



UTM
UNIVERSITI TEKNOLOGI MALAYSIA

DESIGN THINKING (REPORT)

SMART THERMOSTAT



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INTRODUCTION

In today's era of advanced technology, energy efficiency and convenience are critical considerations for homeowners. Our project aims to address these needs by designing a smart Thermostat that utilizes IoT and machine learning to adapt to user preferences while optimizing energy consumption. Through the Design Thinking process, we developed a solution that is innovative, user-centric, and impactful. This report details the phases of our design journey, the challenges we addressed, and the insights we gained.

STEPS OF DESIGN THINKING

EMPATHIZE:

- Understand user needs by conducting surveys, interviews, and observations with homeowners, office managers, and other potential users.
- Identify pain points like high energy bills, complex interfaces, and inconsistent temperature control.
- Gather insights on user preferences, such as ease of use, integration with smart devices, and aesthetic design.

DEFINE:

- Clearly articulate the problem:
"How might we design a smart thermostat that provides energy efficiency, is user-friendly, and integrates seamlessly with existing smart home systems?"
- Establish user personas to focus on their unique needs and behaviours.
- Set key goals, such as improving user comfort, reducing energy consumption, and simplifying the installation process.

IDEATE:

- Brainstorm innovative features like voice control, predictive learning, and remote access via mobile apps.
- Explore aesthetic and functional designs for the thermostat interface.

PROTOTYPE:

- Create initial mock-ups or models of the thermostat design, including interface layouts and hardware components.
- Develop a working prototype that demonstrates core functionalities, such as temperature adjustments, scheduling, and app connectivity.
- Include simulated environments to showcase how the thermostat adapts to user behaviour.

TEST:

- Conduct usability testing with potential users to evaluate the functionality and interface of the prototype.
- Gather feedback to refine features, improve the user interface, and address any issues.
- Iterate on the design based on testing results to ensure the product meets user expectations and project goals.

3D Printing in the Development of Our Smart Thermostat

To create our smart thermostat, we utilized 3D printing technology, which allowed us to design, prototype, and refine the physical components of the device efficiently and cost-effectively. This approach enabled us to achieve a sleek, modern design while maintaining full control over customization and functionality.

Why 3D Printing?

1. Rapid Prototyping:

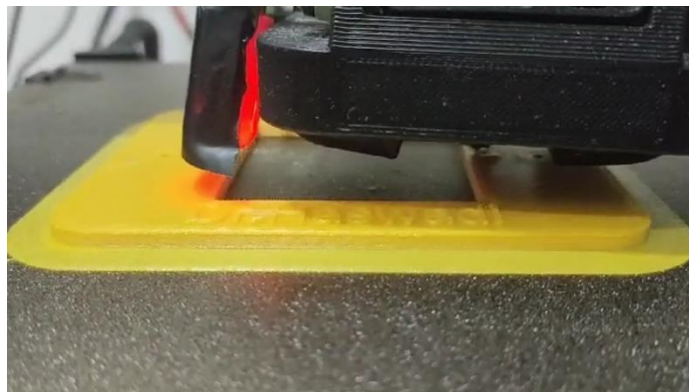
- 3D printing allowed us to produce a physical prototype of the thermostat quickly, for faster iterations and improvements.
- Changes to the design could be implemented and tested in a matter of hours, enhancing development efficiency.

2. Customization:

- The flexibility of 3D printing let us create unique designs tailored to our vision of a compact, user-friendly device.
- It enabled us to experiment with various shapes, sizes, and layouts for the thermostat's housing and interface.

3. Cost Effectiveness:

- Compared to traditional manufacturing methods, 3D printing reduced costs, especially for small-scale production and prototyping.
- Materials such as PLA and ABS were affordable and suited the project's needs for durability and sustainability.



Smart Thermostat Connected to Smart Life Smart Living

A **smart thermostat** connected to the **Smart Life – Smart Living** ecosystem offers an advanced solution for energy efficiency, comfort, and convenience. Smart Life is a widely used platform that integrates IoT devices into a seamless smart home experience, enabling users to control various smart gadgets, including thermostats, lighting, cameras, and more, all from a single app.

1. Remote Control:

- Adjust temperature settings anytime, anywhere using the Smart Life app on a smartphone or tablet.

- Perfect for users who want to prepare their home for their arrival or reduce energy use while away.

2. Voice Assistant Compatibility:

- Works with Alexa, Google Assistant, or Siri for voice-activated control.

3. Customizable Scheduling:

- Allows users to create heating and cooling schedules based on daily routines.

4. Energy Monitoring:

- Tracks real-time energy usage, providing insights into consumption patterns.
- Offers recommendations for energy-saving adjustments, helping users reduce bills.

5. Geofencing:

- Detects when users are home or away based on their phone's location.
- Automatically adjusts temperature settings to conserve energy without sacrificing comfort.

6. Multi-Zone Control:

- For larger homes, the thermostat can be part of a zoned heating and cooling system.
- Users can control different rooms or areas individually through the app.

7. Smart Automation:

- Integrates with other devices in the Smart Life ecosystem for automation.
- For example:
 - When a smart door lock is activated, the thermostat sets to "away mode."

- If a smart motion sensor detects activity, the thermostat adjusts to the preferred temperature.

8. Learning Capability:

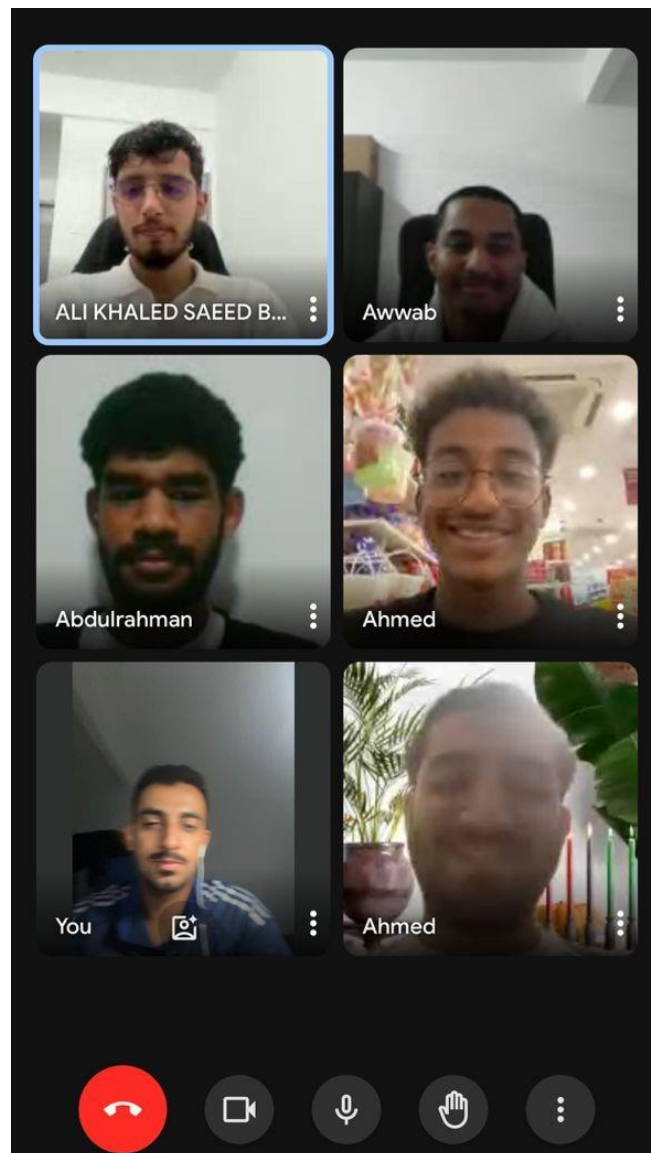
- Advanced models can learn user habits and preferences over time.
- Automatically optimizes temperature settings based on historical data.



OUR MEETINGS

ONLINE MEETING:

1. Introduced the project concept: Smart Thermostat.
2. Discussed the design thinking framework and how to apply it to our project.
3. Brainstormed initial ideas for user needs and potential features.
4. Delegated roles to team members, including research, prototyping, and documentation.
5. Planned the agenda for the next physical meeting, focusing on deeper ideation and prototype development.



PHYSICAL MEETING:

1. Reviewed and refined the user needs identified during the online meeting.
2. Conducted a collaborative brainstorming session to generate innovative ideas for the smart thermostat.
3. Created sketches and models for the thermostat's interface and hardware.
4. Assigned tasks for prototype development and discussed materials or tools required.
5. Scheduled a timeline for testing and feedback collection.



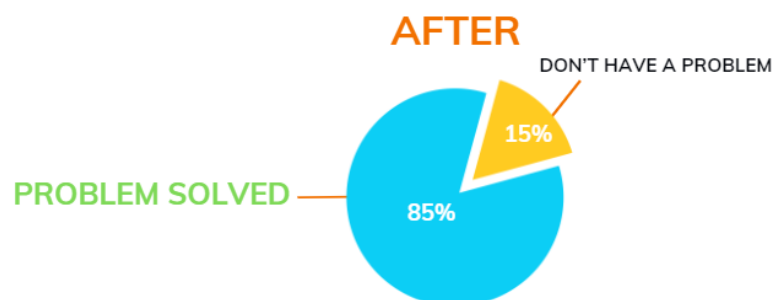
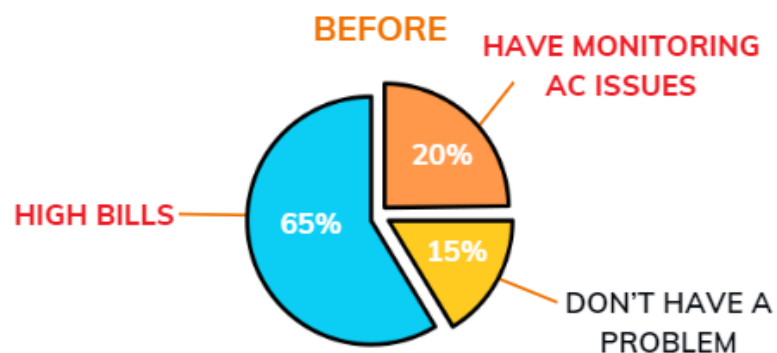
EMPATHIZE

- **Activities:**

- Conducted surveys with 13 potential users, including homeowners.
- Observed the behaviour of users interacting with existing thermostats to identify pain points such as:
 - Difficulty in adjusting settings.
 - Lack of energy-saving awareness.
 - Complex and unattractive interfaces.

- **Evidence:**

Survey results and summary charts showcasing common user complaints. Interviews showed that most people are having problems in this.



INTERVIEWS

QUESTION: “*What challenges do you face with your current thermostat?*”

Faisal 19 years old: *"My thermostat has failed many times to detect the temperature of the room, and it lacks energy saving features whereas by the end of the month I find out that my utility and electricity bills are high over the roof."*



QUESTION: “*What smart features would you find useful for thermostat?*”

Abdulahman 22 years old: *"The first one is, I want to check the temperature on my phone, and secondly, I want when the temperature reach a certain limit to close the air conditioning to save more energy thus making the bill amount less."*

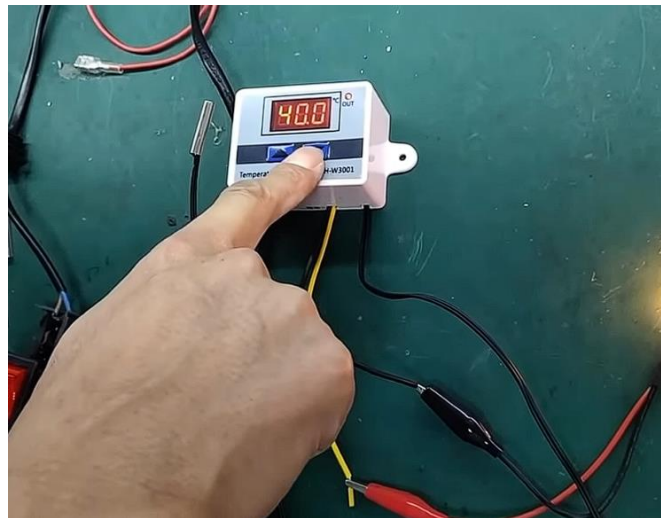


IDEATE

- Brainstormed over 10 ideas using tools like mind mapping.
- Narrowed down ideas based on feasibility, user impact, and innovation.

PROTOTYPE

We have collaborated with (ESCATEC Mechatronics Sdn Bhd) to help us developing our thermostat.



TEST

- Interface simplicity.
- Functionality of temperature adjustments and scheduling.
- Integration with simulated smart home environments.

REFLECTIONS

- a) What is your goal/dream with regard to your course/program?
- b) How does this design thinking impact on your goal/dream with regard to your program?
- c) What is the action/improvement/plan necessary for you to improve your potential in the industry?

AWWAB MOHAMMED ELHASSAN ABDALLA ISMAIL

- a) My goal is to become innovative and capable of creating smart and sustainable solutions that enhance energy efficiency and improve everyday life.
- b) Design thinking helps me focus on user needs and develop practical, innovative solutions, like the smart thermostat, which supports my goal of creating impactful technologies.
- c) I plan to build my technical skills, stay updated on trends, and work on team projects to enhance my industry readiness.

NAIF ABDULALEM SAIF AL-BAIDAH

- a) My goal After studying this course, I gained valuable knowledge, and my dream is to design a smart thermostat or create something innovative that helps make the world simpler and easier for everyone.
- b) Design thinking has helped me understand user needs and how to solve problems while improving solutions. It has given me many great ideas, allowing me to tackle challenges step by step. This aligns perfectly with my goal of creating useful and sustainable innovations in the industry.
- c) To improve my potential, I want to gain more experience and knowledge in IoT and energy management. I aim to enhance my teamwork and communication skills. While I've worked with my team, I believe I need more practical experience through internships and projects.

ALI KHALED SAEED BA YAAQOOB

- a) Focusing primarily on sustainable and energy efficient solutions, my main goal in pursuing this degree is to become an accomplished professional and designer in smart home technology with energy a few will be used to develop devices that increase comfort, and I hope will help make homes smarter, greener and easier to use I will. Combining technology, user-cantered design and environmental responsibility, work on projects such as smart thermostats is ideally suited for this purpose.**
- b) My attitude towards innovation and problem solving has been greatly influenced by my exposure to design thinking. I learned a lot about the needs of users by empathizing with them, like... like the need for reliable, energy efficient, and easy to carry home appliances will be used. I was able to test a variety of innovative solutions during the brainstorming and prototyping phase, making sure they worked and were realistic. In addition to strengthening my technical skills, this experience has highlighted the value of teamwork, flexibility, and critical thinking—skills essential to achieving my goal of owning a smart home in the face of other things.**
- c) I intend to do the following to improve my capabilities with smart home technology. Skills development: I plan to major or earn certificates in energy management, artificial intelligence (AI), and the Internet of Things (IoT) to improve my technical skills has been advanced. Industry engagement: To have a useful experience.**

AHMED ABDELHAFIZ ABDELRAHIM ABDELRAHMAN

- a) **My goal is to learn the skills and knowledge needed to succeed in my field. My dream is to become a skilled professional who can create meaningful solutions and make a positive impact.**
- b) **Design thinking helps me solve problems in creative and practical ways. It focuses on understanding users' needs, which is important for creating effective solutions and achieving my goals.**
- c) **To improve, I plan to:**
 - 1. Learn and practice new skills in my field.
 - 2. Work on real projects to gain experience.
 - 3. Build teamwork and communication skills.
 - 4. Use design thinking to create better solutions.
 - 5. Connect with professionals for guidance.

ABDULRAHMAN MOHAMED ELHADI OSMAN

- a) **To equip myself with understanding of computer networks and cybersecurity principles and having the ability to design implement and manage network systems and having the ability to respond to cyber threats.**
- b) **It helps me to have general idea about the subject and expand my horizon of thinking with this project.**
- c) **Strengthen my fundamentals.**
 - Use resources like online courses or certifications.**
 - Gain practical experience.**
 - Follow industry news to stay updated.**
 - Learning advanced security techniques.**
 - Get advice from professionals in the network industry.**

AHMAD MOHAMMAD MAZEN ALYASIN

- a) **My goal is to become a skilled innovator and problem-solver in the field of technology and engineering. Specifically, I aspire to design and develop impactful IoT solutions that not only address real-world challenges but also enhance user experiences. The smart thermostat project aligns perfectly with my dream as it combines all these elements—leveraging technology, addressing a meaningful challenge, and applying systematic approaches like Design Thinking to achieve practical outcomes.**
- b) **Design Thinking has had a profound impact on how I approach challenges within my program and beyond. By breaking the problem-solving process into Empathy, Define, Ideate, Prototype, and Test, I've learned to adopt a structured yet flexible mindset.**
- c) **To improve my potential and become more industry ready, I have identified several key actions and plans:**
- 1. Enhance Technical Skills:**
 - Gain deeper expertise in IoT technologies, including advanced programming for microcontrollers (e.g., ESP32, Raspberry Pi) and data analytics.
 - Learn more about machine learning algorithms to create smarter, more adaptive solutions.
 - Explore advanced tools for prototyping and system integration.
 - 2. Build a Strong Portfolio:**
 - Work on diverse projects, including smart home devices and automation systems, to showcase my problem-solving and technical capabilities.
 - Document projects like the smart thermostat with detailed case studies and visual representations for prospective employers.