WRS Document

For

Indoor Navigation App for the Visually Impaired

Version 1.4

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Submitted for:

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Project Phase 2 Final

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Revision History

Name	Date	Reason for Changes	Version
All members	10/08/22	Made initial document	1.0
	10/09/22	Asked Professor a Clarification Question	1.0
Callum MacDonald	10/13/22	Working on the Introduction	1.01
Wahid, Mohammed, Mitchell	10/14/22	Preliminary Definition and it issues	1.02
Wahid, Mohammed, Mitchell	10/16/22	WRS, Sketching the UI prototype and writing user manual	1.03
Mohammed	10/20/22	Updating WRS, references and finalizing	1.1
Team Wahid	10/16/22	Revision of Sections 1.2 & 5	1.1
Team Wahid	10/17/22	Revision and Resubmission for Phase 1	1.11
Team Wahid	11/17/22	Rehashing what was corrected from Phase 1 professor notes and splitting work to complete it.	1.2
Team Wahid	12/5/22	Added new details from our work on Phase II to the project plan.	1.3

1. Introduction

1.1 Purpose

The objective of this project is to make an app that will assist blind and visually impaired people so they can navigate indoors. We want to be able to help people using our design. This will be done by using the agile process where we will establish the requirements, design, test and deploy our prototype. The application will be using things such as voice over and assistive technology in order to make it effective in helping the user. The application implementation will be done using a prototyping software that allows us to test the user interface, as well as design.

1.2 Scope

The scope of the project is to use a user interface software to come up with an application designed in helping visually impaired people move indoors. This will be done using Figma, a user interface building tool that can help create mobile apps designed to whatever the developers need. User interactions will be tested through the app's ability to link buttons and actions, as well as demoing the final product. All UI will be prototyped in a design stage before using the software so the basic layouts can already be seen by the developers.

The application building process will be broken into individual tasks for each group member to work on. This will be an ongoing collaborative assignment where each member's parts are required to finish the prototype.

1.3 Objectives and Success Criteria

The objectives and the Success criteria of the app must include the following:

- Allow for voice over
- Have a fast working app
- Intuitive layout for visually impaired person
- Complete all tasks assigned to each group member
- Complete prototype build using Flatterflow
- Test all non intended inputs for correct response
- Complete building layout with ability to add more buildings
- An impaired user can navigate the building with no or minimal obstacles

1.4 Definitions, Acronyms, and Abbreviations

Term	Definition
Agile	A software building method that uses software requirements and continual improvement through a collaborative means with a team
Flatterflow	A collaborative web application used for building interface designs
Prototype	A preliminary model of the application that comes before the final product
Task	A small part of the project usually assigned to an individual for completion
UI	An acronym for user interface, the layout/design and interaction of the application with the user.

1.5 Overview

In section 2 we discuss the preliminary domain with the functional and non functional requirements. In section 3 we talk about the functional requirement issues with more detail about the rationale and options in those issues. This spans both functional and non functional requirements.

Section 4 is the WRS section that breaks down the problems and the description to each respective problem as well as their responding goals. The goals are then broken down individually giving a description of each goal as well. The stakeholders are then listed as well as the objectives for the functional requirements and nonfunctional requirements. Sections 5 and 6 show the prototype design and the interface mock-ups. References are attached at the end in Section 7

0. Preliminary Definition

2.1 Preliminary Domain

PD_ID	Preliminary Domain Description
PD1	indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, etc.

2.2 Preliminary Functional Requirements

P FR_ ID	Preliminary FR Description
PFR1	Accepting from the user the destination location to go
PFR2	Verify the destination location and select the best path
PFR3	Telling the user to walk a distance (e.g., 2 minutes before turning, or walk for 30 steps, etc.)
PFR4	Detecting the obstacles on the path and communicating it to the user
PFR5	Telling the user to stop at the right place to turn.
PFR6	Informs or calls the caretaker in case of an emergency

2.2 Preliminary Non-Functional Requirements

P FR_ ID	Preliminary FR Description
PNFR1	The system shall help the user safely navigate indoors.
PNFR2	The system shall lead the user through the route that the user would feel the most comfortable with.
PNFR3	The system shall be cheap
PNFR4	The system shall be usable, i.e. it shall be user friendly to blind person
PNFR5	The system shall be customizable
PNFR6	The system shall be reliable

0. Issues with the Preliminary Definition Given

3.1 Problem, Goals, Improved Understanding, and Domain Issues

Domain Issue ID	Domain Issue Description	
DI1	PD_ID	PD1. indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, etc.
	Is the application going to work for a specific building or indoor design? This issue is problematic because the solution will require us to fundamentally build our app in a certain way. Our improved understanding	
	Option 1	If we chose to have this app work with a certain building layout we can build off of a template but that will limit our usefulness of this app.
	Option 2	If we decide to use machine learning to analyze the building we can build a route from what we see. This will require a lot of work though and could be hard to test
	Option 3	If we decide to have a customer who draws a layout of the build they could have it be customized to them but we would have to have a general guidance system with the route preprogrammed in.
	Choice	We are going to try and go with option 3
	Rationale	Option three provides the most complete domain knowledge of the listed options. It also provides the most preconditions to be met so we don't have to have the user set them up for us.

Domain Issue ID	Domain Issue Description	
DI2	PD_ID	PD1. indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, etc.
	How to navigate indoors? Ambiguous or incomplete. This issue is very open ended and leaves a lot up to interpretation on how to solve it. Unsound: Our users are people who do not have their vision so if they are told to trust our app, we can't fail the user or they could get injured.	
	Option 1	For navigation, does the implementation of it resemble google maps audio navigation.

	Option 2	For navigation the audio could be more personalized with information on speed, step obstacles and generally more detail about the ground.
	Option 3	Does the user want real time updates for obstacles
	Choice	Option 2
	Rationale	Option 2 is the way to get the most information that is going to be useful for the visually impaired user.

3.2 Functional Requirements Issues

FR Issue ID	Description	
FRI2	PFR_ID	PFR2. Telling the user to walk a distance (e.g., 2 minutes before turning, or walk for 30 steps, etc.).
	How would the user's routine be utilized?	
	Option 1	We could use audio queues
	Option 2	We could use vibrations to queue the user for steps
	Choice	Option 2
	Rationale	If the user wants to know the amount of steps that are left or the remaining distance to the destination, we can use vibrations to match with the steps to let them know distance.

FR Issue ID	Description	
FRI1	PFR_ID	PFR1. Accepting from the user the destination location to go.
	How would THEIA take the wanted destination from the user.	
	Option 1	choosing from a list of saved destinations.
	Option 2	Speaking on the microphone to say the destination name.
	Choice	Option 2
	Rationale	Since we want the app to be reliable and flexible, option to would accept more possible destinations

FR Issue ID	Description	
FRI3	PFR_ID	PFR3. Telling the user to stop at the right place to turn
	How would THEIA take the wanted destination from the user.	
	Option 1	choosing from a list of saved destinations.
	Option 2	Speaking on the microphone to say the destination name.
	Choice	Option 2
	Rationale	Since we want the app to be reliable and flexible, option to would accept more possible destinations

FR Issue ID	Description	
FRI4	PFR_ID	PFR4. Placing emergency calls and messages, possibly after detecting a fall or when the system has lost its current location.
	How would THEIA detect that there is an emergency.	
	Option 1	Let the user (The blind person) click or hold something on the phone to tell there is an emergency.
	Option 2	Use fall detection to know that the user has fallen
	Choice	Option 2
	Rationale	If the user fell, he wouldnt be able to reach the phone, which makes option 1 not applicable.

FR Issue ID	Description	
FRI5	PFR_ID	PFR5. Placing emergency calls and messages, possibly after detecting a fall or when the system has lost its current location.
	How would THEIA place the emergency calls or messages, and who is going to receive them.	
	Option 1	call the emergency department in that building
	Option 2	call the assistance of the user
	Option 3	Make a sound so that user can reach the phone after he/she fell.
	Choice	Option 3
	Rationale	Option 1 & 2 would talk a long time to help the blind person, which is going to waste his/her time.

FR Issue ID	Description	
FRI6	PFR_ID	PFR6. Detecting obstacles and telling the user what to do in order to avoid collision.
	How would THEIA detect obstacles.	
	Option 1	using the camera of the phone to detect obstacles
	Option 2	Cancel this feature
	Choice	Option 2
	Rationale	Option 1 is so hard to apply based on our resources and the time we have.

3.3 Non-Functional Requirements (NFR) Issues

NFFR Issue ID	Description	
NFRI1	PNFR_ID	PNFR1. The system shall help the user safely navigate indoors.
	What does the word safely means exactly.	
	Option 1	The app should use sensors, and camera to detect danger and immediately communicate it to the user through audio.
	Option 2	If the user navigates in a crowded environment, crowded locations will impact auditory integration. The user could use headphones to hear the auditory communication, in addition to this the app should use sensory feedback, direction signaling and warning alert to help the blind person navigate safely.
	Choice	Option 2
	Rationale	It is better if the user always uses headphones for better hearing the app's command. Adding the sensory feedback, direction signaling and warning alert features will help the user hearing impairment to use the app and safely navigate indoors.

NFFR Issue ID	Description	
NFRI2	**PNFR_ID**	PNFR2. The system shall lead the user through the route that the user would feel the most comfortable with.
	The word comfortable with is ambiguous in this description. Shall the app lead the user always through elevators instead of routes with stairs? Should the app always select the less crowded routes, if so, how would the app detect and select the less crowded route?	
	Option 1	The app should select the straight paths for taking the blind person to its destination. In my opinion the app must select routes without an elevator, because it would be difficult for a blind person to use the elevator and press the button to the desired floor.
	Option 2	The app should use sensors and camera to detect the less crowded route. Using the AI technologies and sensor the app should have the capability to detect and select the straight route with less obstacles.
	Option 3	The app can use the saved routes data of the building to find the straight routes.
	Choice	Option 1,2,3
	Rationale	After the app detects and selects the safest route the user should have the option to select which route he/she wants to get to the destination.

NFFR Issue ID	Description	
NFRI3	**PNFR_ID**	PNFR3. The system shall be customizable to every user: e.g. volume, the interval of instructions, etc.
	What is meant by the interval of instructions.	
	Option 1	How long the instruction can be, in term of the speed of the instruction being pronounced.
	Option 2	How long should the app wait until saying the next command.

	Choice	Option 2
	Rationale	Option 2 is more reasonable and useful. Also, usually the interval between two instruction will be based on the situation and the route.

NFFR Issue ID	**Description**	
NFRI4	**PNFR_ID**	PNFR4. The system shall be customizable to every user: e.g. volume, the interval of instructions, etc.
	Who is going to customize the system	
	Option 1	The blind person.
	Option 2	The assistant
	Choice	Option 2
	Rationale	It will take time and effort for the blid person to customize the system.

0. WRS

4.1 W

4.1.1 Problem

Problem ID	**Problem Description**	**Corresponding Goals**
P1	The user want to know his location and how long he would take to reach the destination	G1, G2
P2	The user will not be able to hear the audible messages from the app if the route is crowded	G1, G2

P3	The user might be hit by someone	G2,G3

4.1.2 Goals

Goal ID	Goal Description	Backward Traceability	Forward Traceability
G1	The user will be receiving audible and sensory messages about his current location and the time needed to reach the destination	P1,P2	IFRO1
G2	The user will be able to hear the audible messages, even if the route environment is noisy.	P1,P2,P3	INFRO1
G3	The app will make sure that the user avoid crowded routes	P3	INFRO2

4.1.3 Improved Understanding of Domain, Stakeholders, Functional, and Non-Functional Objectives

4.1.3.1 Improved Domain

Improved Domain ID	Improved Domain Description
ID1	The application should save the design of the routes in the specific building that the blind person will be walking through.

4.1.3.2 Stakeholders

- **Primary Stakeholder**
  Blind person

4.1.3.3 Internal stakeholders

- **Sponsors**
  - Faculty: Bolong Zeng.
- **Project team members**
  - Wahidullah Rahimi, Mohammed Al Ahbabi, Callum MacDonald, Mitchell Kolb

4.1.3.4 External stakeholders

- **Customers**
  - People with impaired visions
  - Blind people assistants
- **Analysts and researchers**
  - Software Developers using Agile software development.
  - Software Requirements Analysts
  - Software Project Managers

0. Improved Functional Objectives

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

Improved FR Objective ID	**Objective Description**	**Alleviates Problems**	**Achieves Goals**
IFRO1	If the user wants to know the number of steps that are left or the remaining distance to the destination, we can use vibrations to match with the steps to let them know distance.	P1,P2	G1
IFRO2	User can search for the destination by speaking to the microphone		

0. Improved Non-Functional Objectives

Improved NFR Objective ID	Objective Description	Alleviates Problem	Achieves Goal
INFRO1	The user would need to wear headphones to make sure that he/she can hear the audible messages.	P1, P2, P3	G2
INFRO2	The app should help the user avoid crowded routes, elevators, and uneven routes.	P3	G3

4.1.2 RS

4.1.2.1 Functional Requirements

FR ID	Description
FR1	The app should accept from the user the destination location to go.
Satisfies Functional Requirement Issue	FRI1
Satisfies Objectives	IFRO2
Satisfied by prototype feature	Voice commands page

- This has to be further refined in terms of specification(s).

4.1.2.2 Non-Functional Requirements

NFR ID	Nonfunctional Requirement 1
NFR1	The app will find the safest and fastest route with the following specifications: (1) less crowded (2) even and straight (3) stairs instead of elevators.
Satisfies Nonfunctional Requirement Issue	NFRI1, NFRI2
Satisfies Non-functional Objective	INFRO2

Satisfied by prototype feature	It is an implicit feature that cant be displayed using sketches

4.1.2.3 Specifications

Functional Specification ID	Functional Requirement
FS1	If the user tape and hold -for example- and speaks to the app for the destination he/she want. The app will load the data and find the route.
Satisfies Functional Requirement	FR1
Satisfies Objectives	FO1, FO2, FO3
Satisfied by prototype feature	Voice commands page

0. Goal Oriented Software Requirements using KAOS

THEIA's Goal Oriented Model using KAOS Methodology

THEIA is an indoor navigation system that helps visually impaired people to navigate indoor.

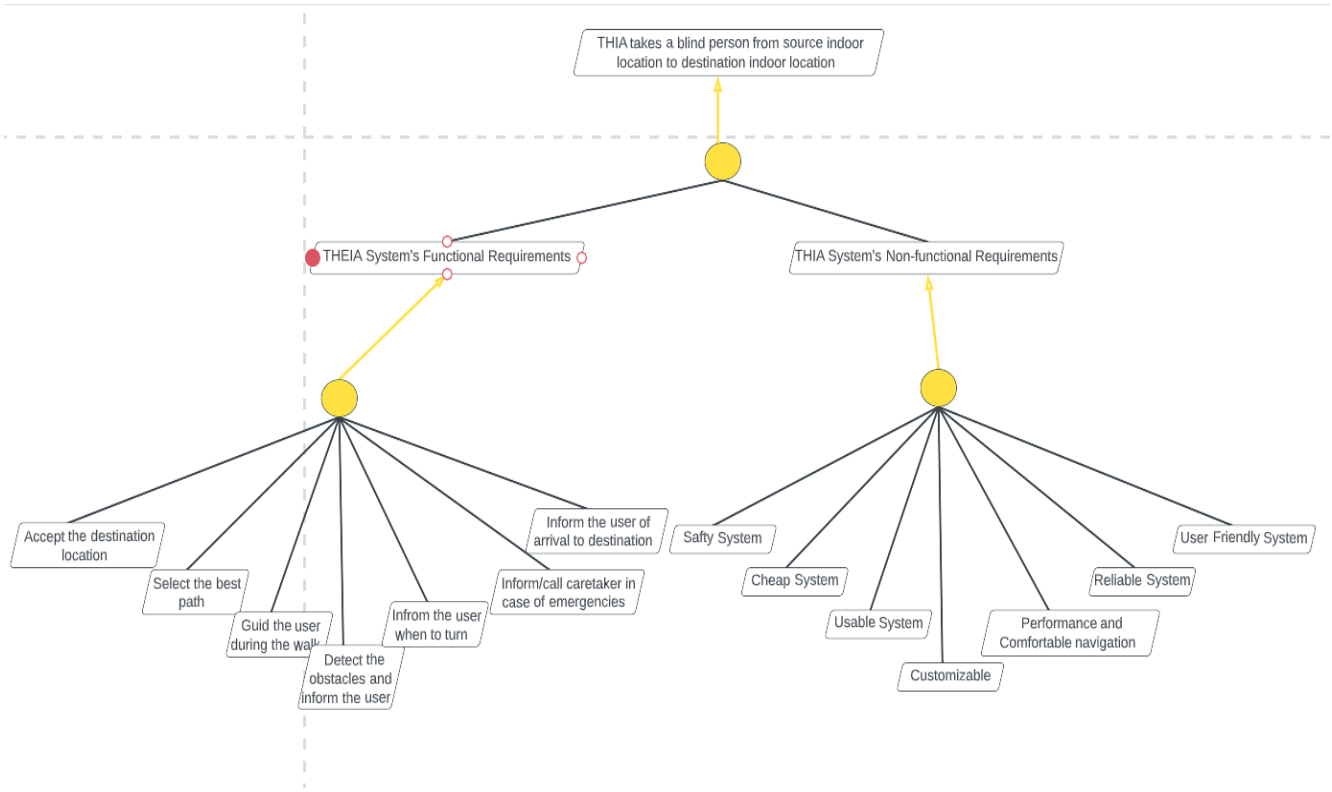
The following KOAS Goal Models are the set of interrelated goal diagrams that have been put together for tracking a particular problems in THEIA development.

6.1 THIA System Goal Model:

This section of WRS document aims to investigate the requirements analysis for THIA system

6.1.2 THIA Functional and Nonfunctional Requirements Model:

Team Wahid tried to gather the functional and nonfunctional requirements for THIA System through different group meetings and interviews with team members, one person playing the blind role and other as analyst trying to gather the requirements for the system. The following KOAS Model show THIA's Functional and Non-Functional Requirements:



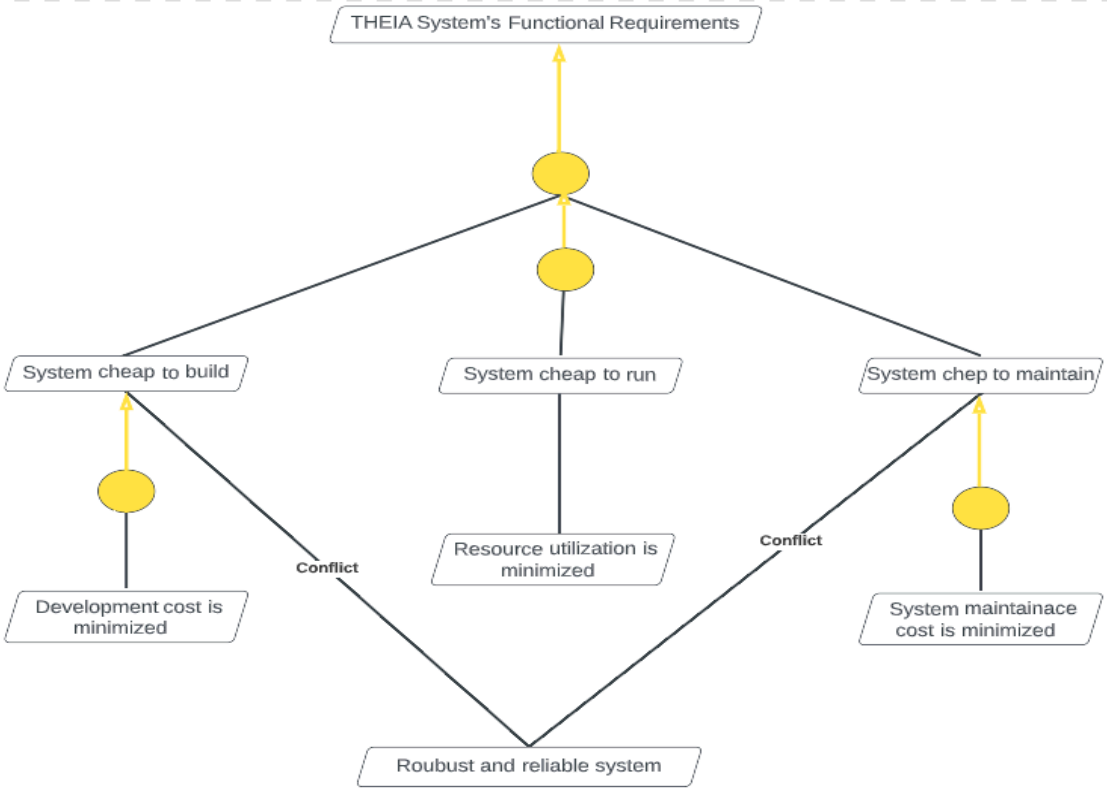
Each parallelogram represents a goal. Each yellow circles represent the refinement of a parent goal, and each parallelogram bellow the yellow circles represent the sub-goals.

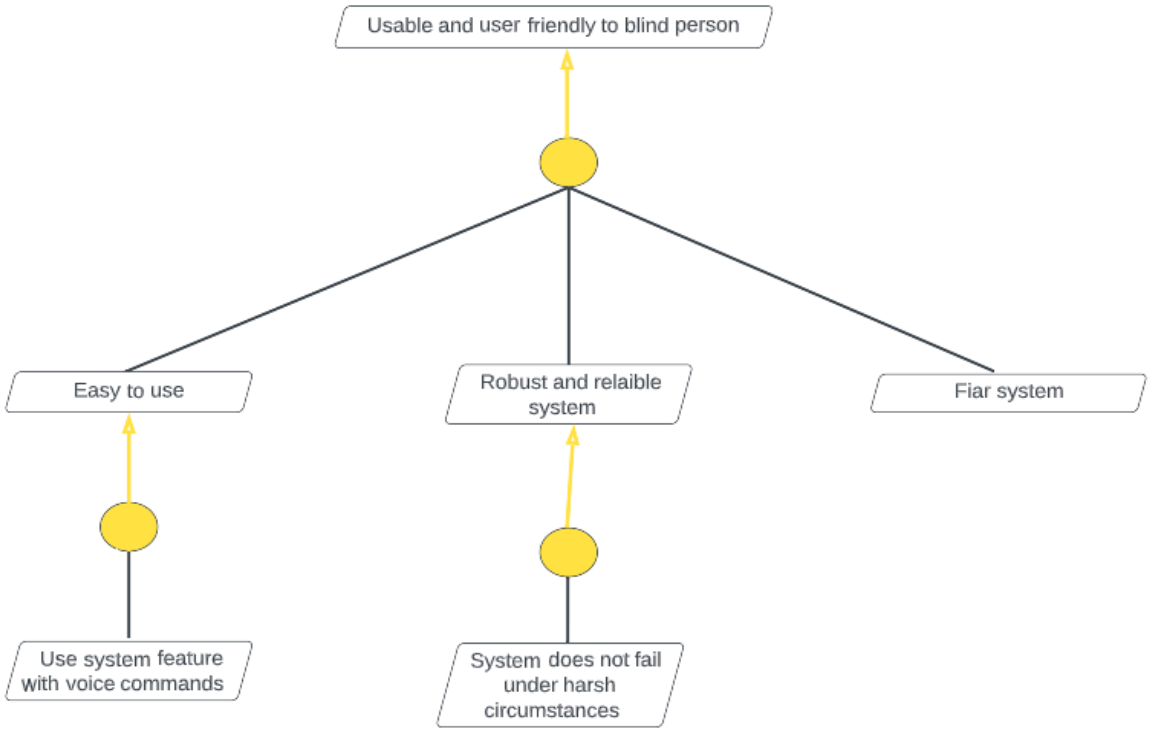
The goal of THEIA system is to help a blind person navigate indoor. The KOAS diagram above show the major functional and non-functional requirement of THEIA system.

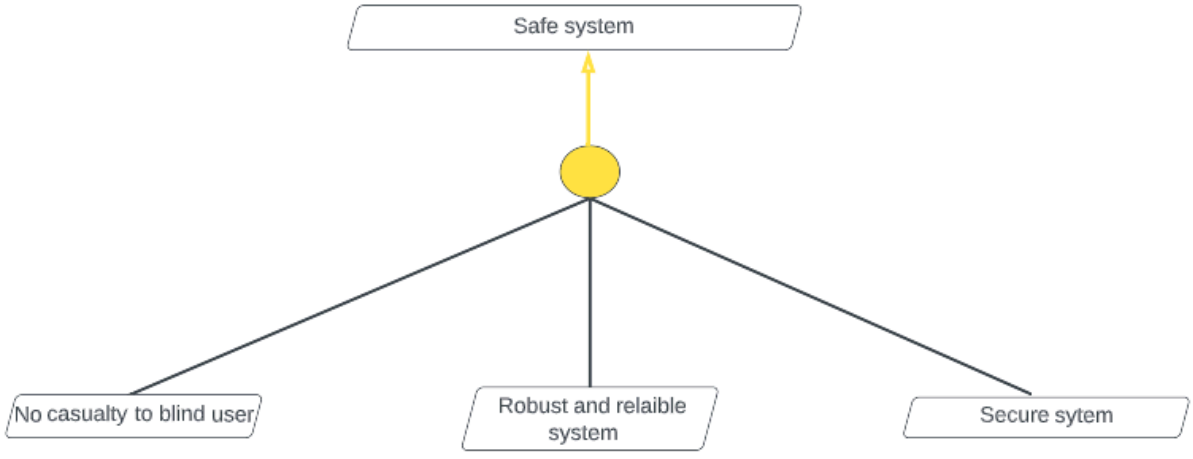
Non-functional goals are classified as follows:

- Safe system: the system must help the blind person safely navigate indoor
- The system must be cheap and useable for visually impaired people
- The system must be customizable, based on blind person preference. For example the user should be able to change important settings such as volume and notification systems
- They system should be fast and select the best routs
- The system should be reliable
- The system shall be customizable and extensible
- Functional goals are classified as follows:
- The system should accept the destination location from user prior to starting navigation
- The system must confirm the destination
- The system must select the shortest and best path that has less obstacles
- The system must guide user by voice command on how long to walk and when to turn
- The system must detect obstacles on the path, inform the user and tell the user what to do
- The system must inform the nearest agency (building office, caretaker, family member, police) in case of an emergency
- And finally the system must inform the user of arrival to the destination location

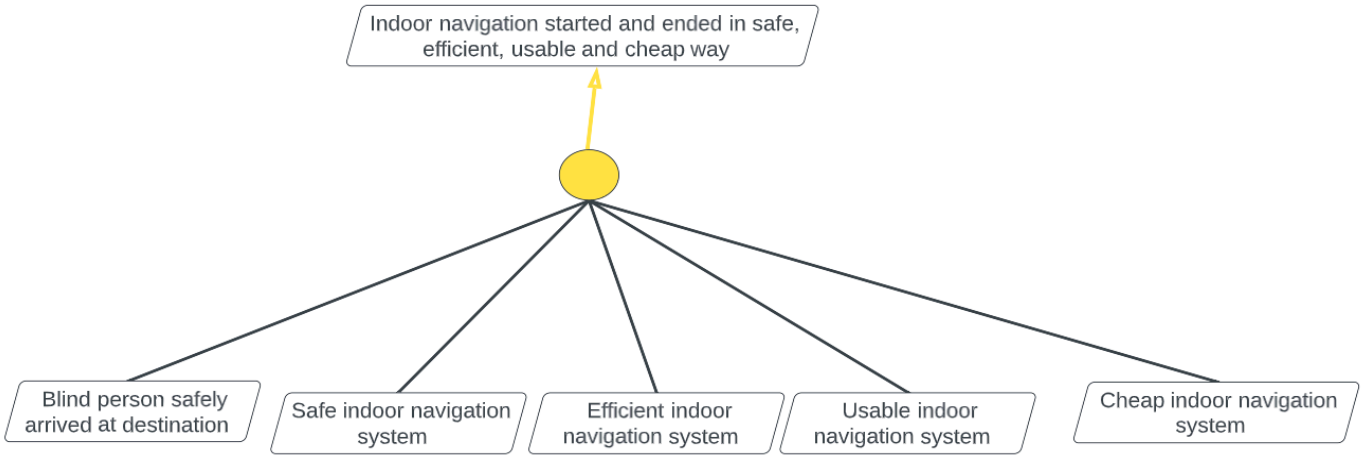
THEIA's functional objective is mainly safe indoor navigation for a visually impaired person.
We further decomposed the functional and non-functional subgoals to achieve the requirements that are assignable to agents.
For example, the following diagram shows the economical aspect of THEIA system. The system must be built economically first and must be run and maintained. This diagram also shows a conflict between two goals: "System cheap to build" and it must be "Reliable and robust".
THEIA's development const reduction badly impact the system's robustness and reliability. Conversely, improving robustness and reliability of the system increases the development cost.



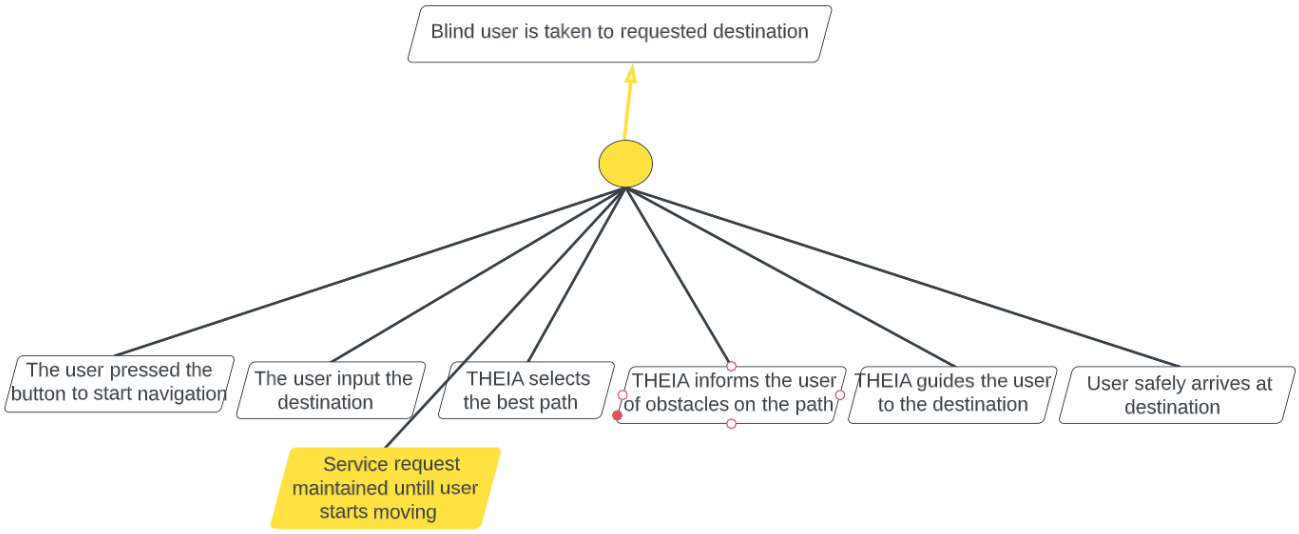

Usable and user friendly to blind person
Easy to use
Robust and relaible system
Fiar system
Use system feature with voice commands
System does not fail under harsh circumstances


Safe system
No casualty to blind user
Robust and relaible system
Secure sytem

THEIA Functional Requirements Goal Oriented Models:

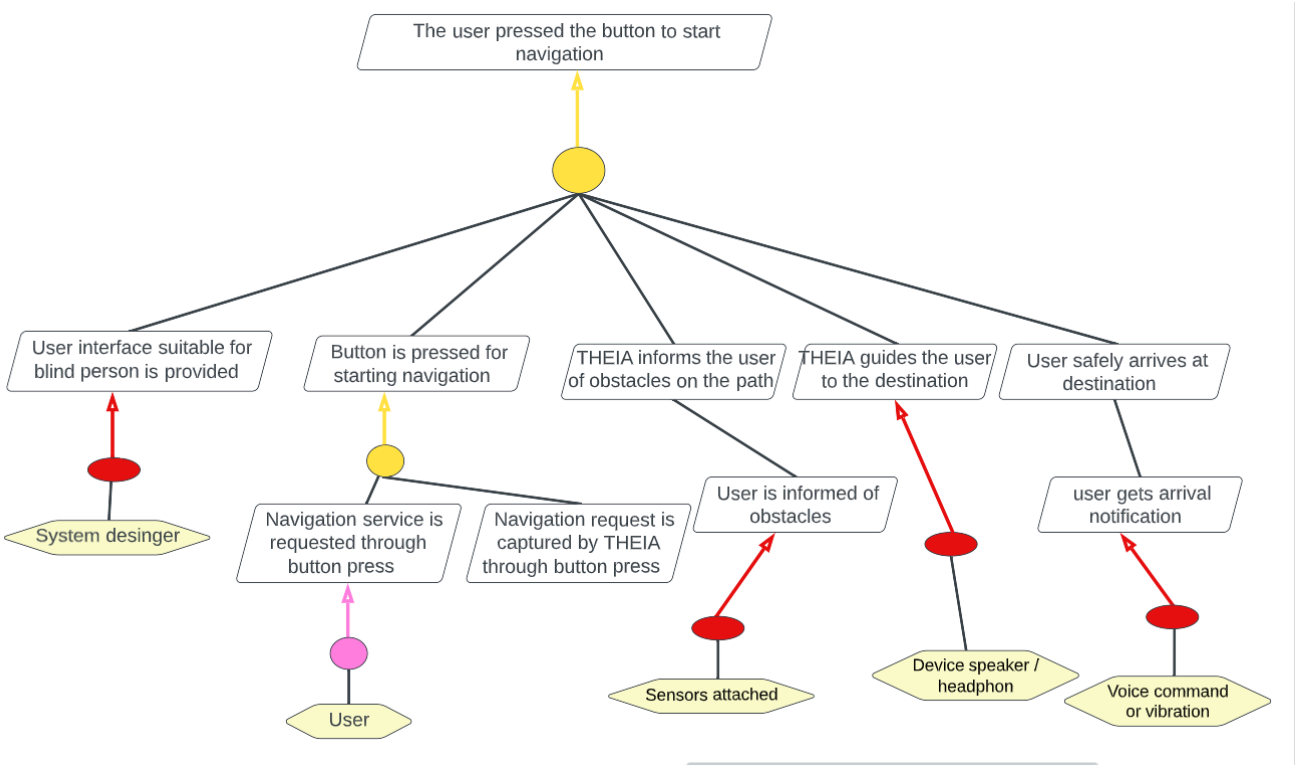


Blind user pressed the button and requested navigation to an indoor destination.

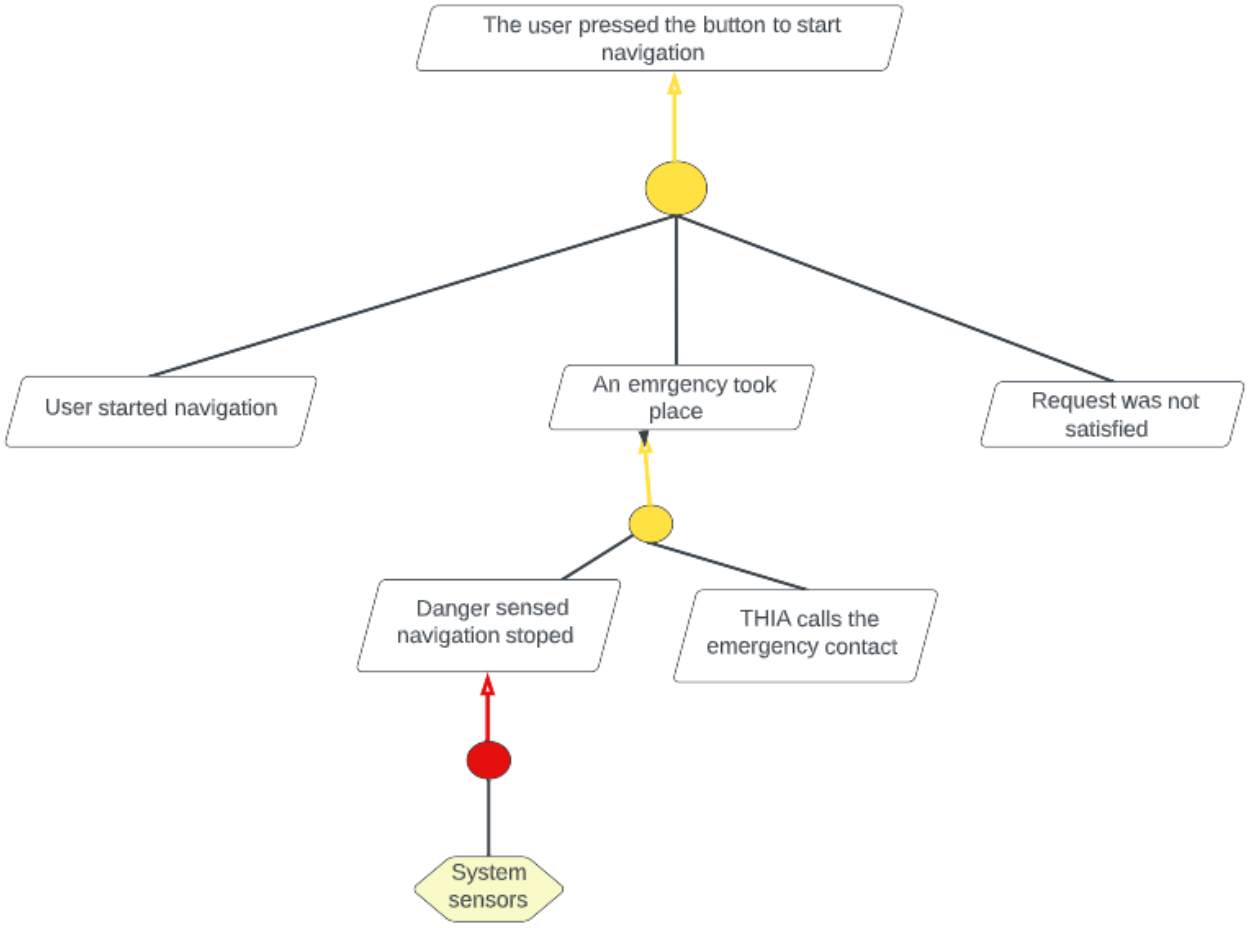


To safely complete an indoor navigation the blind person must first press the button and say the destination location, THEIA recognizes the location and confirms it, then the user must start moving towards destination otherwise the requested service will be maintained by THIA until cancelled or start walking, THEIA starts guiding the user to the destination, the request will be completed when the user safely arrived at the destination.

Following show a KOAS goal model diagram for indoor navigation request.



The following diagram show if an emergency happens during the navigation

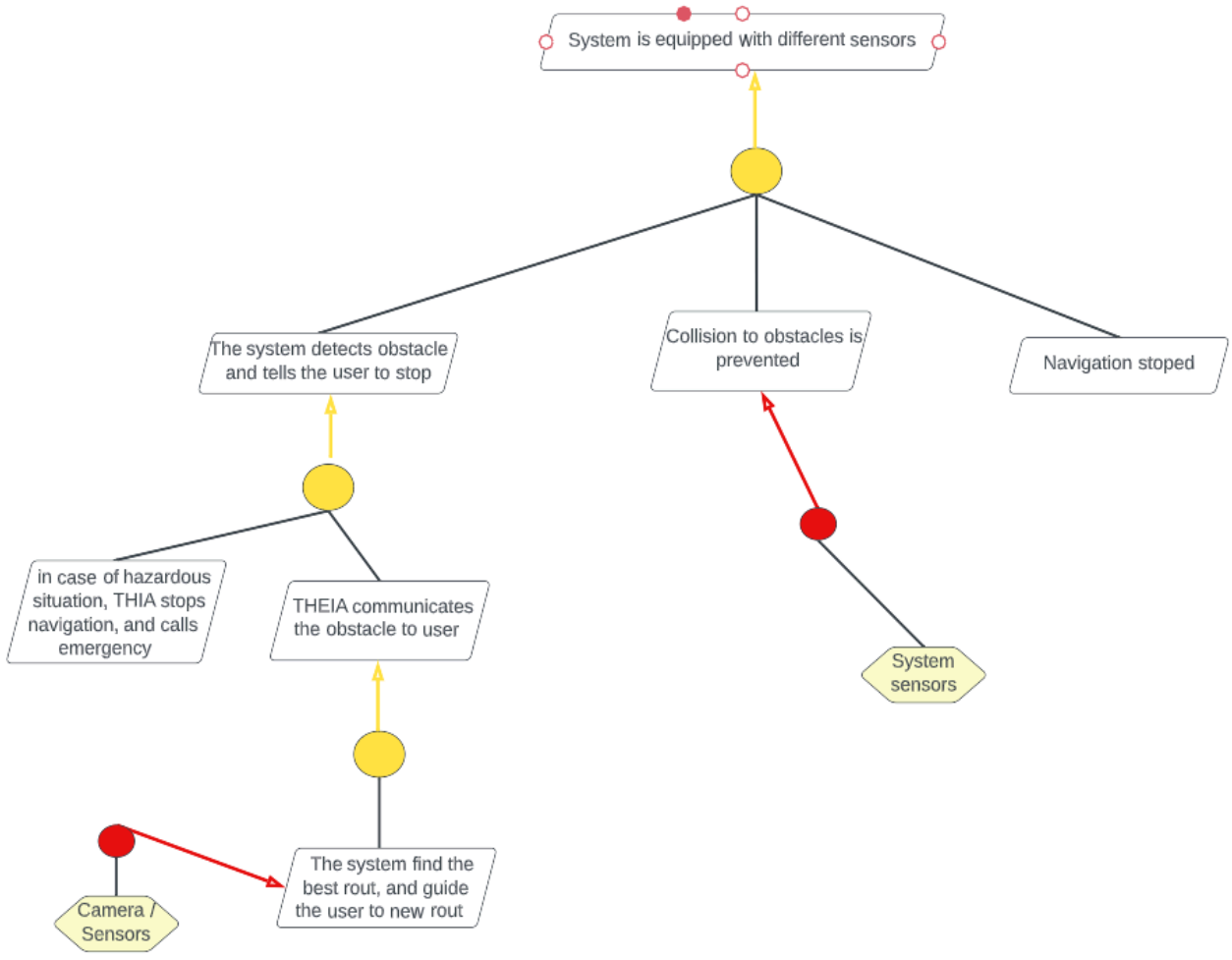


6.1.3 THEIA's Responsibility Model:

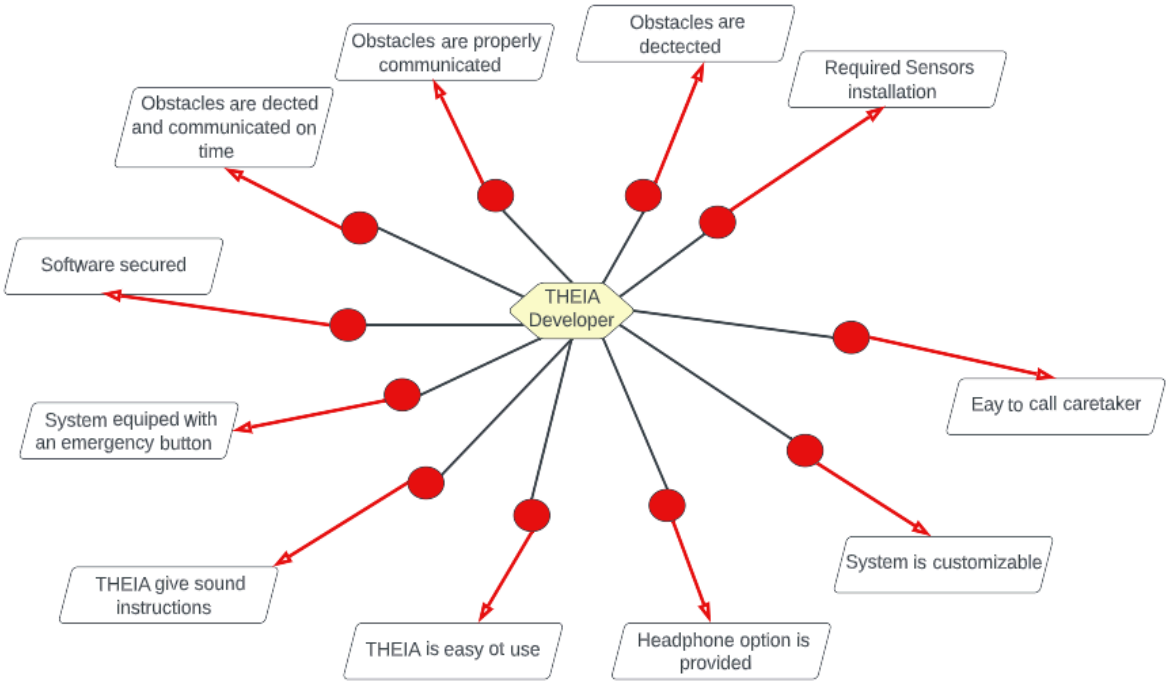
Agents are either human beings or automated component that are responsible for achieving requirements and expectations. In case of THIA, a blind person and sensors such as cameras …etc. are examples of agents. The following THEIA responsibilities model associate each requirement or expectation with an agent responsible for it. In many cases THIA's goals are assignable to many agents rather than one.

The system's sensors are responsible for detecting the obstacles on the path and communicate them to the blind person, also the system recommends the safe actions to the user to complete the navigation.

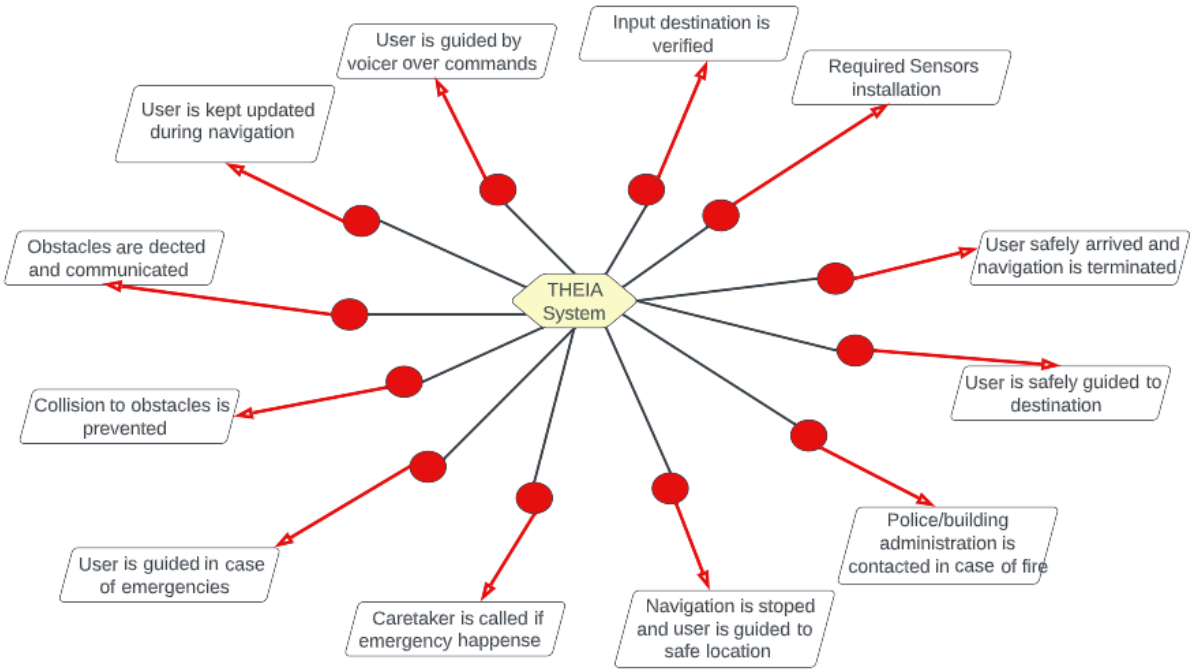
Software developer of THEIA is responsible for writing code and installing sensors that can detect any danger and communicate it to the user.



THEIA’s developer responsibilities:



THEIA’s responsibilities



1. References

[1] Lookout: an app to help blind and visually impaired people learn about their surroundings (blog.google)

[2] Google Maps now helps blind people! – PromiAD II Exploring WOW!