SUNCOOL: AN IOT BASED WATERPROOF COOLING VEST FOR TROPICAL CLIMATES

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A Scientific Research Submitted in Partial Fulfillment
of the Requirement in the Subject
Research II

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APPROVAL SHEET

This Scientific Research entitled **"SUNCOOL: AN IOT BASED WATERPROOF COOLING VEST FOR TROPICAL CLIMATES."** prepared and submitted by **Arichea, Shabrina Chanel Y., Tarayao, Janice A., Camacho, Janrae A., Bugaling, Audrey D., Gadia, Cever M., Urbina, Tavitha Jeay M., Galenzoga, Raynaldo Gloria Jr., Mark Gabriel C** in partial fulfilment of the requirements of the subject Research II has been examined and hereby recommended for approval and acceptance.

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Member, Research Panel

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Accepted in partial fulfillment of the requirements of the subject Research II

Approved:

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SUNCOOL: DEVELOPMENT OF A COST-EFFECTIVE, MIST-SPRAY-BASED EVAPORATIVE COOLING JACKET FOR TROPICAL CLIMATES.

BACKGROUND OF THE STUDY

Heat index is one of the major problems here in the Philippines and around the world. Exposure to extreme heat is a significant public health problem. These impacts can be both immediate and long-lasting. Nowadays, people tend to stay at home rather than risk their health by exposing their bodies to the sun. Workers like traffic enforcers would rather wear long sleeves and sweat all day long than risk the possibility of burning their skin or developing heat-related illnesses just to lessen their heat stress. In addition, heat can pose safety risks to everyone.

Countries are increasingly concerned about the sharp rise in temperatures, as recorded data fails to fully represent people's actual experiences. David Romps co-authored a report revealing that government agencies often miscalculate the heat index during extreme humidity and temperature conditions (Sanders, 2024). A severe heatwave in South and Southeast Asia has led to Vietnam breaking over 100 temperature records in April (France24, 2024). In Yeoju, Gyeonggi, temperatures hit 40 degrees Celsius, the highest in Korea in six years (Jung-Woo, 2024). Reports show that current heat indexes are higher than expected, with 1,546 people hospitalized for heat-related illnesses in Korea since May, and 11 deaths in the past three months, including three women who died recently after fainting (Xinhua, 2024). In Dhaka, ninth-grader Hena Khan is finding it hard to focus on schoolwork due to temperatures exceeding 43 degrees Celsius (109 degrees Fahrenheit) (Paul & Gloria, 2024). This indicates that extreme heat is impacting health, education, and the well-being of both the elderly and young people. Meanwhile, research stated that being exposed to extreme heat will make your heart rate beat faster than usual. For every degree your body's internal temperature rises in the heat, your heart rate increases by about 10 beats per minute. That natural reaction places added strain and stress on your ticker (Cleveland Clinic, 2023).

In the Philippines, the situation is worsening as the state weather bureau PAGASA warns of potential "extreme danger" heat indexes, with temperatures possibly reaching 52 degrees Celsius due to El Niño and the dry season (Gutierrez, 2024). This level of heat can lead to serious health issues like heat cramps and exhaustion, including fatigue, dizziness, headache, vomiting, and light-headedness, according to the Department of Health (Montemayor, 2024). To mitigate heat-related illnesses, the Department of Health advises limiting outdoor exposure, staying hydrated, avoiding caffeine and alcohol, and using sun protection while scheduling strenuous activities for cooler times of the day (GMA Integrated News, 2024). As heat indexes remain above 40 degrees Celsius, labor groups are calling for policies to address heat stress for workers (Abad, M. 2024). The Department of Education has denied reports of two teachers dying from heatstroke in Iloilo (The Philippine Star, 2024). The heat people are experiencing right now shouldn't be taken lightly. It is becoming extremely dangerous; it exceeds one's expectations.

All year round, the Philippines experiences typical humid weather. The humidity in the Philippines has become dangerous for people's safety as climate change has gotten significantly worse. The intense heat has made it difficult for people, particularly for those who work outside and even for students, who find it difficult to wear their uniforms.

Wearing a jacket to protect the skin is also impossible because it simply makes the heat worse. Considering what to wear every day has proven to be very difficult, especially for people who love fashion and styling while staying comfortable. The researchers come up with the idea SunCool: Development of a Cost-Effective, Mist-Spray Based Evaporative Cooling Vest for Tropical Climates, an innovative vest that is comfortable to wear, especially outdoors, and that can also stay up to date with trends and fashion, SunCool offers a potential solution to extreme heat conditions by spraying mist for a cooling effect that is activated by a temperature sensor.

Significance of the study

Outdoor Workers and Laborers. may benefit from SunCool as a personal heat-mitigation tool. It can help reduce the risk of heat-related illnesses, improve work efficiency, and enhance safety during prolonged exposure to high temperatures in tropical climates. This leads to better productivity and overall occupational well-being.

Healthcare Providers and Public Health Institutions. may observe a decrease in heat-related emergencies and chronic stress conditions due to the adoption of enhanced personal cooling practices. It aims to reduce healthcare challenges during the hot seasons. Environmental Advocates. The adoption of SunCool may be supported as an eco-friendly alternative to conventional cooling systems, promoting solutions that are water-efficient and low in energy use. This approach aligns with climate goals and aims to reduce environmental impact.

Farmers and Agricultural Workers. Working long hours under the sun, farmers and agricultural laborers can benefit from the cooling effects of the SunCool vest, reducing heat stress that often limits their work capacity. Such benefits can lead to improved labor output, reduced health risks, and greater agricultural productivity, contributing to food security and rural livelihood stability.

Department of Environment and Natural Resources (DENR). The Department of Environment and Natural Resources (DENR) is dedicated to promoting sustainable environmental practices and climate adaptation strategies in the Philippines. Its adoption aligns with DENR's efforts to mitigate the impacts of climate change and protect vulnerable populations from heat-related health hazards.

Local Communities. By offering an affordable, accessible cooling option, the vest may improve daily comfort and health outcomes for communities most affected by rising temperatures, enhancing overall social welfare and resilience to climate change.

Researchers. May explore new frontiers in wearable thermoregulation, textile innovation, and evaporative cooling systems. The study of SunCool contributes to academic advancement in material science, human-environment interaction, and sustainable design.

Hypothesis

There is a significant improvement in temperature reduction when using the SunCool: An IoT-based Waterproof Cooling Vest for Tropical Climates compared to not using any cooling device under the hot and humid weather conditions in the Philippines, specifically Olongapo City.

Conceptual Framework

To determine the efficiency and adaptability of the **SunCool** system in providing thermal comfort and supporting economic stability, the researchers will use the InputProcess-Output Model. SunCool integrates wearable cooling technologies and the Internet of Things to alleviate heat-related issues in tropical regions. Miniaturized blowers and humidifiers for personal cooling, sensors for temperature monitoring, and a microprocessor for intelligent control are all included in the vest. In hot climates, IoT connectivity improves comfort and safety through data-driven climate adaption and remote monitoring (Ahmed et al., 2021; Kim & Lee, 2020). For people who work outside and are frequently subjected to extended heat stress, such as farmers, construction workers, and delivery staff, this technique is very helpful (World Health Organization, 2020). This strategy supports Universal Design for Learning (UDL) by providing adaptable and accessible solutions that can be used by a wide range of people in different environments and professions (CAST, 2018). In the Philippines, integrating UDL into wearable and assistive technology can greatly enhance inclusivity and user experience in both professional and educational contexts, as backed by Reyes and Cruz (2022). Wearable solutions that incorporate IoT also guarantee more responsive, real-time adaptation to user needs (Green et al., 2023), which enhances productivity and well-being.

Input

- Waterproof Temperature Sensor
- Mini Humidifier
- Mini Fan Modules
- Microcontroller
- Waterproof Fabric Vest
- IoT Modules

Process

- Real-time Temperature Sensing
- Microcontroller-Based Data Processing
- Automated Cooling Activation (Fan & Humidifier)
- IoT Connectivity for Monitoring & Control
- Smart Threshold-based Adjustments
- Waterproofing & Safety Circuitry
- Energy Optimization Algorithm

Output

- Wearable Cooling System
- Mobile App Control Interface
- Real-Time Environmental Monitoring
- Adaptive Temperature Regulation
- Data Logging for Climate Patterns
- Alerts for Temperature Thresholds
- User Comfort & Safety Enhancement

Figure 1. *Research Paradigm*

Statement of the problem

The primary goal of this study is to develop, test, and evaluate the effectiveness of Suncool: An Iot Based Waterproof Cooling Vest For Tropical Climates. The device combines mist-spray and fan-assisted cooling to enhance thermal comfort, particularly in areas with high temperatures and humidity in the Philippines. Specifically, this study aims to address the following questions:

1. How effective is *SunCool* in improving personal thermal comfort compared to fans, using the shade, or thermal cooling particularly in terms of:
   1.1. How much does SunCool reduce the user's body temperature, as measured by built in ds18b20 temperature sensor, in hot and humid environments?

   1.2. How does wearing SunCool affect the user's thermal comfort level and physical response (e.g., heart rate, sweating) during physical activity or exposure to direct sunlight?

2. How does *SunCool* contribute to improved heat protection and daily usability, particularly in terms of:
   2.1. How accurately does SunCool detect and respond to changes in the user's body temperature during exposure to heat?

   2.2. How consistent and precise is SunCool in maintaining a comfortable body temperature during prolonged heat exposure?

3. Has the implementation of *SunCool* improved the practicality and affordability of wearable cooling technology, particularly in terms of:

    3.1. How long can SunCool maintain accurate body temperature regulation before requiring battery recharging or mist refilling?

    3.2. How precisely does SunCool regulate body temperature under varying conditions, and how does this accuracy contribute to its overall practicality and affordability compared to existing wearable cooling devices?

Scope and Limitation

The scope of this study is to develop Suncool: An Iot Based Waterproof Cooling Vest For Tropical Climates, to help mitigate the health and comfort challenges associated with extreme heat. The study will evaluate SunCool's effectiveness in providing personal cooling through an automatic mist-spray system activated by temperature sensors, aiming to reduce the user's heat stress and discomfort even in high humidity. Unlike traditional jackets, which can trap heat and worsen discomfort, SunCool is designed to be breathable, lightweight, and stylish to accommodate fashion-conscious users while enhancing safety and comfort outdoors. This solution specifically targets those most affected by heat—such as outdoor workers, students, and daily commuters—by offering a wearable, user-friendly technology that helps maintain a lower body temperature despite high environmental heat indexes. The research will assess SunCool's performance in terms of cooling efficiency, sensor responsiveness, comfort, durability, energy use, and wearer satisfaction. Prototype development, testing, and data collection will be conducted under typical Philippine climate conditions to ensure the design is appropriate for local needs and environmental stresses.

However, the study has several limitations. Testing will be limited to specific locations within the Philippines with typical tropical and humid climate conditions, excluding performance validation in cooler or drier regions. The study will also focus on short-term technical evaluation, user feedback, and prototype usability without addressing large-scale production, long-term durability under daily use, or commercialization strategies. Additionally, the research will not assess potential policy adoption, worker safety regulations, or broad public-health impacts. These limitations are necessary to keep the study feasible and focused on the initial design, development, and testing of the SunCool prototype.

Definition of Terms

SunCool. The name of the prototype cooling vest developed in this study. It features a built-in mist-spray and fan system that automatically activates based on environmental conditions to provide thermal comfort in tropical climates.

Cooling Vest. A type of wearable clothing designed to reduce or regulate body temperature. In this study, the Cooling Vest uses both mist-spray and airflow to help users feel cooler in hot and humid conditions.

Mist Spray System. A component of the vest that releases a fine spray of water to promote evaporative cooling. The mist is activated automatically when heat and humidity exceed preset limits.

Evaporative Cooling. A natural process in which water absorbs heat as it evaporates, resulting in a drop in temperature. This principle is used in the mist-spray system to enhance cooling.

Temperature Sensor. A device that detects the surrounding air temperature. It helps determine when the vest needs to activate the mist-spray system.

Humidity Sensor. A sensor that measures the moisture level in the air. When humidity is high and combined with heat, the mist system activates for better cooling.

Microcontroller. A small computer (such as an Arduino) that processes data from the sensors and controls when the mist and fans should turn on or off.

Cost-Effective. Refers to the vest being affordable to build and maintain, using materials and components that are economically accessible while still being functional.

Tropical Climates. Climates characterized by high temperatures and humidity, such as those found in the Philippines and other Southeast Asian countries.

Thermal Comfort. The condition of feeling neither too hot nor too cold. In this study, it refers to the wearer's comfort while using the SunCool Vest.

Chapter 2

METHODOLOGY

This chapter outlines the systematic methodology used to conceptualize, design, develop, and evaluate the SunCool Vest—an IoT-enabled, mist-spray-based evaporative cooling system created to address the heat stress challenges faced in tropical climates. The approach combines a developmental phase, focusing on the iterative engineering and refinement of the vest, with a descriptive phase, centered on real-world field testing to assess cooling performance, sensor accuracy, usability, and cost-effectiveness. Data collection integrates both quantitative measurements and qualitative feedback, ensuring that every stage of the research process is guided by the goal of producing a functional, practical, and affordable cooling solution for individuals regularly exposed to hot and humid environments.

Research Design

This study will employ a developmental-descriptive research design to systematically develop, design, and evaluate the SunCool system—An IoT-based Waterproof Cooling Vest for Tropical Climates. The developmental phase will focus on the iterative design and engineering of the wearable device, ensuring it meets criteria for comfort, usability, and environmental adaptability. The descriptive phase will focus on assessing SunCool's performance in real-world tropical settings. The researchers will conduct field testing involving outdoor workers, students, and commuters in high-temperature environments. The goal is to assess the jacket's temperature reduction performance, mist system effectiveness, sensor responsiveness, and user satisfaction. Participants will evaluate its functionality during various activities such as walking, commuting, and working outdoors. The researchers will use surveys, interviews, and direct Observations to collect data on usability, cooling effectiveness, and economic viability. The study's respondents will include individuals who are frequently exposed to extreme heat, such as traffic enforcers, street vendors, and students. Technologists, clothing designers, and public health advocates may also be consulted to explore the broader implications of wearable cooling technologies in health and environmental resilience. Ultimately, this research aims to produce a functional and scalable innovation that bridges fashion, functionality, and public health protection in the era of climate change.

Flowchart of Research Design/Process Flowchart

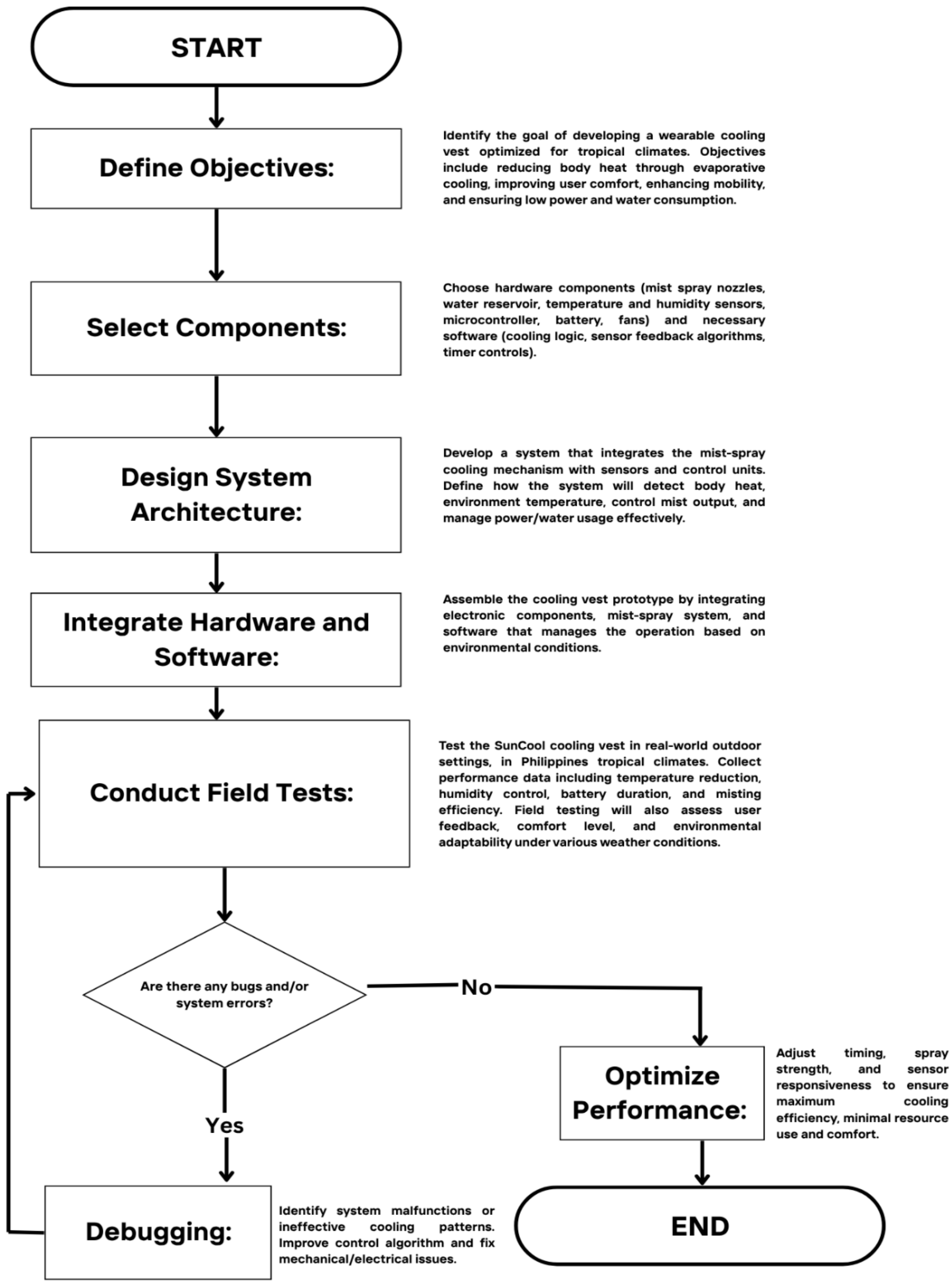


Figure 2. *Process Flow Chart of Research Design*

Description of Research Instrument Used

The study combines a combination of hardware, software, and survey-based instruments to completely evaluate the performance, usability, and comfort of the SunCool IoT-based waterproof cooling vest suited for tropical regions. The main tool is the SunCool prototype, which is made of breathable, waterproof fabric to guarantee comfort and longevity in humid conditions. It is equipped with insulated water channels, micro-pumps, and thermoelectric cooling modules for effective heat dissipation. The vest is equipped with an IoT control unit consisting of a microcontroller, high-accuracy temperature and humidity sensors, and wireless communication modules for real-time monitoring and remote control, following the approach recommended in wearable cooling device development studies (Lee et al., 2021; Zhang & Wang, 2020). In order to test the ambient circumstances and the vest's ability to regulate its temperature under realistic use situations, environmental monitoring equipment is utilized. This contains an infrared thermometer to record surface temperature distributions on the wearer's skin and vest, a digital anemometer to measure airflow during outside trials, and an ambient temperature and humidity data recorder to continuously record climate conditions. According to established standards, these instruments evaluate wearable cooling systems in a range of temperature conditions (ASHRAE, 2017; Parsons, 2014).

An IoT-based data collecting system built into the vest continuously gathers and sends data to a dashboard, including skin temperature, vest surface temperature, water circulation temperature, and ambient humidity. The user interface is a specially designed mobile application that allows researchers and participants to directly modify cooling parameters and monitor real-time performance data. Such IoT connection enables both quantitative evaluation and adaptive control during testing, which is in line with best practices in remote physiological monitoring for wearable technologies (Kumar et al., 2022; Rahman et al., 2021). A structured user experience survey is used to evaluate ergonomic compatibility and user satisfaction. The survey collects opinions on comfort, usability, perceived cooling efficacy, mobility, and general satisfaction using both closed-ended Likert scale items and open-ended questions. According to guidelines for usability testing tools, the questionnaire is verified by three subject-matter specialists in wearable technology and human factors engineering to guarantee content validity (Brooke, 1996; Sauro & Lewis, 2016).

Lastly, to replicate normal tropical climate circumstances, a consistent performance testing process is put into place. Wearing the vest while participating in mild to moderate physical activity under controlled heat exposure, baseline measurements are made before the activity begins, physiological parameters like skin temperature, heart rate, and subjective thermal perception are continuously monitored during operation, and post-trial evaluations are conducted. This procedure ensures that the data gathered represents both objective performance and subjective comfort in pertinent environmental circumstances by adhering to international standards for assessing human heat stress and cooling therapies (ISO 9886:2004; Cheung, 2010). These tools provide a thorough and multifaceted assessment of the SunCool vest's efficacy and usefulness in tropical regions by fusing objective environmental and physiological parameters with subjective user feedback.groups.

Data Analysis

The data collected in this study will be analyzed using computer software, including SPSS version 20 and Microsoft Excel 2013. These tools will assist in statistical analysis, interpretation, and hypothesis testing to determine the efficiency, effectiveness, and user satisfaction of Suncool:An Iot Based Waterproof Cooling Vest For Tropical Climates The following statistical methods will be employed:

Frequency and Percentage Distribution This statistical method will be used to analyze the demographic profile of the respondents and their level of satisfaction with the SunCool prototype. It will help the researchers identify the proportion of users who agree or disagree with specific features of the cooling vest, based on age, occupation, or frequency of outdoor exposure.

Weighted Mean will be used to determine the average level of agreement among respondents regarding the effectiveness, usability, and impact of SunCool. Scale

Interpretation:

Scale	**Range**	**Verbal Description**
4	3.50 – 4.00	Strongly Agree
3	2.50 – 3.49	Agree
2	1.50 – 2.49	Disagree
1	1.00 – 1.49	Strongly Disagree

The results will help evaluate how strongly participants agree with the comfort, cooling efficiency, energy usage, and practicality of the Vest.

Standard Deviation will be used to measure the spread or variability of the responses from the mean. It will help determine the consistency of data collected on variables such as cooling effect, usability, comfort, and energy efficiency. A low standard deviation indicates that the responses are clustered closely around the mean, showing consistent user experience. A high standard deviation suggests varied or inconsistent responses across participants.

One-Way ANOVA (Analysis of Variance) will be conducted to evaluate whether there are statistically significant differences in the effectiveness of different cooling methods under the same environmental conditions. Independent Variable: Type of cooling method (SunCool vs traditional fan vs no cooling) Dependent Variable: Cooling or drying time, comfort rating Condition: Tests conducted under similar tropical outdoor settings If the resulting p-value is less than 0.05, it will suggest a significant difference in the effectiveness between groups.

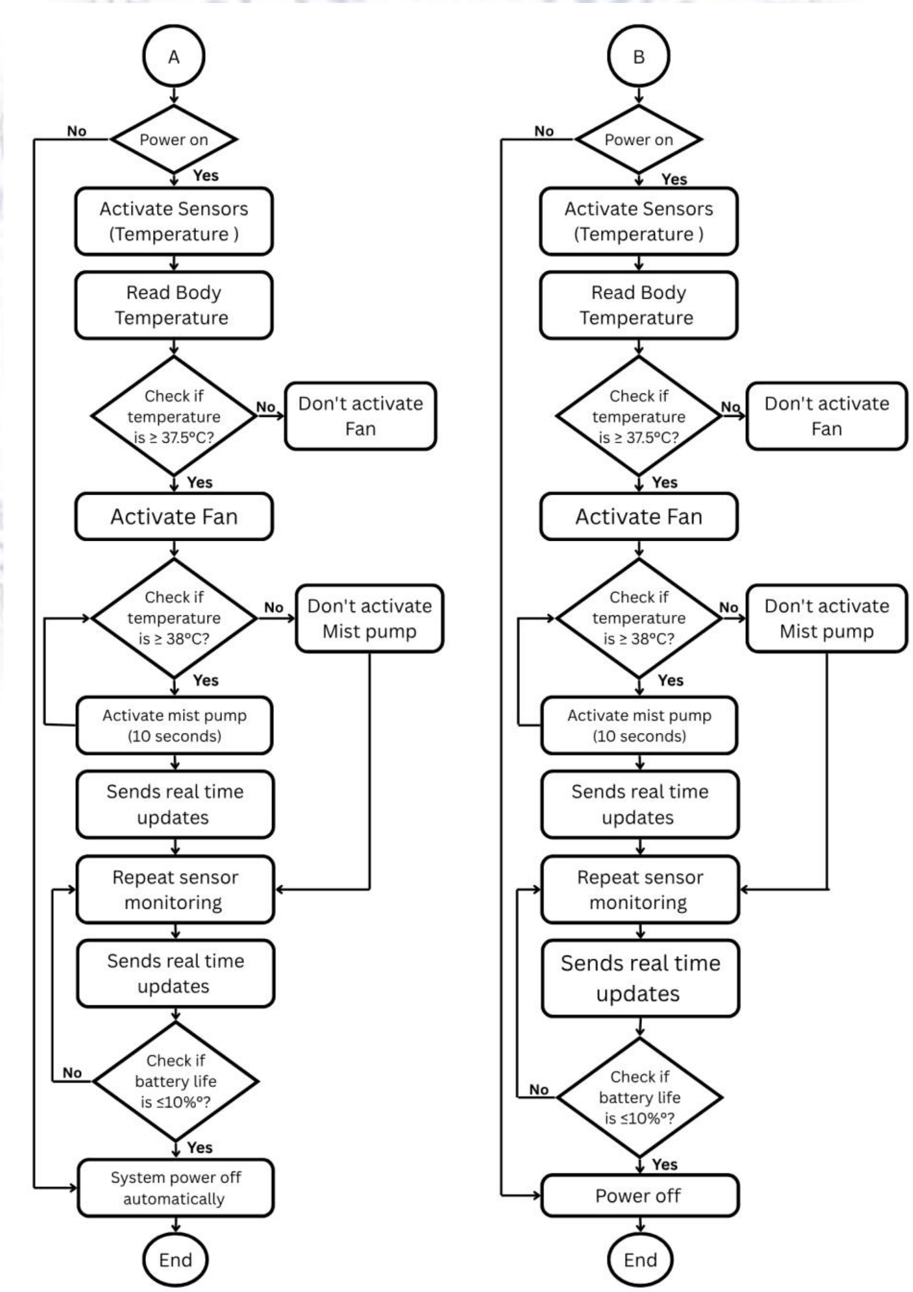
Independent Samples t-Test will be used to compare the mean comfort ratings and cooling performance between two groups:

Participants using the SunCool vest

Participants using Fans

This test will determine whether the differences in performance or comfort levels are statistically significant. Null Hypothesis (H_0): There is no significant difference between the two groups. Alternative Hypothesis (H_1): There is a significant difference in cooling efficiency or comfort. If the t-test yields a p-value less than 0.05, the difference in means will be considered statistically significant, indicating that SunCool has a measurable impact on user comfort or thermal regulation. These statistical tools will allow the researchers to draw valid conclusions regarding the effectiveness, usability, and benefits of the SunCool vest as a climate-adaptive wearable technology.

Process Flowchart



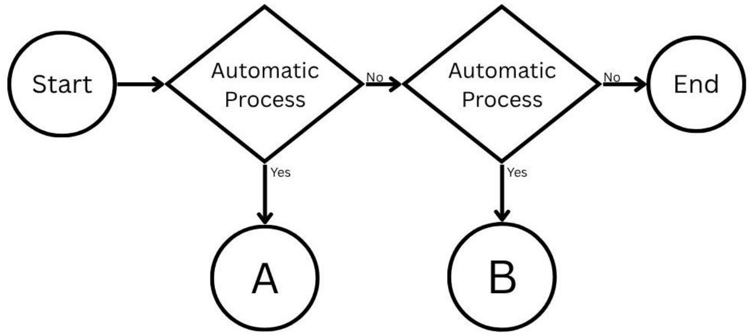


Figure 2.1 Process Flow Chart

he Smart Mist Cooling System is a practical, automated solution designed to improve comfort and safety in high-temperature environments. The system offers two operation modes: Automatic Mode (A) and Manual Mode (B), giving users the flexibility to choose based on their preference or environment.

In Automatic Mode (A), once the system is powered on, it immediately activates its built-in temperature sensor to read the body temperature. If the temperature is greater than or equal to 37.5°C, the system activates a fan to provide initial cooling. If the temperature further exceeds 38.2°C, it activates the mist pump for 10 seconds to enhance cooling. The system continues to monitor the sensor data and sends real-time updates throughout the process. Once the battery life drops to 10% or below, the system powers off automatically to conserve energy.

In Manual Mode (B), the process follows a similar logic but gives the user more control. After powering on, the system activates the sensors and reads the temperature. The fan is activated only if the temperature is 37.5°C or higher, and the mist pump activates for 10 seconds if the temperature reaches 38.2°C or higher. The system continues to monitor conditions and send real-time updates. Unlike Automatic Mode, Manual Mode requires the user to manually power off the system when finished, even after the battery life reaches 10% or lower.

This dual-mode functionality enhances user control while maintaining efficient cooling. By using real-time environmental monitoring, the Smart Mist Cooling System activates misting only when required, conserving both energy and water, and promoting sustainability.

Context Diagram

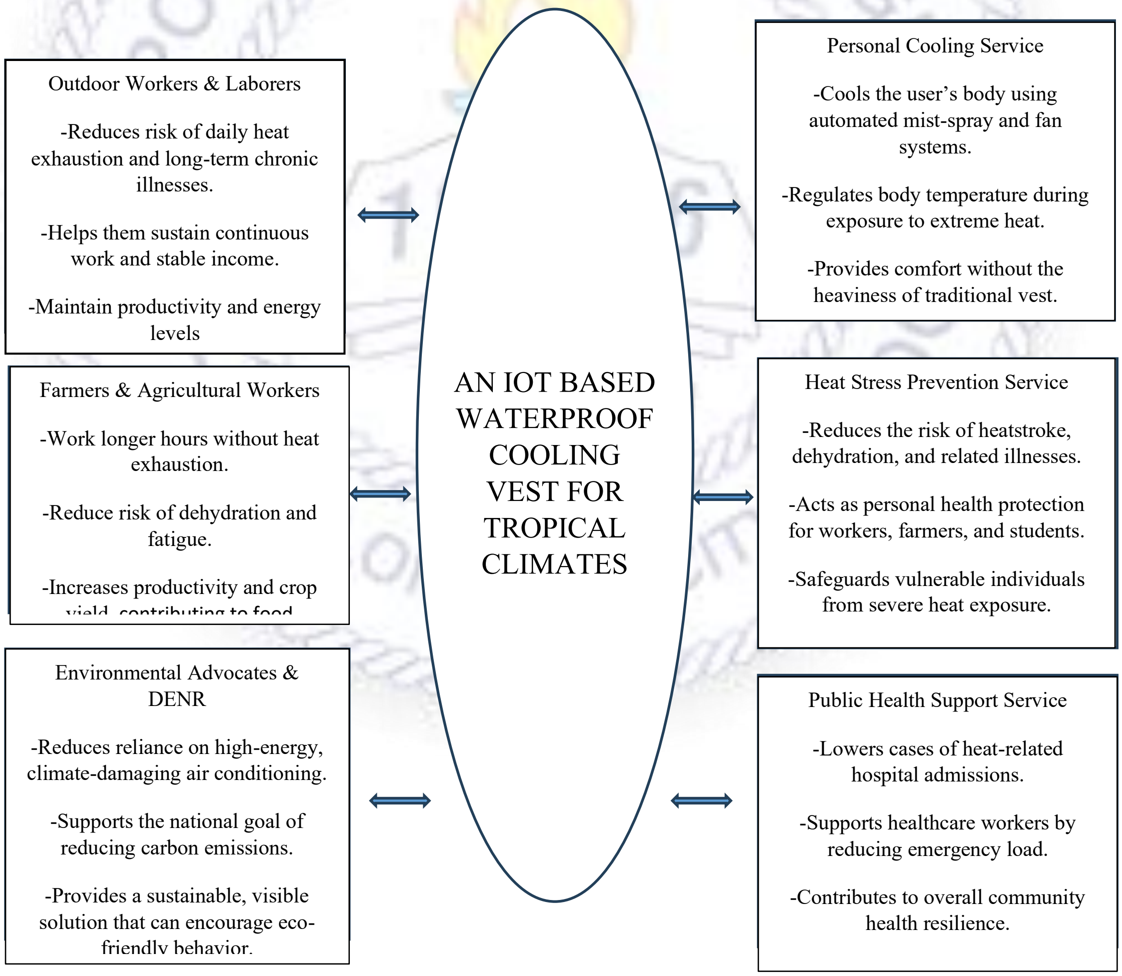


Figure 2.2 *The Context Diagram*

The context diagram gives a summary of how suncool: an iot based waterproof cooling vest for tropical climates connects different users and system components to reduce heat stress and improve comfort, safety, and productivity in tropical outdoor settings. At the core of the system is the SunCool wearable cooling technology, which uses a combination of mist-spray nozzles, small fans, and temperature/humidity sensors to provide evaporative cooling. This system directly supports key user groups, including farmers, agricultural laborers, outdoor workers, public health services, and heat stress prevention programs.

Farmers and agricultural workers use the SunCool vest while performing outdoor tasks such as planting, harvesting, and field preparation. By wearing the device, they experience improved comfort and protection from heat-related stress. The mist-spray and fan system automatically activates based on environmental conditions, helping them sustain longer work periods, reduce fatigue, and minimize dehydration. This leads to more stable productivity and reduces risks associated with prolonged sun exposure. Outdoor workers and laborers in construction, delivery, roadside maintenance, and other physically demanding outdoor jobs also benefit from SunCool. The vest allows them to maintain productivity throughout the day with less strain on their bodies. By regulating body temperature, it helps prevent chronic exposure to extreme heat and associated health issues such as heat exhaustion and stroke. Public health support services benefit from the reduced occurrence of heat-related illnesses among vulnerable populations. By promoting the use of SunCool in high-risk environments, these services are able to support preventive health strategies, reduce hospital admissions related to heat, and help communities become more resilient during periods of extreme weather. Heat stress prevention programs at local and national levels can use SunCool as part of their health and safety campaigns, especially during the dry or summer seasons. The cooling vest acts as a frontline personal protection tool, particularly for populations with limited access to shade or mechanical cooling systems. During operation, the SunCool vest detects high temperatures and humidity levels through onboard sensors. It then activates the mist-spray and fan mechanisms to provide evaporative cooling. Users benefit from immediate relief without requiring manual intervention or adjustments. The jacket is powered by a rechargeable battery and is designed to be lightweight and comfortable for long-term wear in the field

The System Architecture

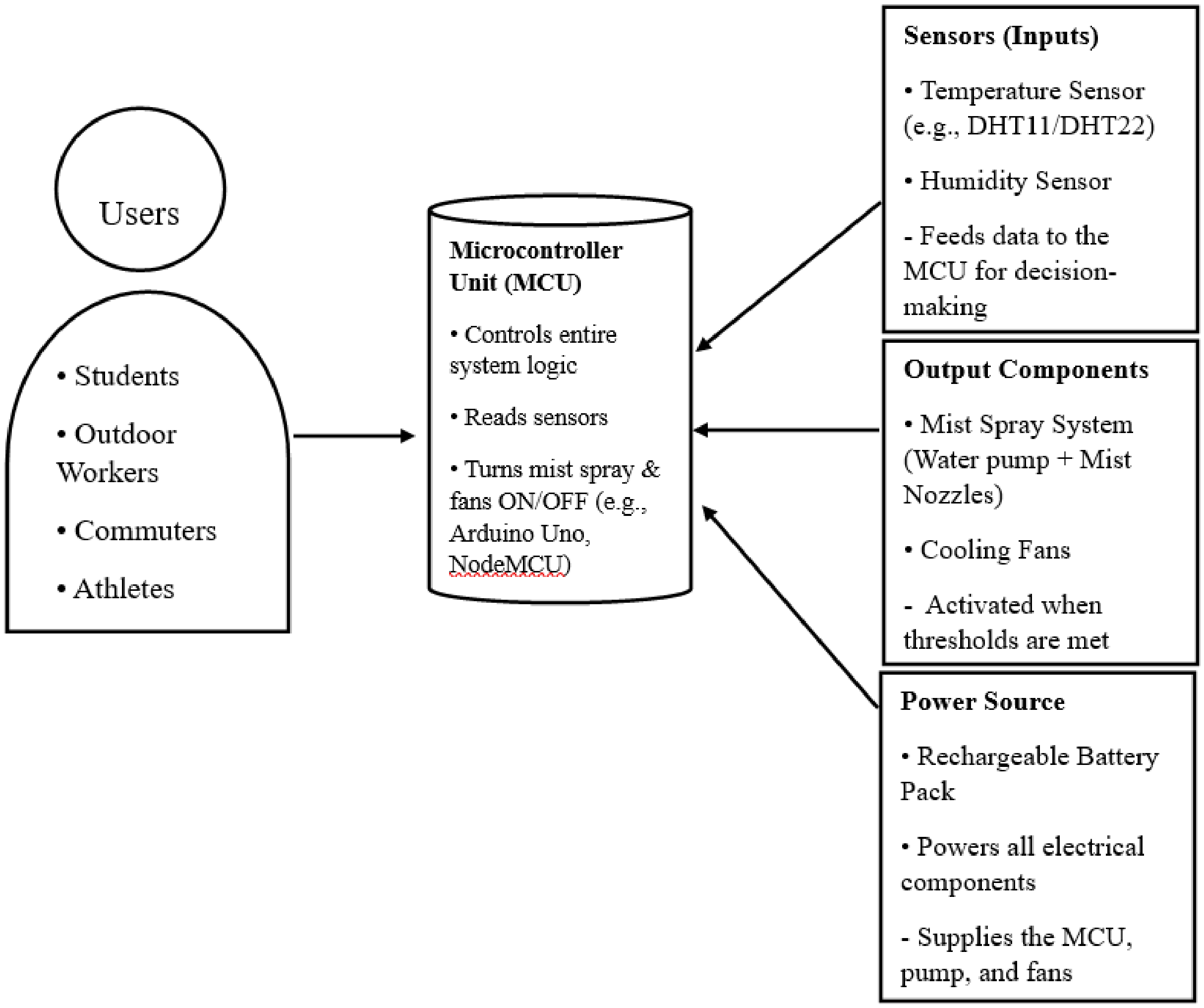


Figure 3.7 The System Architecture

The system architecture of SunCool is designed to operate as a self-contained, sensor-based cooling system that provides comfort in high-temperature and high-humidity environments. It integrates key components that function together to deliver automated cooling through mist and airflow. The process begins with the user, who activates the system through a manual switch. The Microcontroller Unit (MCU) serves as the central control system that manages sensor input and component responses. Once the system is powered on, the temperature and humidity sensors continuously monitor the surrounding environment. When the sensor readings reach or exceed the predefined thresholds, the MCU processes the data and triggers the appropriate cooling response. The output components consist of a mist spray system and internal cooling fans. These are activated by the MCU to initiate evaporative cooling, which helps reduce body heat and improve comfort. The mist system releases a fine spray of water while the fans enhance the evaporation process by circulating air around the user's body. All components are powered by a rechargeable battery pack, which supplies electrical energy to the MCU, sensors, and output systems. This portable power source allows the vest to function without being connected to an external energy supply, making it suitable for outdoor use. This simplified and functional architecture allows SunCool to deliver automatic and responsive cooling tailored to tropical climates, making it an effective solution for individuals exposed to intense heat and humidity.

Research Paper Budget and Allowance

Clothing / Assembly Materials

Item	Price (₱)

Waterproof Vest	₱324
→ Outer shell of the wearable.	
Boning strips	₱35
→ Supports clothing structure.	
Velcro tape	₱24
→ Adjustable fastener.	
Thread	₱44
→ For sewing parts together.	
Adhesive glue	₱69
→ Binds non-sewable parts.	
Subtotal	₱496

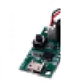
Airflow System Components

Item	Price (₱)
5V DC Fan	₱45

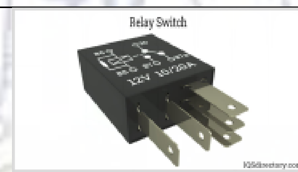
→ Circulates internal air.	
Dust filter sheet	₱134
→ Blocks airborne particles.	
Fan guard	₱46
→ Protects from fan blades.	
Mounting rings	₱65
→ Holds fan in place.	
Subtotal	₱290

Cooling System Components

Item	Price (₱)
Ultrasonic Atomization Maker 20mm 113KHz Mist Atomizer DIY Humidifier	₱63

with PCB DC3-12V Mini USB Humidifier Module	
→ Creates cooling mist.	
Small water pouch	₱100
→ Stores misting water.	
Hose Watering Small Water Pump Horizontal Submersible	₱13
→ Connects water flow.	
Mute Mini Micro Submersible Motor Pump Water Pumps DC 3-5V 70-120L/H USB drive	₱27
→ Moves water to mist module.	
Subtotal	₱203

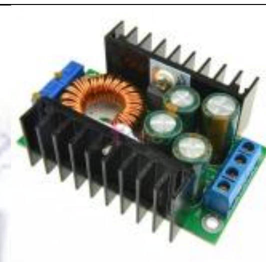
Electronics Components

Item	Price (₱)
PCB circuit board production, Circuit board SMT assembly service	 ₱59
→ Main controller unit.	
Fan speed control (2x)	₱32
→ Adjusts airflow speed.	
Relay (12V Module)	₱39
→ Switches electrical components.	
Hypertech THHN/THWN2 Stranded Wire	₱25
→ Connects electrical parts.	
ON/OFF Rocker Switch SPST 2 pin switch toggle switch automotive switch	₱25
→ Turns system on/off.	

Electrical Tape	₱17
→ Insulates and secures wires.	
Subtotal	₱253

Power Supply

Item	Price (₱)
Rechargeable battery Ncr18650b 4000 and 8000mah Lithium Battery XH2.54 2P interface	₱246
→ Rechargeable power source.	
Micro USB TP4056 1A dedicated lithium battery charging pad charging module lithium battery charger module 1A Charging Board	₱25
→ Safely charges battery.	

Buck power converter adjustable USB step-down charging module	₱68
→ Reduces voltage levels.	
Mini Micro JST 2.0 PH 2-Pin Connector Plug	₱68
→ Connects power components.	
XH-T106 Waterproof Temperature Sensor Probe High Percision 10K/B3950 Thermostat (2x)	₱65
→ Measures surrounding temperature and user's body temperature	
Subtotal	₱472

Grand Total: ₱1714

Questionnaire for SunCool Study

Instructions: Please evaluate each statement based on your experience with the **SunCool Jacket** by using the rating scale provided.

- **1 – Strongly Disagree**
- **2 –Disagree**
- **3 – Agree**
- **4—Strongly Agree**

Category	1	2	3	4
Effectiveness of SunCool in improving personal thermal comfort				
1.1 Does SunCool provide effective cooling in hot and humid environments?				
1.2 Does it offer comfort during physical activities or direct sunlight exposure?				
1.3 Is SunCool adjustable and easy to use?				
Contribution of SunCool to heat protection and daily usability				

2.1 Does it promote energy and water efficiency compared to traditional cooling devices?				
2.2 Is it cost-effective for both local and global users?				
2.3 Is SunCool portable, wearable, and adaptable to various climates and user needs?				
Improvement of practicality and affordability of wearable cooling technology				
3.1 Does SunCool have sufficient battery life and easy mist refill maintenance?				
3.2 Is its cooling performance better than other wearable cooling devices?				
3.3 Can SunCool help reduce heat-related risks for outdoor workers, commuters, and vulnerable groups?				