

# CHAPTER 4: REQUIREMENT GATHERING

## 4.1 Chapter Overview

This chapter focuses on collecting system requirements and analyzing the information collected. First, the system's stakeholders are listed, and their responsibilities are defined. Different techniques for requirement gathering are discussed and reviewed based on the pros and cons of each method. The use case diagram and its definitions are included during the requirement analysis stage. Finally, the system's functional and nonfunctional requirements are specified with a scope definition and categorized according to their priority to the function.

## 4.2 Stakeholder Analysis

The onion diagrams show the established stakeholders who are associated with the system, along with an overview of and stakeholder's position in the system.

### 4.2.1 Onion Model

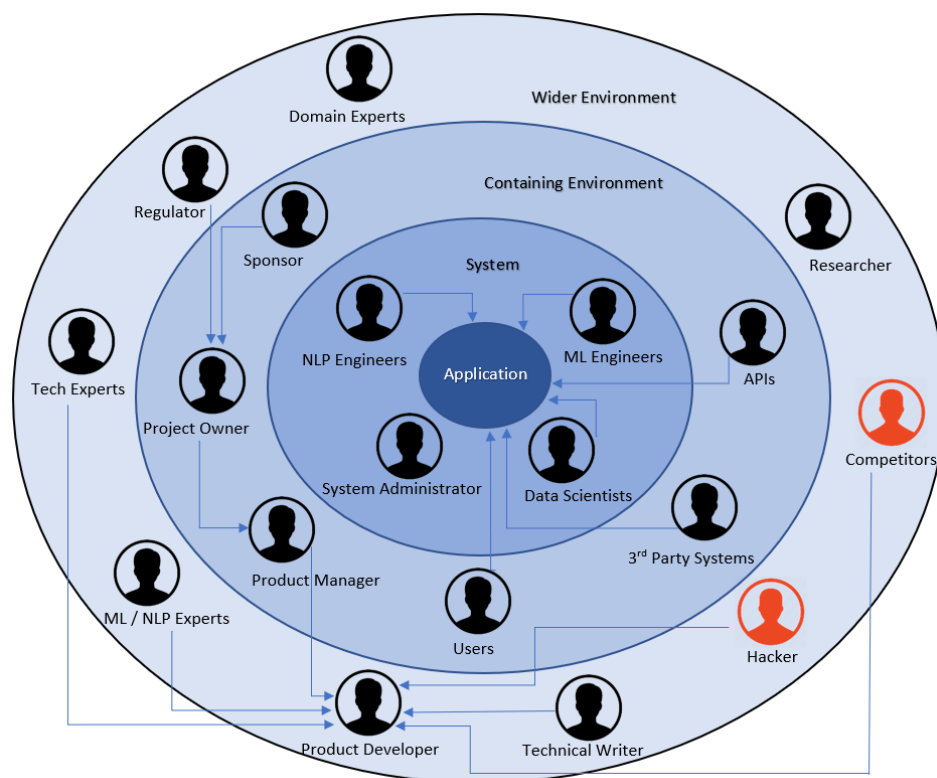


Figure 1: Onion model of the system

<b>Stakeholder</b>	<b>Role</b>	<b>Benefits</b>
Data scientists, NLP Engineers, ML Engineers	Operational Maintenance	Design and Develop the ASR process and models.
System Admin	Operational Administration	Deploying the application and configuring for different environments.
Sponsor	Financial Beneficiary	Investing on the application and make profit from that.
Product Owner	Functional Beneficiary	Owner of the ASR system.
Product Manager	Managerial Support	Managing the process of application to ensure the flow of the project going smoothly.
Users, 3 <sup>rd</sup> Part Systems, APIs	Functional Beneficiary	Using the developed ASR application via different channels or integrating it with other systems.
Regulator	Quality Regulator	Make sure the application does not miss use any data and the data is processed by considering the privacy policies.
Tech Experts	Expert	Determines if a collection of specifications is supported by the platform.
NLP /NL Experts	Expert	Gives an expert view on the project's technology and methodologies.
Domain Experts	Expert	Gives domain view on the project's technology and methodologies.
Product Developer	Developer, Operational Maintenance	Creates and maintains the system.
Technical Writer	Operational Support	Support in system document creation.
Researcher	Educational Beneficiary	Review current systems and approaches to improve the current process and techniques.
Competitor	Negative Stakeholder	creates a application that competes directly with the proposed system in terms of features
Hacker	Negative Stakeholder	intends to create issues or unauthorized access to the application and its data.

### 4.3 Analysis of Requirement Elicitation Methodologies

The various methods of gathering requirements are referred to as requirement elicitation. This segment examines a variety of options, outlining their benefits and disadvantages.

#### 4.3.1 Observing Existing Systems and Literature Review

Reviewing the current systems may be the initial step in requirement elicitation. The domain's current work is analyzed and identified features that need to be improved.

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• The process and the main components of ASR system can be explored.</li><li>• Helps to find the feature gap or the components which needs more improvements can be identified.</li></ul>	<ul style="list-style-type: none"><li>• Even though identifying the features of the available commercial products are not complex, reviewing the existing research and developed systems are complex, since the objective of each researchers are different.</li></ul>

#### 4.3.2 Surveys & Questionnaires

Since the ASR system can be used by all the people, and almost everyone who has a smart phone have tried voice assistant, so that the target audience is very wide. The questionnaire can be a easy option to cover wide and more people.

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Can cover wider and larger group of people</li><li>• Not time consuming</li><li>• Easy to analyze the results using the inbuilt tools</li></ul>	<ul style="list-style-type: none"><li>• Not everyone answers to question as expected manner, which can affect the result</li><li>• Person who fills the questionnaire may misunderstand a question</li></ul>

#### 4.3.3 Interviews

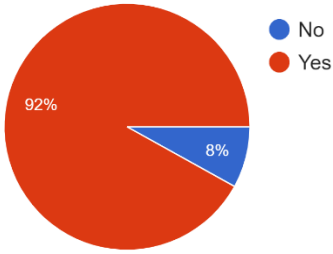
Interviews can be conducted to identify the future gaps and opinions about the currently available ASR systems. But in an ASR system, not only the domain expert and technical experts, the normal day to day users also should be included.

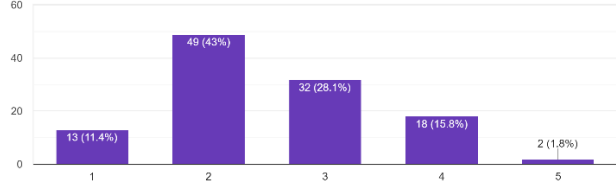
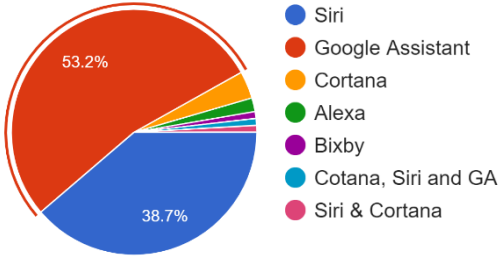
Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Direct interaction is efficient</li> <li>• Person can directly ask the interviewer if there any ambiguity.</li> </ul>	<ul style="list-style-type: none"> <li>• Covering more people and wider audience is difficult and time consuming.</li> <li>• The answers may not be straight forward.</li> </ul>

#### 4.3.4 Followed Requirement Gathering Methods

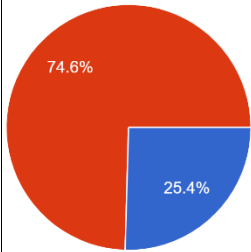
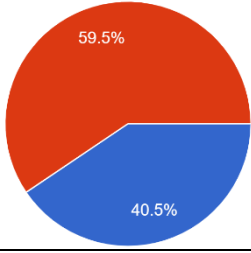
As mentioned above, Since the target audience is very wider, **Surveys & Questionnaires** is the optimal option than the interviews and brainstorming. This will save the time and can easily cover more people which improves the accuracy of the requirements. Other than that Literature review and Reviewing existing systems helps to explore more about the process and different techniques used in different systems. And based on the **mono method** and **quantitative** approach, the Survey has been used.

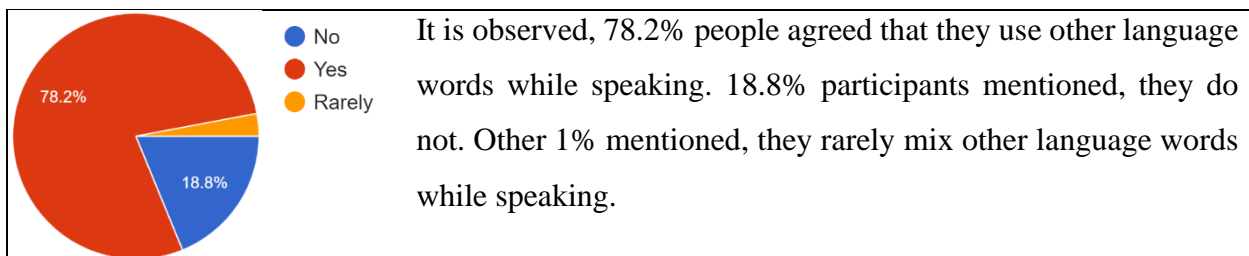
#### 4.4 Questionnaire Findings

<b>Question</b>	Have you ever used any voice assistant in any device? (E.g.- Siri, Google assistant, Alexa)
<b>Aim of Question</b>	To identify popularity of the voice assistant.
<b>Observations</b>	
 <p>It is observed that, 92% of the participants have used / tried the voice assistant application at least once in their lifetime. While 8% of the participants never tried the speech recognition system.</p>	
<b>Conclusion</b>	
Even though, in todays' world almost all of the smart phone users have access to any of the voice assistant, we can see some of the participants never even tried the voice application in their lifetime, which clearly shows, not all the people have interest on speech recognition systems and only 9/10 users have accessed it.	

<b>Question</b>	How often do you use voice assistant?
<b>Aim of Question</b>	To identify the usage / frequency of usage of the voice assistant application
<b>Observations</b>	
<div style="display: flex; align-items: flex-start;">  <div style="margin-left: 20px;"> <p>It is observed that, only 1.8% of the participants, using the voice search frequently. While 43% participants rarely use 11.4% never uses the voice assistants.</p> </div> </div>	
<b>Conclusion</b>	
<p>The graph show, still the frequent users of voice assistants are very low. But Even though the frequent users are very low, 9/10 of the participants are using it. From the decreasing pattern of the frequent users, we can say, people have difficulties in using voice assistant for the day-to-day tasks.</p>	
<b>Question</b>	Which of the following voice assistant/ search function you have used or been using?
<b>Aim of Question</b>	To identify the popular voice assistant among the users.
<b>Observations</b>	
<div style="display: flex; align-items: flex-start;">  <div style="margin-left: 20px;"> <p>53.2% participants use Google assistant, and 38.7% users are for Siri. Cortana, Alexa, and Bixby are used by 4%, 2% and 1% of the participants respectively. Approximately 2% participants said they are using more than one voice assistants.</p> </div> </div>	
<b>Conclusion</b>	
<p>We can see over 90% users are for Siri and Google assistant. This shows the usage of voice assistant is very high in smartphones compare to other devices. Even though Siri and Google assistant are available through smart speckers and other devices, the reason behind the high numbers is mainly smartphones.</p>	
<b>Question</b>	How helpful do you think voice search/assistants are?

Aim of Question	To identify, is voice assistant application really makes things easier?	
Observations		
		Only less than 1% thinks not useful. 31.9% answer for moderate and 33.6% for very useful. Moreover 15% participants think voice search is extremely useful.
Conclusion		
From the above data, almost 80% people think voice assistant is helpful (moderate to extreme). But when it comes to frequency of usage (Question 2) less than 45% has at least moderate use and only 1.8% said they use it frequently. This clearly shows, more participants think, the voice assistant application is helpful, but the actual usage is very low.		
Question	Is your native language available in the voice assistant you use?	
Aim of Question	To know, Are the voice assistant applications supports their users' native language	
Observations		
		It is observed that, 89.2% (almost 90%) participants mentioned that their native language is not available in the voice assistant they use. Only 10.8% participants said the voice assistant has support for their native language.
Conclusion		
According to this survey, the language support in voice support is very limited. We know the smartphones are widely used and not all the users know other language like English. This could be a reason for the difference between the participants who thinks voice assistants are useful and the actual count of the users.		
Question	Do you prefer to have voice assistant in your native language?	
Aim of Question	To identify, Are the users relay expecting to have language support for their language	
Observations		

 <p>74.6% participants preferred to have their native language in voice assistant. Other 25.4% participants not preferred to have their native language support in voice assistants.</p>	
<b>Conclusion</b>	
<p>Even though the 3/4 participants preferred to have their native language support, there are people (1/4 participants) who likes to use it like the current supported language (commonly in English). This shows, some people are comfortable to use English when it comes to interact with machines and systems.</p>	
<b>Question</b>	Do you think that you would use voice assistant more frequently, if that supports your native language?
<b>Aim of Question</b>	To know, does multi-language support in voice assistant increase the users
<b>Observations</b>	
 <p>It is observed that, 59.5% participants said, the native language support will increase the frequency of use, and rest of the 40.5% do not think, even though the language support is given, there will not be any change in the usage frequency.</p>	
<b>Conclusion</b>	
<p>Even though almost 60% of the participant think the native language support would increase the usage frequency, 40% think it is not. There can be various reasons for that, like the user's environment, privacy reasons, or they are comfortable with the type inputs.</p>	
<b>Question</b>	Do you use other language words while speaking?
<b>Aim of Question</b>	To know, how users code switch or code mix while speaking and does voice assistant application must have the mixed language speech recognition support
<b>Observations</b>	



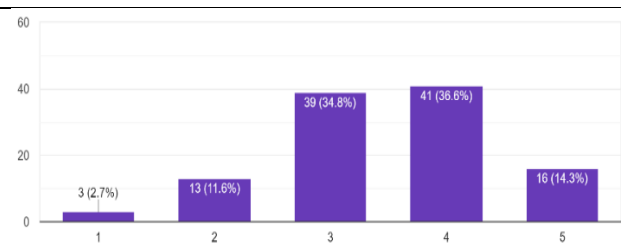
It is observed, 78.2% people agreed that they use other language words while speaking. 18.8% participants mentioned, they do not. Other 1% mentioned, they rarely mix other language words while speaking.

### Conclusion

We can see most of the participants agreed, they code mix or code switch while they speak. This clearly shows, only native language support is not enough, and it should support code mixing with other languages.

<b>Question</b>	How your voice assistant understands / recognizes your accent?
<b>Aim of Question</b>	To know, how accurate / how useful the current voice assistant application and the capability of understanding different accents

### Observations



34.8% participants mentioned, the accuracy is average and 36.6% mentioned the accuracy is good. Only the 14.3% participants mentioned the accent recognition is extremely good.

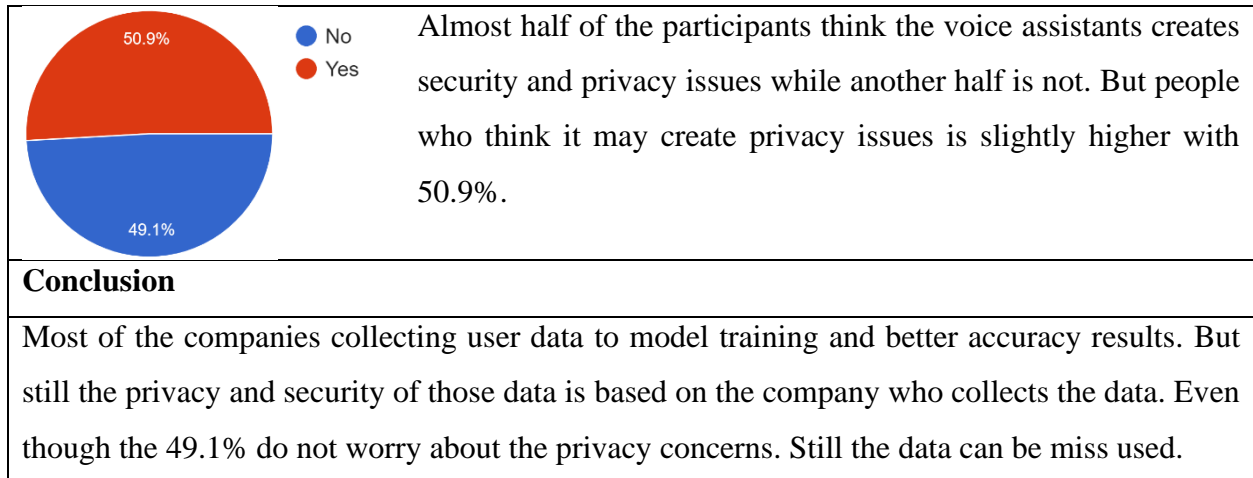
### Conclusion

The survey shows, the accent recognition is comparatively good for the currently used language. Almost 75% participants have moderate accuracy which is a good number for non-native language users.

<b>Question</b>	Do you think Voice assistants create security or/and privacy issues?
<b>Aim of Question</b>	To know, does users worry about the privacy while using the voice assistant application.

### Observations



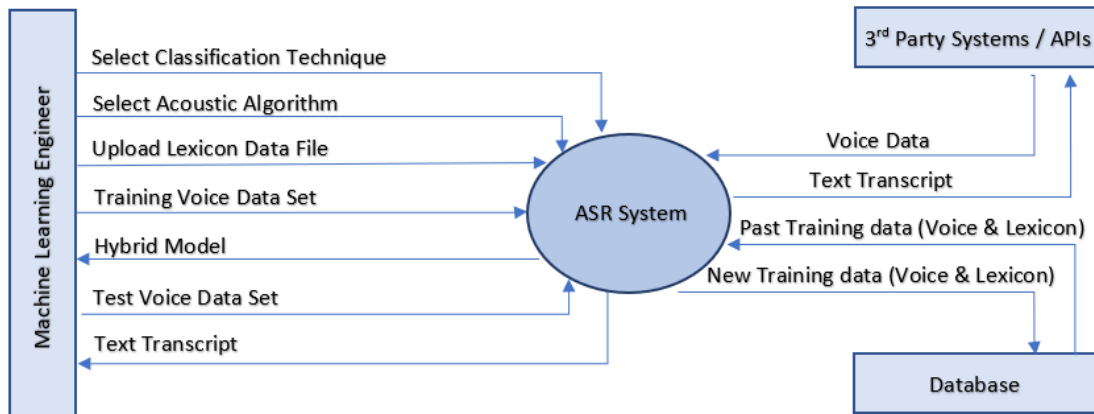


## 4.5 Summary of Findings

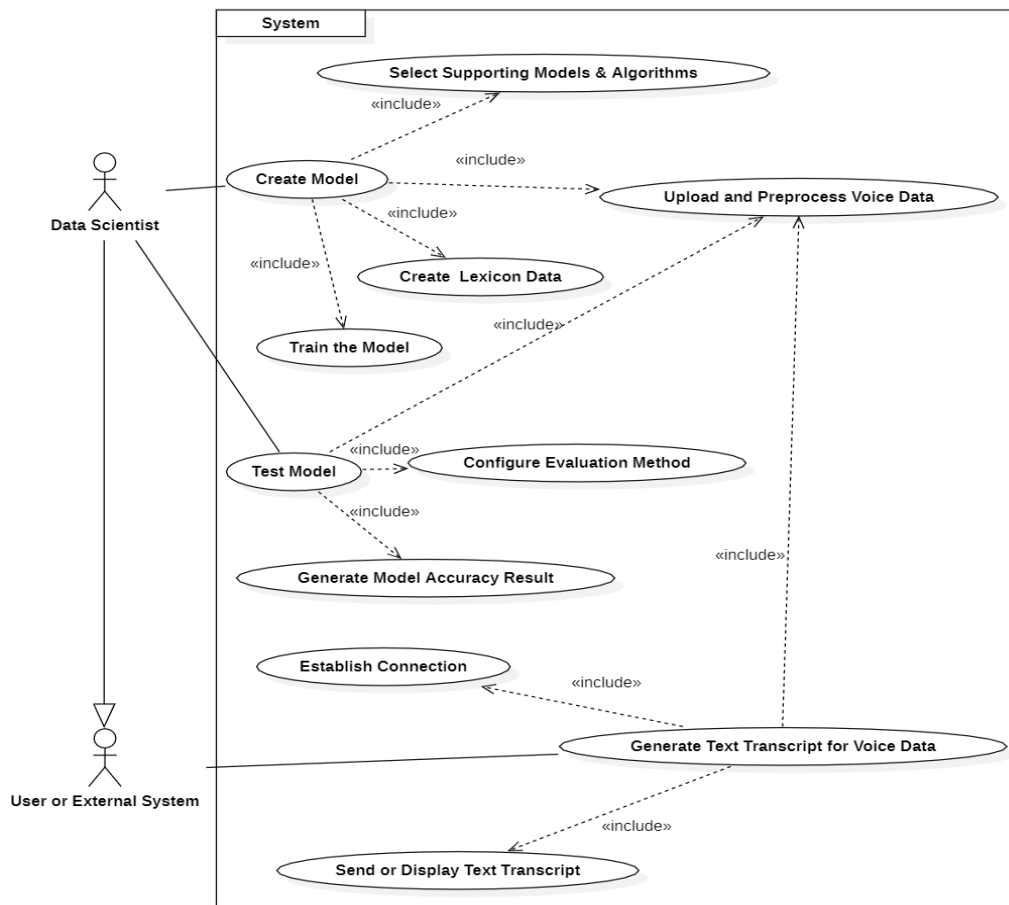
Findings	Literature Review	Questionnaire	Existing Systems
Current Speech recognition systems has lack of language support	X	X	
Speech recognition system should support code mixing and code switching to other languages	X	X	X
ASR should support different accent and dialects to improve the accuracy	X	X	
Lack of data is the primary issues for researchers and data is available only in few languages.	X		X
External factors like environment noise and echo affects the accuracy of the speech recognition	X		
Most research and systems on ASR systems does not focused multiple accent and dialects	X		X
ASR systems assistant may create security or/and privacy issues id it is not maintained properly.	X	X	

## 4.6 Context Diagram

Prior to development, the system's boundaries and interactions with both (internal and external) components should be established. The system's background is illustrated in the diagram below.



## 4.7 Use Case Diagram



### 4.7.1 Use Case Descriptions

Use Case ID	UC001
Use Case Name	Create Model
Description	Select a new model using different techniques, voice data and lexicons
Participating Actors	Data scientist
Pre-Conditions	Developing environment and the supporting tools should be configured and ready for model building.
Main Flow	<ol style="list-style-type: none"><li>1. Select classification algorithm for language switching</li><li>2. Upload voice data</li><li>3. Process voice data for model training</li><li>4. Upload lexicon data</li><li>5. Select acoustic model</li><li>6. Train the model with voice and lexicon data</li><li>7. New model will be created</li></ol>
Alternative Flow	-
Exceptional Flows	<p>E1. System failure / Environment configuration problem</p> <ul style="list-style-type: none"><li>• Use case fails</li></ul>

Use Case ID	UC002
Use Case Name	Test Model
Description	Testing the accuracy based on different evaluation methods
Participating Actors	Data scientist
Pre-Conditions	New model should be created
Main Flow	<ol style="list-style-type: none"><li>1. Upload test voice data</li><li>2. Process voice data using trained model</li><li>3. Generate text transcript</li><li>4. Configure parameters based on the evaluation method</li><li>5. Select evaluation method</li><li>6. Generate result based on the selected evaluation method</li></ol>
Alternative Flow	<p>3.a. Transcript generation fails</p> <ul style="list-style-type: none"><li>• Restart the process from step 1</li></ul>
Exceptional Flows	<p>E1. Model corrupted</p> <ul style="list-style-type: none"><li>• Redo the UC001</li></ul>

Use Case ID	UC003
Use Case Name	Generate Text Transcript
Description	Generate text transcript for the voice
Participating Actors	Data scientist, User, External system
Pre-Conditions	New model should be created
Main Flow	<ol style="list-style-type: none"> <li>1. Upload voice data</li> <li>2. Run the system</li> <li>3. Generate text transcript</li> </ol>
Alternative Flow	<ol style="list-style-type: none"> <li>3.a. Transcript generation fails <ul style="list-style-type: none"> <li>• Restart the process from step 1</li> </ul> </li> </ol>
Exceptional Flows	<ol style="list-style-type: none"> <li>E1. Model corrupted <ul style="list-style-type: none"> <li>• Redo the UC001</li> </ul> </li> </ol>

## 4.8 Requirements Specification

The system requirements are defined and prioritized different levels according to the Priority in this section.

Priority Level	Description
Critical	The system's main features and functionalities
Important	Not mandatory, but is thought to be needed
Non-important	Out of scope requirements.

### 4.8.1 Functional Requirements

The functional requirements of the system are listed in the table below, along with their priority level.

	Requirement and Description	Priority
FR01	Accepting the voice signal	Critical
	<i>As an input, the device must be able to accept sound signal.</i>	
FR02	Remove noise from the sound signal	Critical
	<i>Ambient noise and from the voice signal should be removed / reduced, Since the background noise can mislead the phoneme to be identified.</i>	
FR03	Pre-emphasis voice signal	Critical
	<i>Low frequency signal modules are attenuated, and high frequency modules are enhanced.</i>	
FR04	Signal segmentation	Critical

	<i>Splitting a continuous speech stream into segments of fixed duration to allow for block-wise signal processing.</i>	
FR05	Extract voice signal features	Critical
	<i>Convert the speech signal's waveform to a collection of feature vectors.</i>	
FR06	Map voice and lexicon data	Critical
	<i>Review the signal and map it to a word sequence using the lexicon data.</i>	
FR07	Determine the word sequence	Important
	<i>Based on the training, system should be able to guess the next word using language model.</i>	
FR08	Generate evaluation results for models	Critical
	<i>Even though for end user, it is not important function, in research perspective the accuracy and performance evaluation are an must feature.</i>	
FR09	Experiment meta data should be saved.	Non- important
	<i>To benefit future runs, the meta data of the dataset, generated models and evaluation results should be saved.</i>	
FR10	Support mixed language speech recognition	Critical
	<i>Even though the current research is on Tamil-English mixed language, the model can support other languages.</i>	
FR11	Support different accent	Critical
	<i>Model should support different accent of the language to improve the accuracy.</i>	
FR12	Multiple language support	Important
	<i>Able to support code switching for more than two language.</i>	
FR13	GUI and other Interface support	Non- important
	<i>User friendly UI and API interfaces to connect with the system.</i>	
FR14	Continues learning model	Non- important
	<i>Model should learn, while testing and using the ASR system</i>	

## 4.8.2 Non-functional Requirements

### Accuracy

Accuracy of the system is very important, and it should convert the speech data into text data. more errors in text transcript means, the system or the model is not usable.

### Performance

The data size of train and test set is very large (voice data to lexicon) and will increase with the time. So that the model training time will be longer when using more data.

### Usability

From the very first step end, all the configuration to testing with new voice data everything is done via command prompt. But an UI to upload voice data and display text transcript will make the system user friendly.

### Security

The system is using the customer voice data and have to save it for training and testing. So that the system should be secured to avoid unauthorized access and misuse of data.

	Requirement and Description	Specification	Priority
NFR01	Accuracy of the model should be high	Accuracy	Important
NFR02	Model creation and voice to text transcription should not take very long time	Performance	Important
NFR03	The process should be done with the minimum hardware configuration	Performance	Important
NFR04	System and data should not have unauthorized access and should be restricted based on the role.	Security	Non-important
NFR05	User friendly interface for voice uploading and transcription	Usability	Non-Important
NFR06	Should be able to increase the hardware configuration	Scalability	Non-Important

## 4.9 Chapter Summary

The chapter began with the description of project stakeholders and their participation. To gather requirements, various requirement methods were studied and used. Then the main use cases and the context of the system has been defined. From the Use case definition, the function and non-functional requirements were gathered and prioritized.