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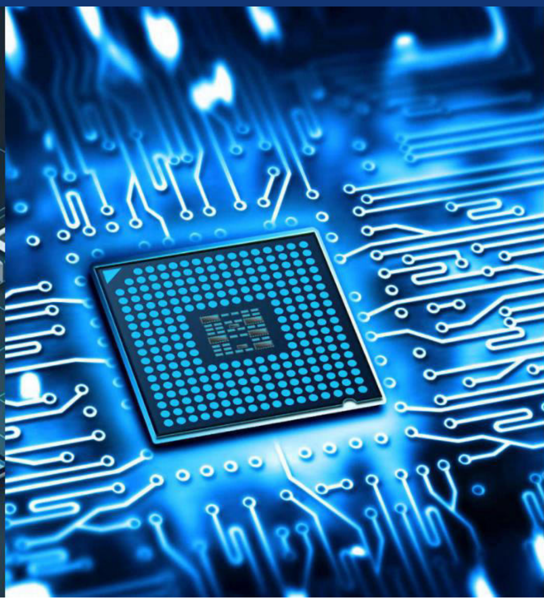


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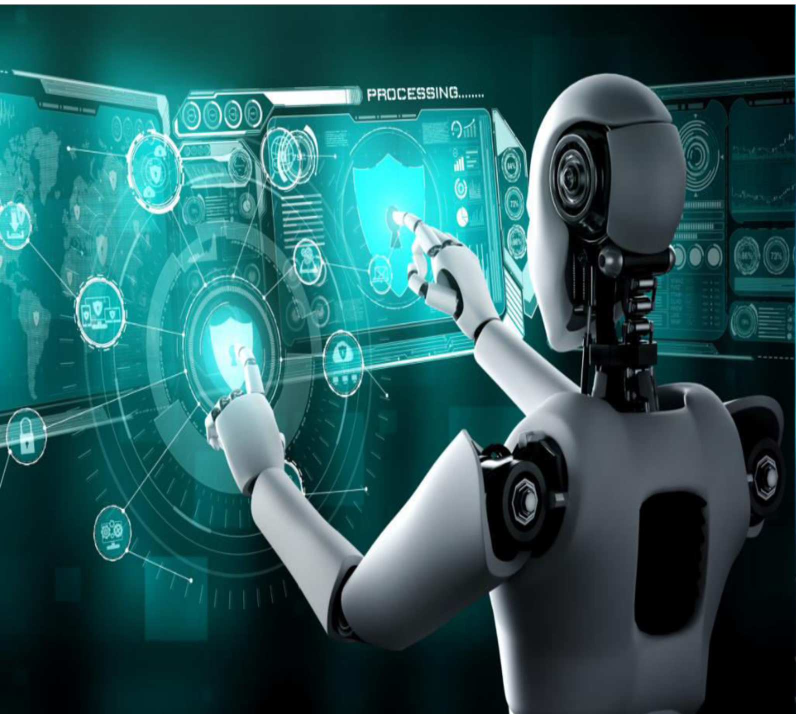

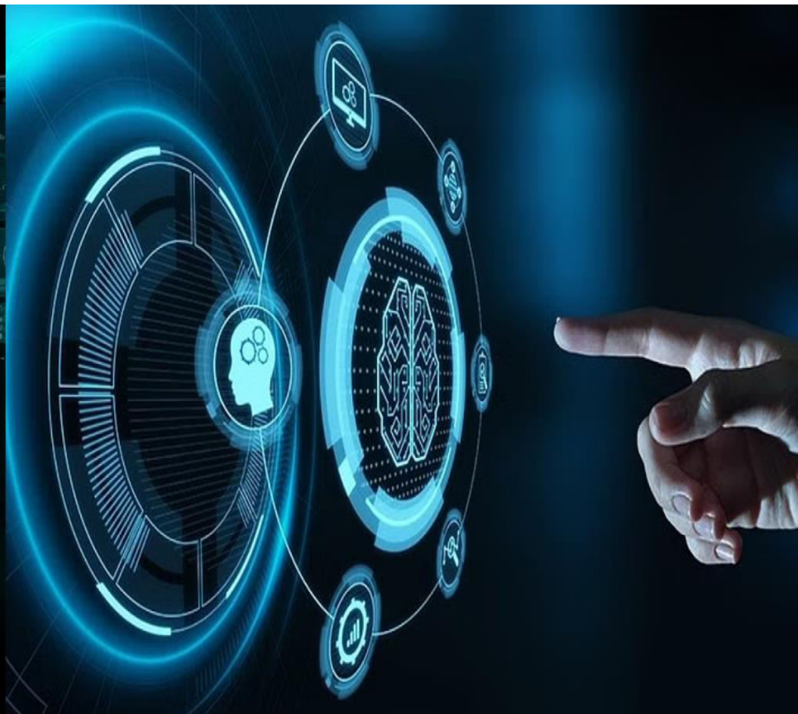

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Water and Electricity Tracking App

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ABSTRACT: The Water and Electricity Tracking App has the purpose of assisting users to monitor and organize their daily use of water and electricity in a convenient way. Utilizing an organized and convenient method, the app allows users to monitor their resource consumption manually and maintain their patterns of consumption under observation throughout the long run.This approach helps enhance awareness and encourages responsible usage, thus allowing people to save. The app is easy to use, from sign-up and log-in, with safe storage of user-specific data. Once logged in, the user is able to input their water and electricity consumption for the day, safely stored for use at a later time.To maintain users' adherence to desired levels of consumption, the app provides instant feedback by sending reminders and alerts whenever the user goes past thresholds of usage. These alerts prompt consumers to remain within their limit, resulting in sounder. Another central aspect of the app is its feature of data visualization, enabling users to visualize intricacies in their consumption patterns.By displaying previous consumption figures in a readable and simple manner, i.e., through charts and graphs, the app allows users to identify trends and make rational decisions to curtail unwanted consumption. Further, timely notifications and nudges serve as the mechanisms of encouragement, offering consistent usage behavior. Through the integration of manual inputting of data, safe storage, goal monitoring, visual inspection, and reminder notices, the Water and Electricity Tracking App provides the user with a means of controlling their usage of resources. Through this systematic approach not only will one save on utility bills, but it also serves to help aid in overall efforts towards sustainability in the environment, making it an essential app for anyone looking to be more responsible in use.

KEYWORDS: Resource monitoring; mobile application; manual data input; usage threshold alert; data visualization; consumption patterns; sustainability..

I. INTRODUCTION

Electricity and water are fundamental utilities whose responsible use is ever more important as usage continues to increase and environmental concerns mount. Most consumers, however, lack the resources to keep track of their daily usage patterns effectively, which leads to overuse, high bills, and unsustainable usage patterns. While IoT- based smart monitoring systems exist, they are too costly and complex for much of the population to access.

For fixing this issue, the Water and Electricity Tracking App offers a convenient but practical feature for the consumers to track and keep record of their usage every day. Using the app, the consumers are able to report their water and electricity consumption by hand, save them safely on a cloud-based database, and track patterns of consumption over a period of time through graphs and charts. By setting usage targets and receiving early warnings when thresholds are met, users are encouraged to stay within their planned usage levels.The main objective of the application is to promote energy and water conservation by providing users with data- driven insights into their consumption behavior. The application supports user authentication, role-based access, cost estimation, and historical data analysis to aid in financial planning and sustainable usage. The ease of manual tracking with smart data visualization guarantees usability, accessibility, and efficient monitoring for individuals, families, and small businesses.The system presented acts as a bridge for consumers who want sustainable consumption without the need to utilize sophisticated or expensive hardware, which translates to cheaper utility bills and less environmental degradation.

II. RELATED WORK

Several approaches have been proposed in the literature for optimizing energy efficiency and resource utilization in wireless networks, most of which indirectly apply to monitoring and optimization in consumption-tracking applications such as the Water and Electricity Tracking App developed in this project.

In [2], authors added average residual battery level and hop count to the RREQ header of an on-demand routing protocol to make retransmission times optimal from an energy perspective. This concept is similar to our app's

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emphasis on efficiency—although we don't work with routing, we track individual consumption to make personalor group energy and water usage optimal.

Similarly, [3] used an optimization function that included packet size, hop count, and distance to determine energy-efficient paths. In our app, though not applied to routing, we also use user-defined goals and thresholds to optimize daily energy and water consumption behavior.

In [4], a Genetic Algorithm was applied for path selection in multicast routing based on lifetime as a fitness function. Although our application does not implement evolutionary algorithms, our backend logic functions similarly by dynamically evaluating user input against historical patterns and goals to trigger alerts, which assists users in prolonging resource sustainability.

The effort in [5] and [6] adapted AODV routing to refuse route requests if battery levels were below certain thresholds or to forward only via active nodes, respectively. This adaptive participation concept with respect to available power is what our app also follows in the sense of reminding users when their usage approaches or crosses specified thresholds, enabling them to make optimal decisions to avert overutilization.

Authors in [7] suggested routing based on hop count and battery power, preferentially choosing lower transmission range-required paths. Our system takes on a similar principle in the shape of behavior adaptation: users get reminders and visual cues to curb their consumption prior to critical thresholds, thereby "routing" their habits towards sustainability.

Though the works cited emphasize routing and power efficiency in networks, the general principle of energy-aware optimization largely shaped the architecture of our Water and Electricity Tracking App. We use real-time analytics, goal thresholds, and notification-based feedback loops, similar to decision-making in energy-aware routing, to promote responsible consumption behavior.

In addition, as opposed to the referenced materials, our answer is designed to suit end-user interaction and behavioral modification as opposed to infrastructure streamlining. This we do through the integration of Firebase Firestore to handle real-time data, MPAndroidChart for dynamic charting, and Firebase Cloud Messaging to provide timely reminders—using new mobile development platforms for a user-friendly and expandable experience.

III. PROPOSED ALGORITHM

A. Design Considerations:

- **Initial Energy:** Nodes (in this case, the app) start with an initial energy (could be storage capacity, network resources, or UI refresh energy). Nodes are able to calculate its residual battery energy (RBE).
- **Residual Energy (RBE):** The app calculates the remaining resources after each update or request.
- **Efficient Use of Resources:** Minimize network usage by selecting the most efficient path (e.g., data calls to Firebase) and using energy-efficient algorithms for UI rendering. Receiving energy is not considered.

B. Description of the Proposed Algorithm:

The aim of the algorithm is to **optimize resource consumption** and ensure that water and electricity usage data is transmitted and visualized efficiently without overwhelming the system resources or the user experience. The algorithm consists of three main steps:

Step 1: Calculating Energy for Data Updates (TEnode)

The **energy** can refer to the **resource consumption** for performing data updates and transmitting information from Firebase to your app, such as:

- **Data Request:** Fetching data from Firestore.
- **Data Processing:** Calculating daily usage totals or percentages.
- **UI Update:** Rendering pie charts or line charts.

Each of these operations has an associated **energy cost**, which can be modeled based on the **number of database calls** or **chart render updates**.

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Transmission Energy for Data Update (TEnode): TEnode∝data request size+UI update complexity

Step 2: Selection Criteria for Efficient Data Update

Feasibility Check:

- The app must ensure that the **RBE** (resource left after the last update) is greater than or equal to the required energy (TEnode) to process or display the new data.
- If **RBE** is not sufficient, the app will delay or optimize the update to avoid unnecessary energy consumption (e.g., skipping unnecessary refresh or load operations).

Efficient Path Selection:

- In terms of **data flow**: When fetching data for charts, we choose the most **efficient paths** (e.g., minimal number of database queries or optimized queries) to avoid high consumption.
- **Sleep Mode for Inactive Nodes:** If the app detects that a particular view (e.g., electricity usage chart) hasn't been updated for a while, it can put the update process in **sleep mode** to conserve resources.

Data Usage Limiting:

- You can implement mechanisms to limit data refresh rates, avoiding repeated updates to the charts if the data hasn't significantly changed.

Efficient Data Aggregation:

- Calculate **total energy consumption** for each node (or section of the app) using:

TTER=∑i=1mTEnodeTTER = \sum_{i=1}^{m} TEnodeTTER=i=1∑mTEnode

where **m** is the number of updates made for a particular graph.

- The route with **least resource consumption** will be selected for frequent updates (e.g., update the pie chart for monthly usage only after significant data changes).

Step 3: Calculating Residual Resources After Update (RBE)

After each data update (e.g., after fetching data from Firestore and updating the chart), the app will recalculate the **residual resources**.

Residual Battery or Resource Calculation (RBE):

RBE=Initial Resource−TEnodeRBE = \text{{Initial Resource}} - TEnodeRBE=Initial Resource−TEnode

Here:

- **Initial Resource** is the resource available at the start (could be network usage, app processing time, etc.).
- **TEnode** is the energy/resource consumed for the data update.

IV. PSEUDO CODE

Step 1: Generate all possible routes

Generate all possible routes for fetching data (daily or monthly usage) from Firebase.

Step 2: Calculate the Transmission Energy (TEnode) for each node in each route For each route:

For each node in the route:

Calculate TEnode for the node using equation (1):

TEnode = k * (distance between nodes) ^n // eq. (1) Store the calculated TEnode

Step 3: Check the available routes based on Residual Battery Energy (RBE)

While no route is available to transmit the packet:

For each route:

For each node in the route:

```
    If RBE <= TEnode  // If residual battery energy is less than or equal to transmission energy:
        Make the node go into sleep mode  // Energy saving by disabling the node
        Else:
        Select all the routes that have active nodes
        End If
         End    For
        End For
```

While no route is available to transmit the packet:
For each route:
For each node in the route:

```
    If RBE <= TEnode  // If residual battery energy is less than or equal to transmission energy:
        Make the node go into sleep mode  // Energy saving by disabling the node
        Else:
        Select all the routes that have active nodes
        End If
         End    For
        End For
```

Step 4: Calculate the total transmission energy for all the selected routes For
each selected route:
Calculate the total transmission energy (TTER) for the route using eq. (2):
TTER = Sum of all TEnode values in the route // eq. (2) Store
the calculated TTER for each route

Step 5: Select the energy-efficient route
Select the route with the minimum total transmission energy (TTER) as the most energy-efficient route

Step 6: Calculate the Residual Battery Energy (RBE) for each node in the selected route
For each node in the selected route:
Calculate the RBE for the node using eq. (3):
RBE = Initial Battery Energy (IBE) - TEnode // eq. (3) Update
the RBE after transmitting the packet

Step 7: Repeat the process
Go to Step 3 for the next transmission or data update

Step 8: End
End of process

V. SIMULATION RESULTS

The Water and Electricity Tracking App provides a simple and efficient means of monitoring water and electricity usage on a daily basis. Proper tracking, secure storage, and proper information for users to enhance water and electricity use are provided in the implementation. With the automation of data input provided, the app empowers users with complete management of consumption records with the addition of an orderly system for tracking and analysis. One of the standoutsaccomplishments to be seen right from the start is the safe user authentication module, which ensures that only users who are logged in can view their information. Login and registration features save user passwords securely in the database, denying unauthorized users access. Upon safe login, users are redirected to the home page, from which they can navigate to other sections, including tracking usage, setting goals, and statistics.The option of target setting is very beneficial in maintaining sustainable use of resources. The users have the ability to set target levels of their daily, weekly, or monthly usage of water and electricity. The application tracks these targets in real time and sends notifications the moment consumption goes above set levels.This option encourages users to regulate their usage patterns, with the ultimate outcome being minimized wastage. The notification facility is a vital process to notify the

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users periodically, utilizing a helper mechanism and receiver of notification for the provision of timely notice on consumption updates.The usage tracker effectively tracks and stores the consumption readings. Consumers enter readings manually on a daily basis and then store them in the database. Users can thus see what has happened over time, comparing their current states to their histories. Storage of structured data allows for easy retrieval for analysis purposes by consumers of how things evolve over time. Inputting reading manually versus a full system that automatically monitors makes the program independent of total reliance on integration while still being informative. The visualization and statistic feature offers a more userfriendly experience via the display of consumption statistics in a readable format. The application generates graphical plots, such as bar graphs and line plots, to illustrate usage patterns over time. These graphical displays allow users to identify periods of high usage and adjust their usage patterns accordingly. Comparability over several periods of time allows users to make decisions about usage patterns, which leads to cost savings and efficiency.Reminder and notification is another key component of the functionality of the app. Real-time reminders to users for overuse, impending deadline goals, or reminder messages to track consumption daily are provided. The proactive function raises the level of user engagement and makes monitoring constant on a daily basis. Integrating reminders in the app ensures minimal chance of failing to get an update of usage information, thereby ensuring correct records.Overall utility of the application sets it useful in offering systematic and interactive use of consumption control. By virtue of the interface between manual reporting and data assessment, the app fills the vacuum between real-time monitoring and human perception. People not only gain to monitor usage but also useful information to utilize resources in their best possible forms. Future scope can be envisioned in predictive computation, customized advisories, and further personalization to make it even more versatile

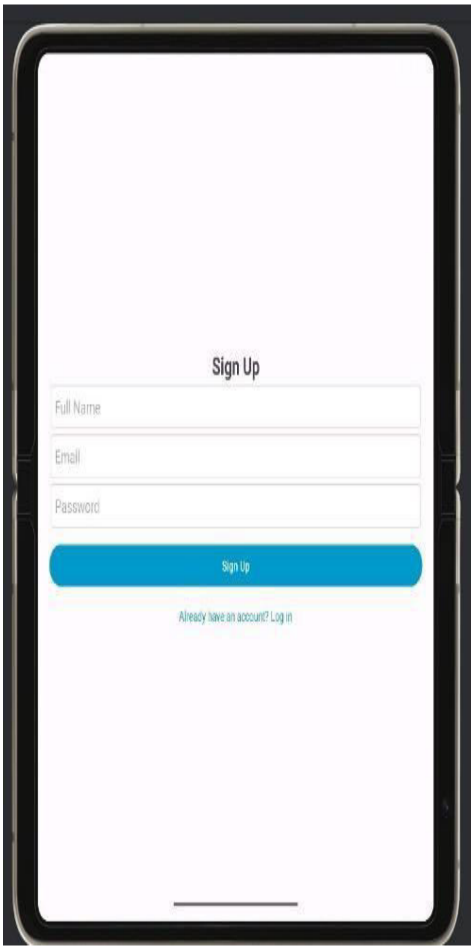


Figure A.1: Sign-up page

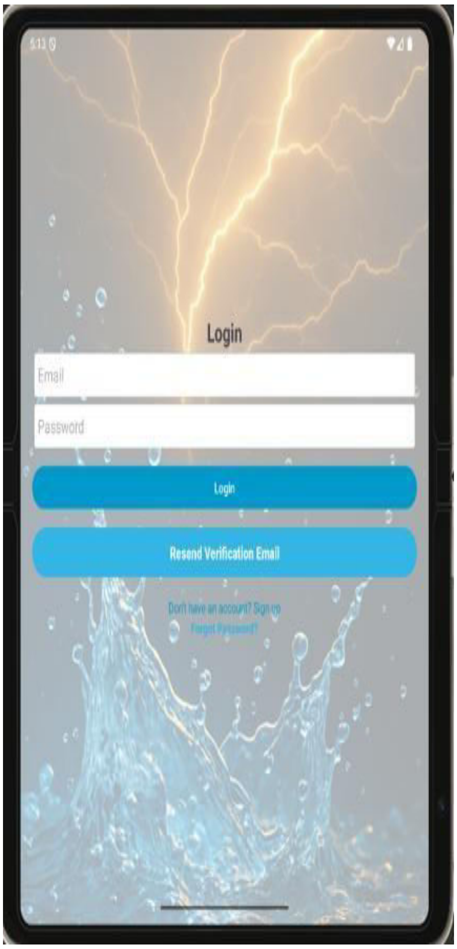
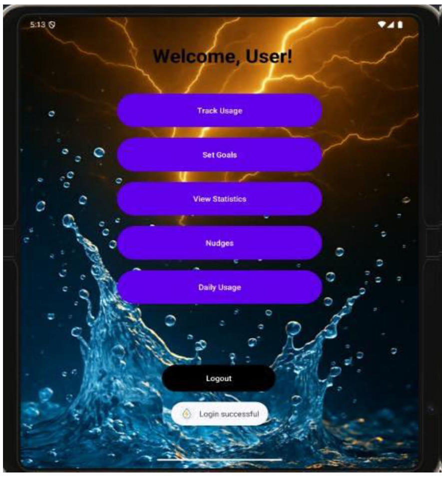
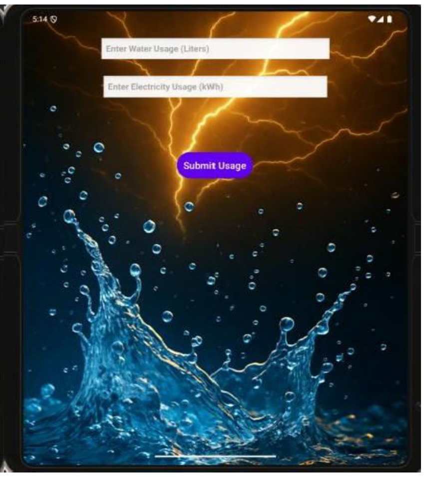


Figure A.2: Login page

Figure A.3: Tracking App





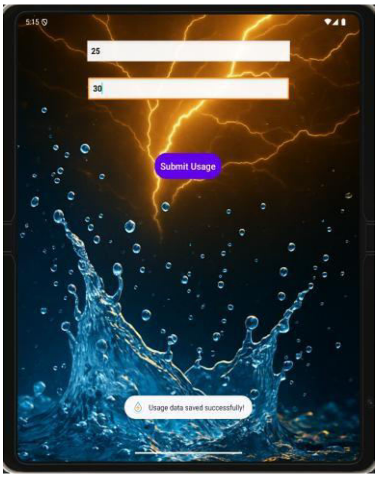
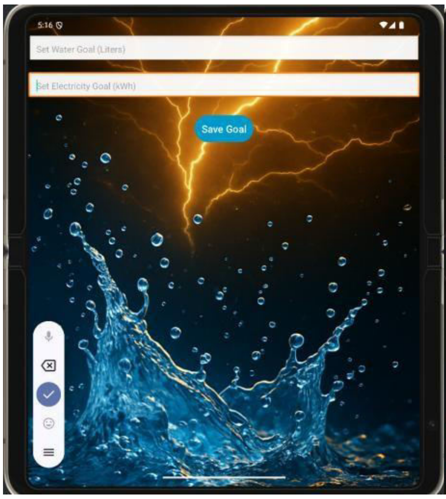
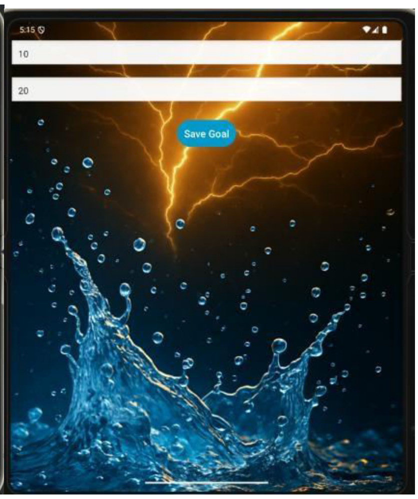


Figure A.4: Home Screen Figure A.5: Usage Screen Figure A.6: Usage Save





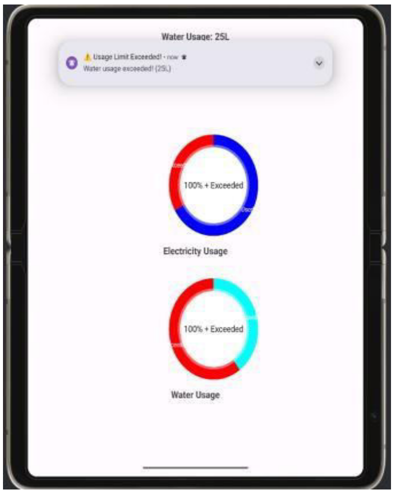
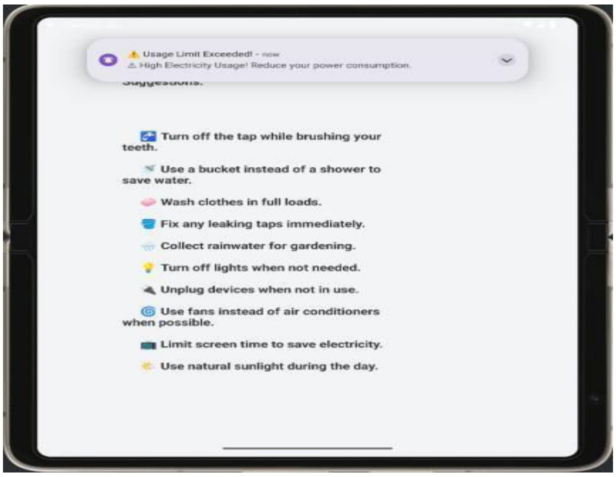


Figure A.7: Goal Screen Figure A.8: Goal Save Figure A.9: Statistics Page



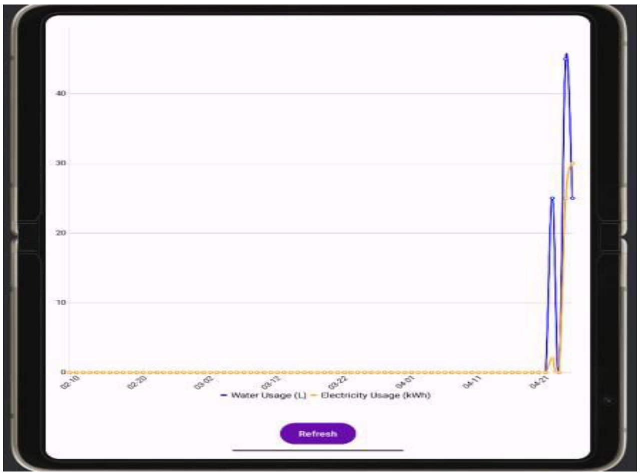


Figure A.8: Usage Suggestion **Figure A.9: Daily Usage**

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VI. CONCLUSION AND FUTURE WORK

The Water and Electricity Tracking App was successfully developed with the aim to provide users with an easy and user-friendly platform to monitor their daily usage of resources. The system was constructed on a structured approach, having several features such as user verification, input, goal setting, statistical calculation, and notification indicators.The front-end user interface of the application is very smooth, allowing users to monitor their water and electricity consumption using an interactive and user-friendly interface. The back-end, on its part, is tasked with storing and retrieving data efficiently, providing users with information pertaining to their usage pattern. Using the manual input system, the app gives complete control over their logged consumption to users without relying on external hardware or automation. With the login and signup feature, consumers are offered a secure method of logging in and creating their account so that their own personal consumption information is kept private and secure.The home page, upon login, serves as a single dashboard showing a simple snapshot of daily, weekly, and monthly usage patterns. Users can input their water and electricity usage through the usage page, in which the system logs and processes information to give meaningful insights. The goal-setting feature allows users to set consumption limits, in which they can stay within allocated targets. Whenever a user exceeds his or her goal, the notification system is employed to send users notifications, hence promoting responsible behavior in consumption. The page for statistics plays a crucial role in helping the users view consumption habits. When presenting data through graph types, the application facilitates the comparison between previous and ongoing usage, helping users identify levels of excessive use, and consequently make choices based on this information.Other than this, the nudges and reminders are also offering immediate notifications, reminding users to stay attentive towards consumption. The timely interventions maintain the users in an active state of monitoring consumption and astray. The backend integration manages database operations effectively, wherein user information is stored securely and retrieved intelligently at the time of requirement. The systematic process of data processing enables instant access to past consumption data, and the users can see trends over time. Moreover, the application's notification system works well, and notifications are timely even when the app is running in the background. This keeps users constantly informed about their consumption status even when they are not using the app.

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