

Smart Plant Irrigation System

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Smart Plant Irrigation System

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Introduction

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Introduction

The use of smart technologies has become increasingly common in everyday life, offering practical and affordable solutions to problems that previously required expensive or complex systems. Advances in embedded systems and microcontroller technology have made automation more accessible, allowing reliable control of sensors and electronic devices in a wide range of domestic applications. One area that has attracted growing interest is automated plant care, where environmental conditions can be monitored continuously to provide water and fan only when it is required, helping to improve plant health while reducing unnecessary water consumption.

Indoor plants are widely used in homes, offices and student accommodation because they improve the appearance of indoor spaces and contribute positively to wellbeing. However, maintaining healthy plants requires regular care, particularly consistent watering. Many people find it difficult to maintain this routine due to work commitments, university studies, holidays or other daily responsibilities. As a result, plants may receive too little or too much water, both of which can affect their long-term health and growth. Although commercial irrigation systems are available, they are often designed with advanced features that are unnecessary for users who only wish to care for a small number of indoor plants. For many domestic users, these systems are also more expensive than required for such a simple task [1].

This project proposes the development of a smart plant irrigation system for indoor plant care. The aim is to investigate how an affordable automated irrigation system can be developed using readily available hardware and embedded software technologies. Rather than attempting to compete with commercial products, the project focuses on demonstrating a practical proof of concept that provides reliable automatic watering for a single indoor plant.

The proposed prototype will be developed using an Arduino based control system together with a soil moisture sensor, relay module and miniature water pump. Before any physical implementation, the complete hardware configuration and control software have been designed and tested using Tinkercad simulation platform. This approach allows the functionality of the system to be evaluated, validated and refined within a virtual environment before moving to physical hardware [2].

To ensure that the project remains achievable within the available time and resources, the current proposal is intentionally limited to the automatic irrigation of a single indoor plant. Restricting the scope allows the core functionality of the system to be evaluated while providing a solid foundation for future development. Potential enhancements, including wireless communication, smartphone integration, cloud-based monitoring and support for multiple plants, have been identified as possible extensions beyond the scope of this proposal.

This research report presents the initial project proposal and outlines the research

undertaken during the planning stage. It begins by exploring creativity, innovation and idea generation before explaining the selection of the proposed project. The report then defines the project aim, objectives and research strategy, research methods, ethical considerations and data collection techniques that will support the successful development and evaluation of the proposed smart irrigation system.

Task 1

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1. Ideation & Mind Map

1. Ideation

The project idea was developed through a structured ideation process using a mind map to organize, compare and evaluate different computing related concepts. Instead of focusing immediately on a technical solution, the ideation process began by identifying real world problems that could potentially be addressed through computing technologies. Innovation involves transforming creative ideas into practical solutions that create value by addressing real world problems [3]. Several project ideas were evaluated based on their feasibility, potential impact and relevance to the Computing programme before selecting the Smart Plant Irrigation System as the most suitable concept for further development.

2. Mind Map

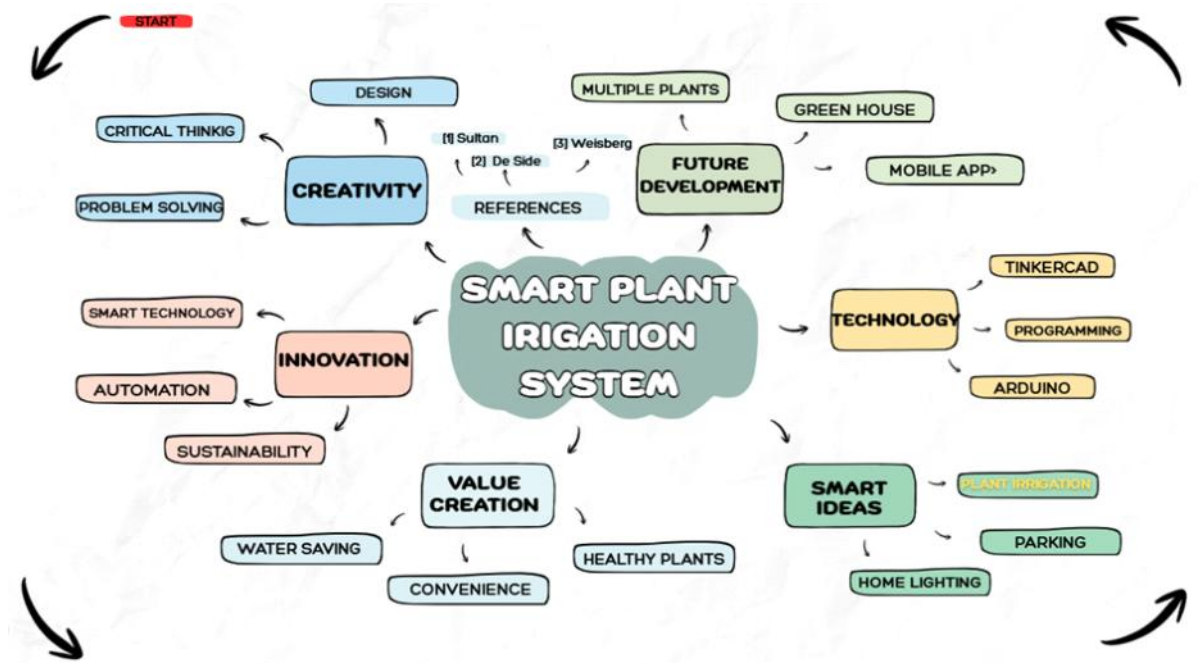


Figure 1. Mind Map

3. Ideation Analysis

The mind map illustrates the structured ideation process behind selecting this computing project. Instead of predetermining a specific technology, the initial phase prioritized identifying real-world problems that demand practical digital solutions. This problem first approach stimulated creative thinking and enabled the exploration of multiple concepts prior to assessing their feasibility and impact [4]. Evaluating several alternatives before deciding on a final concept minimized the risk of developing a technically complex solution with little practical utility. Rather than aiming to invent something entirely new, the goal was to adapt existing technologies into a simple, efficient, and meaningful solution. This methodical approach provided a transparent framework for comparing alternative ideas and selecting the concept that offered the optimal balance between practicality, value creation, and potential for future growth.

Several ideas emerged during brainstorming, including smart lighting, parking systems, waste management, and automated irrigation. Each was vetted for feasibility, value, complexity, and academic relevance. While alternative concepts required excessive infrastructure or fell out of scope, the Smart Plant Irrigation System provided the most balanced, practical solution to a daily problem. Its achievable scope perfectly merges software with hardware design, establishing a solid foundation for future development [4].

A technical evaluation also is considered the technologies required to make the vision of the project a reality. Embedded systems, microcontrollers and environmental sensors are the most appropriate technologies as they provide a good balance of reliability, cost and flexibility for small automation applications. By selecting these technologies, programming, circuit design, and hardware integration skills can be improved, meaning that the proposed solution will be realistic and achievable. Their use in current automation is an example that the project is based on existing technologies and can be used for everyday problems instead of complex and experimental solutions [5].

Proving practical value creation was crucial for selection of this project. The Smart Plant Irrigation System helps people who cannot look after their plants by using soil moisture data to automate watering processes. This simple system allows to make use of low-cost resources and results in better plant health, demonstrating how a simple computing application can be as effective as possible in terms of value creation [5]. Although the prototype was designed for one plant only, it has a very strong application potential to be implemented in the future in the home, educational, and small-scale agricultural context.

The mind map shows that our prototype should be viewed as the beginning of a wider concept rather than a full solution. Several future opportunities were

identified for this development such as wireless communication, smartphone integration, cloud connection and support for multiple plants in the development process which was not part of initial prototype. These were not part of the initial prototype to keep a realistic project scope in mind and to make sure that the proposed solution remains feasible with time and resources [3].

4. Project Idea

Following the ideation process and the evaluation of several alternative concepts, the Smart Plant Irrigation System was selected as the most suitable project to be developed throughout this proposal. This concept was chosen because it offers the most effective balance between technical feasibility, practical value and relevance to the Computing programmed. Unlike the alternative concepts, it can be realistically implemented within the available time and resources while providing opportunities to integrate programming, hardware and automation into a single prototype. Furthermore, it is practical application and potential for future expansion establish a strong foundation for continued development throughout the remaining stages of this project [5]. The proposed project delivers practical value by automating the plant watering process, reducing the need for continuous manual intervention while promoting healthier plant growth through more efficient water management. In addition to addressing a common everyday challenge, the concept provides a scalable foundation for future enhancements, enabling the system to evolve into a more advanced smart irrigation solution as new technologies are incorporated. Having established the project concept and justified the selection, following section defines the project scope, research strategy and objectives that will guide the design and development of the proposed system.

Task 2

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2. Aim & Objectives and Research area

1. Project Aim

To investigate the feasibility of developing a low-cost Smart Plant Irrigation System for indoor plant care through the design and simulation of an Arduino based prototype.

2. SMART Objectives

The following objectives have been developed using the SMART framework to ensure they are specific, measurable, achievable, relevant and time bound throughout the duration of this project [6].

- **S** - To review current literature on smart irrigation systems, embedded systems and soil moisture monitoring to establish the technical background for the project.
- **M** - To design an Arduino-based smart irrigation prototype using a soil moisture sensor, relay module and water pump suitable for a single indoor plant.
- **A** - To develop and simulate the proposed system in Tinkercad to verify its functionality before physical implementation.
- **R** - To evaluate the performance of the prototype by assessing its ability to activate irrigation only when the soil moisture level falls below the predefined threshold.
- **T** - To identify the limitations of the proposed prototype and recommend realistic improvements for future development, including wireless connectivity and support for multiple plants.

3. Research Philosophy

An applied research philosophy has been adopted for this project because it focuses on solving practical problems through the application of existing knowledge and technologies. This philosophy is appropriate as the project aims to design, simulate and evaluate a Smart Plant Irrigation System rather than develop new theoretical concepts. The research will combine a review of relevant academic literature with prototype design, simulation and evaluation to support informed design decisions and assess whether the proposed solution meets the project aim and objectives [7].

Consequently, the applied research approach provides a structured framework for developing and evaluating a practical embedded system prototype.

4. Search Tools

To ensure that the project is supported by reliable and relevant academic evidence, a structured literature search will be conducted using several recognized research databases. Google Scholar will be used to identify key publications and citation networks across the research area and provide access to peer-reviewed engineering research related to Arduino, embedded systems and automation. The literature will be selected according to its relevance to the project objectives, publication quality and contribution to the research area, including Boolean operators and keywords in selection criteria [8].

The search tools, databases and example search strings are presented in Appendix.

5. Search Strategy

A systematic literature search strategy was developed to ensure that the evidence used throughout this project is relevant, reliable and directly aligned with the research objectives [9]. Search terms including Smart Irrigation, Arduino Uno, Soil Moisture Sensor, Embedded Systems, Indoor Plant Monitoring and Internet of Things were identified from the project scope and combined using Boolean operators to improve search precision and reduce irrelevant results. Additional studies were identified through reference chaining by reviewing the reference lists of key publications. The retrieved literature was then critically evaluated according to its relevance, peer-review status, publication quality and contribution to the project objectives.

Examples of the Boolean search strings used are presented in Appendix.

6. Research Process

The overall research process adopted for this project is illustrated in Figure 2.



Figure 2. Research process adapted for proposed project

Task 3

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3. Research Strategies

1. Validity, Reliability, Generalisability and Ethical Considerations

The research will make several efforts to make the findings more credible. Validity will be helped by gathering data that is relevant to the project and comparing the prototype to the requirements. The reliability will be enhanced by using the same testing procedures and repeating key simulations. Because the prototype is designed for a single indoor plant, the idea can be generalized to other applications, and ethical considerations include voluntary participation in the pilot questionnaire, informed consent, anonymous responses and secure use of the collected data [10].

2. Research Strategy

An applied research strategy will be adopted to develop and evaluate the proposed Smart Plant Irrigation System. The study combines secondary research, through a review of academic literature, with primary research to collect user feedback. This approach supports informed design decisions while ensuring that the proposed solution is based on both theoretical knowledge and practical evidence [7].

3. Data Collection Method

Primary data will be collected using a short pilot questionnaire to gather feedback on participants plant care habits, awareness of smart irrigation systems and expectations of the proposed solution [11]. The findings will be used to refine the project requirements and support the design of the prototype.

The pilot questionnaire is presented in Appendix.

Link available online:

https://docs.google.com/forms/d/e/1FAIpQLSc00nLURZAV9aKQWp8VtKe-kTfkRotFYu57s_rRrILMVwILwg/viewform?usp=publish-editor

4. Pilot Data Collection

A pilot questionnaire was distributed to a small group of participants to evaluate the clarity and relevance of the proposed data collection method [11]. The pilot study aimed to gather initial feedback on plant care habits and opinions regarding the proposed Smart Plant Irrigation System before the main development stage. The responses helped identify areas where the questionnaire and project requirements could be refined, ensuring that the proposed solution better reflects potential user needs.

A summary of the pilot questionnaire results is presented in Appendix.

5. Quantitative and Qualitative Analysis

Quantitative analysis uses numerical data to identify patterns through descriptive statistics such as frequencies and percentages. Qualitative analysis examines non-numerical data by using thematic coding to identify common themes and opinions [8]. In this project, quantitative analysis will be applied to the closed-ended questionnaire responses, while qualitative analysis will be used to evaluate the open-ended feedback collected during the pilot study [12].

A summary of the results Excel is presented in Appendix.

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- [9] A. Booth, A. Sutton, M. Clowes, and M. Martyn-St James, *Systematic approaches to a successful literature review*, Third edition. London: SAGE Publications Ltd, 2023.
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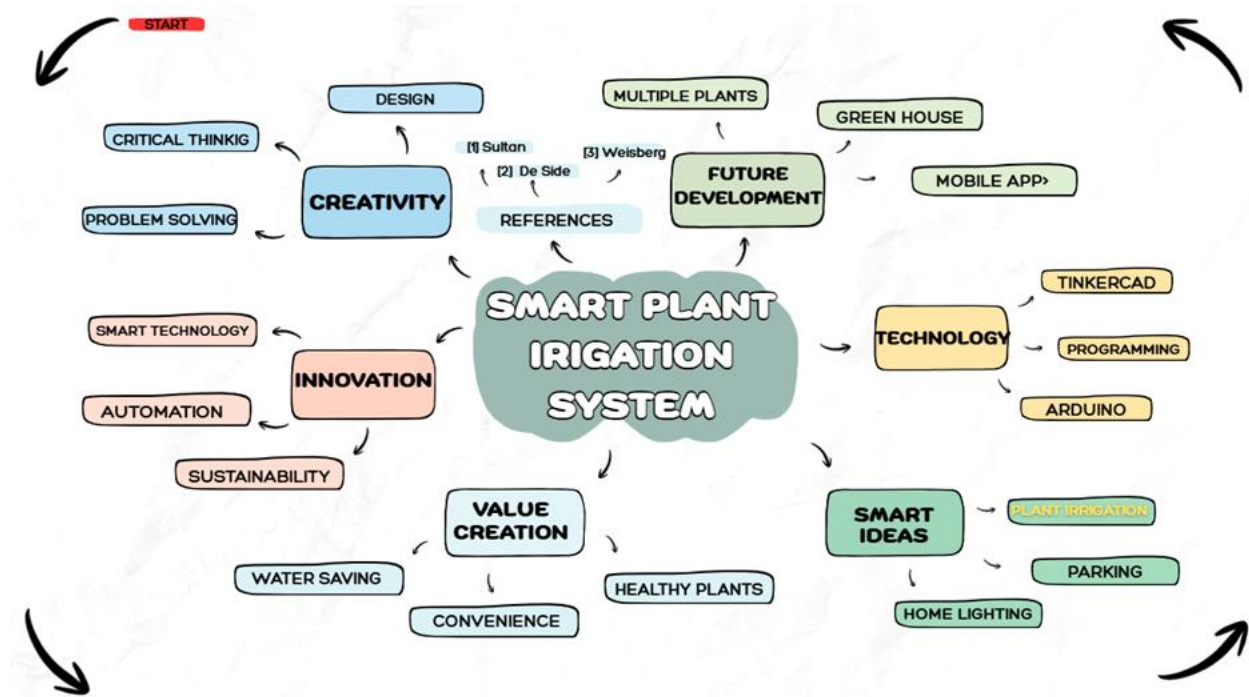
Appendix

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Appendix

1. Mind Map



2. Research Databases

Database	Reason for Selection	Example Search String
Google Scholar	Broad academic literature and citation tracking	Smart Irrigation AND Arduino
UWTSD Library	Engineering and embedded systems research	Arduino OR Irrigation

3. Boolean Search Strings- literature

- Smart Irrigation AND Arduino
- Arduino Uno AND Soil Moisture Sensor
- Embedded Systems OR Irrigation

4. Research Process



5. Pilot questionnaire

Link available online:

https://docs.google.com/forms/d/e/1FAIpQLSc00nLURZAV9aKQWp8VtKe-kTfkRotFYu57s_rRrILMVwILwg/viewform?usp=publish-editor

Smart Plant Irrigation System

This questionnaire aims to collect feedback on plant-care habits and opinions regarding a proposed Smart Plant Irrigation System. Participation is voluntary and anonymous. The information collected will be used for academic research purposes only.

* Indicã o întrebare obligatorie

Do you currently own any indoor plants? *

☐ Yes

☐ No

How often do you water your indoor plants? *

☐ Daily

How often do you water your indoor plants? *

- ☐ Daily
- ☐ Every 2-3 days
- ☐ Once a week
- ☐ Only when I remember

Have you ever forgotten to water your indoor plants? *

- ☐ Yes
- ☐ No
- ☐ Maybe

How useful would an automatic Smart Plant Irrigation System be for you? *

- ☐ Very useful
- ☐ Useful
- ☐ Neutral
- ☐ Not useful

Which features would you consider most valuable? (Select all that apply.) *

- ☐ Automatic watering
- ☐ Soil moisture monitoring
- ☐ Water level notifications
- ☐ Mobile App integration
- ☐ Water-saving functionality

Would you consider using an affordable Smart Plant Irrigation System? *

- ☐ Yes
- ☐ No
- ☐ Maybe

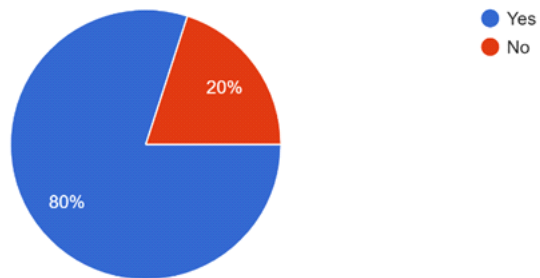
Please provide any suggestions that could improve the proposed Smart Plant Irrigation System. *

Răspunsul tău

6. Data Collection

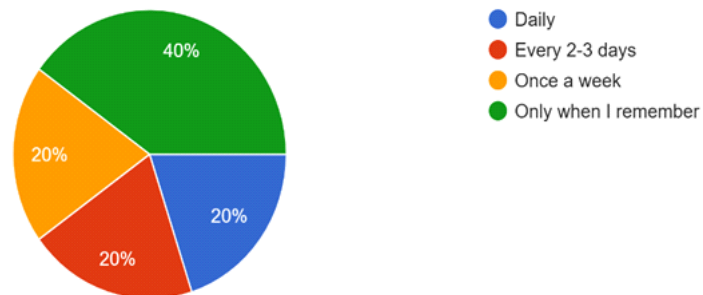
Do you currently own any indoor plants?

5 răspunsuri



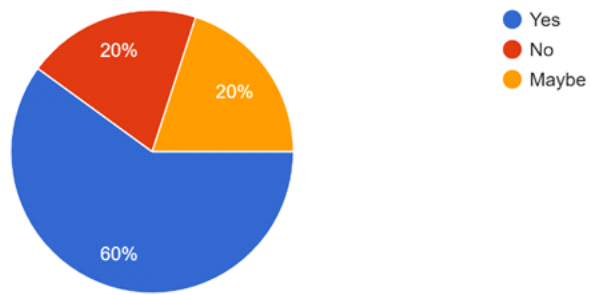
How often do you water your indoor plants?

5 răspunsuri



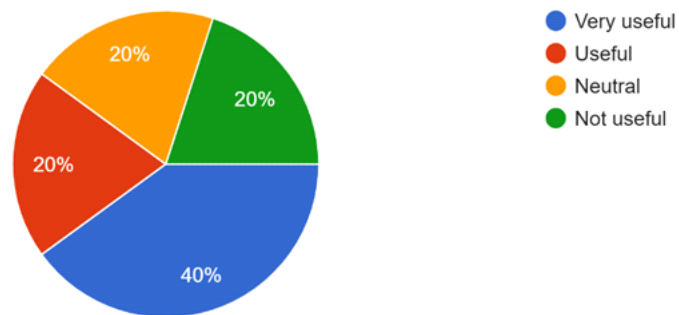
Have you ever forgotten to water your indoor plants?

5 răspunsuri



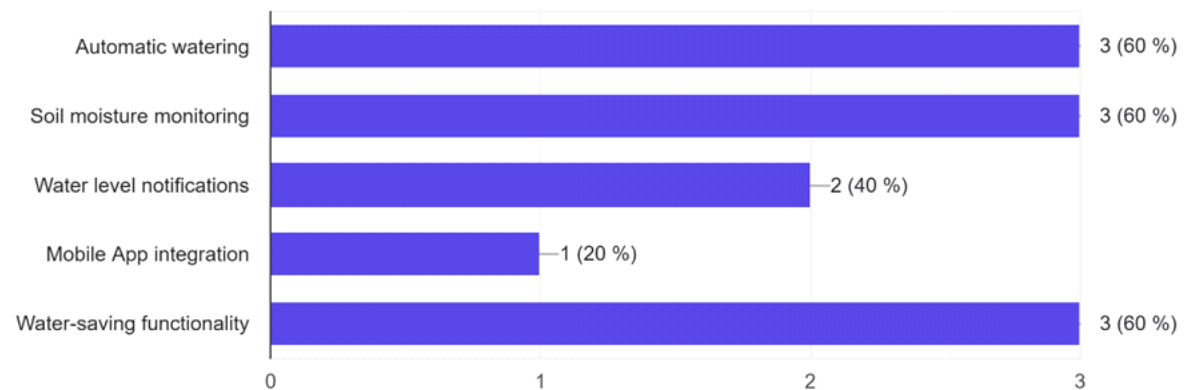
How useful would an automatic Smart Plant Irrigation System be for you?

5 răspunsuri



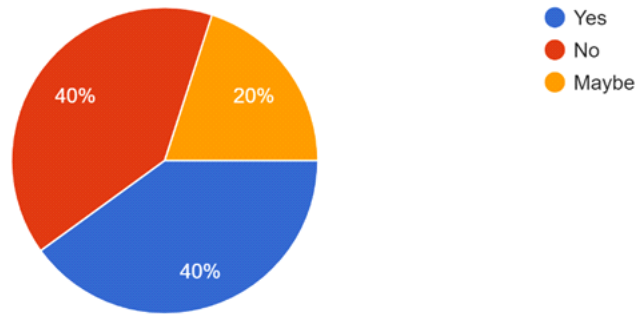
Which features would you consider most valuable? (Select all that apply.)

5 răspunsuri



Would you consider using an affordable Smart Plant Irrigation System?

5 răspunsuri

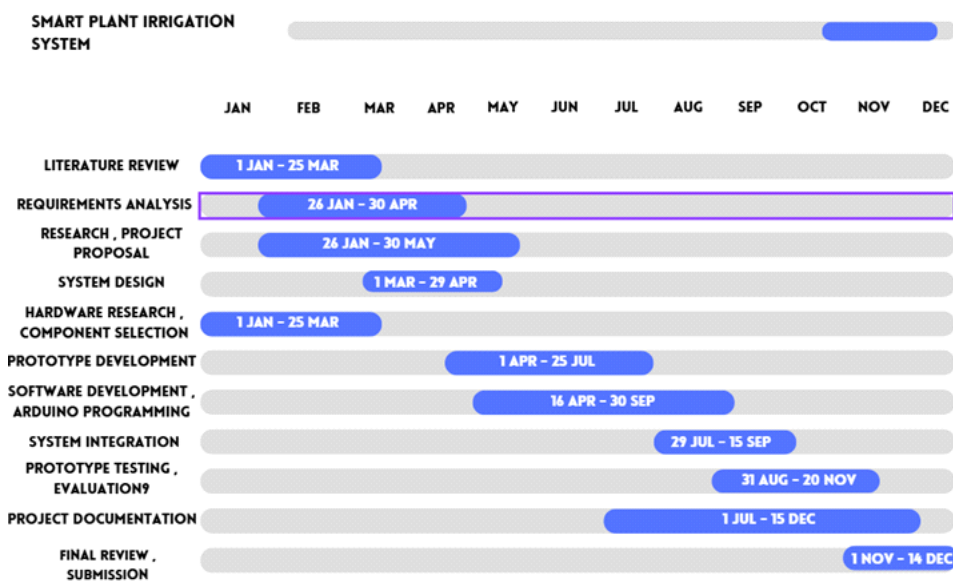


	B	C	D	E	F	G
	Do you currently own any indoor plants?	How often do you water your indoor plants?	Have you ever forgotten to water your indoor plants?	How useful would an automatic Smart Plant Irrigation System be?	Which features would you consider most valuable?	Would you consider using an affordable Smart Plant Irrigation System?
Yes	Yes	Daily	Yes	Very useful	Automatic watering	Yes
Yes	Yes	Every 2-3 days	No	Useful	Soil moisture monitoring, Water level notifications	No
No	No	Only when I remember	Yes	Not useful	Water-saving functionality	No
Yes	Yes	Once a week	Maybe	Neutral	Automatic watering, Soil moisture monitoring, Water level notifications	Maybe
Yes	Yes	Only when I remember	Yes	Very useful	Automatic watering, Soil moisture monitoring, Water level notifications	Yes

7. Qualitative Data Analysis

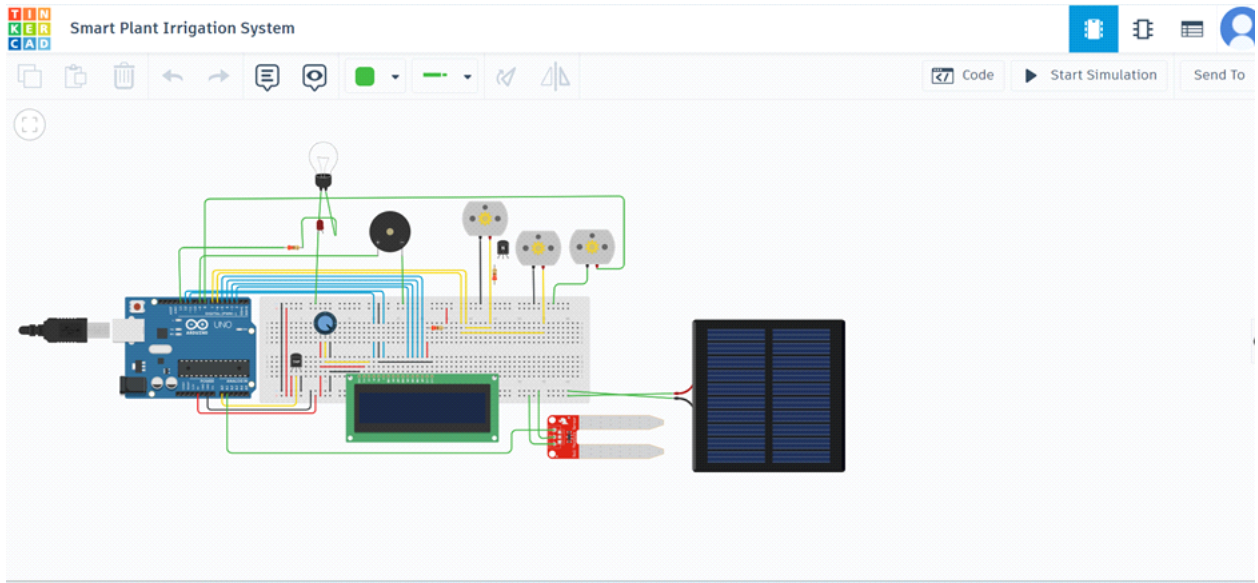
	A	B	C	D
1	Participant	Response	Initial Code	Theme
2	P1	Mobile app	Mobile App	Smart Features
3	P2	Notifications	Notifications	Smart Features
4	P3	Save water	Water Saving	Sustainability
5	P4	Easy to install	Ease of Use	Usability
6	P5	Affordable	Low Cost	Affordability

8. Gantt Chart



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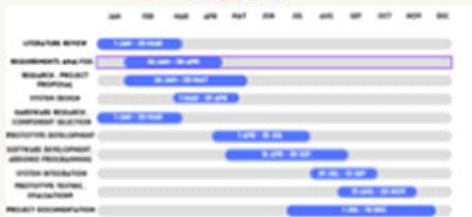
9. Tinkercad design-based Arduino



10. Poster

SMART PLANT IRRIGATION SYSTEM

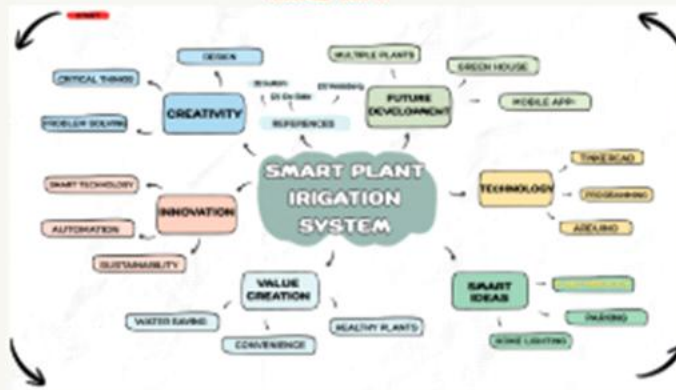
GANNT CHART



SMART OBJECTIVES:

- DESIGN THE IRRIGATION SYSTEM.
- DEVELOP THE PROTOTYPE.
- TEST AND EVALUATE PERFORMANCE.
- ANALYSE USER FEEDBACK.
- IMPROVE WATER EFFICIENCY.

MIND-MAP



AIM:



TO DESIGN, DEVELOP AND EVALUATE A LOW-COST SMART PLANT IRRIGATION SYSTEM USING ARDUINO TECHNOLOGY.

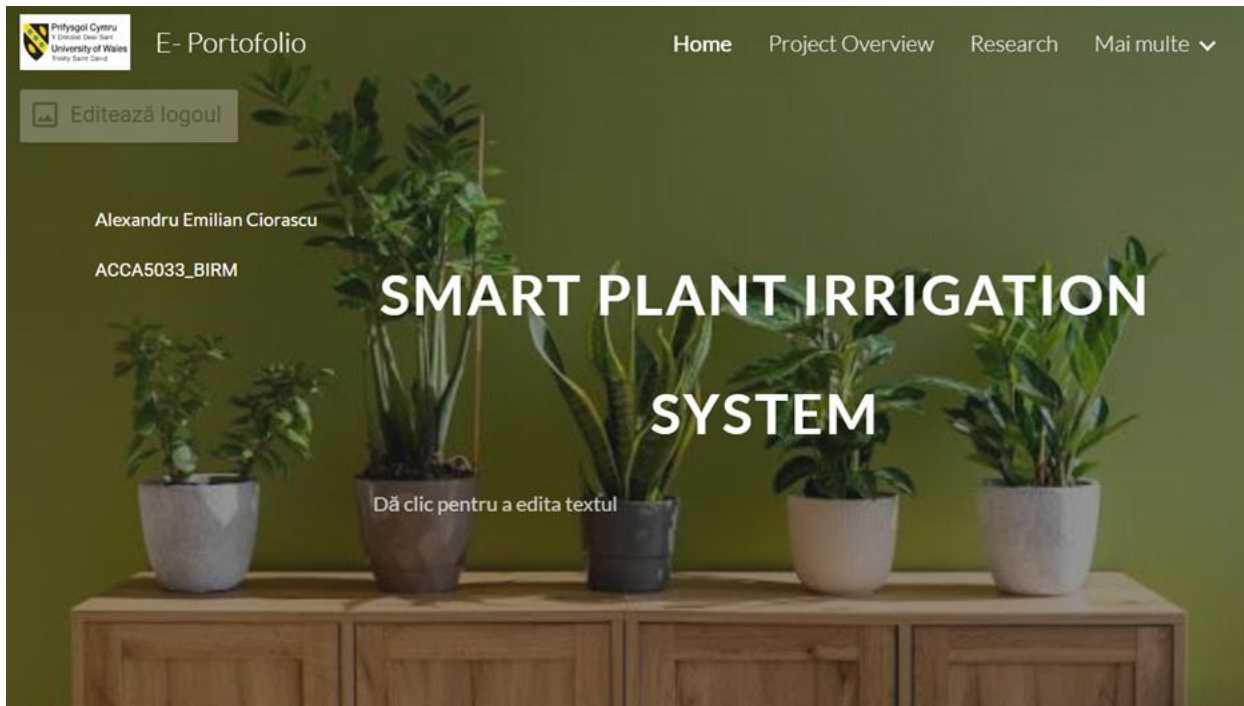
REFERENCES:

- BJERKE & RINGER (2017)
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- PRESSER (2004)

EXPECTED OUTCOMES:

- AUTOMATED PLANT WATERING
- REDUCED WATER CONSUMPTION
- REAL-TIME SOIL MOISTURE MONITORING
- LOW-COST ARDUINO-BASED SOLUTION

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Link available online: <https://sites.google.com/view/smart-plant-irrigation-system/home>