SRI LANKA INSTITUTE OF INFORMATION

TECHNOLOGY

Department of CIVIL Engineering

CE1913-Introduction to Sustainable Engineering

Smart Rainwater Harvesting System For Urban Area

Group 01

Continuous Assessment Cover Sheet
Faculty of Engineering

Module Details			
Module Code	CE1913	**Module Title**	Introduction to Sustainable Introduction
Program: SLIIT		**Course: BSc (Hons) Engineering**	
Stream: Common			

Assessment details			
Title	Preparation of a report covering tasks 4, 5, and 6.	**Group assignment**	**YES**
		If yes, Group No.	01
Lecturer/ Instructor	Prof. Shiromi Chandanika Karunaratne / Mr. Nafees Mohammed	**Date of Performance**	

Student statement and signature

By this declaration, I/we confirm my/our understanding and acceptance that the work reported in this report is my/our own work. I/we also understand the consequences of engaging in plagiarism or copying others work without proper citation. Any material used in this work (whether from published sources, the internet or elsewhere) have been fully acknowledged and referenced and are without fabrication or falsification of data.
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By this declaration, I/we confirm my understanding and acceptance that-

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Details of the student/s submitting the assignment

ID Number	Name (As per the institute records)	Signature
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EN25300076	Gunarathna M.R.S	[illegible]
EN25300070	M.A Sheron	[illegible]
EN25102324	P. Kowarthana	[illegible]
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Receiving Officer (seal, signature, date)	Specific comments about the work (including overall comments and guidelines for improvement)
	Tutor: Signature: Date:
	Marks: [All marks are subject to external moderation and approval of board of examinations]

Sri Lanka Institute of Information Technology

Department of Civil Engineering

CE1913 Introduction to Sustainable Engineering

D5-Evaluation form- Report

Project title	Smart rainwater harvesting system for urban use		
Group number	01	**Name of the Mentor**	Mr. Nafees Mohammed
	Vithana N.K(Leader)		
Gunarathna M.R.S		M.A Sheron	
P. Kowarthana		Hatharasinghe S.D	
Wijesinghe U.M.P.D			
Marks (out of 100)			
Comments			

This rubric is designed to assess three key components of a student report. Each section is evaluated based on clearly defined performance levels, with a maximum total of 45 marks.

Criteria	Excellent (13-15)	Good (9 to 12)	Needs Improvement (0-8)	Marks
4. Proposed Solutions & Justification (15 marks)	• Three wellarticulated, context-relevant solutions addressing people, environment, and economy. • Strong benchmarking with literature and global practices. • Sound justification for selected best option.	• Three relevant solutions with some discussion on impact. • Limited literature support or weak benchmarking. • Best option identified but justification may lack depth.	• Less than 3 solutions; weak relevance. • No benchmarking or literature support. • Poor or absent justification for the best option.	/15
5. Sketches and Drawings (15 marks)	• Clear, scaled drawings with plans, elevations, and at least one perspective view. • Proper use of 3D software tools. • Scale information clearly stated and accurate.	• Some drawings missing or not scaled properly. • Minor issues in clarity or completeness. • Perspective drawing present but not well executed.	• Drawings poorly done or missing. • Scale not mentioned or inaccurate. • Perspective missing or not understandable.	/15
6. Resources Identification & Categorization (15 marks)	a) Comprehensive list of materials. b) Clear categorization of material resources into renewable and nonrenewable.	a) Adequate but not complete resource listing. b) Categorization attempted but with some errors or omissions.	a) Incomplete or unclear resource identification. b) No or incorrect categorization of materials.	15

Member Declaration:

ID No.	Name	Contribution
EN25103423	Vithana N.K(Leader)	**Led the group, coordinated all project activities, allocated tasks to each member, managed them, and assisted in report writing, proofreading, and final editing of the report writing**
EN25300076	Gunarathna M.R.S	**Designed the IoT based control system, circuit diagram, block diagram explanation, and assisted in background study on rainwater harvesting systems, identifying materials, making cost estimation table and took the lead report writing**
EN25300070	M.A Sheron	**Explained rainwater collection, distribution and storage process, assisted in making 3d sketches, circuit diagram, made sure our rainwater harvesting system accomplishes required SDG goals**
EN25102324	P. Kowarthana	**Took the lead in presentation, contributed to risk analysis, limitations and analyzed the economic, social, and environmental impacts, assisted in making stakeholder benefits and proofreading**
EN25300578	Hatharasinghe S.D	**Prepared 3d sketch, assisted in making stakeholder impacts, proposing and comparing the proposed solutions, helped in report writing**
EN25300064	Wijesinghe U.M.P.D	**Went through background research on rainwater harvesting systems, prepared the cost estimation table, proposed solutions, assisted in identifying materials, explaining the collection, storage, and distribution process, and proofreading**

01. Executive Summary:

Urban areas commonly experience both droughts and floods due to major reasons like poor rainwater management, inefficient traditional rainwater harvesting systems, and inadequate drainage infrastructure. Most conventional systems rely on manual operation, lack real-time monitoring, and often result in wastage of water, poor quality control, and high costs. These issues highlight the need for a smart and sustainable solution to manage urban water.

This project focuses on a Smart IoT-Based Rainwater Harvesting System designed specifically for urban environments. According to our design, rainwater is collected from rooftop gutters and conveyed through downpipes, where a first-flush diverter removes the initial contaminants. The water is then filtered using a sand and gravel filter before being stored in an underground concrete tank. Excess rainwater is safely discharged through an overflow pipe, helping to reduce urban flooding.

The water stored is used for non-potable household applications such as toilet flushing, gardening, and cleaning, reducing the need for treated municipal water. The system integrates IoT sensors, an ESP32 controller, and smart valves to monitor rainfall, water level, flow rate, and system status in real time. Automated control and remote monitoring increase efficiency and reduce the need for manual operation.

Key stakeholders of this project include urban households, local authorities, engineers, technicians, and the environment. Overall, the proposed system is technically feasible, environmentally sustainable, and economically beneficial, making it a practical solution for modern urban water management.

02. Proposed Solutions :

Features	Structure 01	Structure 02	Structure 03
Collecting Rainwater	Rainwater catchment	Smart gutter system	Smart gutter system
Store Rainwater	Rooftop tank	Underground tank	Modular plastic tank
Purify Rainwater	Solar water disinfecti on	Sand and gravel Filter system	Activated carbon filters
Clean water collecting surface	Manual cleaning schedule	First flush method	Automated spri nkler cleaning system
Measure/control the tank water level	Ball valve	Using IoT sensors	Ultrasonic sensor system
Predict weather	Weather forecasting sensors	Analysing online w eather predictions	Dew Point / Condensation-Based Weather

			Prediction Method.

Numbers	Evaluation criteria	Weight (%)	Solution 1	Solution 2	Solution 3
1	Environmentally impact	15	0.8	0.9	0.8
2	Economic feasibility	15	0.9	0.9	0.5
3	Social impact	15	0.9	0.9	0.9
4	Technical feasibility and practicality	15	0.2	0.8	0.8
5	Safety and accessibility	10	0.4	0.9	0.6
6	Innovative approach	5	0.7	0.7	0.8
7	Sustainable materials and resources	10	0.2	0.4	0.1
8	Energy efficiency	15	0.7	0.7	0.5

Among the 3 solutions we choose solution 2 because it achieved the highest overall score on evaluation criteria.

1. **Collecting Rainwater –**
   - Rainwater catchment

     When it rains, it serves as a surface to collect raindrops. It can be fastened to a building's roof.
   - Smart Gutter system

     Raindrops are collected and sent to the tank via a gutter system. When the tank water level is about to exceed, it can divert the water flow to the ground.
2. **Store Rainwater –**
   - Underground tank

     Using a sealed water tank that is made from concrete
   - Rooftop tank

     This is a tank attached to the building rooftop.
   - Modular plastic tank

     Sealed, high-durable plastic tanks.
3. **Purify Rainwater –**
   - Solar water disinfection

     Using a UV sterilization system to kill bacteria and algae.
   - Sand and Gravel filter system

     Let the collected rainwater flow through the chambers, which are filled with sand and gravel.
   - Activated carbon filters

     Using active carbon (charcoal) for filtration.
4. **Clean water collecting surface -**
   - Manual cleaning schedule

Cleaning the surface by maintenance staff regularly.

- First flush method

  Cleaning the water-collecting surface using rainwater at the beginning of the rain.
- Automated sprinkler cleaning system

5. **Measure / control the tank water level –**
   - Ball valve

     Attach the ball valve to prevent an overflowing tank.
   - Using IoT sensors

     Get real-time water level data using integrated IoT sensors.
   - Ultrasonic sensor system using and measure the water level using ultrasonic technology**.**

6. **Predict weather –**
   - Weather forecasting sensors

     Gather data from own sensors and analysing data and predict weather using that data.
   - Analysing online weather predictions

     Forecasting weather by analysing data from online sources.
   - Dew Point / Condensation-Based Weather Prediction Method

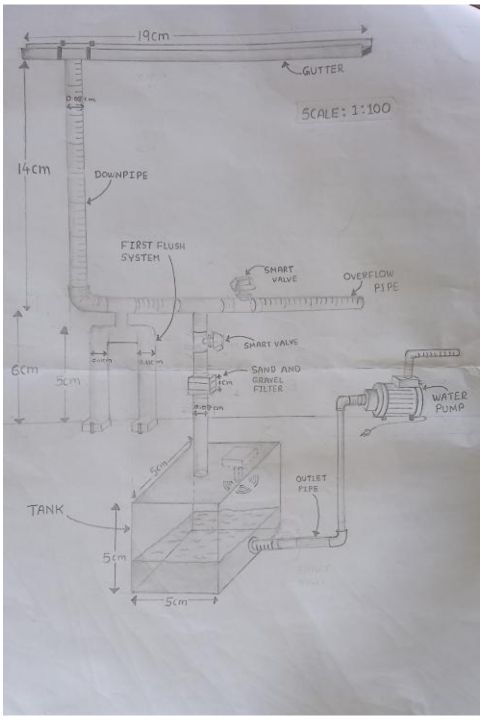
     Observing the relationship between the air temperature and the dew point to forecast specific events like fog, clouds, and potential for severe weather**.**
7. **Distribute stored rainwater**
   - Water pumping system

     Distribute stored rainwater using a water pump.
   - Gravity-fed distribution system

     Distribute stored water using gravitational force.
   - Smart valve system

03. The sketches and the 3d design (Task 5)

The sketch



04. Materials and Resources Used(Task 06) :

List of Materials, Human, and Financial Resources :

Materials	**Human Resources**	**Financial Resources**
Cement (tank)	Civil engineer	Tank cost

PVC pipes and connectors	Plumber/technician	Material cost
Sand and gravel (filter)	IOT developer	Labor cost
IOT sensors	Labor for installation	Maintenance cost
Smart valves		
Wiring and control units		

Cost Estimation Table

ITEM	Quantity	Unit Cost	Total Cost (LKR)
Gutters(S-LON)	2	1900	3800
PVC pipes (S-LON DOWN PIPE,3.5in)	6	1150	6900
PVC pipes (S-LON DOWN PIPE,4.5in)	4	1500	6000
Smart valve	3	5000	15000
Wires and data transfer cables			4000
IOT sensors			10000
Sand and gravel filter	1	3500	3500
Labor			60000
Smart water flow divider	1		15000
Cement	32	1850	59200
SAND (with transport)	3 cube	35000	105000
Aggregate (with transport)	6cube	20000	120000
Construction Steel (12m m)	170	1300	221000
mini excavators' foe 5 ho urs		10000 (for 1 hour)	50000
Others			15000
TOTAL			

Renewable Material	**Non-renewable Material**
Sand	Cement
Aggregate	PVC pipes
Gravel	Electronic sensors
Aggregate	Construction steels
	Smart valves
	Gutters

Table 5. materials to be used and their rough costs

06.Smart System Description:

6.1.WHY IOT SYSTEM IS USED IN THIS PROJECT:

The Internet of Things (IoT) enables physical devices to collect data, communicate, and take decisions without human intervention. In a rainwater harvesting system, conditions such as rainfall intensity, tank water level, and water usage change continuously. IoT allows real-time monitoring and automatic decision-making, which is not possible with traditional systems.

1. Problems in Traditional Rainwater Harvesting:
    - Manual valve operation
    - No real-time water level information
    - Overflow and water wastage
    - No remote monitoring
    - Poor water quality control
2. Advantages of Using IoT:
    - Auto control valve and pump
    - monitoring using sensors
    - Real-time data access using mobile application
    - Reduced human effort
    - Improved water conservation and management

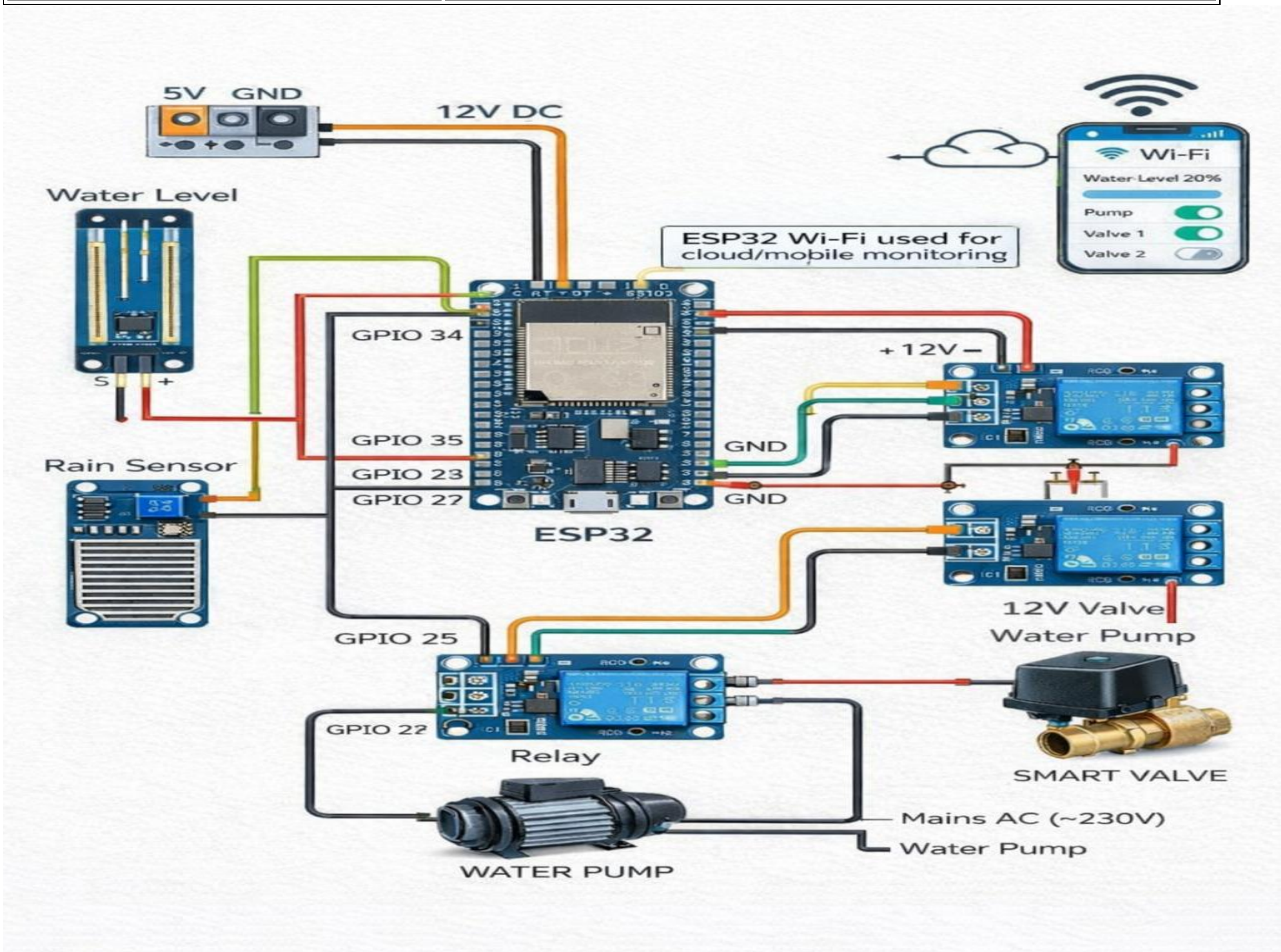
6.2. Block Diagram Explanation:

The rain sensor serves as the main source of environmental input data. This device can measure both the amount and intensity of rainfall and provide an electronic signal that will indicate how much moisture there is. The ESP32 microcontroller will process this information as it becomes available. At the same time, the water level sensor will be continually measuring the amount of water in the tank and transferring the data to the controller. The ESP32 microcontroller is the main device (Brain) of the system. It receives and processes input from the rain sensor and water level sensor using control logic based on inputs from sensors. Depending on how much rain falls and how full the tank is, the ESP32 will control relay modules that power the high-power actuators. This includes both solenoid valves and water pumps, which will work together to control the influx of rainwater, store it in the tank, and distribute the stored water while also preventing overflow and dry running. Finally, the built-in Wi-Fi module of the ESP32 will send data about the system operations to the mobile app. This real-time monitoring of the operational data will include the status of rainfall, the water level of the tank, and the state of the actuators. This feature allows you to access remote system monitoring and performance tracking, both of which increase the future reliability and sustainability of the rainwater harvesting system.

6.3. Circuit Diagram:

Below shows the circuit diagram of the Smart IoT-based Rainwater Harvesting System. The diagram shows electrical connections between sensors, ESP32, relay modules, smart valve, and water pump

Equipment	ESP32 Pin
Rain Sensor Output	GPIO **27**
Water Level Sensor	GPIO **34** (ADC)
Relay 1 (Valve)	GPIO **25**
Relay 2 (Pump)	GPIO **26**
5V Supply	5V
Ground	GND



07.Risk Analysis and Limitations:

Risk	Impact	Mitigation
Sensor Failure	Incorrect mesurement	Countinuos measurement
Power Failure	System Downtime	Battery/solar using
Maintain issues	Reduced Efficiency	Scheduled insepection

Limitation:

- Project depends on electrical power
- Initial setup cost
- Requires basic maintenance

08. References

[1] Carollo, M., Butera, I. and Revelli, R. (2022a) 'Water savings and urban storm water management: Evaluation of the potentiality of rainwater harvesting systems from the building to the city scale', *PLOS ONE*, 17(11). doi: 10.1371/journal.pone.0278107.
[2] Oberascher, M. *et al.* (2021) 'Revealing the challenges of smart rainwater harvesting for integrated and digital resilience of Urban Water Infrastructure', *Water*, 13(14), p. 1902. doi:10.3390/w13141902.
[3] Shetty, N. *et al.* (2022) 'Examining how a smart rainwater harvesting system connected to a green roof can improve urban stormwater management', *Water*, 14(14), p. 2216. doi:10.3390/w14142216.
[4] Alvarez, A.N., Flores-De-la-Mota, I. and Anguiano, F.I. (2024) 'Smart rainwater harvesting service design', *Procedia Computer Science*, 232, pp. 465–472. doi:10.1016/j.procs.2024.01.046.
[5] Judeh, T., Shahrour, I. and Comair, F. (2022) 'Smart rainwater harvesting for sustainable potable water supply in arid and semi-arid areas', *Sustainability*, 14(15), p. 9271. doi:10.3390/su14159271.