| CptS 484: Software Requirements |
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| WRS Evolution |
| Requirements Elicitation |

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# **Revision History**

| Date | Version | Changes | Editor |
| --- | --- | --- | --- |
| 10/9/2022 | 1.0 | Initial document | Team edit |
| 10/11/2022 | 1.1 | Added issues | Team edit |
| 10/15/2022 | 1.2 | Added WRS section | Team edit |
| 10/16/2022 | 1.3 | Finish WRS and proofread | Team edit |

# **Introduction**

## **Purpose**

The purpose of this project is to develop an application for blind and visually impaired individuals in order for them to be able to navigate indoors. There are several factors involved with this process, as blind and visually impaired individuals need guidance between floors and around obstacles in real time.

This WRS document was created to be used for further analysis of the problems or issues found in the Preliminary Requirements Document (PRD). It will detail the steps that Team SSH followed to come to a consensus and rectify the issue.

The targeted audience will be all the stakeholders of the Theia project including developers and project sponsors.

## **Scope**

Theia is designed specifically for blind and visually impaired people. This application assists with navigation when walking indoors. It will provide clear, concise, and detailed directions to navigate the user. Theia’s highest priority is the safety of its users. It will calculate how long it will take the user to reach its destination, how many steps the user will take until the next instruction and alerts the user of obstacles.

## **Objectives and Success Criteria**

The project objectives and success criterias are that the software must:

* Navigate users to their desired location
* Detect obstacles so users can navigate safely
* Allow users to place emergency calls for assistance if needed
* Be accessible and easy to use for people with visual impairments

## **Definitions, Acronyms, and Abbreviations**

| **Term** | **Definition** |
| --- | --- |
| Theia | The smartphone application to be built |
| PRD | Preliminary Requirements Document |
| WRS | World Requirements Specification |

## **Overview**

The first section in this document gives an introduction with respect to the purpose, scope as well as definitions and acronyms used in the rest of the document. Lastly, this first section gives a list of criteria for success and an overview of what to expect in the rest of the document.

In the second and third section, the issues found in the project for the Theia project will be identified, options for resolution raised and the decisions taken will be enumerated along with the rationale for such decisions.

Section four contains two of the most important topics for the WRS document: W, which contains the problems and their corresponding goals along with backwards/forwards traceability for these components, and RS, where functional requirements, non-functional requirements, and the specifications and satisfaction of the previous issues noted in earlier sections. The W also contains stakeholders and various improved aspects of the domain, functional objectives and non-functional objectives.

The fifth and sixth sections contain the preliminary prototype and the interface mock-ups for our prototype and the seventh section contains the user manual for the current build.

Section eight contains our references utilized throughout the WRS development process.

# **Preliminary Definition**

## **Preliminary Domain, Stakeholders, Functional and Non-Functional Objectives**

| **PD\_ID** | **Preliminary Domain Description** |
| --- | --- |
| PD1 | The app to be deployed on various smartphones and supported mobile devices. |
| PD2 | Indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators. |
| PD3 | Elderly and hearing impaired individuals that may have other issues such as vision, muscle weakness or memory issues. |

## 

| **PD\_ID** | **Preliminary Stakeholders Description** |
| --- | --- |
| PSH-1 | The target user for the app, a blind or visually impaired person |
| PSH-2 | An assistant who is available to aid the user |

## **Preliminary Functional Requirements**

| **PFR\_ID** | **Preliminary Functional Requirements Description** |
| --- | --- |
| PFR1 | Accepting from the user the destination location to go. |
| PFR2 | Figuring out the routes to reach the destination, and informing the user of the options (if there are more than one), and accepting the user's preference. |
| PFR3 | Telling the user to walk a distance (e.g., 2 minutes before turning, or walk for 30 steps) |
| PFR4 | Telling the user to stop and turn at the correct place. |
| PFR5 | Relaying to user about an obstacle and telling the user what to do in order to avoid collision |
| PFR6 | Placing emergency calls and messages, possibly after detecting a fall or when the system has lost its current location. |
| PFR7 | Ability to recalculate route if the user overshoots their destination. |

## **Preliminary Non-Functional Requirements**

| **PNFR\_ ID** | **Preliminary NFR Description** |
| --- | --- |
| PNFR1 | Generating desired sentences and representing them pictorially as well as associating with a sound/voice. |
| PNFR2 | The system shall help the user safely navigate indoors. |
| PNFR3 | The system shall lead the user through the fastest route. |
| PNFR4 | The system shall lead the user through the route the user would feel most comfortable with. |
| PNFR5 | The system shall be usable for blind people. |
| PNFR6 | The system shall be ubiquitous. |
| PNFR7 | The system shall be customizable for every user: e.g. volume, the interval of instructions, etc. |
| PNFR8 | The system shall be easily extensible to accommodate the following typical variations: variance in interface, language, definitive needs of the user, new features, new sensors and hardware, etc. |
| PNFR9 | The system shall allow users to contact an assistant. |
| PNFR10 | The system shall be able to contact emergency services in case of distress. |
| PNFR11 | The system shall be usable on all platforms (IOS, Android). |
| PNFR12 | Based on the user defined schedule, the application will suggest possible actions and accept the user’s choice. |

# **Issues with the Preliminary Definition Given**

## **Domain Issues**

| **Domain Issue ID** | **Domain Issue Description** | |
| --- | --- | --- |
| DI1 | PD2 | PD2. Indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators. |
| * Incomplete: How will our application know which floor the user is currently located on. | |
| Option 1 | Beacons in each floor will be able to relay data such as floor information to the application locally. |
| Option 2 | GPS can keep track of the user through elevation changes. |
| Option 3 | The user can announce the floor they are on between transitions. |
| Choice | Option 1 |
| Rationale | Option 1 allows us to utilize existing technology to accurately relay user position in real time, due to the beacon communicating local positions in detail. |
| Revised wording | 4.1.3.1 | |

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| **Domain Issue ID** | **Domain Issue Description** | |
| --- | --- | --- |
| DI2 | PD3 | Elderly and hearing impaired individuals that may have other issues such as vision, muscle weakness or memory issues. |
| * Incomplete: There are degrees of blindness and memory/motor issues. For whom will the app primarily be designed around? | |
| Option 1 | The application will be designed to be accessible for those able to operate a smartphone with moderate efficiency. |
| Option 2 | The application will be designed to accommodate all degrees of blindness, focusing on those who cannot see whatsoever. |
| Option 3 | The application will receive regular feedback from visually impaired testers to determine direction. |
| Choice | Option 2 |
| Rationale | Option 2 allows us to focus on those most affected by blindness and allow for an application that helps them most while still being useful, if overly accessible, to those that are less affected. |
| Revised wording | 4.1.3.1 | |

## 

| **Domain Issue ID** | **Domain Issue Description** | |
| --- | --- | --- |
| DI3 | PD1 | The app to be deployed on various smartphones and supported mobile devices. |
| * Ambiguous: What platforms will specifically be supported? | |
| Option 1 | Keeping it ambiguous for development and scope purposes. |
| Option 2 | Providing support for all moderately used mobile platforms. |
| Option 3 | Keeping development to iOS and Android. |
| Choice | Option 3 |
| Rationale | The first option does not keep stakeholders in mind and option two increases the scope too much. Option three will allow the development team to complete the project in a timely manner and reach many users. |
| Revised wording | 4.1.3.1 | |

## **Functional Requirements Issues**

| **FR Issue ID** | **Description** | |
| --- | --- | --- |
| FRI1 | PFR-1 | Accepting from the user the destination location to go. It might even be able to suggest or confirm a possible destination location, utilizing the user’s routine schedule or habit. |
| 1. How does the user input the destination to the app?  2. What does the app record? | |
| Option 1 | Voice recognition commands to suggest destinations to the app. |
| Option 2 | An assistant would enter the location into the app via typing. |
| Option 3 | The app records user destinations and schedules. |
| Option 4 | The app does not record the user |
| Choice | Option 1 & 4 |
| Rationale | The app should be usable by the blind individual by themselves without assistance from others. Option 2 was chosen due to privacy concerns for the user. |
| Satisfied by | FR1 | |

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| **FR Issue ID** | **Description** | |
| --- | --- | --- |
| FRI2 | PFR-2 | Figuring out the routes to reach the destination, and informing the user of the options (if there are more than one), and accepting the user's preference. |
| 1. How does the app decide which route to take?  2. How does the app find routes? | |
| Option 1 | App prompts the user of the choices from least amount of steps to the most. |
| Option 2 | App chooses the path with the least amount of steps automatically . |
| Choice | Option 1 |
| Rationale | Gives the user the freedom of choosing their preferred path |
| Satisfied by | FR1 | |

| **FR Issue ID** | **Description** | |
| --- | --- | --- |
| FRI3 | PFR-3 | Telling the user to walk a distance (e.g., 2 minutes before turning, or to walk for 30 steps, etc.) |
| 1. What metric will the app use to convey the distance to the user? | |
| Option 1 | Voice relays to user to walk for a set period of time (e.g. 2 minutes) |
| Option 2 | Voice relays to user to walk for a set number of steps |
| Choice | Option 1 |
| Rationale | Using time is the most consistent metric, and the one used in most applications relating to distance for the visually impaired. |
| Satisfied by | FR2 | |

| **FR Issue ID** | **Description** | |
| --- | --- | --- |
| FRI4 | PFR-4 | Telling the user to stop and turn at the correct place. |
| 1. When should the app tell the user to stop and turn? | |
| Option 1 | Let the user know a short distance before the turn that there is a turn approaching and the direction of the turn. |
| Option 2 | Tell the user when they get to the turn to immediately stop and turn. |
| Choice | Option 1 |
| Rationale | The user would risk bumping into an obstacle or be made to make a sudden move if the prompt is too abrupt. Letting them know ahead of time lets them be better prepared. |
| Satisfied by | FR2 | |

| **FR Issue ID** | **Description** | |
| --- | --- | --- |
| FRI5 | PFR-5 | Relaying to user about an obstacle and telling the user what to do in order to avoid collision |
| 1. How does the app decide how to avoid collisions?  2. How does the app know where an obstacle is? | |
| Option 1 | The app has a list of static obstacles to reference and as the user’s position is updated the obstacles within a certain distance from the user are made apparent to the user. When the user is close to an obstacle the voice states where the obstacle is in relation to the walls (in the center, towards the right, towards the left) by measuring the distance of the left and right walls and the distance from the walls to the object. Within a certain margin the object is assigned to be in the center, center left, center right, right, or left. The voice then tells the user the location of the obstacle and the corresponding opposite side of the hallway to go in order to avoid the obstacle. |
| Option 2 | The app will use the different sensors to detect objects nearby and alert the user the position of the object. |
| Choice | Option 1 & 2 |
| Rationale | The user needs to be able to know where an obstacle is and be able to avoid them. Both options are viable to keep the user safe. |
| Satisfied by | FR2 | |

| **FR Issue ID** | **Description** | |
| --- | --- | --- |
| FRI6 | PFR-6 | Placing emergency calls and messages, possibly after detecting a fall or when the system has lost its current location. |
| 1. How does the system know when to prompt an emergency call or message? | |
| Option 1 | When the location of the user is lost, prompt the user for assistance. |
| Option 2 |  |
| Choice | Option 1 |
| Rationale | Inside the scope of this project, this method best suits how the app would identify something is wrong. |
| Satisfied by | FR1 | |

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## **Non-Functional Requirements(NFR) Issues**

| **NFR Issues ID** | **Description** | |
| --- | --- | --- |
| NFRI1 | PNFR9 | The system shall allow users to contact an assistant. |
| 1. What does assistant mean in this context? | |
| Option 1 | An assistant will be contacted through customer service. |
| Option 2 | The assistant will be the user’s helper e.g. Family member or nurse. |
| Option 3 | The application will announce the need for assistance to nearby individuals. |
| Choice | 2 |
| Rationale | For confidentiality reasons, we will keep the availability of the user’s info and phone to the individuals already designated to help them. In addition, providing a service to help users via on call customer service will be difficult. |
| Satisfied by | NFR3 | |

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| **NFR Issues ID** | **Description** | |
| --- | --- | --- |
| NFRI2 | PNFR3 | The system shall lead the user through the fastest route. |
| PNFR4 | The system shall lead the user through the route the user would feel most comfortable with. |
| 1. How does the system determine what is a fast route? 2. How does the system know which route the user is most comfortable with? 3. How will the system decide on a route given these different criteria for choosing a route? | |
| Option 1 | The user database will provide the most comfortable route given previous routes navigated by users. |
| Option 2 | The system calculates the shortest route based on steps taken and presents this to the user. |
| Option 3 | The system can ask the user which route they want to choose after being presented with multiple routes. |
| Choice | Options 1, 2, and 3 |
| Rationale | The system will be able to determine both of these types of routes and present them to the user to let them choose which route they want to take. |
| Satisfied by | NFR2 | |

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| **NFR Issues ID** | **Description** | |
| --- | --- | --- |
| NFRI3 | PNFR11 | The system shall be usable on the two major platforms (IOS and Android). |
| 1. To what extent will the application be usable? | |
| Option 1 | The software application should not heavily use the smartphones resources so that less expensive and older phones can use the application |
| Option 2 | More demanding features can be optionally installed on the smartphone. |
| Option 3 | Ensure the system can properly work on previous operating system versions. |
| Choice | Options 1, 2, and 3 |
| Rationale | The system should be accessible and usable by anyone who has a smartphone with these operating systems, especially older models. |
| Satisfied by | NFR3 | |

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| **NFR Issues ID** | **Description** | |
| --- | --- | --- |
| NFRI4 | PNFR6 | The system shall be ubiquitous. |
| 1. What is the term “ubiquitous” referring to in this context? | |
| Option 1 | The ability for the application to work inside all buildings. |
| Option 2 | The system needs to always be running. |
| Choice | Option 2 |
| Rationale | Since the ability for the application to work inside all buildings is unreasonable given the navigation methods, the term “ubiquitous” should mean that the system should always be running. |
| Satisfied by | App beacons, building layout database, NFR1 | |

| **NFR Issue ID** | **Description** | |
| --- | --- | --- |
| NFRI5 | PNFR12 | Based on the user defined schedule, the application will suggest possible actions and accept the user’s choice. |
| 1. What would the suggestions be?  2. How would the user accept the suggestion?  3. How would the system use the user’s schedule? | |
| Option 1 | The app will have a recent and favorite destination library |
| Option 2 | The app records all destinations the user reaches. |
| Choice | Option 1 |
| Rationale | This is the simplest way to recommend locations to the user based on schedule and which destination they want the app to remember. |
| Satisfied by | App library, NFR2 | |

## 

# **WRS**

## **W**

### **Problem**

| **Problem ID** | **Problem Description** | **Corresponding Goals** |
| --- | --- | --- |
| P1 | Hard for blind and/or visually impaired people to navigate around a building even with passing familiarity. | G1 |
| P2 | Hard for blind and/or visually impaired people to know where obstacles are to be avoided. | G2 |
| P3 | What happens if the app loses connection | G4 |
| P4 | It’s hard for blind and /or visually impaired people to interact with a smartphone application. | G5 |

### **Goals**

| **Goal ID** | **Goal Description** | **Backward Traceability** | **Forward Traceability** |
| --- | --- | --- | --- |
| G1 | A blind and/or visually impaired person is able to navigate around a building without being familiar with it. | P1 | IFRO1  INFRO3 |
| G2 | A blind and/or visually impaired person is able to successfully navigate obstacles inside of a building. | P2 | IFRO2  INFRO2 |
| G3 | The application has the ability to contact emergency services when disconnect or sensing a fall | P2 | IFRO4 |
| G4 | A usable navigation application is available to blind and/or visually impaired people. | P4 | IFRO3  INFRO1 |

### **Improved Understanding of Domain, Stakeholders, Functional, and Non-Functional Objectives**

### **Improved Domain**

| **Improved Domain ID** | **Improved Domain Description** |
| --- | --- |
| ID1 | The app to be deployed on various smartphones and supported mobile devices with iOS or Android support. |
| ID2 | Indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, all equipped with beacons relaying location in comparison to application/device. |
| ID3 | Elderly and hearing impaired individuals that may have other issues such as vision, muscle weakness or memory issues, with a focus on those will advanced conditions. |

### **Stakeholders**

| **Stakeholder** | **Description** |
| --- | --- |
| User (Blind Person) | Person who needs to navigate indoors. |
| Software Developer | Person(s) who will develop the application for the user and caretaker to use. |
| Requirements Analyst | Person who will help in the generation of the requirements specification list. |
| Caretaker | Person who will configure the application for the user. |

### **Improved Functional Objectives**

Based on the above information and our goals, the functional objectives of HOPE are:

| **Improved FR**  **Objective ID** | **Objective Description** | **Alleviates Problem** | **Achieves Goals** |
| --- | --- | --- | --- |
| IFRO1 | Accept user input in order to calculate routes around a building, from a starting point to a destination. | P1 | G1 |
| IFRO2 | Built-in technologies (such as advanced cameras) will detect obstacles and inform the user. | P2,P1 | G2,G1 |
| IFRO3 | A majority of iPhones and Androids will be able to support the application and can be downloaded through their app stores. | P4 | G5 |
| IFRO4 | Users are easily able to contact emergency services in the event of an accident/injury. | P2 | G5 |

### **Improved Non-Functional Objectives**

| **Improved NFR**  **Objective ID** | **Objective Description** | **Alleviates Problem** | **Achieves Goal** |
| --- | --- | --- | --- |
| INFRO1 | The system shall be customizable for the blind/visually impaired person according to their needs. | P4 | G5 |
| INFRO2 | The system shall use the different sensors available to prevent any injury. | P1 | G2, G3 |
| INFRO3 | The system will designate the fastest route as the route with the least amount of steps. | P1 | G1, G5 |
| INFRO4 | The system will record the route the user chooses the most often as the first choice. | P4 | G3 |
| INFRO5 | The system shall rely on voice commands and feedback to interact with the user. | P4 | G5 |

## **RS**

### **Functional Requirements**

| **FR ID** | **Description** |
| --- | --- |
| FR1 | If a user makes a sound to the system, the system shall make a sentence from the detected sound. |
| Satisfies Functional Requirement Issue | FRI1 |
| Satisfies Objectives | IFRO1, INFRO5 |
| Satisfied by prototype feature | App’s voice recognition |

| **FR ID** | **Description** |
| --- | --- |
| FR2 | Accepting from the user the destination for navigation by using voice commands. If a caretaker or family member is available, then a predefined route may be set by them using the app’s UI. |
| Satisfies Functional Requirement Issue | FRI1 |
| Satisfies Objectives | IFRO1, INFRO4 |
| Satisfied by prototype feature | App’s voice recognition |

| **FR ID** | **Description** |
| --- | --- |
| FR3 | The App updates the user to turn and stop to guide them to their destination |
| Satisfies Functional Requirement Issue | FRI3 |
| Satisfies Objectives | INFRO5 |
| Satisfied by prototype feature | Voice feedback, beacons, GPS |

### **Non-Functional Requirements**

| **NFR ID** | **Nonfunctional Requirement 1** | |
| --- | --- | --- |
| NFR1 | The system shall be ubiquitous. As it is always running, the system will recognize buildings based on GPS and/or room beacons and inform the user via voice. | |
| Operationalized Functional Requirements | OFR1    OFR2 | System uses GPS to locate you so that it knows where you are when entering a building.  The system is able to voice places/commands while the phone screen is not turned on/in pocket or hand. |
| Satisfies Nonfunctional Requirement Issue | NFRI4 | |
| Satisfies Non-functional Objective | INFRO1, INFRO2, INFRO5 | |
| Constrains | IFRO3 | |
| Satisfied by prototype feature | Voice feedback, beacons, GPS | |

| **NFR ID** | **Nonfunctional Requirement 2** | |
| --- | --- | --- |
| NFR2 | The system calculates the shortest route and presents it to the user. But the user is given the option of taking other routes as well. | |
| Operationalized Functional Requirements | OFR1    OFR2 | The system shall calculate the shortest route based on steps taken from other users.  The system shall let the user decide which route they want to take. |
| Satisfies Nonfunctional Requirement Issue | NFRI2, NFRI5 | |
| Satisfies Non-functional Objective | INFRO3 | |
| Constrains | IFRO1 | |
| Satisfied by prototype feature | Voice feedback, beacons, GPS | |

| **NFR ID** | **Nonfunctional Requirement 3** | |
| --- | --- | --- |
| NFR3 | The software shall be compatible with iOS and Android smartphones, including those with older hardware. To this end, the application will be lightweight while also offering more features at a higher system demand. | |
| Operationalized Functional Requirements | OFR1    OFR2 | The system shall be developed and tested on older devices.  The system shall provide hardware acceleration for phones with better hardware. |
| Satisfies Nonfunctional Requirement Issue | NFRI1, NFRI3 | |
| Satisfies Non-functional Objective | INFRO1 | |
| Constrains | IFRO3 | |
| Satisfied by prototype feature | Voice feedback, beacons, GPS | |

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### **Specifications**

| **Functional Specification ID** | **Functional Requirement** |
| --- | --- |
| FS1 | If a textual sentence is entered to the system, the system shall make a sound corresponding to the input sentence. |
| Satisfies Functional Requirement | FR1 |
| Satisfies Objectives | IFRO1, INFRO5 |
| Satisfied by prototype feature | By voice commands and voice feedback |

### 

| **Functional Specification ID** | **Functional Requirement** |
| --- | --- |
| FS2 | If the app loses connection, the user is prompt if they want to contact emergency services |
| Satisfies Functional Requirement | FR1 |
| Satisfies Objectives | IFRO4 |
| Satisfied by prototype feature | App emergency contact function |

### 

| **Functional Specification ID** | **Functional Requirement** |
| --- | --- |
| FS3 | While the user is being guided to their destination, real-time location data from GPS/Beacons is relayed via voice commands to help the user reach their destination quickly and safely. |
| Satisfies Functional Requirement | FR3 |
| Satisfies Objectives | IINFRO2, INFRO3, INFRO5 |
| Satisfied by prototype feature | App emergency contact function |

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# **Preliminary Prototype**

The preliminary prototype of the application is outlined within the individual documents on each component. These documents contain a description, implementation, and testing metric.

Component documents:

* [Navigation component](https://docs.google.com/document/d/1u6rdCraidn9w2DyVgroPalFF2LfwI1bY/edit?usp=sharing&ouid=118323420196628441602&rtpof=true&sd=true)
* [Emergency contact component](https://docs.google.com/document/d/1sjkBnmGfv1n3Zkuo5k_OGNROlfoQTo8N/edit?usp=sharing&ouid=118323420196628441602&rtpof=true&sd=true)
* [GUI component](https://docs.google.com/document/d/1O3dSKx16nf_dUL_PXq1IZoEr4MVxTN9R/edit?usp=sharing&ouid=118323420196628441602&rtpof=true&sd=true)

## **Prototype Interface Mock-ups**

See [mock-up document](https://docs.google.com/document/d/14lisDueC4KJWCPZSRTfZ9d46Q5gzjSu1wS992YU--vM/edit) (Google doc with snipped images)

Link to the GUI of the app:

<https://www.figma.com/file/jcVb7OMn63n7Jb7YKUPkXH/Phone-GUI?node-id=0%3A1>

Link to the GUI component diagram:

<https://www.figma.com/file/1zbgJO7ttLJw9FxC27PThr/GUI-Diagram>

## **User Manual**

See [Manual document](https://docs.google.com/document/u/0/d/1yQdCYWXnksikr6mIszo7GQFa0ouNfBbMUhgNjjdHhAs/edit)

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