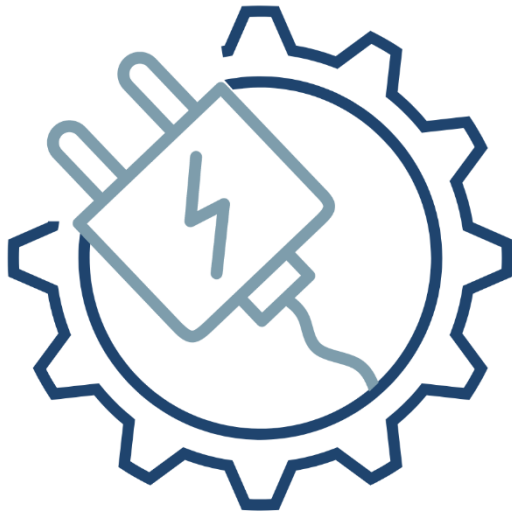




King Abdulaziz University
DEPARTMENT OF COMPUTER SCIENCE
Faculty of Computing and Information Technology
CPCS-351, Fall 2022



KAFA'A

Project ID: group 7

Section: B0A

Date	Version	Description
11-9-2022	0.1	Phase1
29-9-2022	0.2	Phase2
30-10-2022	0.3	Phase3
10-11-2022	0.4	Phase4

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Phase 1: Project Description

1.1. Introduction

Oxagon represents the economic and industrial engine of NEOM, as it will lead innovation in industry and technology, in addition to the exceptional living that its residents will enjoy. Oxagon is designed to attract excellent minds and talent to breathe new life into the manufacturing sector; Ideas in this place will change the world. It will adopt the principle of circular economy, to serve as an economic front for advanced industries in NEOM, and will establish an integrated system for clean energy, in which the concept of "multiple uses" is applied instead of "single-use", to reduce waste and enhance productivity. It will embrace many sectors, including the renewable energy sector.

As is known, in the last two years, the Electricity Company in the Kingdom of Saudi Arabia has raised the prices of electricity bill, which led to an increase in the prices of electricity bills and the difficulty of paying them for many people. In our “Kafa’a” project, we seek to educate community members about their electrical consumption, to conserve electrical energy from wasting in vain, by applying an intelligent system that controls electricity in a way that reduces its consumption.

1.2. Problem Description

The main problem is the high prices of electricity bill in Saudi Arabia, due to people's lack of awareness of the extent of their electricity consumption. Such as forgetting some electrical appliances are open without needing them. It makes sense to have an application linked to a device installed on the electricity meter at home so that the user's consumption of electricity is monitored, which contributes to his awareness to reduce his consumption of it.

1.3. Project Objectives

Our project is a smart application linked to a device that is placed on the electricity meter.

- Helps not to waste electrical energy in vain and saves on the electricity bill.
- Records a daily report on the electricity consumption of each device separately.
- Provides the feature to turn off devices automatically when they exceed the maximum period of operation.
- In the afternoon, the application turns off the lights and opens the curtains to take advantage of the sunlight instead of consuming electrical energy.
- -Send notifications about the places that have electricity when it runs out at home.

1.4. Project Goals

The application aims to achieve many goals that contribute to educating the user about the extent of interest and following up on his electricity consumption, so our goals are:

- Educating the individual about his electricity consumption.
- Taking the advantage of sunlight and reducing electrical energy consumption.
- Conserving electrical energy and reducing wastage in vain.
- Economy in the price of the electric bill.
- Submit a detailed report on the electricity consumption of each device separately.
- Turn off devices and lights automatically when they exceed the maximum period of operation.
- Send notifications about the places that have electricity when it runs out at home.

1.5. Sources of Domain Analysis Information

The source of domain analysis was those who noticed excessively high electricity bills in their daily use and community members who aim to monitor their electricity consumption.

1.6. Scope of the System

"Kafa'a" is an application for mobile phones and computers. It is associated with a device that is placed on the electricity meter to control electrical devices in the home. It provides functions for users to manage their electricity consumption.

1.6.1. This System Include:

- Conserving electrical energy and reducing wastage in vain.
- Economy in the price of the electric bill.
- opening the blinds in the afternoon and turning off light automatically.
- Send notifications about the places that have electricity when it runs out at home.
- A report on the electricity Consumption of each device separately.
- Smart feature to turn off devices automatically.



1.6.2. This System Exclude:

- Calculating the electrical consumption of places that do not contain the device.
associated with the application.
- Kafa'a does not work unless the device is on the electricity meter.

1.7. System's Stakeholders

The stakeholders of our system are general society, admins (staff in electrical company), and system developers.

Phase 2: Business Requirements Specifications

2.1. Techniques for Gathering Data

2.1.1. Survey

We gathered data using the Electric Energy Statistics Bulletin that relies on the data of administrative records from its main sources from the relevant government agencies provided by the General Authority for Statistics. The total electrical energy consumed for the year 2020 AD in the Kingdom of Saudi Arabia amounted to 333,289 GWh. The western region accounted for the largest share with 97.30% of the total electrical energy consumed, followed by the central region with 87.29% then the eastern region with 69.28%. The lowest consumption was for the southern region, with 47.10% of the energy consumed. For detailed information check [Appendix A](#).

According to a report published by EnergyPoa, it was found that the percentage of electricity consumption in commercial areas is the highest. This is due to several reasons, such as running electronics in an empty place, not having an energy management system, and Inefficient lighting practices.

2.1.2. Competing System

"Saudi Electricity" has launched a new "Kahraba" application, that allows the user to review daily consumption. The application provides a package of new services such as account services, requests for bills, and a review of all requests and reports.

A Kafa'a application focuses on studying the total electrical energy consumed side to educate the user and help him to reduce consumption. Through several services that depend on intelligent systems, such as a system for sending notifications to the user if the device exceeds the daily consumption limit so that it will be closed automatically, and turn off the lights and open the blinds automatically in the morning. In addition to providing the service of knowing the nearby places where there is electricity and alerting the user at the end of each month to pay the bill.

2.2. Requirements & Its Types

2.2.1. Functional Requirements

Kafa'a allows:

R1: The possibility of creating an account.

R2: Displaying a daily report showing the consumption of each electrical device separately.

R3: Sending an alert to the user in the morning. In the event of failure to respond to the alert, the lights will turn off automatically and open the curtains to take advantage of the sunlight.

R4: Determining a consumption limit for each device, and in case one of the devices exceeds the limit, an alert will be sent to the user, otherwise the device will be closed.

R5: Knowing the user's location.

R6: If the power runs out, It will provide a map that shows the nearby places to the user, where there is electricity is working.

R7: Display the place information (its location, number of rooms, location of each room, the number of electrical devices in each room, and the consumption of each device separately).

R8: The possibility of logging in and out for users.

R9: The ability to share electricity consumption through social media.

R10: Reviewing the monthly electric consumption record and each month's bill, as well as a reminder of the bill payment date.

R11: The possibility of following up the electrical consumption of each device on the day and date chosen by the user, whether by day or by month.

R12: The ability to view and modify the user's account information.

R13: Possibility to print electrical consumption reports.

2.2.2. Non-functional Requirements

Kafa'a shall:

R1: Protect user privacy and user information.

R2: Be available to all users 24/7.

R3: Be maintainable.

R4: Provide a user-friendly interface and easy to understand.

R5: Runs on all operating systems.

R6: Support multiple languages: (English, Arabic).

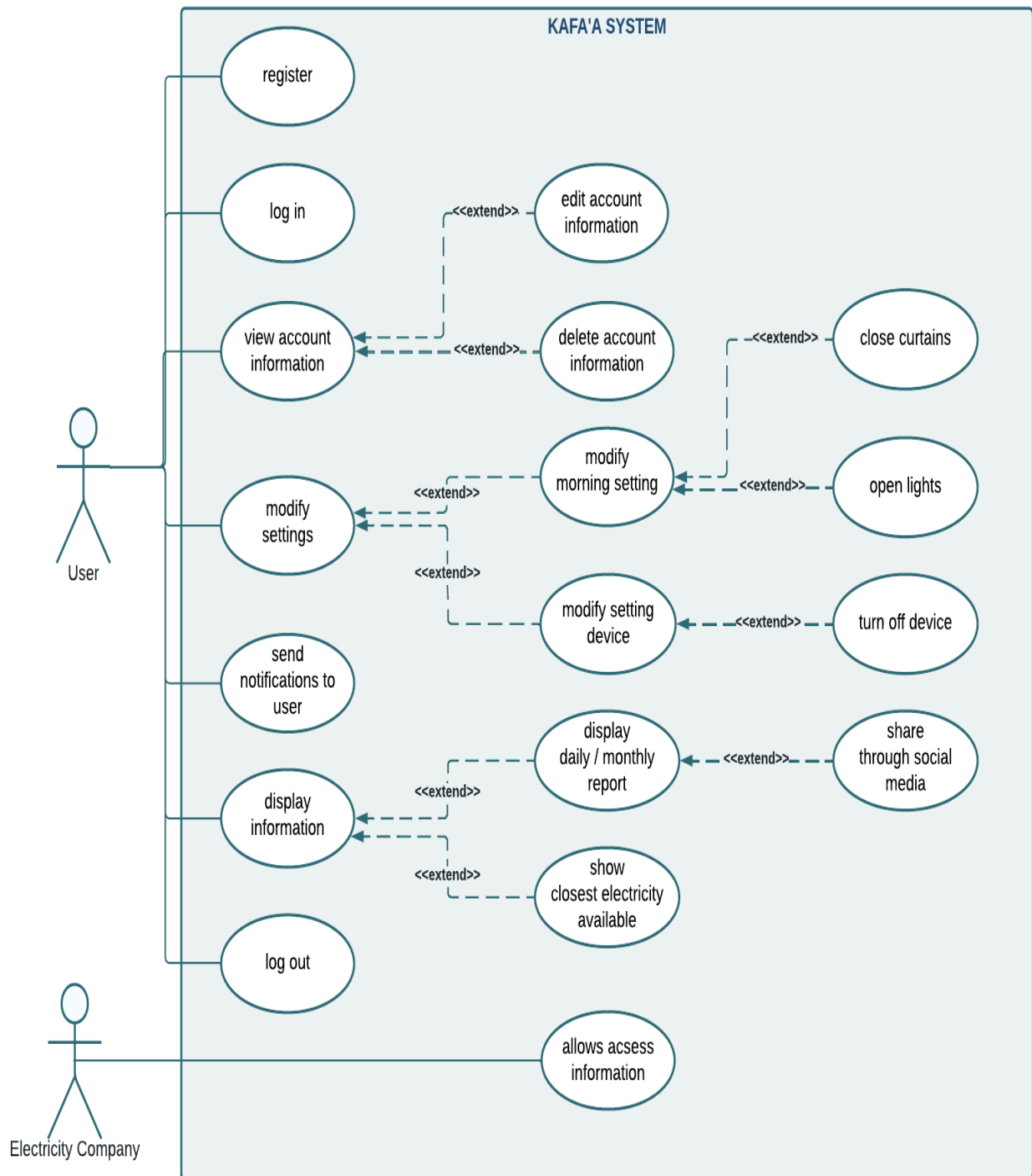
R7: Users can choose the screen mode (Dark, Light).

R8: Have a FAQ (frequently asked questions) page.

R9: Have suggestions and a report a problems box.

R10: Displaying encouragement messages in case the consumption is less than the daily limit or the monthly limit.

2.3. Use Case Model



2.4. Use Case Description

2.4.1. Use case 1

ID:	UC-1
Title:	Register
Description:	The user must register to use the application.
Primary Actor:	User.
Preconditions:	The user must enter the correct information. In addition to the presence of a counter for the application.
Postconditions:	The account is created for the user.
Main Success Scenario:	<ol style="list-style-type: none"> 1. The user can open the application from his phone screen. 2. The user can create an account by selecting the Create Account button from the main interface. 3. The user fills in the requirements fields with correct information such as username, mobile number, counter reference number, location, email, and password. 4. The account is saved in the system and the profile is created.
Extensions:	If the system fails to create the account <ul style="list-style-type: none"> • The system displays the message "Be sure to enter the required information"
Special requirement:	The user needs to be connected to the Internet and have a mobile application. Also, make sure that the devices are connected to the counter.

2.4.2. Use case 2

ID:	UC-2
Title:	Modify morning setting
Description:	The user can adjust the morning settings in case he wants to close the curtains or open the lights
Primary Actor:	User.
Preconditions:	The user must be logged into the system.
Postconditions:	Depending on the choice of the user, the adjustment is made, he can close the curtains or open the lamps.

Main Success Scenario:	<ol style="list-style-type: none"> 1. The system will send a notification by morning, so that the lights are closed and the curtains open 2. The user logs into the application if he wants to modify 3. The user presses the "Modify Settings" button. 4. The user selects " Modify morning settings" 5. The user presses the "open lights" button. 6. The system will turn on the lights. 7. The user presses the "close curtains " button. 8. The system will close the curtains.
Extensions:	<p>If the system fails to turn off the lights</p> <ul style="list-style-type: none"> • The system will display the message "Make sure the lights are connected to the counter ". <p>If the system fails to open the curtains</p> <ul style="list-style-type: none"> • The system will display the message "Make sure that there is nothing stuck to the curtains ".
Special requirement:	The user needs to be connected to the Internet and have a mobile application. Also, make sure that the devices are connected to the counter.

2.4.3. Use case 3

ID:	UC-3
Title:	Modify device setting
Description:	Allow the user to modify the limit settings of each device and also the user can turn off the devices
Primary Actor:	User.
Preconditions:	The user must be logged into the system.
Postconditions:	New limit settings will be set for each device and the devices selected by the user will be turned off
Main Success Scenario:	<ol style="list-style-type: none"> 1. The user is logged in. 2. The user presses the "Modify Settings" button. 3. The user selects "Modify Device Settings" 4. The user sets new limit settings for the devices he wants 5. The system adopts the new limit set by the user for devices 6. The user can press the "turn off devices" button. 7. The system turns off the devices specified by the user.
Extensions:	<p>If the system fails to turn off the devices</p> <ul style="list-style-type: none"> • The system displays the message "Make sure that the counter is connected to your devices". <p>If the system succeeds in turning off the devices</p> <ul style="list-style-type: none"> • The system displays a message to the user "You helped the Earth today".
Special requirement:	The user needs to be connected to the Internet and have a mobile application. Also, make sure that the devices are connected to the counter.

2.4.4. Use case 4

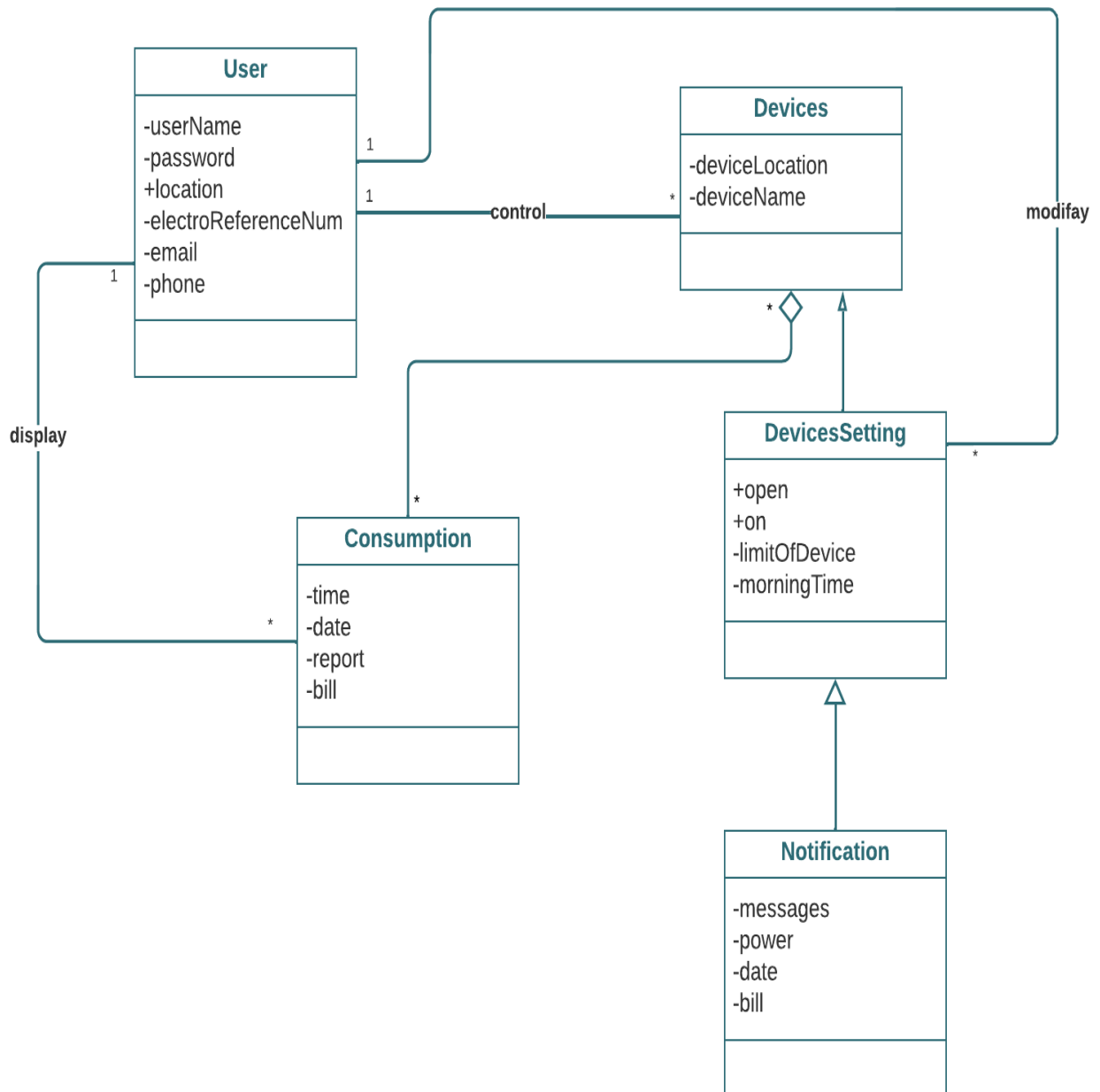
ID:	UC-4
Title:	Display monthly/daily report
Description:	The user can display the monthly/daily report of the electricity consumption for each device in his home and also share it on social media
Primary Actor:	User.
Preconditions:	The user must be logged into the system.
Postconditions:	The monthly/daily report of the electricity consumption will be shown to the user
Main Success Scenario:	<ol style="list-style-type: none"> 1. The user is logged in 2. The user presses the " Display information " button. 3. The user selects " Display monthly/daily report" 4. The system will display the monthly/daily report to the user 5. The user can click "Share through social media" 6. The system will share the monthly/daily report on social media.
Extensions:	None
Special requirement:	The user needs to be connected to the Internet and have a mobile application. Also, make sure that the devices are connected to the counter.

2.5. Difficulties & Risk Analysis in the Domain:

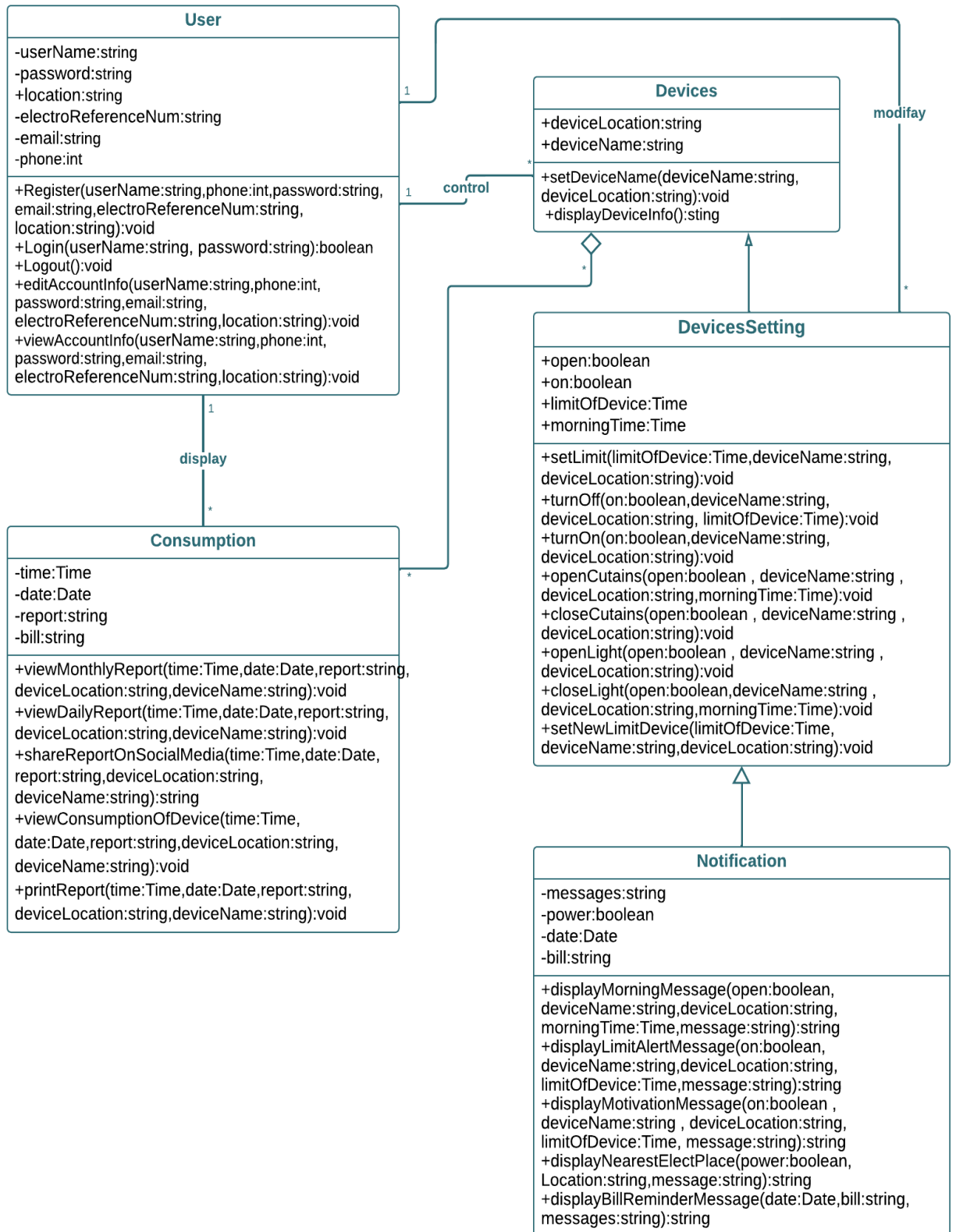
1. Difficulties in collecting the needed information.
2. Difficulties connecting the electricity counter to the application.
3. Difficulty obtaining permission from the electricity company to put the device on the electricity meter.
4. In the event of a counter malfunction, the system will not operate.

Phase3: Software Design and Structuring

3.1. Domain Model



3.2.UML Class Diagram



3.3. Relationships and their Multiplicity

3.3.1. Association relationships

1. Between User class and DeviceSetting class
 - A user can modify zero or more devices Setting.
 - A device setting can be modified by one user.
2. Between User class and Consumption class
 - A user can display zero or more of consumption information.
 - A consumption information can be displayed by one user.
3. Between User class and Device class
 - A user can control zero or more devices.
 - A device can be controlled by one user.

3.3.2. Aggregation relationships

1. Between Devices class and consumption class
 - A Consumption is part of Devices since Consumption provides electricity consumption reports about devices.
 - Each device can display zero or more consumption reports.
 - A consumption reports is displayed by zero or more devices.

3.3.3. Inheritance relationships

1. Devices class is inherited by DeviceSetting class

3.3.4. Generalization relationships

1. Notification is generalized into devices-settings, and it shares all attributes and functions

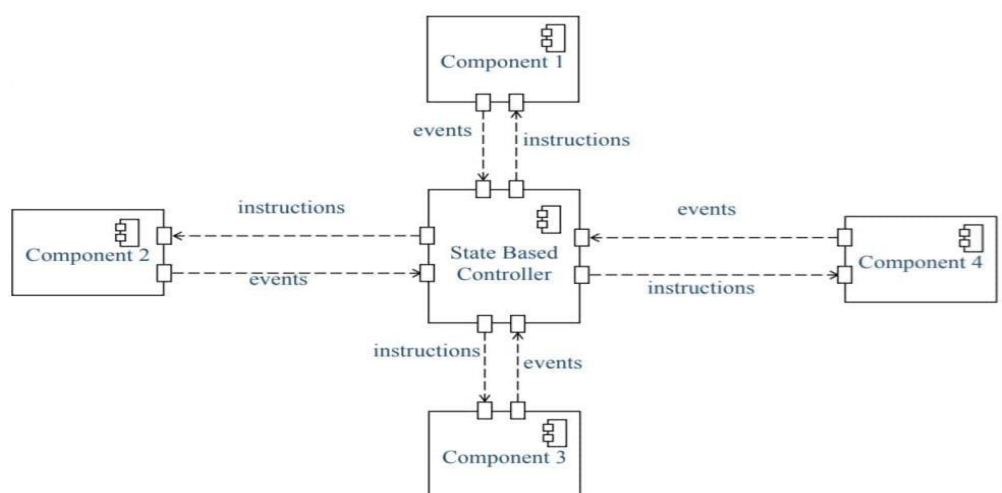
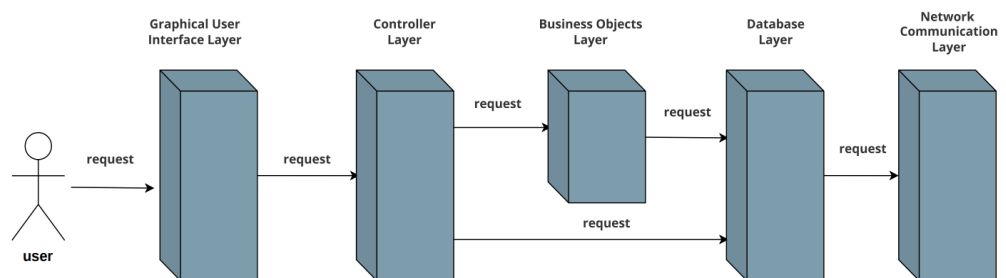
3.4. System Architecture

3.4.1. Type of The System

The main choice is n-tier architecture because our design is focused on being interactive with the user such as logging in and out, responding to alerts, displaying the invoice and modify settings.

A part of the system is Event Driven, the user will respond to the alerts sent by the application to determine if the light can be turned off in a certain area of the house because it has exceeded the specified period. If the user does not respond, the process will be done automatically by the system.

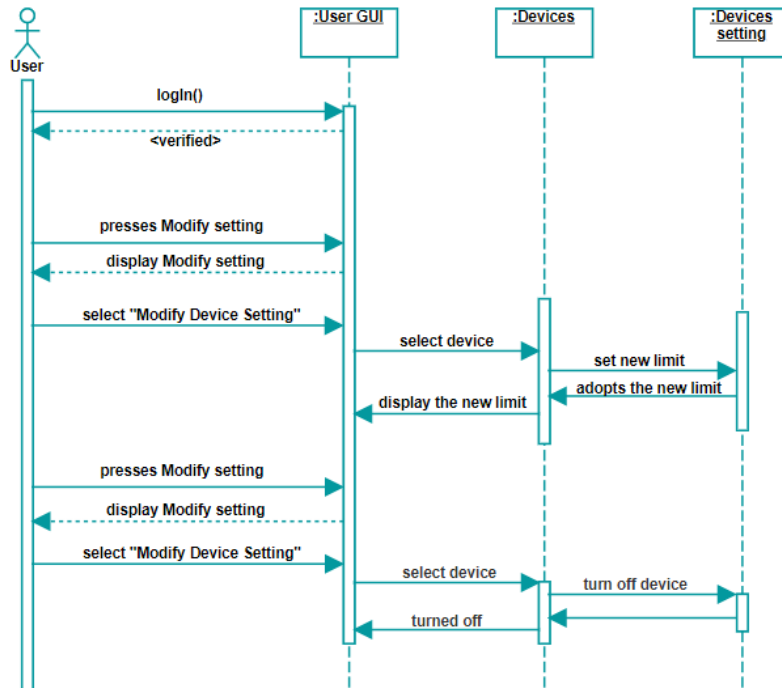
3.4.2. Architectural Design



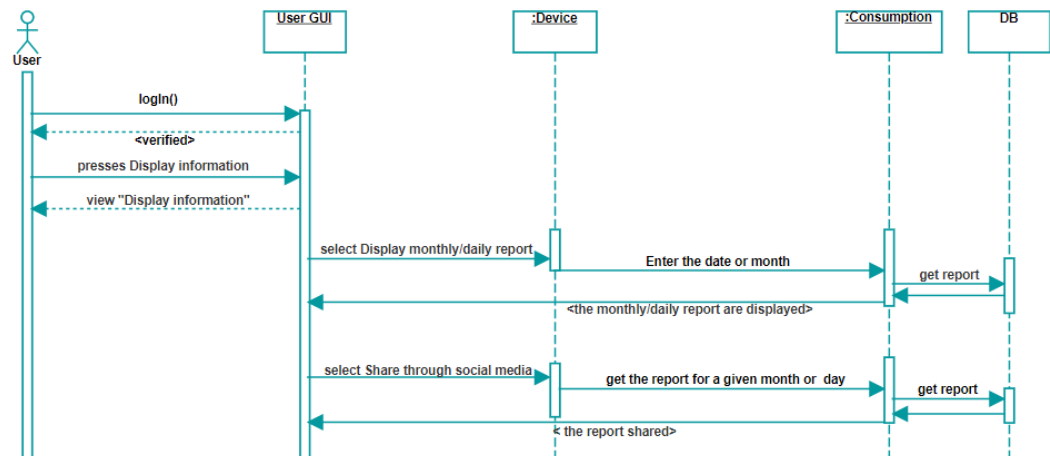
Phase4: Modeling, Interaction, and Behavior

4.1. Sequence Diagrams

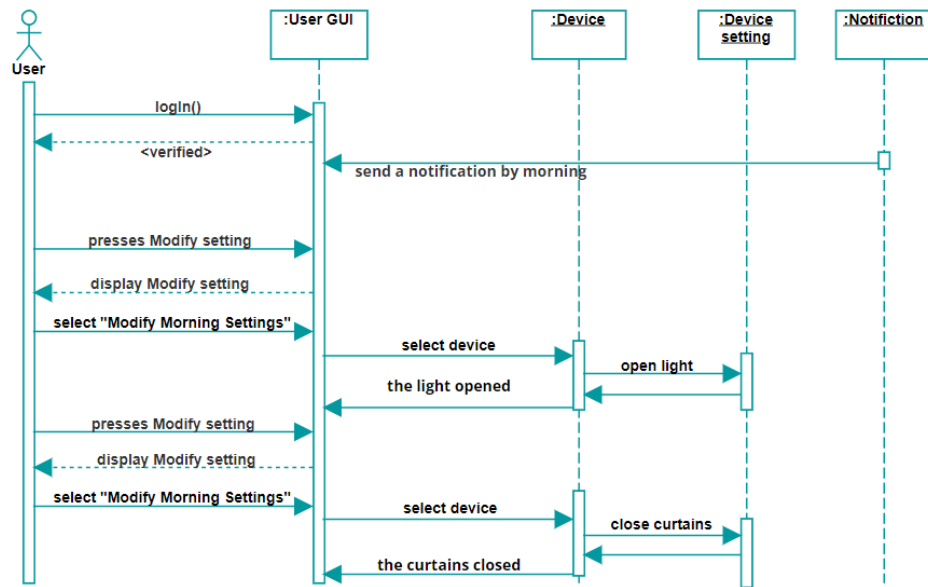
4.1.1. Sequence Diagram 1: Modify device setting



4.1.2. Sequence Diagram 2: Display monthly/daily report

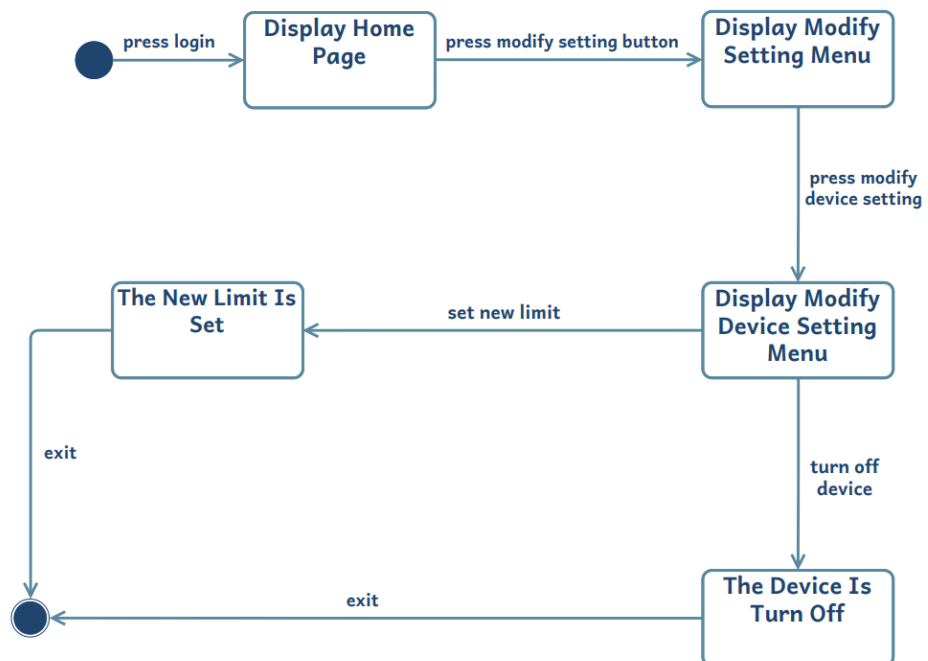


4.1.2. Sequence Diagram 3: Modify morning setting

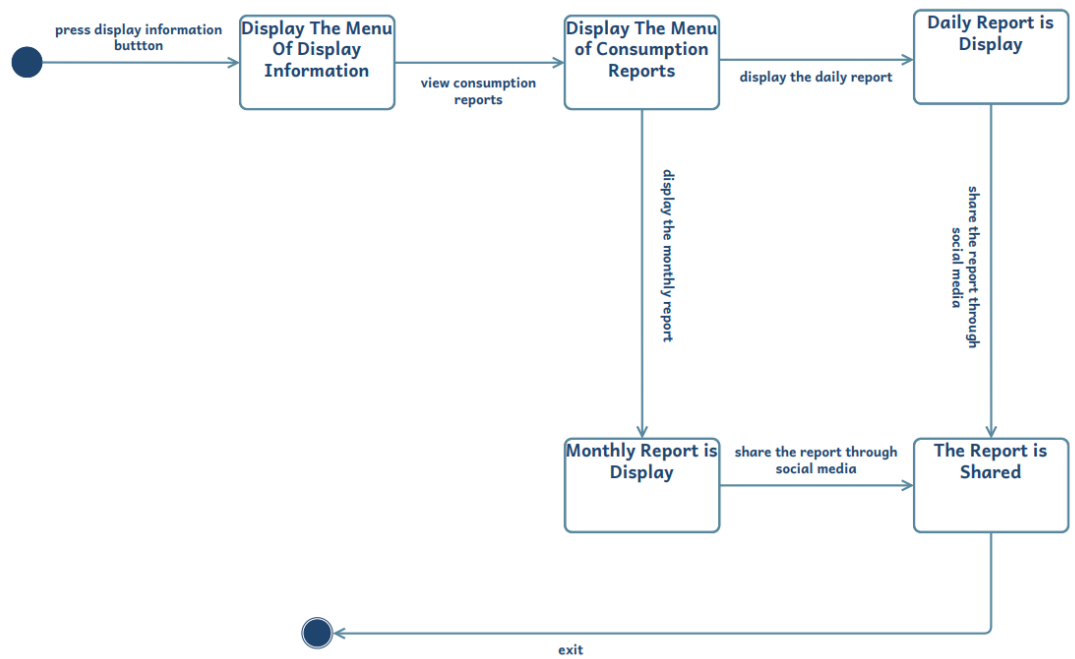


4.2. State Diagram

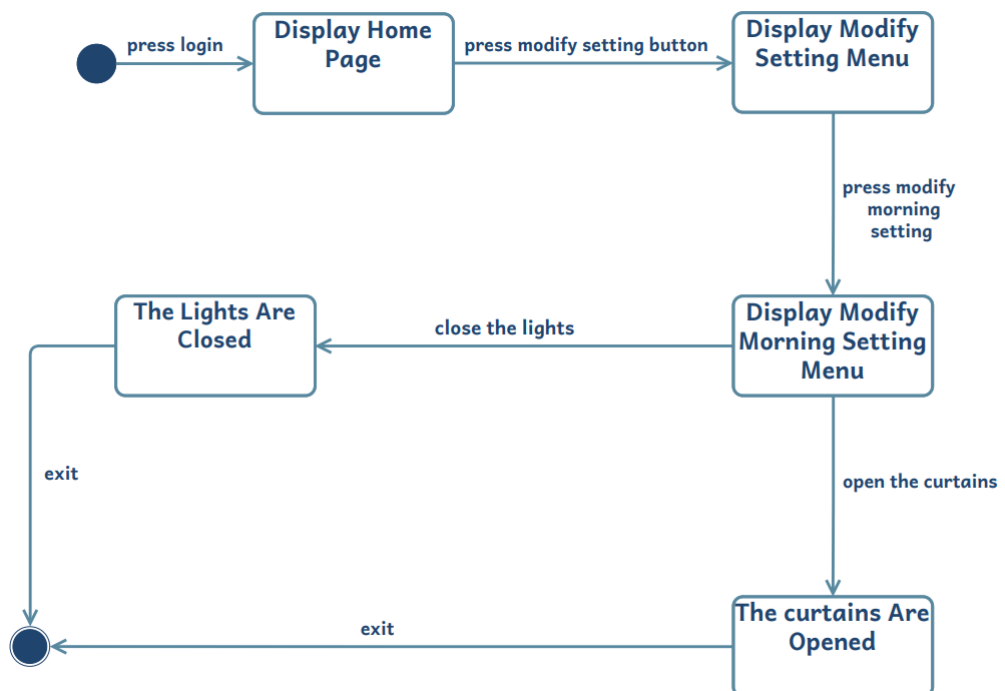
4.2.1. State Diagram 1: Modify device setting



4.2.2. State Diagram 2: Display monthly/daily report

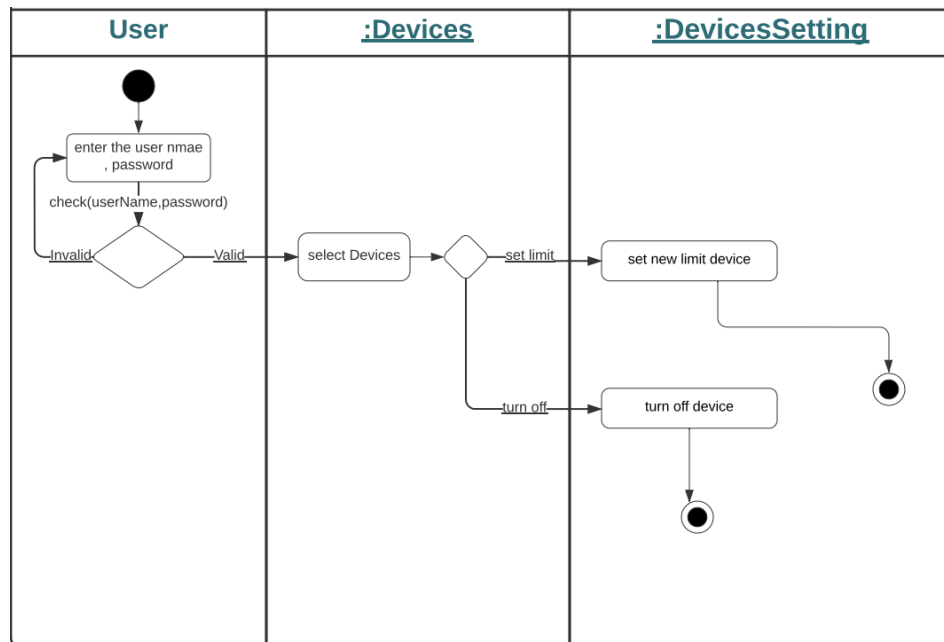


4.2.3. State Diagram 3: Modify morning setting

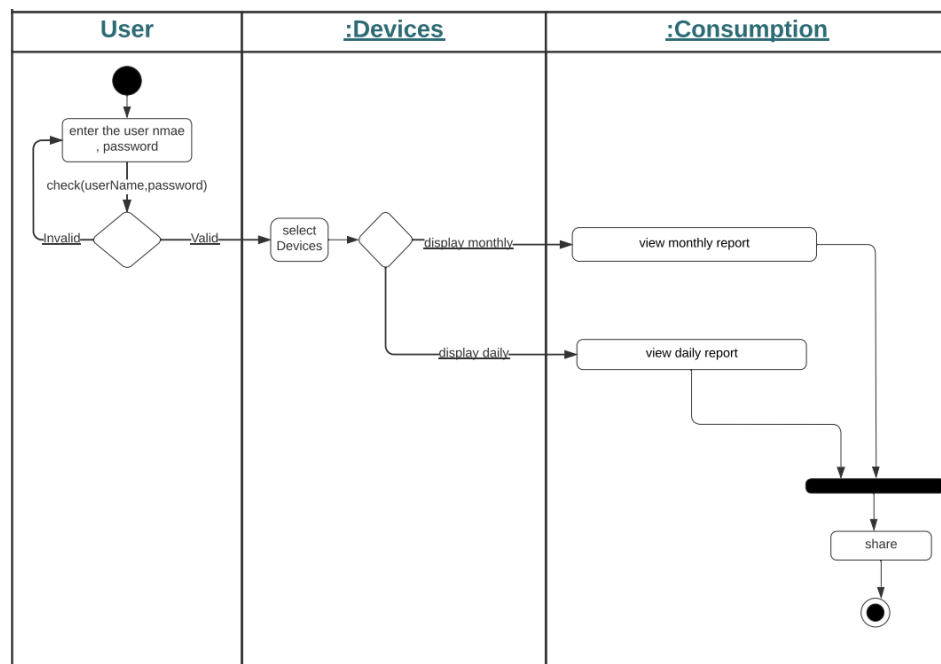


4.3. Activity Diagrams

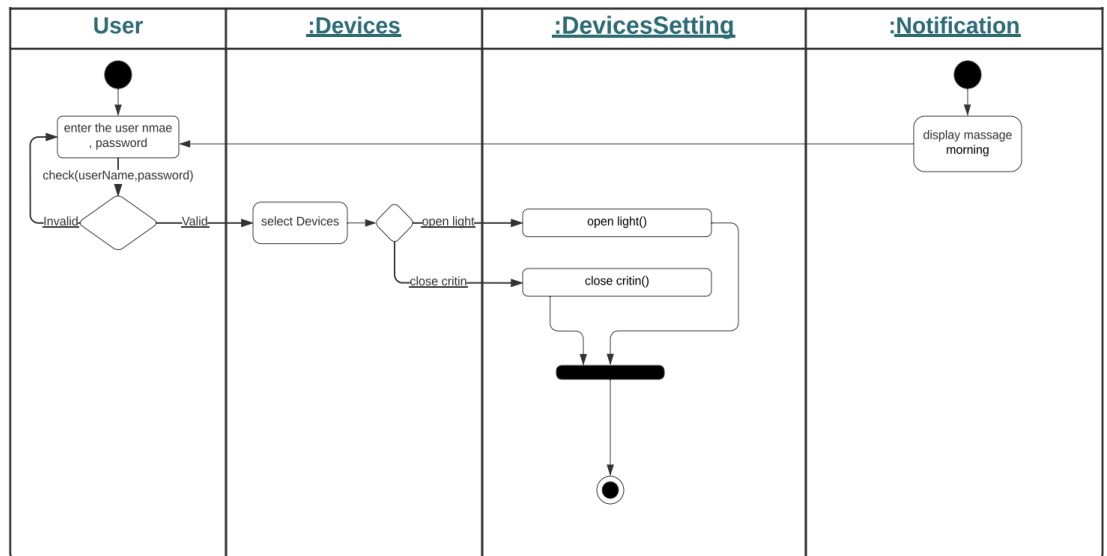
4.3.1. Activity Diagrams 1: Modify device setting



4.3.2. Activity Diagrams 2: Display monthly/daily report



4.3.2. Activity Diagrams 3: Modify morning setting



4.4. Testing

4.4.1. Objectives

- To identify potential system errors.
- Test the efficiency and work of all features of the system in a proper manner.
- To ensure that user interfaces function as expected and correctly.
- Check the flexibility of the design and how easy it is for the user to experience and see if it meets the requirements.

4.4.2. Testing Strategy

The main goal of testing is to ensure the system meets the requirements, and that it is functioning properly. It aims to detect errors and bugs as well. In our report the selected functionalities to be tested are Display monthly/daily report, Modify device setting, and Modify morning setting. The pass criteria here is the system result meeting the expected response, otherwise the test fails.

4.4.3. Approaching

The testing approach used in this report is a black box testing approach. This approach focuses more on testing the functionality and the behavior of the system. It also can test the interaction and behavior of system user interfaces by providing input and inspecting the output. This allows you to see how the system reacts to expected and unexpected user activities, as well as the system's reaction time, usability difficulties, and reliability concerns.

4.4.5. Test Plan 1

System: KAFA'A iOS/Android App.

Test case name: Modify device setting

Description: Allow the user to modify the limit settings of each device and the user can turn off the devices

Test Scenario: Check whether the system responds when the user enters the specified limit for each device

Precondition:

- Install the application.
- The user must be logged into the system.

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results	Actual Results	Pass / Fail
1	Check whether the system responds when the user enters the specified limit for each device	<ol style="list-style-type: none"> 1. The user is logged in. 2. The user presses the "Modify Settings" button. 3. The user selects "Modify Device Settings" 4. The user sets new limit settings for the devices he wants 5. The system adopts the new limit set by the user for devices 	Device name: air conditioner Outlet location: 20 Limit: 10 min Counter: connected to device App connection: connect	The device limit has been successfully modified	As expected	Pass
2	Check whether the system responds when the user enters the specified unexpected limit for each device	<ol style="list-style-type: none"> 1. The user is logged in. 2. The user presses the "Modify Settings" button. 3. The user selects "Modify Device Settings" 4. The user sets new limit settings for the devices he wants 5. The system adopts the new limit set by the user for devices 	Device name: air conditioner Outlet location: 20 Limit: -7 min Counter: connected to device App connection: connect	an error message occurs "Unexpected hour limit, please try again"	As expected	Pass

Postcondition: The new limit has been set

4.4.6. Test Plan 2

System: KAFA'A iOS/Android App.

Test case name: Display report

Description: The user can display the monthly/daily report of the electricity consumption for each device in his home and also share it on social media.

Test Scenario: Check if the system responds when the user enters a valid date.

Precondition:

- Install the application.
- The user must be logged into the system.

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results	Actual Results	Pass/Fail
1	Check if the system responds when the user enters a valid date	<ol style="list-style-type: none"> 1. The user is logged in 2. The user presses the " Display information " button. 3. The user selects " Display monthly/daily report" 4. The system will display the monthly/daily report to the user 	Date: 11-10-2020	The report has been displayed successfully	As expected	Pass
2	Check if the system responds when the user enters an Invalid date	<ol style="list-style-type: none"> 1. The user is logged in 2. The user presses the " Display information " button. 3. The user selects " Display monthly/daily report" 4. The system will display the monthly/daily report to the user 	Date: 32-10-2030	Error message with a blank page "Invalid date, please try again"	As expected	Pass

Postcondition: The monthly/daily report of the electricity consumption will be shown to the user

4.4.6. Test Plan 3

System: KAFA'A iOS/Android App.

Test case name: Modify morning setting

Description: The user can adjust the morning settings in case he wants to close the curtains or open the lights.

Test Scenario: Check if the system responds when the user commands to close the curtains

Precondition:

- Install the application.
- The user must be logged into the system.

Test Case ID	Test Scenario	Test Steps	Test Data	Expected Results	Actual Results	Pass/Fail
1	Check if the system responds when the user commands to close the curtains	<ol style="list-style-type: none"> 1. The user logs into the application 2. The user presses the "Modify Settings" button. 3. The user selects " Modify morning settings" 4. The user presses the "close curtains " button. 5. The system will close the curtains. 	Device name: curtains 1 Status: closed Counter: connected to device App connection: connect	Curtains closed successfully	As expected	Pass
	Check if the system responds when the user commands to close the curtains	<ol style="list-style-type: none"> 1. The user logs into the application 2. The user presses the "Modify Settings" button. 3. The user selects " Modify morning settings" 4. The user presses the "close curtains " button. 5. The system will close the curtains. 	Device name: curtains 1 Status: closed Counter: connected to device App connection: not connect	An error message occurs "Make sure the app is connected to the curtains"	As expected	Pass

Postcondition: The curtains will be closed.

4.4.7. Equivalence Partitioning

Test Conditions: limit time (from 1 min to infinite)

Invalid Partition	Valid Partition
<ul style="list-style-type: none"> • 0 min • -1 min • -2 min • -3 min • 	<ul style="list-style-type: none"> • 1 min • 2 min • 3 min • 4 min •

4.4.8. Boundary Value Analysis

Test conditions: Date (day (1-31))

Invalid Partition - Valid Partition Lower Boundary		Invalid Partition - Valid Partition Upper Boundary	
BV Below the Boundary	BV Above the Boundary	BV Below the Boundary	BV Above the Boundary
0	1	31	32

4.4.9. Decision Table Testing

Test conditions: Valid date

Test Steps:

- The user enters a valid date.
- If the date is valid, the report is displayed on that day.
- If the date is invalid, an error message "Invalid date, please try again" is displayed.

Condition	Action
Enter valid date	Expected Response
T	The report has been displayed successfully
F	Error message "Invalid date, please try again"

Test Login User

Test Steps:

- User enters username and password
- Click on login

Condition		Action
Enter username	Enter password	Expected Response
F	F	Error: Email and Password incorrect Please Try Again
F	T	Error: Email and Password incorrect Please Try Again
T	F	Error: Email and Password incorrect Please Try Again
T	T	Login processed successfully

4.5. Conclusion

Finally, the project discusses a major problem facing the community. The main problem is the high prices of electricity bill in Saudi Arabia, due to people's lack of awareness of the extent of their electricity consumption.

The solution proposed is creating KAFA'A SYSTEM. It is a helpful system, which is Help not to waste electrical energy in vain. It helps to reduce user's consumption of electrical energy by sending notifications, displaying daily and monthly reports for each device. In addition, turns off the lights and opens the curtains to take advantage of the sunlight instead of consuming electrical energy during the morning.

Reference

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- 5 Biggest Causes of Wasted Energy. (2016, January 4). Electro Industries/GaugeTech. <https://www.electroind.com/5-biggest-causes-of-wasted-energy/>

Appendix A

نصيب الفرد والمشارك من الطاقة الكهربائية المباعة من عام 2010م إلى 2020م



إنتاج واستهلاك الطاقة الكهربائية من عام 2010م إلى 2020م

