

# REQUIREMENTS SPECIFICATION

COMPUTER ENGINEERING PROJECT 2



*A light guidance system*

GROUP 4

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# 1 Introduction

Glow2Go is a light guidance system which purpose is to guide elderly people living on their own to the bathroom at night using motion sensors and led strips on the floor.

The requirements are based of the problem description in "week 1 introduction slides", however some things have been altered and added (described in sections 4 and 5).

## 2 Reading guide

The following section contains a problem description giving a brief overview of the problem at hand and the components needed to solve it.

This is followed by a section on assumptions and limitations of our system but also our users and their behaviour. This section covers mostly what our system is *not* designed to do while the rest of the specification will document what it can do.

The clarifications section seeks to make clear and define some terms that are used in the following sections. We also clarify what is being tracked as the user moves between rooms and what the alarm does.

The following section contains a brief explanation of what happens in the overlap between the active and inactive hours of the system while the user is using the system. This section and the previous one seeks to highlight some important parts of our system that aren't immediately clear and are hard to specify in use cases.

The following section, Use case diagram, is a use case diagram showing each actor and use case and their relation to each other. This serves as a first introduction to our solution.

The section, Use case overview, gives as the name suggest gives another overview with a short description of each use case.

The last two sections serves to as primer for, Use Cases, a detailed explanation of each use case including their pre- and post-conditions, main scenario (or flow through the use case) and finally exceptions that mean the use case cannot be completed.

The last section contains basic mockups for the user interface (UI) for the web interface. These are not final and should be used mostly as references when reading the use cases that pertain to the web page. They serve as a guide to link the buttons mentioned in a use case to the buttons on the UI mockup to help with understanding.

### 3 Problem description

Our task is to create a distributed system that helps the user (referred to as resident) of the system navigate safely to the bathroom at night. It should detect when a resident leaves their bed, guide them to the bathroom using ground-level lights, and then back to their bed. The system must cover at least 2 rooms (a bedroom and a bathroom), turning on lights as needed and turning on automatically between 22:00 and 09:00 by default. It should report event details to a monitoring server and provide a webpage where logs are stored and the system can be customized by the resident or a caregiver i.e change the active hours. Components include movement sensors and LED lights, with support for Zonal Intercommunication Global-standard (Zigbee) and Python on Raspberry Pi. Communication should follow Message Queuing Telemetry Transport (MQTT) protocol with JavaScript Object Notation (JSON) encoding as well as follow the Healthcare Equipment Usage and Context Data (HEUCOD) recommendations.[3]

### 4 Assumptions and limitations

- I. We assume that when the resident gets out of bed they only move between the bathroom and bedroom (They can turn around if they want to). Moving outside the path is unspecified behavior (that may lead to a false alarm).
- II. The resident only starts from their bedroom. If the resident is outside his room when the active hours begin the system does not activate before the next time the resident enters the bedroom.

### 5 Clarifications

This section seeks to clarify some of the terms what we're using and how we're using them. It also serve to clarify what is meant when we say we log data and what data is logged.

#### 5.1 The user actor

There are two different actors in our diagrams and use cases, these being **Resident** and **Caregiver**, for use cases where both are the primary actor (UC7, UC8, UC9 and UC10) we choose to describe the caregiver/resident as a user. Meaning the resident and Caregiver inherit from an **abstract** actor **user**.

Meaning use cases where either the caregiver or resident can act out the actions a "user" is used to describe both the resident and caregivers actions.

#### 5.2 What is tracked

The system needs to be able to measure the residents habits during the night. These include when the resident leaves the bed, how long before they reach their bath-

room, how long they stay in the bathroom and finally how much time it takes them to get back to their bedroom.

This is measured from the moment the resident leaves their bedroom and until they get back to their bedroom. When collecting data we collect the full walk and stores the timings locally before finally uploading it when the resident gets back to their bedroom.

This timer is referred to as "timer event" in the use cases.

### **5.3 The alarm**

As well as being a light-guide for elderly people, the system also has the ability to detect a potential fall or other another hazard from which the resident would require assistance.

The alarm system falls outside the scope of Glow2Go and will not be implemented. It will simply be referred to as "the alarm" or "sounding the alarm" without specifying or having knowledge of its implementation at all.

If the alarm has been sounded relevant information could be stored in a direct interface in which the resident or another company could implement their configuration of the alarm.

A limitation of the system is that the system only detects the absence of movement. Therefore the system is unable to detect a potential fall in the bedroom as it does not distinguish between laying on the floor or in the bed.

### **5.4 Overlap between active and inactive hours**

If the resident is walking to or from his bathroom and the time changes to be outside the active hours the resident will finish that walk before the system shuts off.

This has the possibility of false sounding the alarm if they get up while the system is active and not going back to their bed however we feel this is better than shutting off the system and therefore the lights off leaving them stranded.

## **6 Use case diagram**

The use case diagram in figure 1 shows how the caregiver and resident actors can interact with the glow2go system and which stakeholders are affected. It also shows an overview of the use cases and how they relate to each other. A brief description of these can be found in the following section, Use case overview.

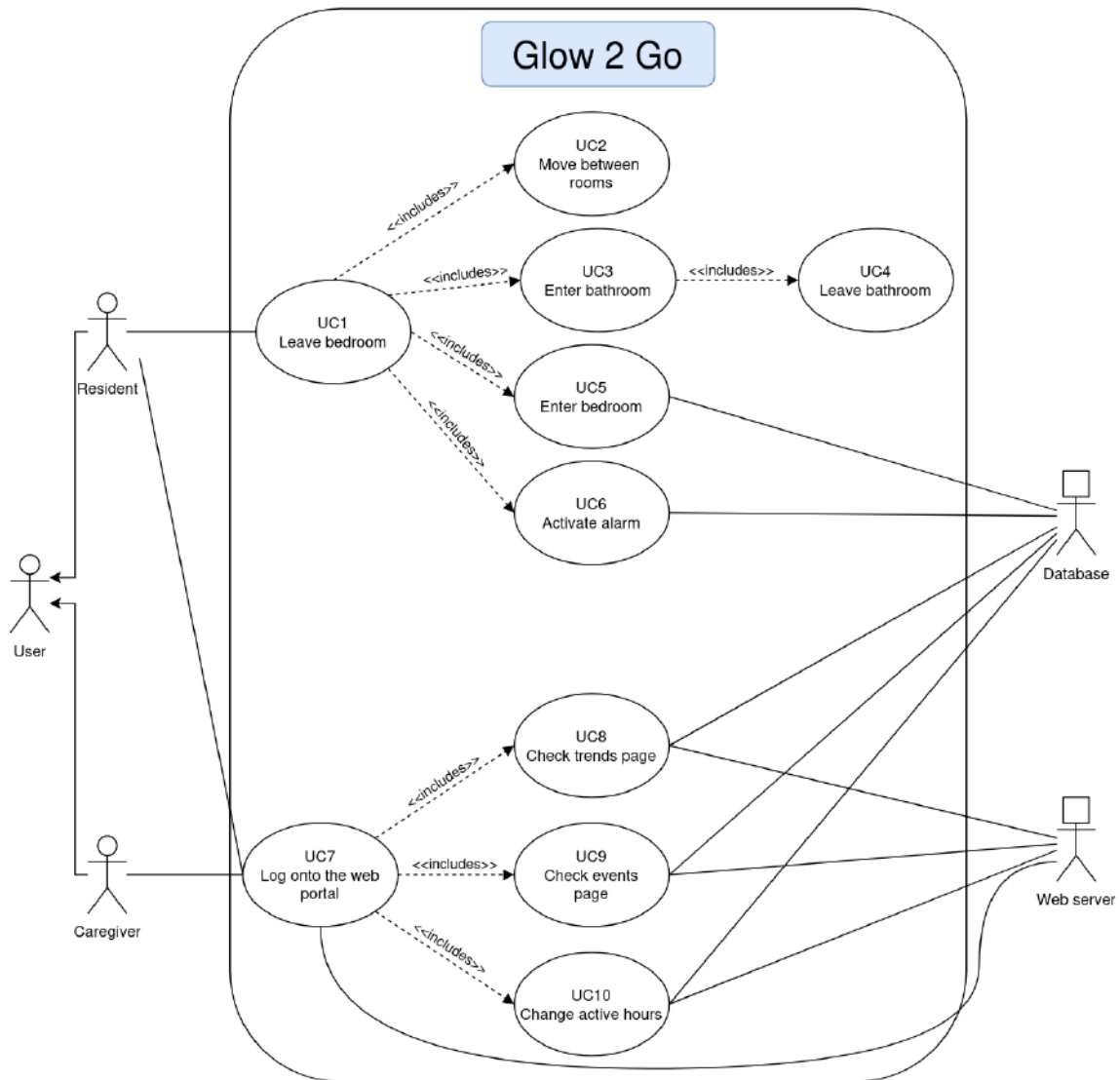


Figure 1: Use case diagram showing the relationship between actors and stakeholders for each use case.

## 7 Use case overview

In table 1 a short description is given of all the different use cases. These are all described in detail in the following section, Use Cases.

Use case nr.	Use case name	Description
UC1	Leave bedroom	The resident gets out of bed and lights turn on in the bedroom and the next room. The resident leaves their bedroom and a timer event starts.
UC2	Move between rooms	The resident moves to a different room and the light in room before the previous room turn off and the light in the next room turn on.
UC3	Enter bathroom	The resident enters the bathroom and the current time is logged locally.
UC4	Leave bathroom	The resident exits the bathroom, the current time is logged locally.
UC5	Enter bedroom	The resident enters their bedroom the timer event then writes the relevant time stamps to the server. The only light that is on is in the bedroom and the next room. This light turns off after no movement has been detected for 5 minutes.
UC6	Activate alarm	After the resident has left the bedroom and no movement has been detected for 2 hours a alarm is activated.
UC7	Log onto the web portal	The user enters web page url and logs in with username and password. User is now on the home page.
UC8	Check trends page	The user presses the trends button and gets to the trends page and can the trends for "total time", "bathroom time" and "travel time."
UC9	Check events page	User presses the events button on the home-page all events are displayed in a scrollable format.
UC10	Change active hours	User presses the settings button on the home-page and gets to the settings page where the user can change the active time.

Table 1: An overview of the use cases describing the functional requirements

## 8 Use Cases

In this section all the functional requirements are presented using the use cases which were referred to in the use case diagram in figure 1.

Name	Leave bedroom
Use Case Nr.	UC1
Primary Actor	Resident
Stakeholders	Resident
Pre-conditions	<ol style="list-style-type: none"><li>1. The resident is in their bedroom.</li><li>2. The time is between the specified hours in UC10.</li></ol>
Post-conditions	<ol style="list-style-type: none"><li>1. A timer event has been created and the starting time has been logged locally.</li><li>2. The light in the bedroom current room and next room is on.</li></ol>
Main Scenario	<ol style="list-style-type: none"><li>1. The resident gets out of their bed.</li><li>2. When movement is detected in the bedroom the light turns on in the bedroom and in the next room to guide the resident out of the bedroom.</li><li>3. The motion sensor in the next room is activated signaling the resident has left their bedroom.</li><li>4. A timer event is created.</li><li>5. The timer event logs the current time as the starting time locally.</li></ol>
Extensions	<ol style="list-style-type: none"><li>3a. If the resident does not leave the bedroom (no movement is detected in the next room) and no movement is detected in the bedroom after 5 minutes it's assumed that the resident went back to bed. The light in the bedroom turns off and nothing is logged in the database.</li></ol>

Table 2: UC1



Name	Move between rooms.
Use Case Nr.	UC2
Primary Actor	Resident
Stakeholders	Resident
Pre-conditions	<ol style="list-style-type: none"> <li>1. UC1 is completed.</li> <li>2. Light in the current room is on.</li> <li>3. Light in the next room is on.</li> <li>4. Light in the previous room is on.</li> </ol>
Post-conditions	<ol style="list-style-type: none"> <li>1. The light in the room before the previous room has turned off (two rooms back from where the resident is at this point).</li> <li>2. The light in the room after the one the resident has entered has turned on.</li> <li>3. The resident has entered the next room.</li> </ol>
Main Scenario	<ol style="list-style-type: none"> <li>1. Resident enters a new room.</li> <li>2. The light in next room turns on.</li> <li>3. The light in the room before the previous room turns off (two rooms back from where the resident is now).</li> </ol>
Extensions	

Table 3: UC2

Name	Enter bathroom.
Use Case Nr.	UC3
Primary Actor	Resident
Stakeholders	Resident
Pre-conditions	1. UC1 is complete.
Post-conditions	<ol style="list-style-type: none"> <li>1. The resident is in the bathroom.</li> <li>2. The timer event has logged the time for when the resident entered the bathroom locally.</li> <li>3. Lights are on in bathroom and room next to bathroom.</li> </ol>
Main Scenario	<ol style="list-style-type: none"> <li>1. The resident enters the bathroom.</li> <li>2. The light in the room before the previous room turns off (two rooms before the bathroom).</li> <li>3. The timer event logs, locally, the time that the resident enters the bathroom.</li> </ol>
Extensions	

Table 4: UC3

Name	Leave bathroom.
Use Case Nr.	UC4
Primary Actor	Resident
Stakeholders	Resident
Pre-conditions	1. UC3 is completed.
Post-conditions	1. The resident has left the bathroom. 2. The timer event has logged the time for when the resident left the bathroom locally. 3. Light are on in next room current room and bathroom.
Main Scenario	1. The resident leaves the bathroom. 2. The timer event locally logs the time for when the resident leaves the bathroom (the motion sensor in the next room is activated). 3. Lights turn on in next room.
Extensions	

Table 5: UC4

Name	Enter bedroom.
Use Case Nr.	UC5
Primary Actor	Resident
Stakeholders	Resident and database
Pre-conditions	1. UC1 is complete.
Post-conditions	<ol style="list-style-type: none"> <li>1. The resident is in their bedroom.</li> <li>2. The timer event has logged the time for entering the bedroom. The timer event finishes and is done logging for this trip. The log is sent to the database.</li> <li>3. All lights are turned off.</li> </ol>
Main Scenario	<ol style="list-style-type: none"> <li>1. Resident enters their bedroom.</li> <li>2. The timer event logs, in the database, all the recorded times for this trip.</li> <li>3. All lights except in the bedroom and room next to bedroom turn off.</li> <li>4. Lights in bedroom and next room turn off when no movement has been detected for 5 minutes.</li> </ol>
Extensions	4a If movement is detected, handle as UC1.

Table 6: UC5

	Activate alarm
Use Case Nr.	UC6
Primary Actor	Resident
Stakeholders	Resident and database
Pre-conditions	<ol style="list-style-type: none"> <li>1. UC1 has been completed.</li> <li>2. The time is between the specified hours in UC10.</li> <li>3. UC5 has not been completed.</li> </ol>
Post-conditions	<ol style="list-style-type: none"> <li>1. The alarm has activated.</li> </ol>
Main Scenario	<ol style="list-style-type: none"> <li>1. No motion detector has detected movement in the past two hours.</li> <li>2. The timer event logs the time and that an alarm has been activated and the timer event finishes.</li> <li>3. Alarm is activated.</li> </ol>
Extensions	<ol style="list-style-type: none"> <li>1a. Movement is detected by a motion sensor and the two hour window before alarming is reset.</li> </ol>

Table 7: UC6

The following four use cases specify how the web interface works. For each use case there are references to specific buttons and UI elements. Please refer to section 10, UI Mockup for an early view of what the UI will look like. Note that this is not final as is also specified in section 10.

Name	Log onto the webpage
Use Case Nr.	UC7
Primary Actor	Resident, caregiver
Stakeholders	Resident, caregiver and webpage
Pre-conditions	
Post-conditions	1. The user is logged in and on the homepage.
Main Scenario	<ol style="list-style-type: none"> <li>1. The user enters the webpage URL .</li> <li>2. On the webpage the user is prompted for a username and password.</li> <li>3. The user enters their password and presses login.</li> <li>4. The user is now on the homepage and sees three buttons for the Trends page (UC8), Events page (UC9) and Settings page (UC10).</li> </ol>
Extensions	3a. If incorrect credentials are entered, the user will be prompted with an error message and will not be logged into the webpage.

Table 8: UC7

Name	Check trends page
Use Case Nr.	UC8
Primary Actor	Resident, caregiver
Stakeholders	Resident, caregiver, database and webpage
Pre-conditions	1. UC7 is completed and the user is logged in.
Post-conditions	1. The user is informed about their trends through graphs and averages.
Main Scenario	<ol style="list-style-type: none"> <li>1. On the homepage the user presses the trends page buttons.</li> <li>2. The user is presented with a page containing a graph.</li> <li>3. The page contains two buttons that changes which graph is shown. <ol style="list-style-type: none"> <li>(a) The "Total time" button shows a graph of the total time from leaving the bedroom to getting back to the bedroom.</li> <li>(b) The "Time in Bathroom" button shows a graph of the total time used in the bathroom.</li> </ol> </li> <li>4. On the page an average time spend in total and an average time spend in the bathroom is shown.</li> </ol>
Extensions	

Table 9: UC8

Name	Check events page
Use Case Nr.	UC9
Primary Actor	Resident, caregiver
Stakeholders	Resident, caregiver, database and webpage
Pre-conditions	1. UC7 is completed and the user is logged in.
Post-conditions	1. The user is informed about individual events.
Main Scenario	<ol style="list-style-type: none"> <li>1. On the homepage the user presses the events buttons.</li> <li>2. On the events page the user is presented with a list of every trip they have taken while the system is active. This data includes <ol style="list-style-type: none"> <li>(a) Event number.</li> <li>(b) Start time and date</li> <li>(c) Time to reach toilet <ol style="list-style-type: none"> <li>i. If applicable</li> </ol> </li> <li>(d) Bathroom time <ol style="list-style-type: none"> <li>i. If applicable</li> </ol> </li> <li>(e) Time to reach bed <ol style="list-style-type: none"> <li>i. If applicable</li> <li>ii. This is the time it takes the user to get back to their bedroom after leaving the bathroom</li> </ol> </li> <li>(f) Total time <ol style="list-style-type: none"> <li>i. this is the time it takes from when the user leaves the bedroom until he enters the bedroom again.</li> </ol> </li> <li>(g) If the alarm activated the event will be coloured red.</li> </ol> </li> </ol>
Extensions	

Table 10: UC9



Name	Change active hours.
Use Case Nr.	UC10
Primary Actor	Resident, caregiver
Stakeholders	Resident, caregiver, database and webpage
Pre-conditions	1. UC7 is completed and the user is logged in.
Post-conditions	1. The active hours have been updated.
Main Scenario	<ol style="list-style-type: none"> <li>1. On the homepage the user presses the setting page button.</li> <li>2. The user enters a new start time, end time or both.</li> <li>3. The user presses save button.</li> </ol>
Extensions	<ol style="list-style-type: none"> <li>1a. If the user does not change the active hours and exits the settings page the previous active hours still apply.</li> <li>3a. If the user does not press the save button and exits the settings menu a confirmation prompt will appear asking the user if they are okay with the change being discarded.</li> <li>3b. If the system is active when the user presses save an error message appears with text "Active hours cannot be changed while the system is active!" and the active hours are not updated.</li> </ol>

Table 11: UC10

## 9 Non-functional requirements

These non-functional requirements describe (testable) qualities that our light guidance system and web server should fulfill. Briefly we want the light guidance system to work without user input and be configurable for multiple rooms.

### 1. Sensors and actuators

#### (a) **Compatible motion sensors**

Aqara Motion Sensor model RTCGQ11LM or model MS-S02.

#### (b) **Compatible light strip**

Gledopto RGB+CCT LED Strip Light Kit model GL-MC-001PK.

#### (c) There will be one compatible light strip and one compatible movement sensors for each room.

### 2. Guidance system

#### (a) The guidance system and the logging system should work independently

Guidance system as a critical part.

Logging/web server as a non-critical part.

It's important that the guidance system can work without the web application and logging part so that a user can be guided to the toilet even if the server goes down or if they lose internet.

#### (b) The guidance system should work for at least 5 rooms.

#### (c) The guidance system should work without input from the resident.

#### (d) The guidance system is run on the Raspberry Pi 5 (Raspberry Pi Ltd, Cambridge UK).

#### (e) The Raspberry communicates with the server. hosting the web application and the database, such that events can be logged and the active hours of the system is as specified.

### 3. Server

#### (a) The data logged, is stored on a database hosted on an external server.

#### (b) The website containing the logs is also hosted on an external server hosting the web application.

### 4. Active hours

#### (a) The system default is active from 22 : 00 - 09 : 00. This can be changed in UC10.

#### (b) If the resident starts a guided walk in the active hours that goes outside the active hours that run will be finished before the systems shuts off.

## 10 UI Mockup

These UI mockups serve as a guide when reading use case 7-10.

None of the screens are final but they serve to show a rough estimate of where each UI element goes and the relevant buttons mentioned in each use case 7-10.

A hand-drawn UI mockup of a login page for 'GLOW2GO'. The mockup is drawn on a grid background. At the top left, the text 'GLOW2GO' is written in a large, bold, sans-serif font. In the top right corner, there are three small icons: a horizontal line, a square, and an 'x'. Below the logo, the word 'Username' is written in a smaller, sans-serif font. Underneath this label is a rectangular input field containing the text 'Username'. Below the input field, the word 'Password' is written in a smaller, sans-serif font. Underneath this label is a rectangular input field containing six asterisks '\*\*\*\*\*'. At the bottom center of the mockup, there is a rounded rectangular button containing the text 'Log in'.

Figure 2: The user login page for accessing the webpage. Relevant for UC7.

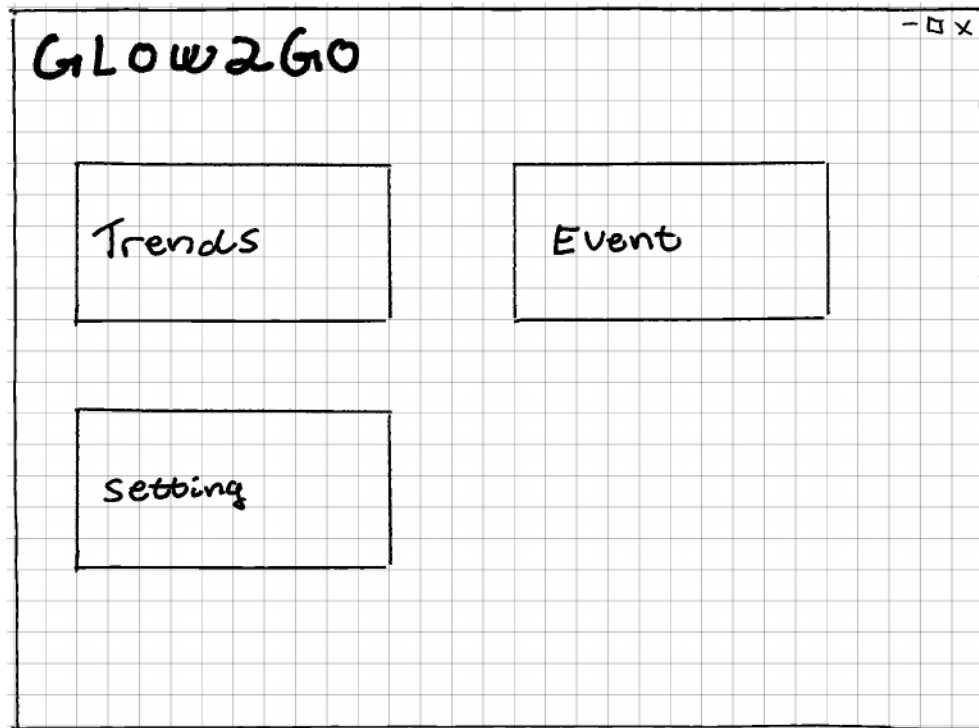


Figure 3: The homescreen serves as link between the three relevant pages. Where UC7 ends. Relevant for UC8-10.

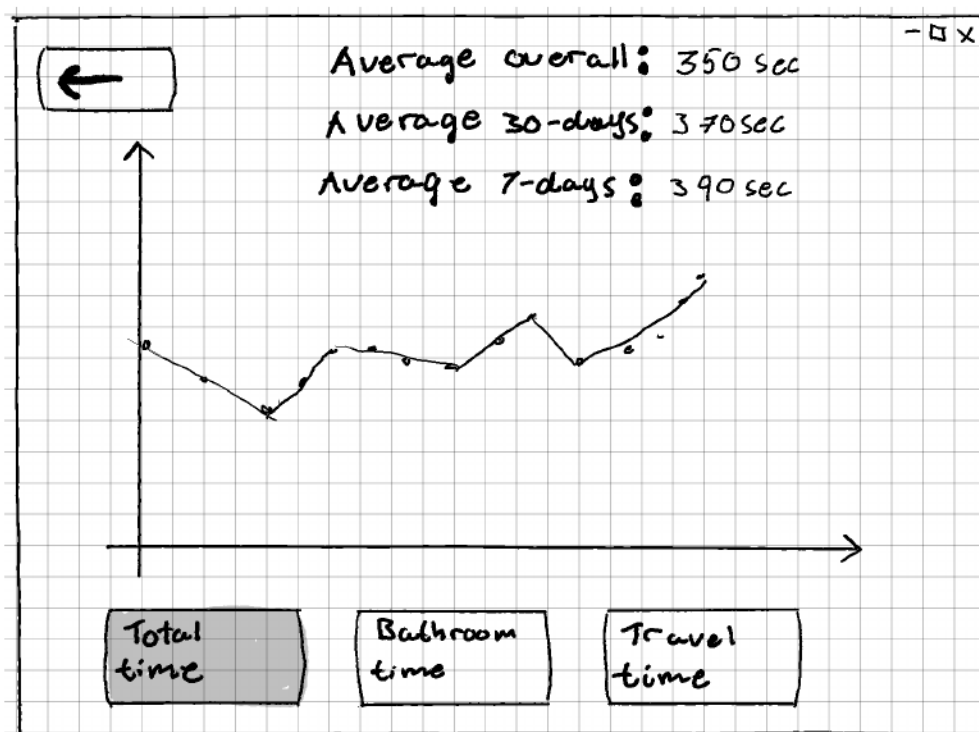
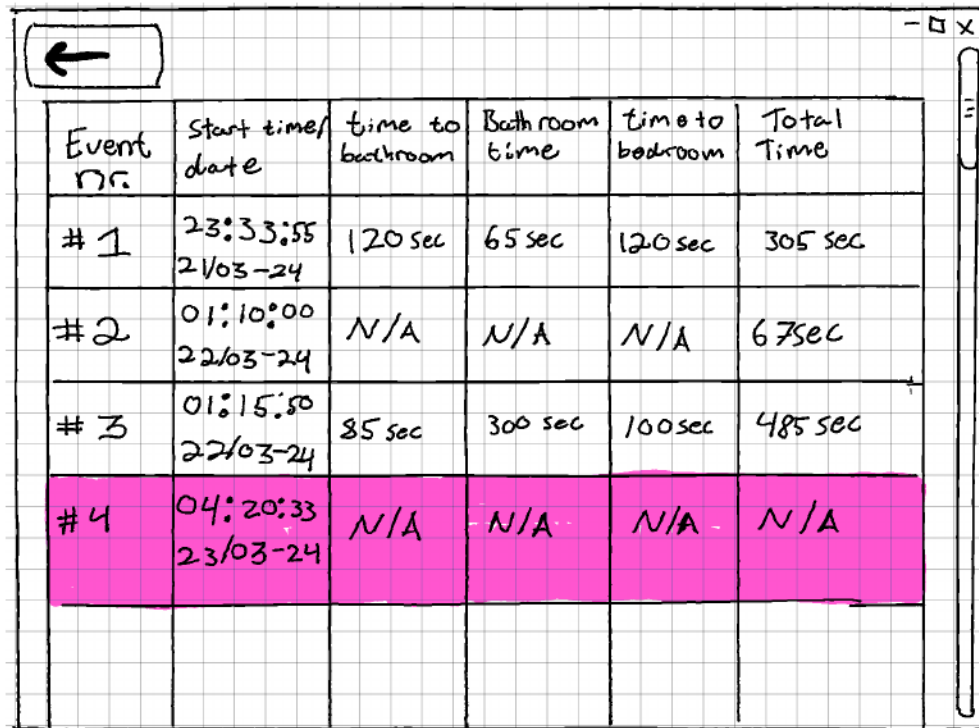
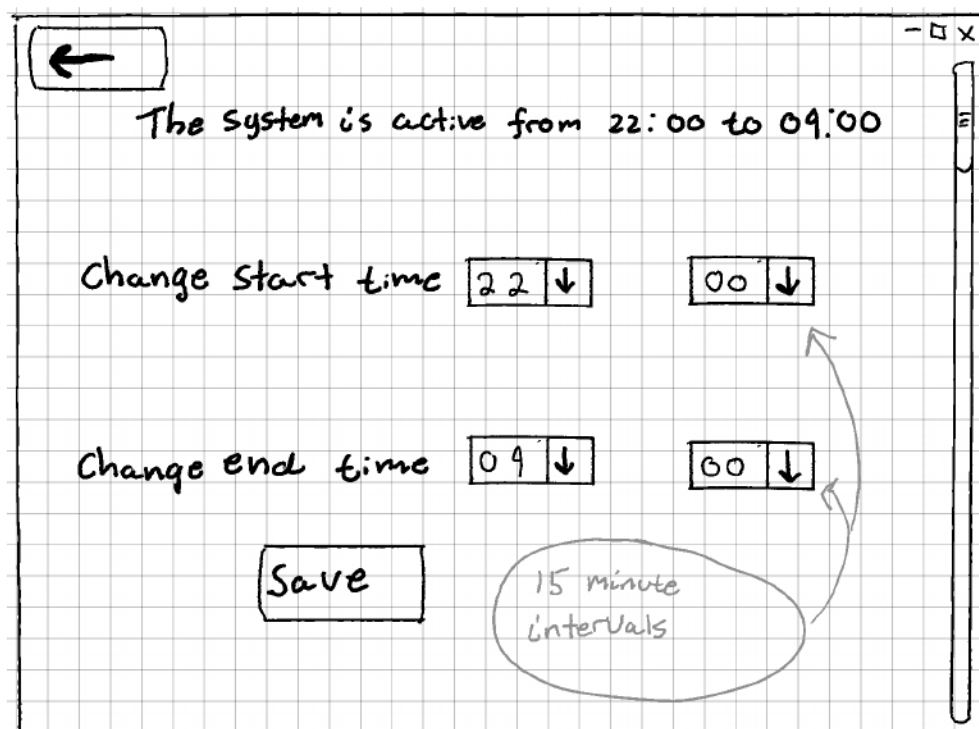


Figure 4: The trend pages will a graph of how long the resident spends on various parts of the trip. It will also show an average of all time and a 30-day and 7-day average as well. Relevant for UC8.



Event No.	Start time/date	time to bathroom	Bathroom time	time to bedroom	Total Time
#1	23:33:55 21/03-24	120 sec	65 sec	120 sec	305 sec
#2	01:10:00 22/03-24	N/A	N/A	N/A	67 sec
#3	01:15:50 22/03-24	85 sec	300 sec	100 sec	485 sec
#4	04:20:33 23/03-24	N/A	N/A	N/A	N/A

Figure 5: Each event will be shown on this page and the relevant times. Some fields might be *not applicable* if the resident did not reach the bathroom. The red field shows events where an alarm was triggered. Relevant for UC9



The system is active from 22:00 to 09:00

Change start time 22 00

Change end time 09 00

Save

15 minute intervals

Figure 6: The settings page to change the active hours. The minute setting can be changes with a granularity of 15 minutes. Relevant for UC10.

## 11 References

- [1] Software Engineering by Ian Sommerville, *Literature on Software Engineering by Ian Sommerville*, Ian Sommerville, Software engineering ISBN: 9781292096148 10th edition, 2016.
- [2] DrawIO, *Draw.io Software used to draw use case diagram.*, <https://app.diagrams.net/>
- [3] Problem description, *Original problem description for the Glow2Go project*, Available on Brightspace under the 'content' tab of the course 'Computertechnologiprojekt II (F24.285201U030.A)'.