	IT4010 – Research Project - 2024
SLIIT UNI THE KNOWLEDGE UNIVERSITY	**Topic Assessment Form**

Project ID:

24-25J-222

1. Topic (12 words max)

Home Energy Management System

2. Research group the project belongs to

Software Systems & Technologies (SST)

3. Research area the project belongs to

Smart Systems (SS)

4. If a continuation of a previous project:

Project ID	-
Year	-

5. Brief description of the research problem including references.

Residential energy consumption has become challenging as urban energy demand grows. Traditional energy management is inefficient, leading to unnecessary electricity, water, fire, and gas consumption. As a result of this inefficiency, natural resources are consumed and the environment is degraded. For that problem, decide to develop an integrate Home Energy Management System that monitors and manages energy components.

Gas and Fire Consumption: Gas and fire usage inefficiencies also pose significant challenges. Unmonitored gas-powered and fire-based appliances, such as stoves, heaters, fireplaces, and other devices, can create safety hazards and escalate consumption costs. These appliances necessitate careful monitoring to guarantee safe and efficient operation, ensuring optimal usage and minimizing risks. [3].

Water Consumption: Water usage management and wastage at home is another critical issue. Leaks in plumbing systems can remain undetected for extended periods, leading to significant water loss. Additionally, outdated appliances and inefficient usage practices, such as leaving taps running, further contribute to the problem [1].

Electricity Consumption: Households often exhibit inefficient use of electrical appliances, with devices left running even when not needed. Common examples include lights in unoccupied rooms and HVAC systems operating at full capacity irrespective of occupancy levels. This behavior contributes to substantial energy wastage, which could be mitigated through smarter energy management solutions [4].

Integration of Smart Technologies: The integration of smart home technologies with Artificial Intelligence (AI) offers a promising solution to these issues [1]. AI can monitor and analyze energy consumption patterns, providing insights and automated control to reduce wastage and optimize usage. And also can use prediction models to energy components. This part of the system

integrate all sensors, actuators, and smart appliances into a single control unit. Develop BlackBox as a software to store data, to provide actionable insights and recommendations based on data analysis [2].

References

[1] Y. Wang, Q. Chen, T. Hong and C. Kang, "Review of smart meter data analytics: Applications, methodologies, and challenges," vol. vol. 7, no. IEEE Access, pp. 34815-34832, 2019.

[2] M. Kuzlu, M. Pipattanasomporn and S. Rahman, "Communication network requirements for major smart grid applications in HAN, NAN and WAN," *Computer Networks,* vol. 67, pp. 74-88, 2014.

[3] A. Anvari-Moghaddam, H. Monsef and A. Rahimi-Kian, "Optimal smart home energy management considering energy saving and a comfortable lifestyle," *Transactions on Smart Grid,* vol. 6 no. 1, pp. 324-332, 2015.

[4] S. Firth, K. Lomas, A. Wright and R. Wall, "Identifying trends in the use of domestic appliances from household electricity consumption measurements," *Energy and Buildings,* Vols. 40, no. 5, pp. 926-936, 2008.

6. Brief description of the nature of the solution including a conceptual diagram

The proposed solution is an AI-powered smart home energy management system designed to optimize the consumption of electricity, water, and gas. This system integrates various smart devices and sensors to monitor and control energy usage in real-time.

Components:
1. **AI Controller:** Central processing unit that analyzes data and makes decisions to optimize energy consumption.
2. **Electricity Management:** Smart plugs, lighting controls, and HVAC management systems to reduce unnecessary electrical usage.
3. **Water Management:** Smart meters, leak detectors, and automated shut-off valves to optimize water usage and prevent wastage.
4. **Fire & Gas Management:** Gas leak detectors and smart meters to monitor and control gas consumption safely and efficiently voice controlling fire control system.
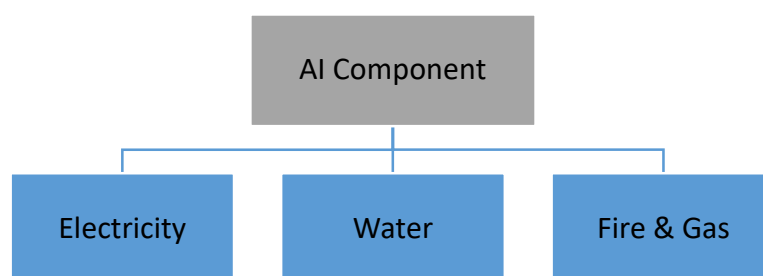
The AI controller communicates with the electricity, water, and fire & gas management modules, processing data from sensors and smart devices to optimize usage patterns.
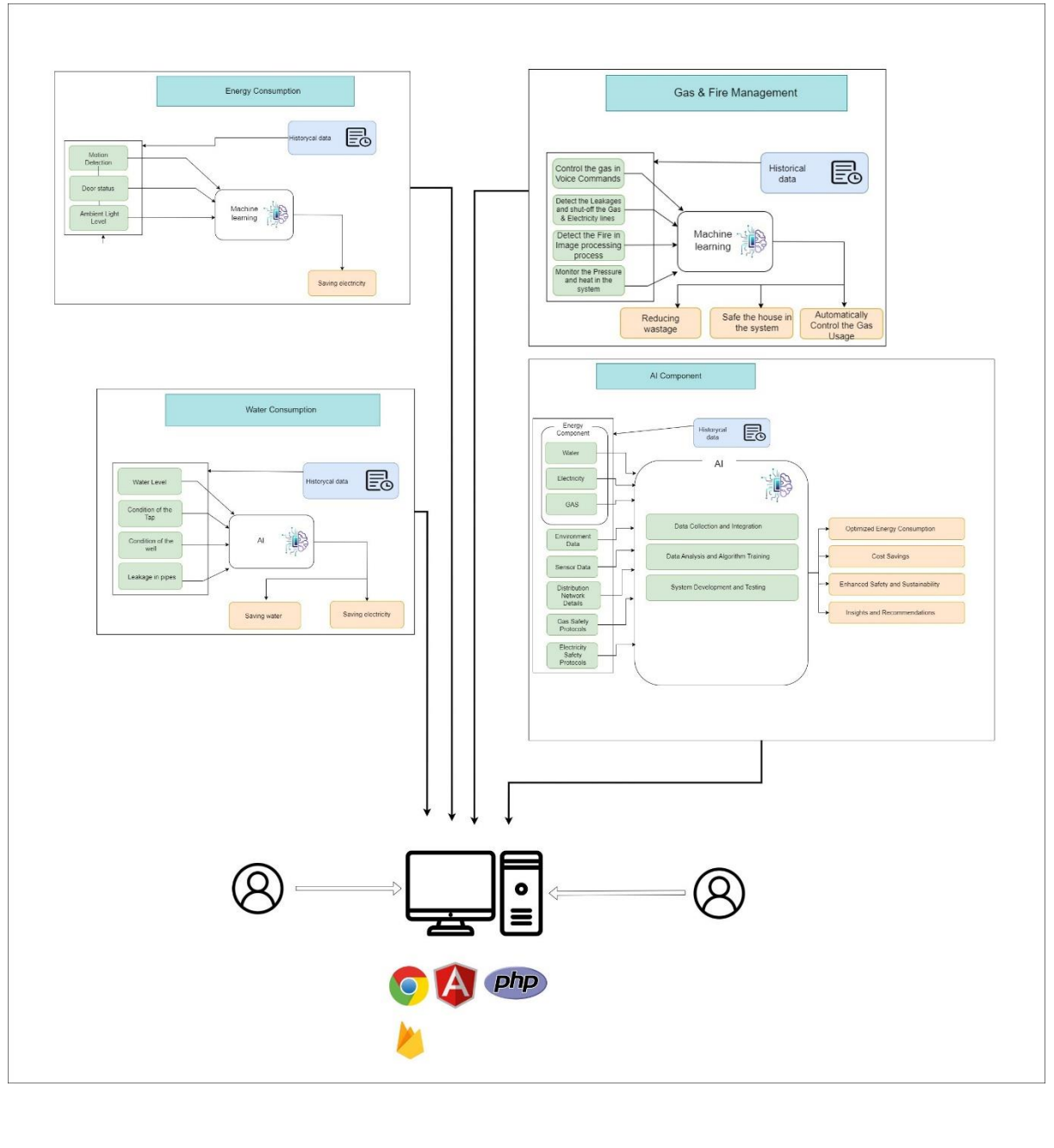
7. Brief description of specialized domain expertise, knowledge, and data requirements

Firstly, considering the entire research topic and the development of the smart home energy management system, we must acquire comprehensive datasets on energy consumption, which includes electricity, water, and fire and gas usage. To achieve this, we need to collaborate with utility companies and relevant governmental bodies to obtain historical and real-time data on household energy consumption patterns. This collaboration will also provide access to statistical details and survey data on energy usage across various regions, ensuring our system can be adapted to different environments.

For the AI and machine learning aspects of our project, it is essential to have access to detailed consumption patterns to train our algorithms. This will involve collecting data from smart meters, temperature and humidity sensors, and occupancy sensors. Therefore, we will need to work closely with IOT hardware manufacturers and suppliers to integrate these devices into our system effectively.

Moreover, in the area of plumbing and water systems, we require expertise in water distribution networks and leak detection technologies. To gather the necessary data and technical knowledge, we will engage with plumbing professionals and water management authorities. This collaboration will help us implement smart water meters and automated control systems efficiently.

Regarding gas engineering, we need to ensure our system adheres to the highest safety protocols. Therefore, expertise in gas safety and monitoring systems is crucial. We will consult with gas utility companies and safety regulators to obtain data on gas usage patterns and best practices in leak detection.

8. Objectives and Novelty

Main Objective

The primary objective of this development is to develop a home energy management system for the maintenance of the main energy components, such as water, gas & fire, and electricity. In this development, we hope to develop maintain, reduce wastage, deduct and pre-identify accidents occurring with these energy components, minimize wastage and damages, assist users in identifying their usages, and inform them about those uses. Additionally, the system will enable users to understand their energy consumption in real time and make better informed choices. As a result of any anomalies or issues that may occur, users will also receive alerts and warnings.

Member Name	Sub Objective	Tasks	Novelty
K.G.P. Sithumini IT21170584	A component of the AI system maintains all the other components in the system, including electricity, water, and fire & gas, collects data from each component individually and makes major decisions. The part reduces waste and works as a safety system.	Detect usages of the component and analyze data Analyze the usage data to identify patterns and trends. Compare the usage data to other data sources to get a better understanding of the component's performance. Adjust the component based on the data. Make sure all the lines are safe and if there have any fault inform them and shut down that line.	Collect data from every individual parts in the system and analyze data such as smart meter to collect real time data and calculate usages and sensors to detect leaking. Use IoT to connect all the systems to a center IoT hub to communicate with AI technology. Use automated controlling system. Have an alerts and notification for the system maintenance and leakage details. Create a user-friendly dashboard to display

		Inform users about their usage of the components. Help to minimize wastages of the energy components	real-time and historical data. Generate usage reports, efficiency analyses, and cost savings over time.
A.M.S.S. Adhikari IT21173318	Controlling the Gas according to the voice commands Consider the fire situation and detect the fire in image processing method	By using a voice command such as "open the gas", "close the gas", or "set the gas to 50%", you can turn gas on and off. Moreover, safety protocols prevent accidents, such as shutting off the gas valves if there is an emergency or leak. It's determined whether the fire is a controlled environment fire or a danger fire, so some solutions are automatically applied. For example, when the fire is high, all the water valves are open.	Controlled by voice control commands (on or off), the gas appliance operates as needed. CCTV camera photos are analyzed to determine whether the flame is a fire in a controlled situation or a danger, and appropriate solutions are given accordingly. Solution tips for this include extinguishing the fire from the water taps and shutting off the gas and electricity supply to the house
K.G.K.M.J. Kodithuwakku IT21173936	In order to ensure a consistent supply of water, a well and a tap line are used. When the water level drops below a predetermined minimum, the system initiates filling. To fill the tank, the system first checks	The smart water meters can be installed in bathrooms, kitchens, gardens, and laundry rooms. Using sensors, monitor water flow and consumption in real time. Display real-time water usage data on a	The system checks for water leaks by detecting whether the tap is open or closed. If the tap is open, there is no conclusive information available. In the event that the tap is closed, a sensor will search for any human beings

	for adequate water quality and well availability. If either condition isn't met, it switches to the tap line. The tank is filled automatically if both conditions are met.	dashboard. Provide detailed reports and visualizations.	near the leak. The water supply for that area will be turned off automatically if no human is detected in order to prevent water waste and damage. It is possible to respond quickly to leaks using this approach.
K.T.D. Mahanama IT21301490	Build a system to handle home electrical Equipment in a fully automatic manner.	Select IoT devices like motion sensors, a door sensor, a control unit and smart switches/plugs. Program the control unit to handle inputs and control devices. Develop a web application for manual control and monitoring. Integrate all components via Wi-Fi.	This system uses motion sensors and a main door switch to improve energy efficiency. It detects occupancy and turns off lights automatically. If the main door is closed and no motion is detected, all electrical equipment will be turned off. Homeowners can easily monitor and control their electricity usage with a user-friendly web application.

9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

| Yes | ✓ | No | |

b) Does the proposed topic exhibit novelty?

| Yes | ✓ | No | |

c) Do you believe they have the capability to successfully execute the proposed project?
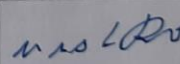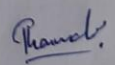
| Yes | ✓ | No | |

d) Do the proposed sub-objectives reflect the students' areas of specialization?

| Yes | ✓ | No | |

e) Supervisor's Evaluation and Recommendation for the Research topic:

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Dr.	Samantha	Rajapaksha	_(signature)_
Co-Supervisor	Ms.	Thamali	Kelegama	_(signature)_
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

This part is to be filled by the Topic Screening Panel members.

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	✓
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

- Check the evolution plan
- Each component should have some novelty.

- Last member can do a prediction for Smart energy usage within the house.

The Review Panel Details

Member's Name	Signature
Dhovh Khum	
Uthpala Samarakoon	

*__Important__:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.

2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.