene and consumption.

Sample Collection and Preservation

Water samples were collected from six stations, the reservoir pond (source water), the alum pond, the flocculation pond, the soda ash pond, the water storage tank for the male hostel, and the female hostel in sterile 500 mL polyethylene bottles according to Standard Methods for the Examination of Water and Wastewater (APHA, 23rd edition). All samples were stored in cooler boxes at 4°C and transported to the laboratory within 6 hours for analysis.

Microbiological Analysis

The microbial quality was assessed by quantifying the presence of Total Coliform Bacteria and *Escherichia coli (E. coli*) in a water samples. The Most Probable Number (MPN) method was employed in accordance with APHA Methods 9221B (Total Coliform) and 9221F (*E. coli*). Results were reported in MPN per 100 mL of water.

System Performance Evaluation

The treatment efficacy was determined by comparing microbial concentrations in raw and treated water samples. The percentage of microbial removal was calculated using the formula below:

$$\text{Removal Efficiency (\%)} = \frac{\text{Craw-Ctreated}}{\text{Craw}} \times 100$$

Where C_{raw} and $C_{treated}$ represent microbial concentrations before and after treatment, respectively.

RESULTS AND DISCUSSION

The installation of a decentralized, solar-powered mini water treatment plant at SMK Bongkol markedly improved the microbiological quality of water supplied to the student hostels. Prior to treatment, water samples collected from key points in the system, particularly the alum pond and the hostel storage tanks demonstrated an unacceptable level of microbial contamination. Specifically, *Escherichia coli* was detected at 78 MPN/100 mL, while total coliform bacteria were present at concentrations of 3500 MPN/100 mL. These values exceed the maximum permissible limits set by the World Health Organization (WHO) and the Ministry of Health Malaysia, both of which stipulate 0 MPN/100 mL for both *E. coli* and total coliforms in drinking water intended for human consumption (WHO, 2017; MOH, 2021). Following the commissioning of the treatment plant, post-treatment results showed a complete elimination of *E. coli* and total coliforms in all treated samples, including those taken from the alum pond, the male hostel water tank, and the female hostel tap. Both microbial parameters were consistently recorded at 0 MPN/100 mL. Only the reservoir pond, which serves as the untreated raw water source, remained contaminated with *E. coli* at 90 MPN/100 mL and total coliforms at 240 MPN/100 mL as shown in table 1. These findings are consistent with other studies that reported the effectiveness of modular water treatment units in removing microbial contaminants in rural and peri-urban settings (Ahmed et al., 2021). Results show a 93.14% removal efficiency for total coliform, indicating strong performance of the treatment process. However, the 15.38% growth in *E. coli* level resulted in a negative removal efficiency, indicating the possibility of bacterial recurrence. These findings emphasize the need for extra system optimization, notably in reducing *E. coli* and assuring consistent microbial safety in the final water.

Table 1. Removal Efficiency of *E. coli* and Total Coliforms Before and After Treatment

Parameter	C_{raw}/100mL	$C_{treated}$/100mL	Removal Efficiency (%)
E. coli	78	90	-15.38
Total Coliform	3500	240	93.14

CONCLUSIONS

The implementation of a mini water treatment plant at SMK Bongkol considerably improved water quality by efficiently eliminating *Escherichia coli* and total coliform contamination to a safe level that satisfies national and international drinking water requirements. The post-treatment water had no identifiable microbiological pathogens, and no more cases of waterborne skin infections were reported among hostels students. The solar-powered, decentralized system demonstrated both technical effectiveness and operational sustainability, making it a viable solution for improving rural water supply in remote school settings. This case study emphasizes the necessity of specific approaches to address localized water quality concerns and advocates for the widespread use of mini water treatment plants as adaptable, community-based alternatives for ensuring safe drinking water accessibility in rural areas of Sabah and beyond.

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