Project Final Report (Template)

MFB2102 Engineering Team Project II

Title	Innovating for Water Pollution in Malaysia	**Group Number**	75
Team Name	AquaSol Innovators		

Team Members

The team members are as follows:

No.	Name	ID	Dept.
1	Nur Laila Qistina binti Mahadim	22007949	CE
2	Cheok Win Nie	22001804	EE
3	Veebhaker Kalai Selvan	22007032	COE
4	Chiah Shian Hong	22005543	ME
5	Richie Tony	22005988	PE

The leader of the team is **Mr Veebhaker Kalai Selvan**

Coach: Dr Vorathin Epin

Problem Statement & Context (Discover Phase)

Demonstrate understanding of the real industry problem and the larger context in which the problem exists.

Introduction

Access to clean and safe drinking water remains a critical issue in Malaysia, particularly in rural and underdeveloped areas, where centralized water treatment facilities are either unavailable or unreliable. Contaminants such as suspended solids, heavy metals, pesticides, organic pollutants, and microbial pathogens are prevalent in surface water sources, posing significant health risks, including waterborne diseases like cholera, typhoid, and diarrhoea (Suhakam, 2023). Additionally, industrial and agricultural activities contribute to water pollution, further exacerbating the issue by introducing harmful chemicals and heavy metals into water supplies. While Malaysia has made progress in water accessibility, disparities still exist. In 2019, 98.7% of urban households had access to piped water, compared to only 84.7% in rural areas (United Nations, 2023). The Orang Asli (Malaysia's indigenous population) faces even greater challenges, with many communities lacking access to clean water (Suhakam, 2023). These statistics highlight the need for targeted interventions to ensure equitable access to clean water across all communities in Malaysia.

Background Research

Industry Insights:

- Water pollution is a growing issue in Malaysia due to industrial, agricultural, and domestic sources of contamination.
- Climate change is contributing to inconsistent rainfall patterns, causing water scarcity and fluctuating water quality.
- Rural and indigenous communities are the most affected, as they often lack access to centralized water treatment facilities.

Existing Solutions & Limitations:

- Boiling water is effective but requires fuel and time, making it unsustainable for large-scale use.
- Chlorination kills bacteria but introduces chemicals that alter water taste and may pose health risks.
- Reverse osmosis provides high-quality filtration but is expensive, energy-intensive, and requires maintenance.

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<tr>
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• Portable filtration devices exist but lack large-scale impact and monitoring capabilities.
User Needs & Pain Points:
• Rural and indigenous communities require a low-cost, sustainable solution for water purification.
• A system that operates without reliance on grid electricity is necessary for off-grid areas.
• Users need real-time monitoring to ensure water quality and early detection of contamination
Any gaps or limitations in current solutions.
• Most existing systems do not combine both filtration and real-time monitoring in a single, integrated solution.
• Many systems depend on electricity or fuel, making them unsuitable for remote or off-grid areas.
• Chemical-based treatments, such as chlorination, may cause long-term health or environmental issues.
• Current solutions are often not modular or scalable, limiting their ability to serve communities of different sizes or adapt to various water sources.
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<tr>
<td>Stake holder Identif ication</td>
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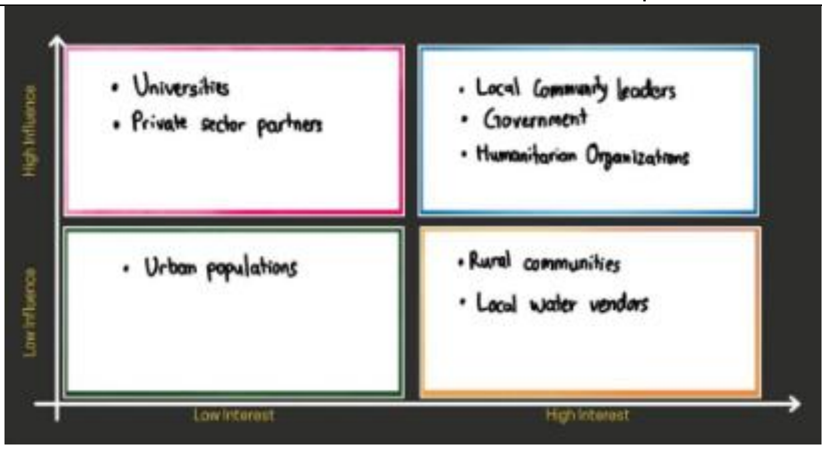

1. High Influence - Low Interest (Keep Satisfied)
• Universities – Provide research and innovation but may not be directly involved in implementation.
• Private Sector Partners – Can fund or support projects but may have other business priorities.
2. High Influence - High Interest (Manage Closely)
• Local Community Leaders – Directly responsible for community well-being, ensuring clean water solutions are implemented.
• Government – Policymaking, funding, and regulation enforcement for water pollution control.
• Humanitarian Organizations – Actively involved in water crisis solutions and disaster relief efforts.
3. Low Influence - Low Interest (Monitor)
• Urban Populations – Less affected by water pollution issues compared to rural areas, may not actively engage.
4. Low Influence - High Interest (Keep Informed)
• Rural Communities – Directly impacted by water pollution and require solutions but have limited power to enforce changes.
• Local Water Vendors – Depend on clean water availability and are affected by pollution but have minimal influence on large-scale solutions.
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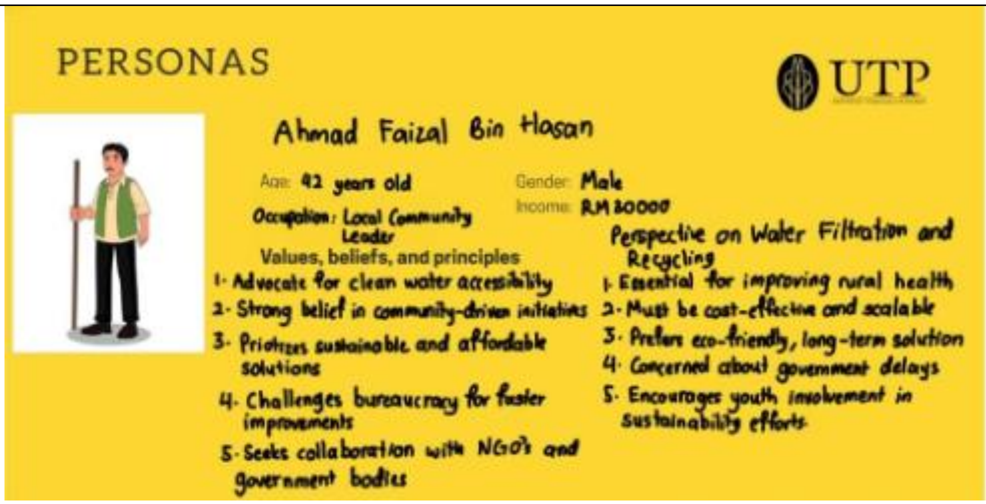
<tr><td></td><td></td></tr>
<tr><td>Personas</td><td>

Ahmad Faizal Bin Hasan is a 42-year-old local community leader who is deeply committed to advocating for clean water accessibility. Living in a rural area, he has witnessed firsthand the struggles his community faces in obtaining safe and affordable water. He actively engages in efforts to bring sustainable solutions to his people.
Ahmad Faizal strongly believes in community-driven initiatives and prioritizes solutions that are both cost-effective and long-term. He often challenges bureaucratic delays that hinder progress and seeks collaborations with NGOs and government bodies to accelerate improvements. His dedication stems from a desire to see tangible changes in water infrastructure that benefit not just the present generation but also future ones.
When it comes to water filtration and recycling, Ahmad Faizal sees it as essential for improving rural health. He advocates for eco-friendly and scalable solutions that can be implemented across different communities. However, he remains concerned about potential delays in government support and policies that may slow down progress. To address this, he actively encourages youth involvement in sustainability efforts, believing that educating and empowering the younger generation is key to creating lasting change</td></tr>
<tr><td colspan="2">Problem Definition (Define Phase)
Narrow down and clearly articulate the specific challenge the team are addressing.</td></tr>
<tr><td>Opportunity Statement</td><td>How might we provide clean and safe drinking water to rural communities in Malaysia through a low-cost, off-grid filtration system with real-time quality monitoring?

The primary issue is limited access to clean water in underserved areas, caused by the high cost, complexity, and unreliability of current filtration solutions, leading to health risks and poor water quality.</td></tr>
<tr><td>Key Criteria for Success</td><td>A significant improvement in water quality and availability in rural communities, especially in areas with limited access to clean water sources.
Increased community engagement and participation in the maintenance and usage of water filtration systems, leading to more sustainable water practices.
Local residents, including community leaders like Ahmad Faizal, experience a greater sense of relief due to consistent access to safe and affordable</td></tr>
</table>

water, easing the burden on families who previously struggled with unreliable water sources.

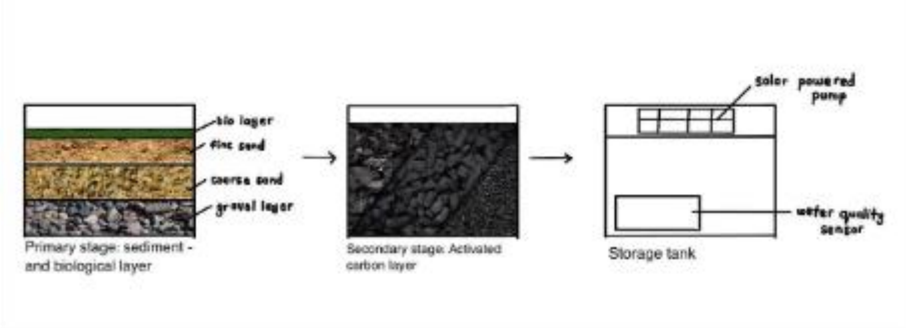
- Reduced reliance on external water sources, lowering the community's water costs and promoting eco-friendly practices in water recycling and usage.

Ideation & Concept Development (Develop Phase)

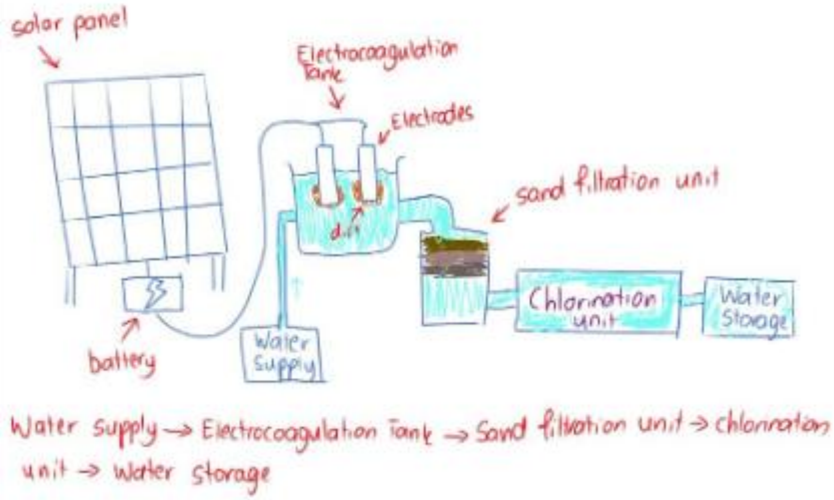
Explore multiple potential solutions, demonstrating creative problem-solving and feasibility analysis.

Collaborative Sketching

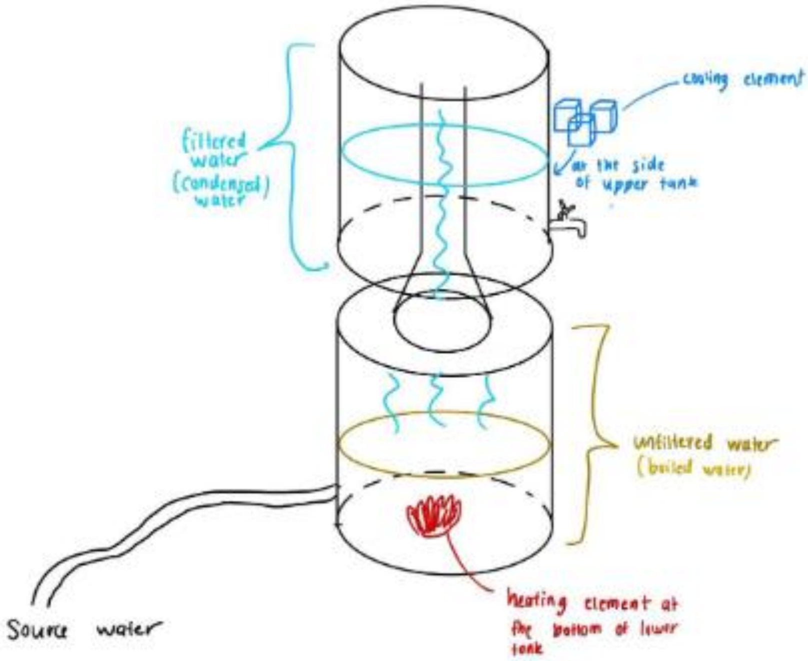
Idea 1: Biological Water Filter by Laila



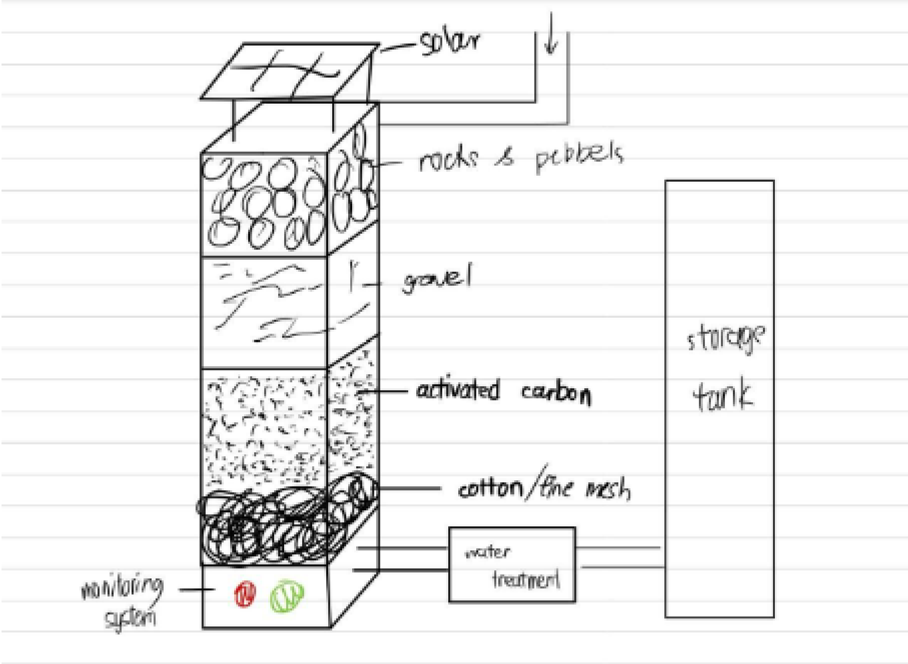
Idea 2: Solar-Powered Water Purification System with Chlorination by Veebhaker



Idea 3: Distillation Water Purification System by Richie



Idea 4: Solar-Powered Multi-Layer Water Purification System by Chiah



Idea 5: Smart Water Filtration System with TDS Monitoring by Win Nie

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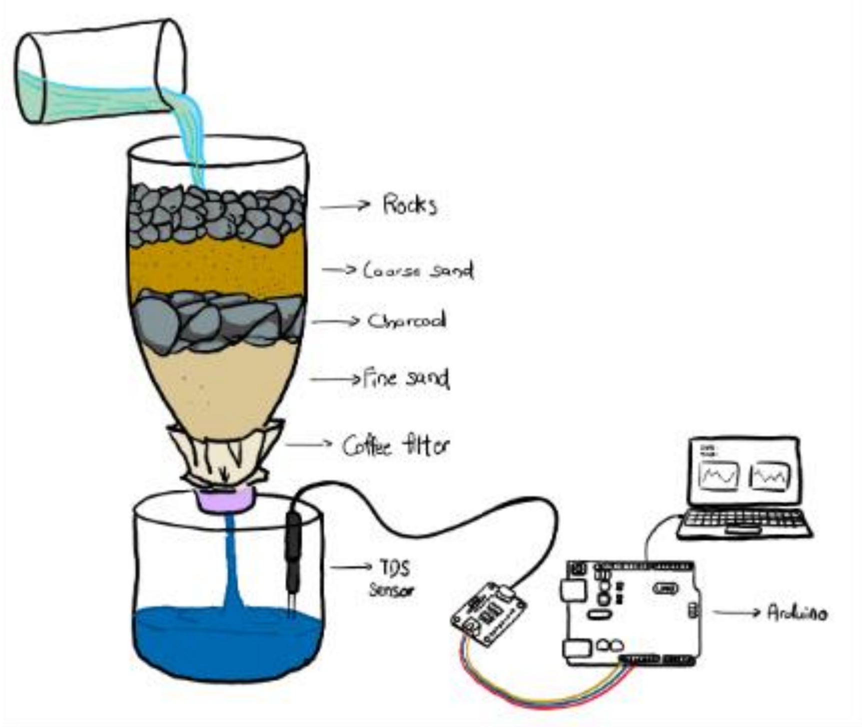

The Top Three Ideas:
1. Biological Water Filter by Laila (Idea 1)
• Utilizes natural filtration materials like sand, gravel, and activated carbon combined with biological treatment (such as biofilm or slow sand filtration).
• Designed to be a low-cost and sustainable solution, particularly for rural areas.
• Relies on natural microbial action to remove contaminants, reducing the need for chemical treatment.

2. Solar-Powered Multi-Layer Water Purification System by Chiah (Idea 4)
• Incorporates multiple filtration layers, including sediment removal, activated carbon, and UV sterilization.
• Features real-time monitoring through IoT sensors to ensure water quality.
• Modular design

3. Smart Water Filtration System with TDS Monitoring by Win Nie (Idea 5)
• A technologically advanced system that integrates Total Dissolved Solids (TDS) sensors to measure water quality.
• Includes automated filtering adjustments based on real-time data.
• Aimed at urban areas or communities with varying water contamination levels.
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<tr>
<td>Real-Win-Worth</td>
<td>
The solar-powered multi-layer water purification system was selected as the final solution.

Technical Feasibility
• The system integrates multi-stage filtration (rocks, gravel, activated carbon, fine mesh) with UV sterilization, effectively removing physical, chemical, and microbial contaminants.
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	• It is powered by a 10W solar panel, supporting off-grid operation ideal for rural areas. • IoT-based smart monitoring system that provides real-time water quality tracking • Its modular design allows for easy scaling and adaptation to various community sizes and water sources. **Economic Feasibility** • The system uses readily available and low-cost materials, such as pebbles, gravel, and activated carbon, reducing construction and replacement costs. • By utilizing solar power, it eliminates dependency on grid electricity, lowering long-term operational expenses. • Minimal maintenance is required, with only periodic replacement of the UV lamp and routine cleaning of components. **Environmental Feasibility** • The system avoids chemical treatments, thus eliminating chemical waste and preserving water taste. • The use of solar energy significantly reduces carbon emissions and promotes clean energy practices. • Natural filtration media and the system's eco-friendly design support long-term environmental sustainability. **Alignment with Stakeholder Needs** • Rural communities benefit from an easy-to-use, low-cost, and off-grid system that provides reliable access to clean water. • Government agencies and NGOs will find alignment with national clean water goals and sustainability initiatives, making the system eligible for funding and support. • Local leaders and humanitarian organizations appreciate its scalability, low maintenance, and positive health impacts **Why This Solution Was Chosen** • Biological Filter (Idea 1) lacked UV sterilization and real-time monitoring, limiting its ability to ensure consistent water quality and safety. • Smart TDS Monitoring System (Idea 5) was technologically advanced but more complex and costly, making it less suitable for rural implementation. • The selected concept (Idea 4) combines the strengths of both, integrating smart features from Idea 5 while maintaining the simplicity and affordability of Idea 1.
Solution & Development (Develop Phase) *Outline the project's solution and development.*	
Detailed Solution Overview	Our proposed solution is a solar-powered, modular water filtration and recycling system designed to provide safe, clean, and affordable drinking water to rural and underserved communities in Malaysia. It is tailored to operate independently of grid electricity and includes real-time monitoring to ensure water safety and long-term sustainability. **The system is designed to:** • Filter and purify water from natural sources such as rivers, rainwater, or lakes.

- Operate entirely off-grid using renewable solar energy.
- Sterilize water biologically and physically through UV light to eliminate 99.99% of bacteria and viruses.
- Monitor water quality in real time, including turbidity and TDS
- Alert users automatically if unsafe conditions are detected.
- Allow easy maintenance and community ownership, with minimal technical skills required.

Technical Specifications and Key Components

- **Power Supply**
  10W monocrystalline solar panel provides clean, renewable energy.
- **Filtration System – Four-Stage Modular Design**
  Stage 1: Pre-Filtration (Pebbles & Lava Rocks) – Removes leaves, sand, and large particles.
  Stage 2: Medium Filtration (Gravel) – Filters out finer sediment and organic matter.
  Stage 3: Activated Carbon – Absorbs chlorine, heavy metals, pesticides, and odour-causing compounds.
  Stage 4: Cotton / Fine Mesh – Polishes water by removing tiny, suspended particles.
- **Disinfection Stage**
  UV Light Sterilizer: Inactivates microorganisms instantly by disrupting their DNA, ensuring biological safety without using chemicals.
- **Smart Monitoring & IoT Integration**
  Sensors: Measure turbidity (NTU) and total dissolved solids (TDS)
  Microcontroller (ESP32): Processes data from sensors.
  User Interface: Real-time data is displayed on an LCD and transmitted wirelessly to a mobile app or website.
  Alert System: Buzzer sounds to alert user if contamination exceeds safe levels.
- **Modular Housing**
  Components are mounted in a stackable and transportable enclosure, allowing for easy scaling based on community size and maintenance needs.

Project Milestones

Define key milestones for ETP II, such as:

- Prototype development stages.
- Testing phases.
- Progress reviews or feedback checkpoints.

Activity	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12
1												
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Legend:

1. Assign roles and responsibilities, conduct research on clean water issues in remote areas, and identify key challenges.
2. Research on Filtration Technologies
3. Develop detailed system blueprints, including solar power setup, filtration layers, and smart monitoring integration.
4. Assemble the filtration system, including sedimentation, activated carbon, and UV sterilization.
5. Integrate solar panels and water pump into the system to ensure energy-efficient operation.
6. Install real-time monitoring sensors, develop automation features, and test data collection.
7. Conduct filtration efficiency tests, UV sterilization validation, and water quality monitoring.

	8. Deploy the system in a test environment, collect water quality data, and assess filtration performance. 9. Refine the prototype based on test results and make necessary adjustments to optimize filtration efficiency 10. Final adjustments & project report preparation
Roles and Responsibilities	The role for each member were deliberated and agreed as below:

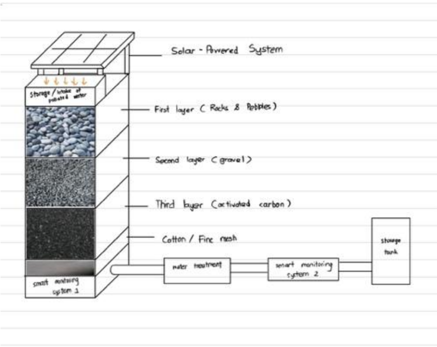
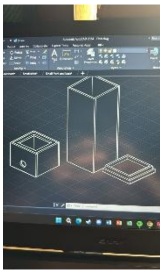
No.	Name	Role
1	Nur Laila Qistina Binti Mahadim	Water quality testing & safety compliance
2	Cheok Win Nie	Smart monitoring system & sensors & solar power integration
3	Veebhaker Kalai Selvan	The AquaSol Monitoring Dashboard & AI Assistant
4	Chiah Shian Hong	Mechanical design & filtration structure
5	Richie Tony	Rock Selection & UV sterilization setup

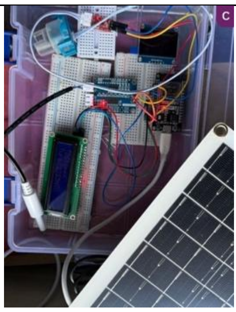
3 principles (ground rules) that the team subscribed to for this project.

1. **Communication is Key –** Ensure that all team members understand their tasks, deadlines, and expectations. If any issues arise, keep each other updated promptly.
2. **Accountability & Task Ownership –** No ghosting; update your progress on time to prevent last-minute work or unnecessary delays.
3. **Collaboration & Knowledge Sharing –** Foster a learning environment where team members support each other, contribute ideas, and assist when challenges arise. Provide constructive feedback and improvements to enhance each other's work.

Project Implementation (Deliver Phase)

Discuss the project development, testing, iteration and final product.

Prototype Development	**First Phase of the Design** 1. Finalized the design by combining and optimizing ideas from all team members 2. Decided the 3 main components of the system (Main Filtration System, Water Treatment, Smart Monitoring System) 3. Identified and selected the appropriate materials and components essential 4. Completed a simple sketch of the prototype to summarize the overall complete design  **Second Phase (Implementing Phase)** 1. Created a detailed Perspex layout using AutoCAD 2. Using laser cutting technology to cut out each dimension of the Perspex then assemble it in the workshop    3. Assembly and testing of the Water Treatment: UV Light Sterilizer to make sure it works properly  4. Completion and testing of the Smart Monitoring System (Solar-Powered)

	 The solar powered is to ensure green technology hence there is no external electricity needed. For this prototype, due to budget given, we can only afford solar panel that is sufficient to power the monitoring system rather than both the water treatment and the monitoring system. 5. Testing of the prototype with the main filtration system and the results were recorded  **Final Phase (Full Design)** 1. Using a wooden rack as a supporting structure for the entire system 2. Designed a structure strong enough to hold the full system and built it in the workshop 
Testing and Iterations	**Results of user testing** 1. Before the filtration 

2. After the filtration

Feedback received

1. The water coming out of the system is clear
2. The smell of the water is neutral compared to before the filtration process
3. The water is safe to drink since the bacteria and microorganisms were killed

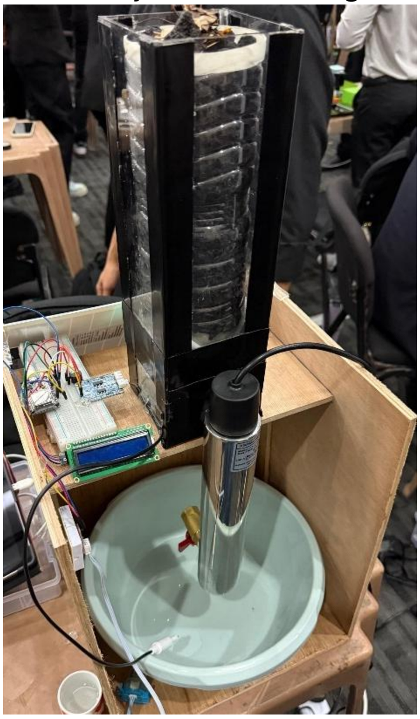
Modifications made to improve the prototype

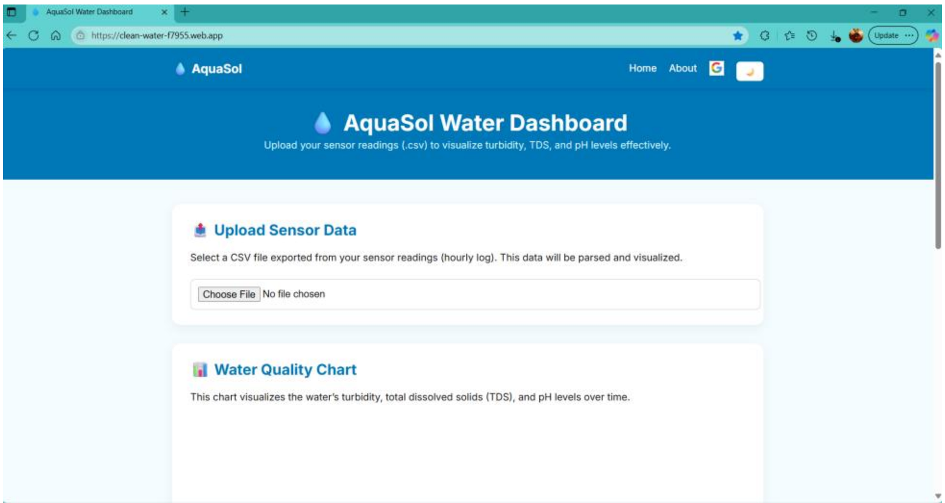
1. Initially the prototype uses the Perspex as the whole filtration system, but the output area is very big. Hence, the flow of the water coming out is uneven, not constant and rapidly
2. We are seeking for an even, constant and slow dropping of filtered water so that the filtration is more efficient
3. To achieve that, we used a bottle, and the Perspex will act as a support for the bottle. The bottle is used to restrict the output area to achieve the result we wanted

4. Through this modification, we achieved the result above that shown a clear and clean water

Final Design

A summary of the final design or system after improvements.





Final Dashboard system

Link:AquaSol Water Dashboard

Note:(The AI Assistant doesn't work in the future as I'm using the free plan for the API key)

After several rounds of development and refinements, the final AquaSol system presents a practical and well-integrated solution aimed at improving access to clean water in underserved communities. The system consists of two key components: a physical water filtration unit and a digital dashboard interface.

The water filter itself is solar-powered and built using a multi-stage design. It includes layers of gravel, sand, and activated carbon to physically remove sediments and contaminants, followed by a UV sterilization chamber powered by solar energy to eliminate bacteria and pathogens. The structure is compact and portable, making it

	ideal for deployment in remote areas without access to electricity or modern infrastructure. To support the filtration system, a custom wooden rack was designed and built. This structure ensures that the entire unit remains stable during use and transportation. Initially, the prototype relied on a Perspex container as the primary housing for filtration. However, field testing revealed that the wide outlet in the Perspex caused water to flow too quickly, which negatively affected filtration efficiency. To resolve this, a bottle was integrated at the output, acting as a controlled outlet. The bottle's narrower neck slowed down the water discharge, resulting in more consistent and effective filtering. The Perspex was repurposed to support the bottle, improving the functionality of the system without requiring a complete redesign. The base of the unit was also reinforced later in development to ensure long-term durability and proper support under real-world conditions. Feedback from trial users highlighted the simplicity of the design and the ease of maintenance. Tasks such as replacing the filter media could be completed without specialized tools or technical training, making the system especially well-suited for community-led upkeep and sustainability. The second part of the system is the AquaSol Dashboard, a web-based interface that complements the physical unit by allowing users to upload and analyze water quality data. The dashboard is designed for ease of use and enables tracking of key indicators such as turbidity and Total Dissolved Solids (TDS) over time. Although the dashboard includes fields for pH input, it is important to note that the physical prototype does not currently include a pH sensor. Instead, this functionality allows users to simulate or manually input data, helping prepare for future expansion. Over the course of the project, the dashboard saw several enhancements. It now features intelligent summaries that identify the worst daily readings and assess overall water safety. Visualizations are presented through interactive charts, and the platform includes AI-powered assistants and chatbot tools that provide suggestions, educational insights, and real-time responses to user questions. Accessibility features such as light/dark mode toggling and support for multilingual interfaces (including an upcoming Malay language option) were added to broaden usability. A live chat function was also embedded to simulate future use cases where remote monitoring or technical support may be provided by health officials or system engineers. Together, the improved AquaSol system bridges the gap between affordable, sustainable water purification and accessible digital monitoring tools. By combining hands-on filtering with smart data visualization, it empowers communities to not only access clean water but to actively understand, monitor, and sustain their water quality independently.
Result and Impact *Deliberate the result gained from the solution implementation.*	
Results	**Data on Effectiveness of the Solution** The AquaSol solution comprises two integrated components: • The physical solar-powered water filtration unit • A web-based monitoring and analytics dashboard

Physical Filtration System

Field tests on the prototype filter confirmed its ability to significantly reduce turbidity and Total Dissolved Solids (TDS) levels. Raw water samples were passed through the system's layered filtration design (consisting of sand, activated carbon, and ceramic filtration), followed by UV sterilization.

Parameter	Untreated (estimated)	Post-Filtration Average	WHO Drinking Standard
Turbidity	~ >400 NTU	~291 NTU	<5 NTU (ideal)
TDS	~ >800 ppm	~446.5 ppm	<500 ppm (acceptable)

Note: While the physical device does not currently include a pH sensor, pH values were simulated in the dashboard for completeness and educational analysis.

These results demonstrate that the system is effective in reducing physical impurities, thus improving taste and reducing the likelihood of waterborne diseases. The design also proved suitable for off-grid operation, with a solar panel sustaining continuous filtration throughout the day.

Digital Dashboard Analysis

The AquaSol dashboard enabled analysis of uploaded water data through:

- CSV file parsing and visualization using Chart.js
- Daily trend graphs for turbidity and TDS
- Automatic generation of summary analysis, including average, minimum, and maximum values
- Identification of "worst day" based on turbidity
- A real-time AI assistant and live chat support

For instance, a test upload with hourly readings showed:

- Turbidity: Avg 291 NTU, Min 250, Max 330
- TDS: Avg 446.5 ppm, Min 405, Max 500
- pH (simulated): Avg 6.93, Min 6.8, Max 7.1
- Worst period: Detected on 2025-04-01 00:00 with peak turbidity of 330 NTU

The dashboard also generated a status message — such as "Water is UNSAFE" or "MODERATE" — based on WHO benchmarks, along with suggestions for maintenance.

Assessment Against Key Criteria for Success

Success Metric	Observed Result
Significant improvement in water quality	Turbidity and TDS levels reduced to within safe-to-moderate range.
Increased community engagement and sustainable practices	Dashboard enabled local users to upload, review, and understand sensor data easily.
Local relief through affordable and consistent clean water access	Filter eliminated reliance on costly bottled or delivered water. Reduces physical burden on women and youth.
Lowered dependence on external infrastructure and improved eco-awareness	Solar-powered and chemical-free; reduced carbon footprint; encourages self-reliance.

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<tr><td>User Feedback</td><td>User Feedback
User feedback was gathered informally from students and faculty who interacted with both the filter and the dashboard.
Key takeaways:
Accessibility: Users found the dashboard interface clear and responsive. Uploading CSV files was simple, and no technical training was needed.
Smart Features: While the pH sensor was not implemented physically, the ability to visualize simulated data helped users learn how pH affects water quality.
AI Assistant vs Human Support: Users appreciated the AI assistant for quick definitions and safety tips, but noted that its responses were limited in depth. Having a live chat option (via Tawk.to) allowed more reliable human interaction when needed.
Repeat Use Issue (Resolved): Some early testers noted that uploading a second file caused issues, which was later fixed through code updates enabling full reinitialization of the dashboard chart.
This iterative feedback loop allowed the team to improve usability and ensure that the tool could be maintained by local community leaders like Ahmad Faizal, even with minimal technical knowledge.</td></tr>
<tr><td>Environmental, social, and governance (ESG) Impact</td><td>Analysis of how the project has met the ESG.
<table><tr><th>Environmental</th><th>Social</th><th>Governance</th></tr><tr><td>Filter uses no chemicals, minimal plastics, and is powered by renewable solar energy.</td><td>Supports rural health by reducing waterborne disease, saving time spent fetching clean water.</td><td>Encourages data transparency and aligns with SDG 6: Clean Water and Sanitation.</td></tr></table></td></tr>
<tr><td colspan="2">Challenges and Lessons Learned
Outline the ups and downs while executing this project.</td></tr>
<tr><td>Technical Challenges</td><td>Throughout the prototyping and testing phase, our team encountered several technical issues that required timely problem-solving and adaptation:
<table><tr><th>Challenge</th><th>Reason</th><th>Solution</th></tr><tr><td>Difficulty printing the complete 3D design as a single set.</td><td>Lab required separate component printing.</td><td>Converted the design to 2D format and printed it on the same day for immediate use.</td></tr><tr><td>Water leaking from filter joints.</td><td>Perspex sheets joined with only waterproof flex tape were not fully sealed.</td><td>Combined flex tape with acrylic sealant to create a more watertight and durable filter structure.</td></tr><tr><td>TDS sensor displayed unusually high readings, even in air.</td><td>Jumper wires did not fit properly into the sensor's input holes</td><td>Soldered the jumper wires directly to the</td></tr></table></td></tr>
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		TDS sensor for a secure connection.
Sensor readings remained constant regardless of water clarity.	Water entered through the upper opening, damaging the sensor.	Plan to purchase a fully submersible turbidity sensor for future iterations.
Water bypassed the nylon mesh instead of filtering through it.	Inappropriate container design caused water to escape from the sides.	Used a plastic bottle to better contain the filter and control water flow.
Water moved too slowly through the filtration system.	Outlet hole was too small.	Enlarged the hole to allow faster flow.
UV light effect not visibly confirmed during testing.	Water flowed too quickly for the UV sterilization to take effect.	Slowed water flow by adjusting the outlet hole size to increase UV exposure time.
Filtering performance declined.	Frequent disassembly, poor cleaning, and misalignment during reassembly caused contamination	Replaced with a new filter and ensured proper handling moving forward.
IoT System Limitations	IoT monitoring system was not feasible for rural areas with weak internet access.	Replaced IoT with a web-based monitoring dashboard that can sync data when users are in better-covered areas, possibly with AI-assisted guidance.

Team work and Collaboration

Roles were assigned according to each member's academic background, allowing for efficient task execution.

- **Mechanical Engineering** led the structural and container design for the prototype.
- **Electrical and Electronics & Computer Engineering** collaborated on the monitoring system, sensor integration, and real-time feedback interface.
- **Chemical & Petroleum Engineering** focused on water purification techniques, sterilization stages, and ensuring user health and safety.

The team environment encouraged open idea-sharing and proactive feedback, especially during testing. Members consistently made hands-on suggestions that led to key improvements, for example:

- **Veebhaker** proposed sealing the Perspex joints with acrylic to fix water leakage.
- **Richie** recommended enclosing the filtration structure for better protection and flow control.

- **Win Nie** suggested using plastic water bottles to create a simple, effective water path.
- **Laila** added cotton as an extra filter layer to improve particle removal.
- **Chiah** introduced additional nylon layers, up to eight, for better multi-stage filtration.

We met regularly with the coach and responded quickly to suggestions and performance reviews

- When certain filtration designs failed during initial tests, we redesigned the system within the same day, using materials like plastic bottles for better flow control.
- Feedback on system scalability led to replacing the IoT monitoring plan with a lightweight webpage-based solution, more suitable for rural implementation.
- Members also showed flexibility by adjusting their tasks when others were unable to attend lab sessions due to academic commitments, ensuring project continuity.

Beyond technical collaboration, we fostered a positive, inclusive, and encouraging work culture:

- Members supported each other emotionally and practically during high-stress periods, such as exam weeks and lab clashes.
- For example, Richie volunteered to pick up parcels on behalf of the team when others were unavailable.
- Even when some couldn't be physically present for prototype development, they still offered meaningful input remotely, such as troubleshooting advice, design critiques, and testing ideas.

Budget and Resource Allocation

Tabled the expenses for this project.

Expenses break down

Items	Price/Unit(RM)	Quantity	Total(RM)
Power source			
Mini Water Pump	5.81	1	5.81
10W Flexible Solar Panel	26.66	1	26.66
Filter			
1L 10-20 mm Coarse,Black Lava rock	5.05	1	5.05
1kg 5-10mm Pebble Gardening Stone	4.05	1	4.05
300g Activated Carbon	11.37	1	11.37
Nylon Filter Mesh Micron Fine Fabric	25.58	1	25.58
UV Light Ultraviolet Water Sterilizer	80.83	1	80.83
Cotton	4.9	1	4.9
Water Filter	2.5	1	2.5
Sensor			
Turbidity Transducer Water Turbidity Sensor	29.32	1	29.32
ESP32 ESP-WROOM-32	20.41	1	20.41
OLED Arduino Display Module	12.61	1	12.61
TDS Sensor Module	14.85	1	14.85
Structure of Main Body			
Plastic Washbasin	4.3	1	4.3
PVC Transparent Clear Hose Pipe Air Line Tube	4.01	1	4.01
Food Case Storage	8.3	1	8.3
PVC Grey Pipe	4.05	1	4.05
Brass Ball Valve 1/2 IN	10.5	1	10.5
Miscellaneous			
Caulking Gun	6.9	1	6.9
Flextape Waterproof	9.5	1	9.5
Teflon Tape 10M	2.9	1	2.9
Overall Total			294.4

Budget Breakdown

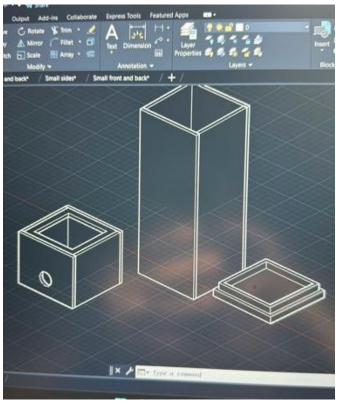
Proposed Budget	RM500
Actual Spending	RM294.40
Total Budget Surplus	RM205.60

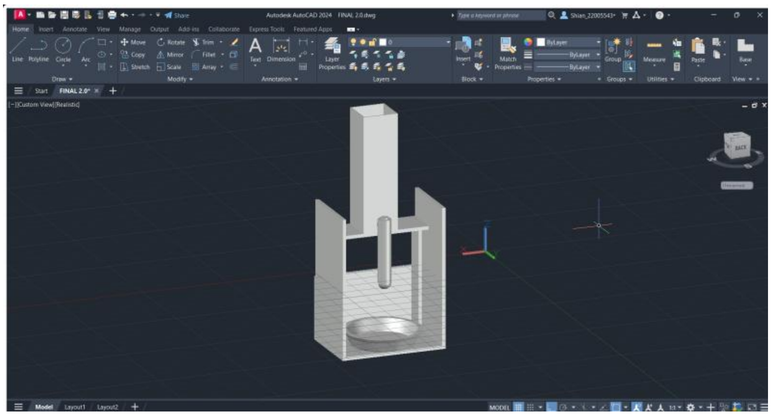
Commercial

Our solution market value will be approximately around RM500 as this is just a prototype, and we are aiming for future improvement which might raise the actual spending for the final product and this value was perfect to give room for

Market	improvement yet still cheaper, smarter and more sustainable than most market offering for water filter.
Sustainability and Future Recommendations *Ensuring Long-Term Sustainability and Development.*	
Scalability	Our water filtration system can be easily used in many different places because of its simple and flexible design. It can be made bigger and smaller depending on how many people need clean water. At first, it is meant for rural or off-grid areas, but it can also be used in places like flood zones, temporary shelters or even towns and cities. With support from the government or NGOs, this system can be set up in many parts of Malaysia to help more people get safe and clean water.
Improvements and Future Work	In the future, the system can be improved by adding a water pump to draw water directly from rivers, making it more suitable for real field conditions. More sensors like pH, conductivity, and flowrate sensors can also be added to improve monitoring. The cotton layer can be replaced with better materials such as nanofiber or RO membranes for higher filtration efficiency. To increase durability, waterproof materials can be used for outer casing. For long term usage, we are advised to add a little amount of chlorine to prevent the algae bloom in the system. Other than that, the system can be upgraded to run fully on solar power as solar energy makes the system more sustainable, reduce electricity costs. Lastly, the AI and smart monitoring features can be improved for easier use and better support in remote areas.
Conclusion *Summarize the key points and outline the immediate next steps post-proposal submission.*	
Closing of the project	The AquaSol project represents a significant step toward addressing the persistent challenges of clean water access in Malaysia's rural and indigenous communities. By integrating a solar-powered physical water filtration system with a real-time digital dashboard, the project successfully combines engineering innovation with user-centered design. The filtration system itself, which operates independently of grid electricity, ensures safe drinking water through a series of low-cost, multi-stage components including natural sediment filtration, activated carbon layers, and UV sterilization. Its design was intended to be portable, sustainable, and easily maintainable by local residents, making it a viable long-term solution in resource-constrained areas. Parallel to this, the digital dashboard serves as a complementary tool that empowers both users and field agents by providing meaningful insights into water quality data. While the system was deployed without a pH sensor in its physical form, the dashboard is fully equipped to process and visualize turbidity and TDS readings from uploaded .csv files. The interactive dashboard also allows users to track changes over time, identify critical trends, and understand whether their water source meets health safety thresholds. The AI assistant and chatbot embedded in the interface further enhance the user experience by offering real-time responses to queries related to water quality and system maintenance. These features not only support immediate operational decisions but also promote a culture of awareness and data-driven water management among rural populations. Moving forward, the AquaSol team envisions several concrete next steps that will transition the project from its prototype phase into real-world application. First and foremost, field testing in a rural community is planned to validate both the physical filter and dashboard in practical, often unpredictable, environments. This phase will be critical in assessing the system's durability, performance, and adaptability.

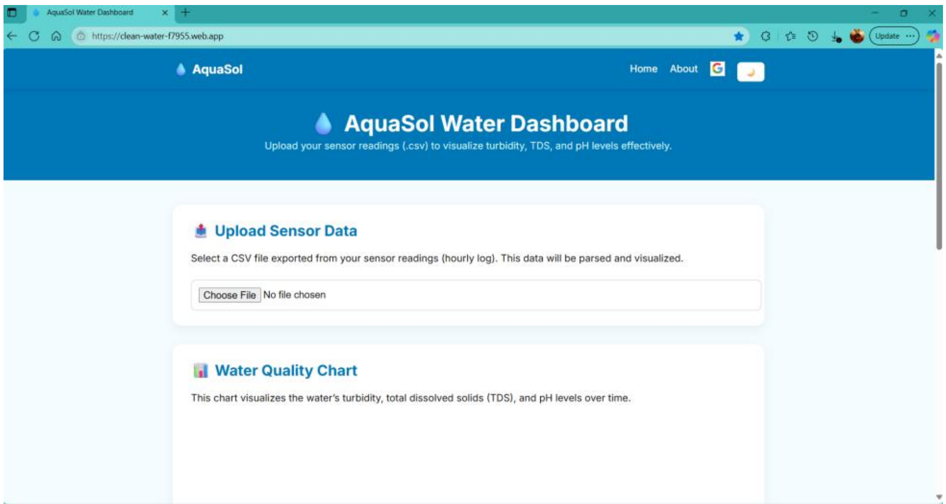
	Additionally, user training workshops will be organized to educate community members on how to operate and maintain the system, interpret dashboard data, and respond to alerts or unusual trends. These training sessions are expected to build local capacity and ensure the solution's long-term sustainability. Data collected during this testing phase will also be used to refine the hardware design, improve the dashboard's analytical capabilities, and develop predictive models that can forecast future contamination or maintenance needs. As the project reaches the close of its current development phase, it reflects not only technical achievement but also alignment with broader social and environmental goals. AquaSol supports multiple Sustainable Development Goals (SDGs), particularly SDG 6: Clean Water and Sanitation, by enabling consistent access to safe water in marginalized areas. It also advances goals related to health (SDG 3), affordable and clean energy (SDG 7), innovation (SDG 9), and reducing inequalities (SDG 10). The positive feedback received from users and stakeholders during demonstrations highlights the project's relevance and potential impact. Many users reported feeling more confident about water safety and more informed about water quality parameters, thanks to the educational features embedded in the dashboard. Others expressed appreciation for the dashboard's ability to quickly highlight dangerous conditions or recommend actions, which is particularly useful in remote communities without immediate expert access. With this submission, the AquaSol team formally concludes its initial project development phase. The outcomes achieved demonstrate that it is not only possible—but essential—to develop holistic water purification solutions that combine physical reliability with digital intelligence. As the team prepares for community deployment and scaling, its commitment remains clear: to contribute meaningfully to water equity, environmental sustainability, and improved living conditions for communities that have long been underserved.
Appendices	
References	Green.org. (2024, January 30). Solar-powered water purification systems: Sustainable solutions for clean water. Retrieved March 26, 2025, from https://green.org/2024/01/30/solar-powered-water-purification-systems IWA Publishing. (2019). Feasibility of solar-powered ultrafiltration membrane water treatment system in Perak, Malaysia. Retrieved March 26, 2025, from https://iwaponline.com/ws/article/19/6/1758/66487/Feasibility-of-solar-poweredultrafiltration MIT News. (2015, October 8). Mexican village uses solar power to purify water. Retrieved March 26, 2025, from https://news.mit.edu/2015/mexican-village-solarpower-purify-water-1008 Modular Water Systems. (n.d.). Innovative modular water treatment solutions. Retrieved March 26, 2025, from https://www.modularwater.com Muhamad Ideres, K., Adam, A., & Tan Yen Ling, S. (2022). The legal framework for water pollution in Malaysia: An analysis. ResearchGate. Retrieved from https://www.researchgate.net/publication/371678302_THE_LEGAL_FRAMEWORK_FOR_WATER_POLLUTION_IN_MALAYSIA_AN_ANALYSIS/fulltext/648f06cfb9ed6874

	a5 b5c148/THE-LEGAL-FRAMEWORK-FOR-WATER-POLLUTION-IN-MALAYSIA-AN-ANALYSIS.pdf Rakesh, K., & Goyal. (2021). On-line training of SAARC professionals on power purchase agreements of renewable energy projects: Risk assessment and mitigation techniques for renewable energy projects. Retrieved from https://www.saarcenergy.org/wp-content/uploads/2021/11/Day-2-Slot-2-RakeshKumar-Goyal-Risk-assessment-and-mitigation-techniques-for-Renewable-EnergyProjects.pdf Reuters. (2024, December 4). Malaysia health volunteers on alert for waterborne disease after devastating floods. Reuters. https://www.reuters.com/business/healthcare-pharmaceuticals/malaysia-health-volunteers-alert-waterborne-disease-after-devastating-floods-2024-12-04/ Solar-Powered Water Purification System Index Terms-Solar energy-Water purification-IoT technology-clean water access-Rural infrastructure-Portable filtration systems-Renewable energy solutions-Real-time monitoring-Sustainable development-Off-grid water systems-Water scarcity Decentralized water purification-Smart water purification. (2024). International Journal of Scientific Research & Engineering Trends, 10(5), 2395–2566.https://ijsret.com/wp-content/uploads/2024/09/IJSRET_V10_issue5_449.pdf Soroptimist International. (n.d.). Clean water for rural communities in Peninsular Malaysia. Retrieved March 26, 2025, from MFB2061 Engineering Team Project I https://www.soroptimistinternational.org/clean-water-for-rural-communities-inpeninsular-malaysia Suhakam. (2023). Right to clean water. Retrieved from https://suhakam.org.my/portfolio/right-to-clean-water/ United Nations. (2023). Malaysia SDG progress report. Retrieved from https://sdgs.un.org/basic-page/malaysia-34130
Additional Visuals/ Diagrams	 Cad Design Perspex Model for laser cutting

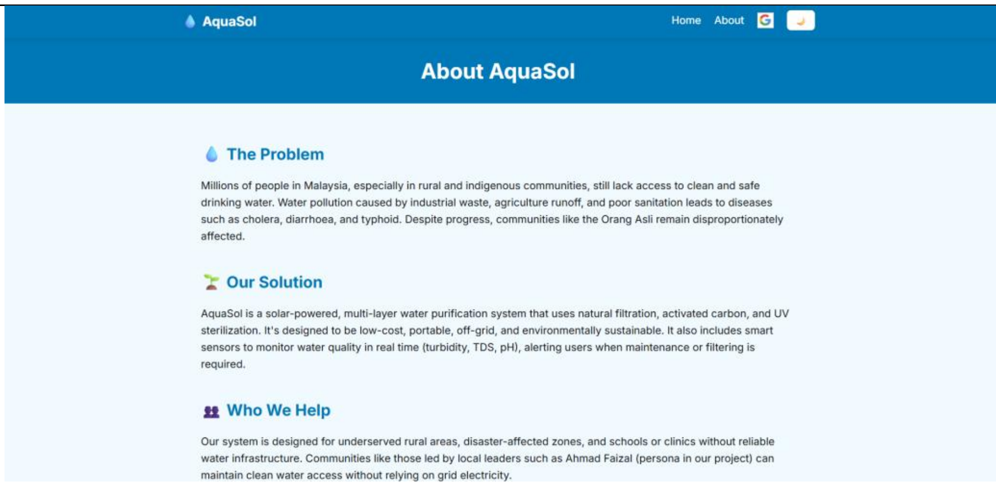


Final Prototype Cad Model

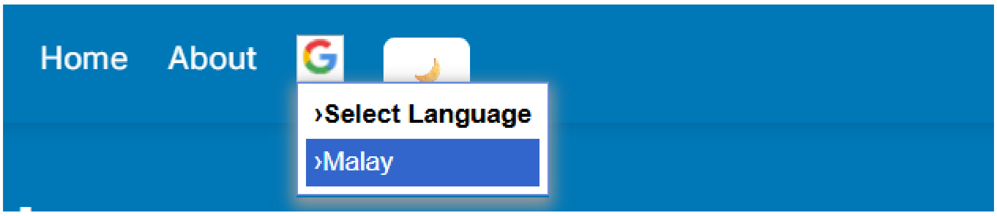
- Raw data collected during user testing or interviews with stakeholders.
- Visual documentation of the prototype development, testing, and final product in use.



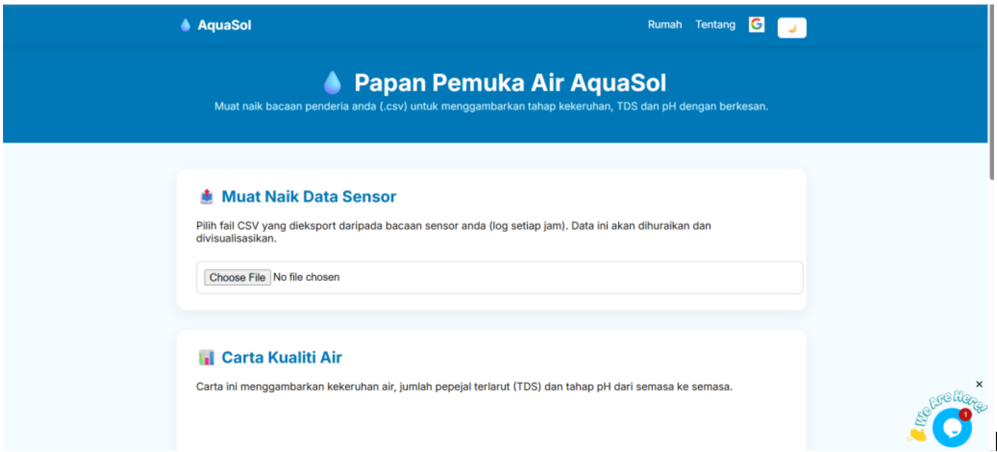
Aquasol Dashboard Visual



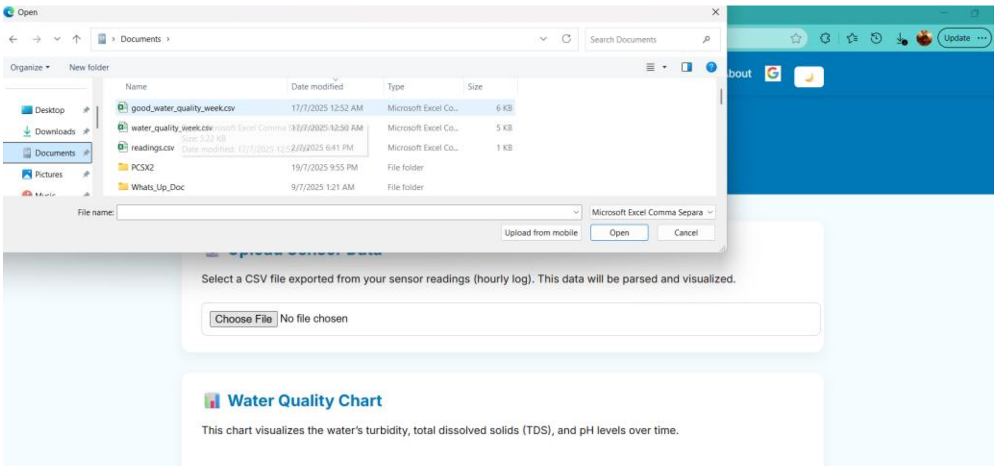
About page



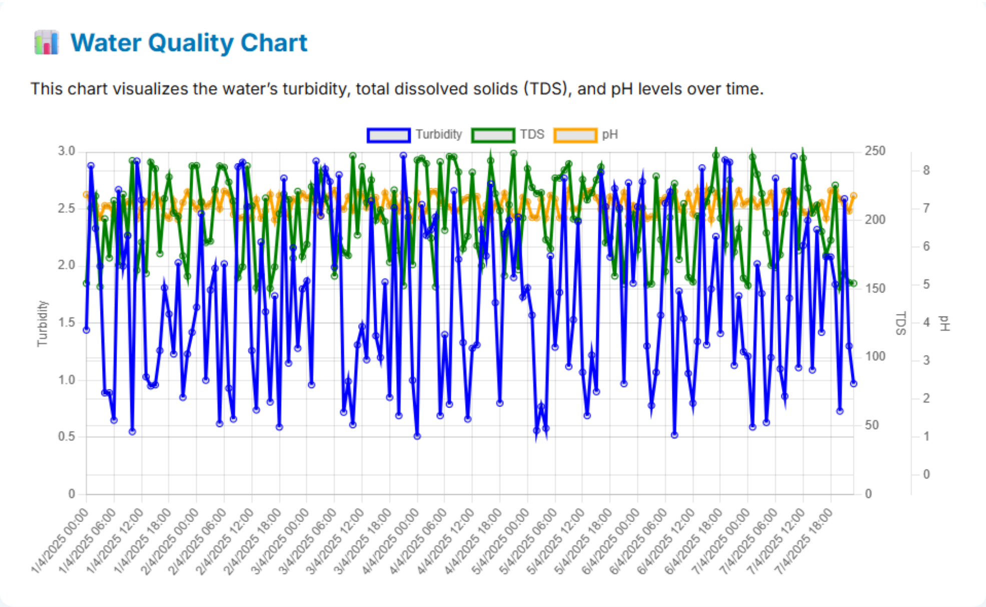
Google translate widget to translate content from English to BM

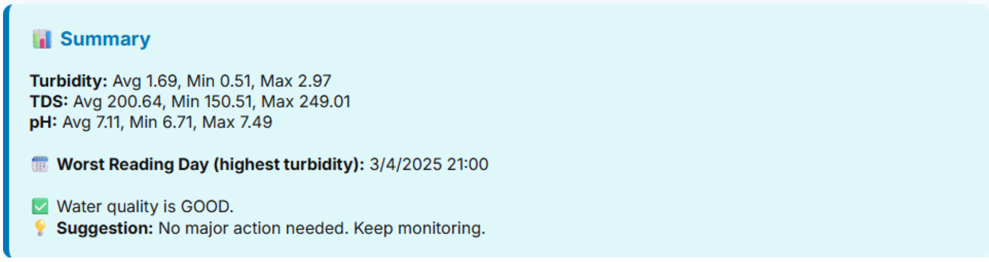


BM version

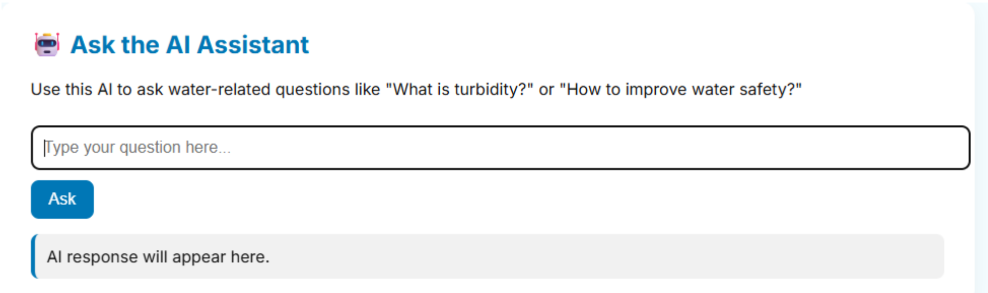


Choose the csv file with the data from the sensors

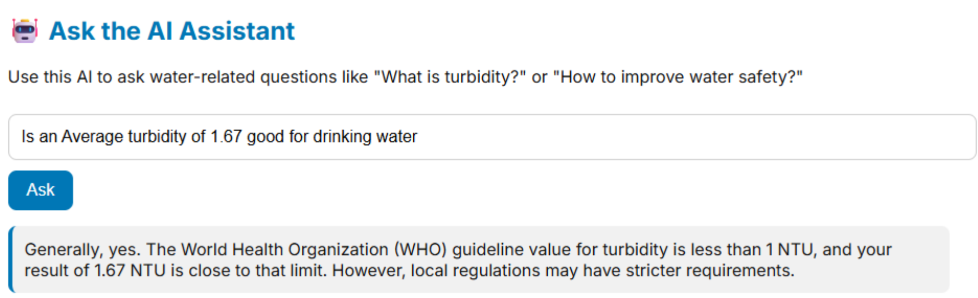




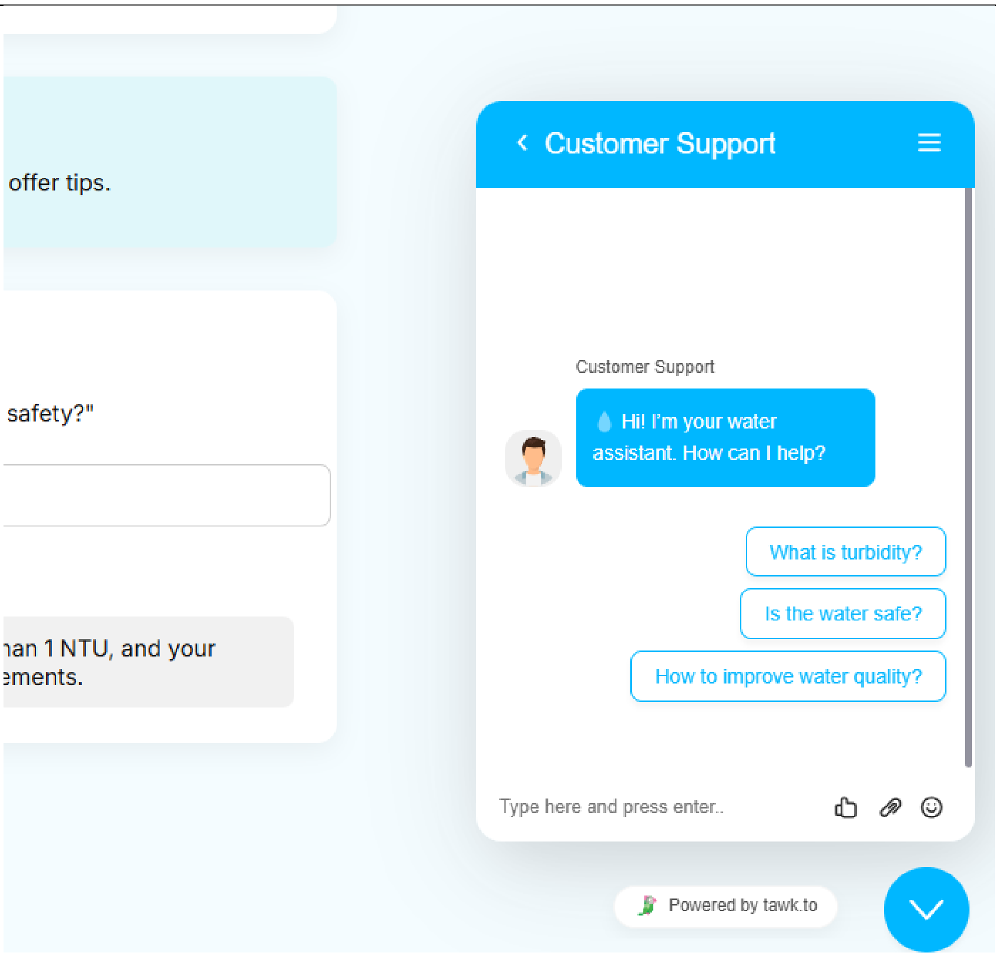
The data uploaded will be analysed. A suggestion will be given.



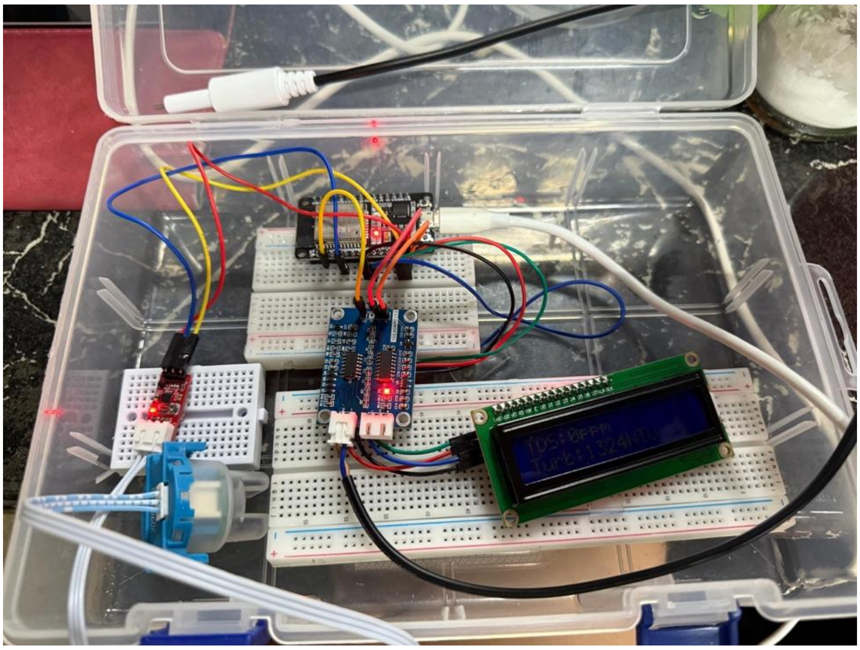
AI Chat



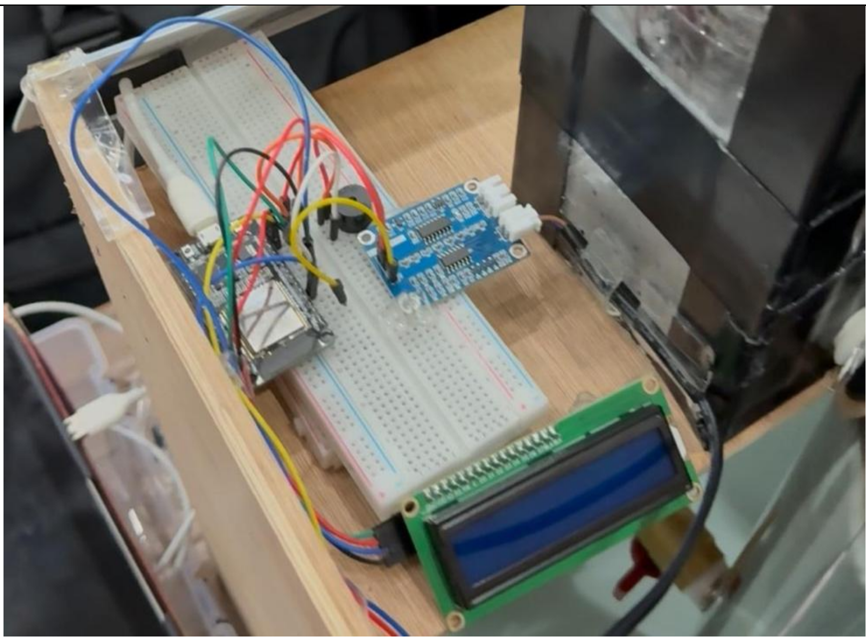
Example of answer given



Human chat also powered by tawk.to



Circuit diagram

	 Circuit assembled with our filter system **Group75 Working Video**