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*Article*

# Speakable Me: The Development Of Speech Assistance Tools For Patients With Speech Disabilities

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***Abstract*— This project involves analyzing and designing a system that functions as an Augmentative and Alternative Communication (AAC) to help individuals with speech and language disorders (e.g., aphasia and dysarthria) who are unable to use verbal speech to communicate by producing sounds based on the words entered by users. The main objective of this project is to assist patients with various types and levels of speech disabilities in communicating their needs, achieving a higher rate of Words Per Minute (WPM) with minimal financial cost. This system is developed using React Native, Visual Studio Code, and Firebase. Speakable Me provides three categories of speech assistants. In particular, Category 1 allows patients to enter the words with full spellings, and the system produces sounds based on the words entered. Meanwhile, Category 2 uses Morse code, which is a combination of 1 and 0 that has been pre-determined and assigned to a word in the library. This category aims to help patients with limited movement since it only requires patients to use two fingers to press the keys. Following this, Category 3 is a category that uses pictograms and has limited keys. Each key represents basic sentences and words that patients usually use. Patients need to press one key, and the system will voice out the whole sentence. Speakable Me also provides a feature that allows patients or their caregivers to add their own words and pre-recorded voices to the library for Categories 1 and 2. While sentences and words for Category 3 can be replaced, they are limited to the ten keys of the numbered keyboard.**

***Keywords*— augmentative and alternative communication; Morse code; speech disabilities; stroke, stroke caretaker**

## I. INTRODUCTION

Speakable Me is a speech assistant mobile application developed to help people with speech disabilities deliver their messages. It is an application that allows patients to speak simply by typing or pressing keys on the keyboard, and the system will produce sound based on what the user enters.

Patient with post-stroke aphasia, dysarthria, and Amyotrophic Lateral Sclerosis (ALS) commonly experience communication disorders due to their neurological condition. This is caused by brain damage resulting from a severe head injury, a tumor, an infection, or a degenerative process [5]. The patients may speak in short and incomplete sentences, unrecognizable words, and substitute one word for another.

Note that these problems faced by them might be worse as they can lead to stress and depression since they cannot talk like a normal person [4]. As a solution, patients need a tool that helps them deliver their messages easily and clearly.

Currently, there are existing Augmentative and Alternative Communication (AAC) technologies, such as LetMe Talk, Lingraphica, HelpMe Talk, Accent 800, and Virginia, that are developed to help patients with speech disabilities to communicate in their daily lives. However, these technologies are relatively expensive and still have many features that need improvement to meet the user requirements [6].

Since the existing AAC technology is expensive and not affordable, this mobile application has been developed to make it accessible for everyone, including low-income individuals.

## II. LITERATURE REVIEW

In this emerging era, technologies have made human life much easier. Presently, numerous AAC technologies and speech assistant applications have been developed by other researchers to assist individuals with speech disabilities in communicating. The other systems focus on one group of people with the same level of severity.

Furthermore, many systems that focus on AAC technologies have been developed nowadays to assist people with speech disabilities to communicate better. For this project, the researchers chose AAC-based systems and mobile applications as a comparison and system adaptation. The systems and mobile applications include LetMe Talk, Lingraphica, HelpMeTalk, Accent 800, Virginia, and AAC technologies in general. The researchers also did some research on illnesses that cause speech disabilities, which are aphasia and dysarthria.

The first section of the literature review will discuss the AAC technologies and speech assistant applications available in the market. Meanwhile, the second part of the literature review will cover illnesses that cause speech disabilities, which are aphasia and dysarthria.

### *A. **System Review***

#### 1) AAC technology

AAC is a broad term that encompasses all the ways people can communicate if they are unable to rely on speech or writing. It is used by individuals with a wide range of speech and language impairments, whether congenital (autism or cerebral palsy) or acquired (stroke or head injury). AAC is augmentative when used to supplement existing speech, and alternative when used in place of speech that is absent or not functional. It employs a range of methods and tools, including picture communication boards, line drawings, Speech-Generating Devices (SGDs), tangible objects, manual signs, gestures, and finger spelling. These methods help individuals express their thoughts, wants, needs, feelings, and ideas [15].

AAC is divided into two categories: unaided and aided. Accordingly, unaided forms of AAC do not require any tools and utilize motor control. For example, gestures, body language, facial expressions, and sign language. On the other hand, aided forms of AAC require tools, either electronic or non-electronic. Non-electronic aided forms are often referred to as "light-tech" or "low-tech," such as pen and paper, pictures, objects, and photographs, as depicted in Figure 1. In contrast, electronic forms are referred to as "high-tech," such as SGD and AAC software, as depicted in Figure 2. A well-designed AAC system is flexible and adaptable, thus maximizing the individual's ability to communicate effectively across environments [1]. In this project, the researcher utilizes the "high-tech" aided AAC system by incorporating SGD and adding a library feature where user can add their commonly used words through typing or voice recording.


Figure1. Low-tech aided AAC system

Figure 2. High-tech aided AAC system

AAC application is a high-technology software that helps people with speech and language impairment to communicate. It is easy to obtain, as many developers have launched their own AAC software that users can easily download onto their devices. Moreover, AAC applications are portable, as the software is downloaded onto users' devices, such as smartphones, laptops, and tablets, and can be carried anywhere. In line with this, AAC applications are used by a wide range of people, regardless of their age, since they are accepted as systems that can engage users. Despite its advantages of offering an alternative to traditional communication, which opens avenues for

expressing thoughts, feelings, needs, and desires, enhancing overall communication abilities, this technology is expensive and requires knowledge and skills to effectively use it.

However, there are limitations in utilizing this technology. One of them is knowledge of technology in general. The first obstacle is when users lack technology literacy. Some people need time to learn and familiarize themselves with the technology. Consequently, this hinders the efficiency of the AAC system since users cannot directly use the technology without proper training.

2) LetMe Talk

LetMe Talk is a mobile application that supports communication in all areas of life, which also provides a voice to everyone. It lines up images in a row and reads them as a sentence. It contains more than 9000 easy-to-understand images. This mobile application is developed by AppNotize UG and is currently available for Android and iOS users in the Google Play Store, App Store, and Amazon to be downloaded by users [3].

Figure 3. Main page of LetMe Talk

LetMe Talk is a mobile application that can be downloaded and used by users anywhere, anytime, as it does not require an internet connection. In addition, LetMe Talk also supports many languages, including English, Spanish, French, Arabic, and many more. Therefore, users only need to choose their preferred language. This mobile application also features voice support for images and sentences, indicating that a voice will be produced when the user chooses an image or types a sentence. Figure 3 illustrates a screenshot of the LetMe Talk application. Whenever the user selects any image and clicks the play button, the voice of the chosen image will be produced. As an alternative, users can type in their desired sentence for the existing or new image, and this application will generate the voice according to the sentence entered. Users can also create an unlimited number of new categories and add new images to the library.

LetMe Talk uses a First-In-Last-Out (FILO) function, where users must first choose a category and then find the right word to be displayed. For example, they must first choose the 'Food' category. Only then can they select the word 'Pizza.' They also need to return to the homepage in order to select another category. This is problematic, as users must navigate back and forth between the main page and the category page. Note that this application uses images and words to represent items. However, some images are challenging to interpret, and the font used is very small.

LetMe Talk is an app that facilitates communication and provides a speech therapy tool for individuals who struggle with speaking due to various conditions. Although it is designed with a simple and easy-to-navigate interface, unfortunately, due to its capability of allowing users to enter images and sentences, the screen will not display the earlier images since the speech screen is too small and contains excessive images. Furthermore, it uses an American accent, which some people may struggle to understand what is being pronounced.

3) Lingraphica AAC

Lingraphica AAC is an SGD that is simple and easy to use. The devices are enhanced by real-world experiences from people with aphasia, caregivers, and speech-language pathologists. Lingraphica AAC is developed by Copyright Lingraphica AAC, and their first tablet-style SGD was launched in 2011, as displayed in Figure 4. This application is available in the Play Store and App Store [2].


Figure 4. Three available sizes of Lingraphica AAC devices – midsize tablet, lightweight laptop, and small tablet

Lingraphica AAC allows users to create custom icons from pictures they have taken. They can insert the pictures into their library. Lingraphica AAC also offers a simple and intuitive menu and navigation system. The interface is neat, and the images are relatively large, making it easy for patients to click on them. In addition, Lingraphica AAC features a built-in touchscreen and on-screen keyboard. Thus, users do not have to bring a physical keyboard with them wherever they go.

However, Lingraphica AAC has limited language options, supporting only English and Spanish. It uses a FILO function, as users need to select one category before they can proceed to the right words they intend to use. Moreover, Lingraphica

AAC is a high-cost device that retails for approximately $7,500 on the market. Some people may not be able to afford it [10].

4) HelpMe Talk

HelpMe Talk is an app to facilitate communication and provide a speech therapy tool for individuals who have difficulty speaking due to various conditions. It was released in 2019 by HycsApp. This app is full of engaging pictures, interesting animations, voices, and effective exercises. Android users can download this application from the Google Play Store. Unfortunately, this application is not supported by iOS [7].


Figure 5. Main page of HelpMe Talk

HelpMe Talk, as displayed in Figure 5, is designed to support multiple languages and voices. Users can choose from any of the languages available in the application, including English, Italian, Arabic, Urdu, and Chinese, among others. Users can also customize pictures by choosing from their device or taking new photos. This picture can be used to create a new category or word in the library. In addition, user can also record their own voice to be added to the library to represent the pictures added.

Similarly, HelpMe Talk deploys a FILO function where users must first choose one category and then find the right word to be displayed. Following this, they need to return to the main page if they wish to select another word from a different category. Nonetheless, this mobile application cannot be accessed unless the user grants permission for media, files, camera, and microphone access on their smartphone. Such requirements may compromise the users' privacy, as they need to give permission to use this application.

5) Accent 800

Accent 800 is an integrated SGD that was developed by PRC-Saltillo in 2018. The upgraded version of Accent 800 is called Accent 1000. This device offers advanced functionality, including durable and dynamic performance, user-friendly features, and a touch screen function. It is a small and portable device that offers a variety of vocabulary options. Accordingly, Accent 800 will add value to a supported person's life as it will enable the user to communicate with words. This will empower them to advocate for themselves while promoting their independence and right to inclusion. The company also introduced the Accent 1400 and Accent 1000, which have similar functionalities to the Accent 800 [9], as depicted in Figure 6.


Figure 6. Accent 800 device

Although Accent 800 has many great features to help people with speech and language disabilities, it also has a few disadvantages. Accent 800 is a device that comes with embedded software. Hence, it is very expensive, with a market price of around $6,000. Individuals with limited financial resources may find it challenging to acquire them, while it may be accessible primarily to those with greater financial means. Furthermore, for Accent 800 users, training is required to use the technology effectively, and this process might be time-consuming.

Accent 800 is a device that provides word and picture prediction features that study the user's most common extended vocabulary choices and automatically arrange the 'Activity Row' icons for easier access. Thus, the time required for patients to type the words or locate the pictures can be reduced. This device also features enhanced audio recording and speech output quality, ensuring voices are clear and of high quality. It also features an auditory prompts option to aid patients with visual impairments, allowing them to rely solely on voice input.

6) Virginia

The Virginia application is useful for individuals with speech disabilities, whether originating from congenital disabilities, acquired disabilities, or temporary conditions. This application enables the device on which it is installed to

communicate voice prompts, conveying needs and problems through speech. It serves as a communicator for individuals with speech disabilities. Virginia is available in the Google Play Store, having been launched by the Cisano company in 2012 [13]. The main page of the Virginia Application is presented in Figure 7.


Figure 7. Main page of Virginia

Similar to LetMe Talk, Lingraphica, HelpMe Talk, and Virginia, this system also uses a FILO function. However, Virginia does not have a feature that allows users to add new words to the library independently. Some words that they usually use may be unavailable in this mobile application. Moreover, Virginia is not easy to navigate due to the inconsistency of the user interface design. Additionally, this application is not available in the Malay language.

Based on the comparison of a few applications as mentioned above, Table 1 is created to compare each application and its functionalities. The comparisons were made based on its functionality, which includes providing support for multiple languages, voice support, adding new words and images, recording voice, easy navigation, and affordability. In proposing solutions for Speakable Me, all functions will be incorporated into the development of the proposed solutions.

Table 1: Comparison of AAC Technology Applications

| Application/Functi-onalities | Supports many languages | Voice support | Add new words or images | Record voice | Easy navigation | Afford-able |
|---|---|---|---|---|---|---|
| LetMe Talk | / | / | / | | | / |
| Lingraph-ica | | / | / | | / | |
| HelpMe Talk | / | / | / | / | | / |
| Accent 800 | | / | | | | |
| Virginia | | / | | | | / |

*B. Language Disorder*

Apart from the system review, the researcher also investigated the type of motor speech disorder and language disorder faced by post-stroke survivor patients. Language disorder is a type of communication disorder that limits the ability of a person to communicate and understand language. The following are among the disorders related to language:

1) Aphasia

Aphasia is a language disorder resulting from damage to areas of the brain responsible for language. Aphasia usually occurs as a result of a stroke or head injury. Correspondingly, a person with aphasia may have trouble understanding, speaking, reading, or writing. Aphasia may co-occur with speech disorders such as dysarthria or apraxia of speech, which also result from brain damage. Aphasia is an effect of damage to one or more of the language areas of the brain. It also occurs since blood is unable to reach parts of the brain that are used for reading and writing [14].

Most of the symptoms can be recognized when a person frequently speaks in short, meaningful phrases with great effort. The patient also speaks in long sentences that have no meaning, adds unnecessary words, and even creates new "words." In addition, the patient has great difficulty understanding speech and is often unaware of their mistakes. Thus, aphasia can, for a reason, easily frustrate the patient due to their speaking problems [11][13].

2) Dysarthria

Dysarthria is often characterized by slurred or slow speech that can be difficult to understand. Dysarthria occurs when a stroke causes weakness in the muscles used for speaking. This may affect the muscles that move the tongue, lips, or mouth, as well as breathing control when speaking or producing voice. However, the ability to find the right words and to understand others is not affected if the patients suffer from dysarthria. Dysarthria can be caused by brain damage resulting from stroke, brain injury, tumors, Parkinson's disease, ALS, Huntington's disease, multiple sclerosis, cerebral palsy, and muscular dystrophy.

A person with dysarthria will experience symptoms such as slurred or mumbled speech that can be difficult to understand, speaking in a slow and soft tone, and talking too quickly. They may also struggle to move their tongue, lips, and jaw, and their speech may sound robotic or choppy. People who suffer from dysarthria have communication problems, and this will affect their relationships with family and friends. Consequently, dysarthria may lead to social isolation and depression [2].

## III. SYSTEM ADAPTATION

Understanding the characteristics and needs of individuals with aphasia and dysarthria is highly critical in designing the Speakable Me applications. It creates a focus for development, offering a multitude of advantages that lead to enhanced communication, independence, and an overall improved quality of life for individuals with aphasia and dysarthria conditions. Speakable Me enables independent communication, reducing dependency on caregivers or interpreters. It also caters to the unique preferences and requirements of each user, whether through customizable speech recognition settings, tailored vocabulary options, or a stored library function. Moreover, Speakable Me broadens accessibility to AAC technology by offering various communication modalities, such as text, speech, symbols, and images. This ensures inclusivity and equal participation for individuals with diverse communication abilities.

Based on all the existing systems and mobile applications reviewed, the features that the researchers decided to implement in Speakable Me are: In Speakable Me, we develop three categories of speech assistants based on the patient's severity and preferences. Category 1 is intended for patients with low severity, still able to move and speak. They are capable of entering the full spelling of the words or sentences they wish to say. Category 2 focuses on helping patients with limited movement ability, while Category 3 aims to help patients who have lost their speech and motor skills. Having this feature allows people with varying levels of severity to communicate more effectively. Concurrently, some patients may have their own preferences for how to communicate, whether they prefer to type words one by one or use the provided shortcuts.

Speakable Me combines three methods of communicating messages, which are (Category 1) entering Morse code, (Category 2) pressing keys, and (Category 3) using icons on the keyboard. For example, for Category 1, if a user types, "*Saya nak makan,*" the system will produce a voice synthesizer from the sentence into voice. For Category 2, users need to enter Morse code or binary numbers such as 101, which translates to "*Assalamualaikum,*" and 1000, which translates to "*Terima kasih.*" Notably, this Morse code has its own library, where the words have been pre-determined with their respective codes. For Category 3, it has limited keys to represent basic sentences or words that the patients usually use. For instance, key number '7' represents "*Saya nak makan.*".

Since Speakable Me is being developed in Malaysia, the researchers aim to introduce the first AAC technology that utilizes the Malay language as its primary language. However, users who use different languages can also input their voice and words using this application. As such, users can add new words and sentences by recording their own voices and saving them in their library, although basic words and sentences are also provided.

Although numerous systems have been developed to help patients with speech disabilities, most of them are expensive. Therefore, Speakable Me is designed to help patients with limited financial resources to own it, as this mobile application is low-cost and affordable.

This project aims to help people with speech disabilities of different severities to communicate and, at the same time, help the caregivers, such as doctors, nurses, and family members, to understand the needs of the patients better.

## IV. METHODOLOGY

The development approach used in creating Speakable Me is the Waterfall Development Model. The model is a linear and sequential approach that the team must follow step-by-step, without moving forward until the previous phase has been completed [8]. Therefore, by ensuring everything is achieved at its phase, this methodology leaves practically no space for unforeseen changes. It is usually used for developing short projects, where all requirements are well-known and clear [12]. Thus, all the time and cost estimation can be conducted at the early phase.

Since Speakable Me is a short project with clear requirements, the researcher decided to use the Waterfall development approach. Using this approach, it is easier for the researcher to track their progress and expect minimal changes at each step. Considering the hospital's restriction on meeting patients as the targeted audience for this application, the researcher prefers this approach, as it does not require frequent meetings with the client. Instead, the researcher only needs to meet the targeted audience during the requirements collection and testing stage, as well as during prototype design, to guide the researcher in understanding the system's features and the target audience.

Essentially, the Waterfall development approach comprises six phases or stages: requirements collection and analysis, design, development, testing, deployment, and maintenance. The first stage is requirements collection and analysis, in which the researcher collects all the information and requirements from the client and performs the analysis. All the information collected needs to be analyzed and documented to ensure that the applications to be developed meet the users' needs. Additionally, the limitations and constraints, including budget and time constraints, should be estimated at this stage. The next stage is the designing stage. At this stage, the researcher prepared the high-level, low-level, and logical designs, which also include all the diagrams, such as use case diagrams, activity diagrams, and sequence diagrams.

After the design stage is completed, the development stage begins. At this stage, the researcher started coding and developing the application. Following this, the testing stage ensures the application is working properly and identifies any bugs that need to be fixed. This ensures the end-to-end application is completed. After testing is completed, deployment takes place. This stage involves making the

application live for real-time users. The last stage is the maintenance stage, which involves fixing any bugs identified after deployment or enhancing any features of the application.

Requirements specification is critical in building an application or a system that provides a crystal-clear picture of the work that needs to be conducted. This is to ensure that the project's goals and objectives are met and that stakeholders are satisfied with the project's outcome. Consistent with this, the collection of user requirements is the foundation on which a project stands, as it provides a means of communication between users and the researcher. Users communicate what they need in a system or application, and the researcher anticipates their needs.

A set of user requirement questions, consisting of three parts, was developed prior to meeting with doctors, patients, and caregivers. Part A consists of demographic questions, Part B includes questions about patient sickness, speech ability, and rehabilitation, while Part C contains questions about system features. Notably, interview sessions with six respondents, consisting of doctors, medical staff, and patients, were conducted at Sultan Ahmad Shah Medical Center, Kuantan.

There was an equivalent number of respondents for males and females. Their response to Part B has revealed that patient with aphasia and dysarthria can only be average or severe in their ability to speak fluently. Most respondents highlighted that patients often feel stressed when they are unable to communicate effectively. Regarding the question about the help of rehabilitation on patients' ability to speak, the answers were 'average,' 'not helpful,' and 'not helpful at all.' All users answered 'no' to the final questions related to their previous experience using the speech assistant tools.

Based on the above response, the researcher can conclude that the development of Speakable Me is able to improve the functional communication ability of individuals with aphasia and dysarthria. The Speakable Me could also serve as a supplementary tool for rehabilitation support.

## V. PRESENTATION OF THE RESULT

Based on input from literature reviews, system evaluations, and surveys, the following use case diagram was developed. It serves as a blueprint to steer the actual development process. The development of Speakable Me has two main users: the patient themselves, who can use the functionality for Categories. Another type of user is their caregiver, who may be a doctor, nurse, or family member, and uses functionality for Categories 2 and 3.

Patients can choose their category of disability and enter their desired word as input. As for the caregivers, they could also choose the patient's category of disabilities, adding new words, recording voice, and deleting words in the library.

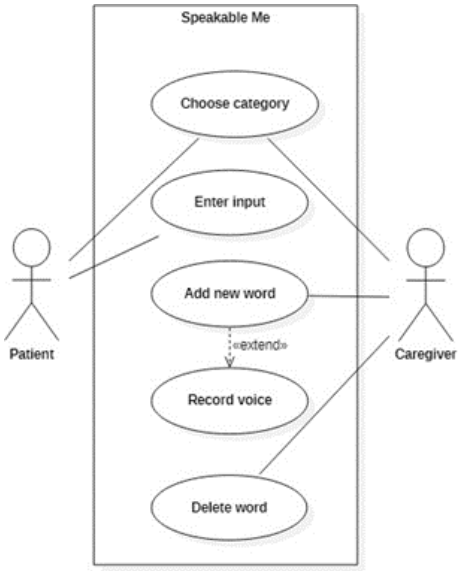


Figure 8. Use case diagram for Speakable Me

### *A. Solution Development*

The above blueprint was further developed into a dialogue chart that illustrates how the entire Speakable Me mobile application functions, as presented below. In general, the Speakable Me has three main features: (i) choosing a category, (ii) typing in a desired word, and (iii) adding the word to its binary combinations.

### *B. Feature 1: Choosing category*

Based on the above Figure 9, Speakable Me allows users to choose from Categories 1, 2, or 3 based on the severity of the patient. Note that all the categories are fixed. Category 1 provides a full typing method that patients or caregivers need to enter the full spelling of the words or sentences they wish to say. Meanwhile, Category 2 focuses on helping patients with limited movement ability, in which patients only need to enter two number keys, specifically 1 and 0, to form a binary code that has already been assigned to their respective word or sentence. Using this category, patients only need to use at most two fingers to type the combination of predefined 1s and 0s and the 'Enter' key. The last category in Speakable Me is Category 3, which aims to help patients who have lost their speech and motor skills by requiring only the press of one key. Each key has already been marked with pictograms and assigned to the basic needs of the patients.

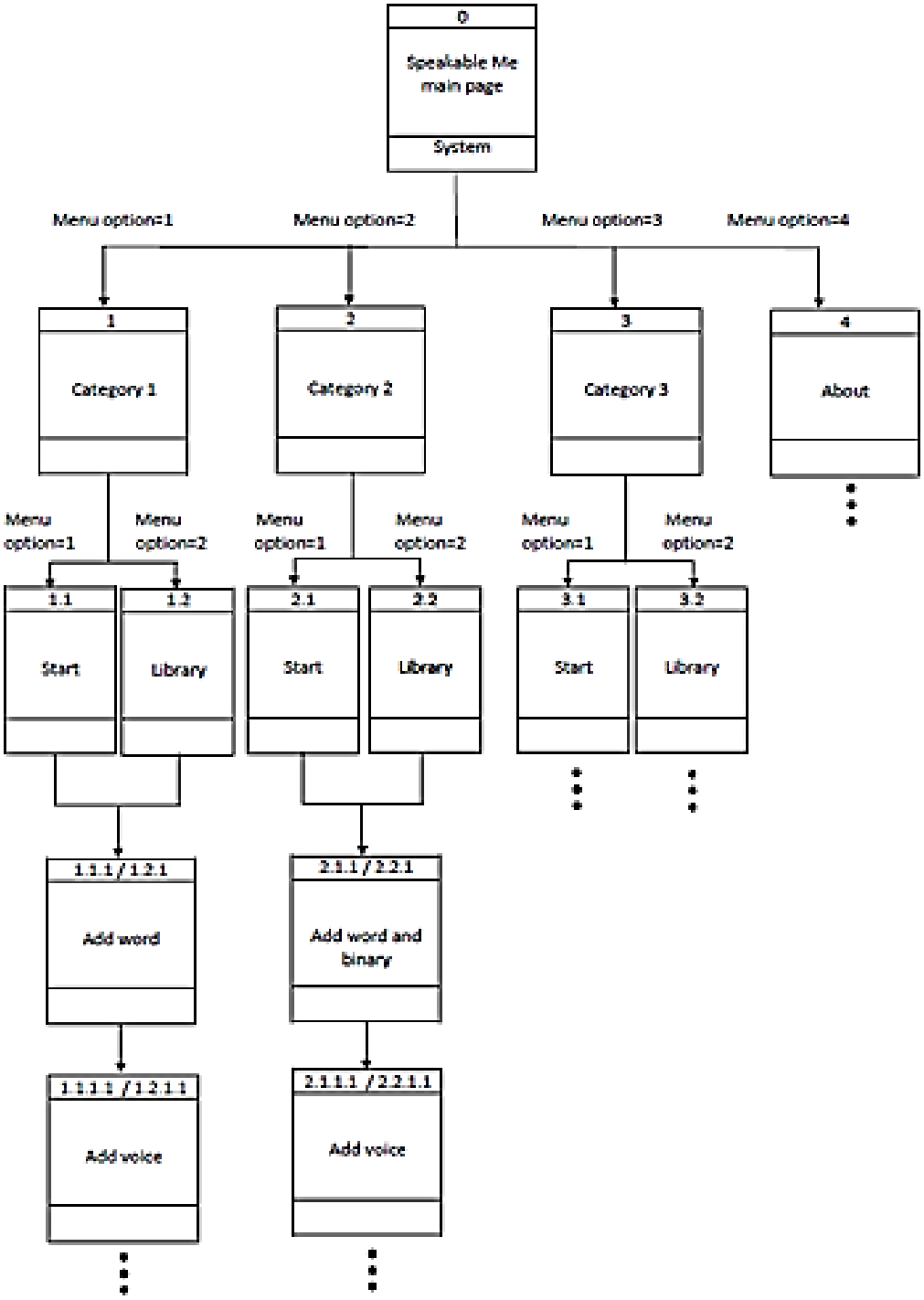


Figure 9. Dialogue chart of Speakable Me

*C. Feature 2: Type and desired word.*

Speakable Me allows users to type new, commonly used words by the patient and record the preferred voice. The words and voice will be stored in the library. This system is capable of capturing different types of language. This feature could be used by patients and caregivers for Categories 1, 2, and 3.

*D. Feature 3: Adding a word and its binary combination.*

While Speakable Me has a great feature to simplify words, it allows users to define any binary combination represented by 1 and 0. This feature offers flexibility to the caregiver in recording their common word with the patient. However, this feature could only be used by patients and caregivers for Category 2. The following section depicts all the screenshots of the Speakable Me mobile application.


Figure 10. Home page of Speakable Me

Figure 10 illustrates the Homepage of Speakable Me. It features three navigation buttons to select the patient category and one button for accessing the apps. For the administrator, it has its own database. The researchers themselves are the administrators who oversee the data and keep it confidential from unauthorized users. In the database, Firebase Realtime Database is being used to store the data in this term. For each category, it is defined as a JSON object that contains child nodes. For example, Category 2 has a child node labeled '100' and under '100,' there are other child nodes of binary, words, and audio. At the same time, the researcher used Firebase Storage to store the media files, specifically the audio recordings and uploads made by the users.

Any selection of the category button will be directed to the category page, as depicted in Figure 11. For Category 1, the patients can use normal typing methods in which they need to enter the full spelling of the words. This category is recommended for patients with a one-sided stroke and individuals with limited expressive language skills, as they can still move all their fingers. Conversely, for patients with limited physical movement ability, it is advisable for them to use Category 2 as they only need to use two fingers to enter 1 and 0. The functionality of the categories differs from each other. For Category 3, it is for those who have lost their speech and motor skills. It is the simplest method, in which they simply press a number key that represents a sentence. For all categories, the system will then produce a sound based on the user's input. However, if the words or sentences do not exist in the library, an error message sound will be produced. The user can later add the non-existing word to the library.

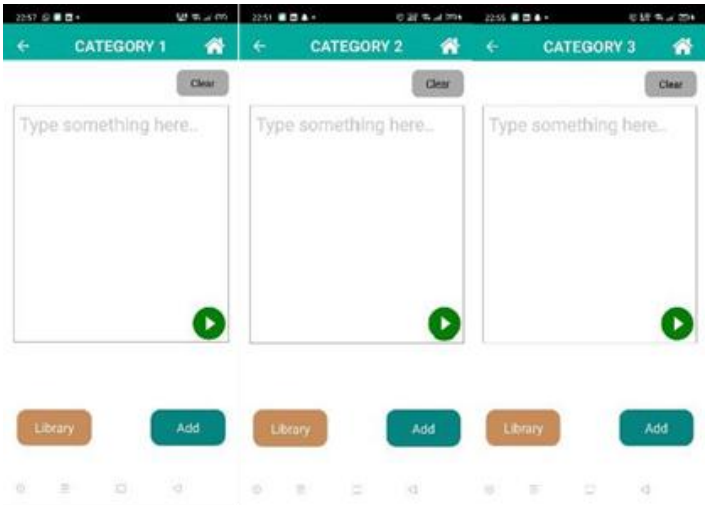


Figure 11. Speech screen function for Categories 1, 2, and 3 in Speakable Me

Figure 12 depicts the page that serves as a form for the caregiver to fill in and add new words or sentences to the library. For Category 1, the user needs to input the full spelling of the words that they desire to be in the system. For Category 2, the user is required to enter any combination of 1 and 0 to form a Morse code and assign it to any sentences that the patients usually use in their daily communication. For example, the user can enter '0011' for the Morse code and "*sakit lutut*" for the sentence. If the user inputs other than 1 and 0, the system will prompt an error message. For Category 3, the user needs to input any number key from 0 to 9 and assign it to a specific sentence. The system will then direct the user to the Recorder page after the 'Done' button is pressed.

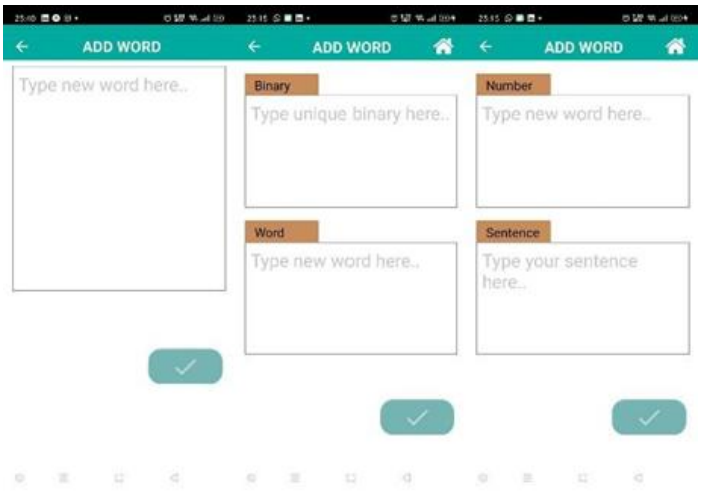


Figure 12. Add word function for Categories 1, 2, and 3 in Speakable Me

After the words have been added, the caregiver must record their voice and upload it to the database, as displayed in Figure 13. The researcher provides several functions in this module, allowing the user to record and replay the audio they have just recorded. If they are not satisfied with the audio, they can re-record another voice. This function demonstrates that Speakable Me provides users with flexibility, allowing them to use their own voice in multiple languages and accents.

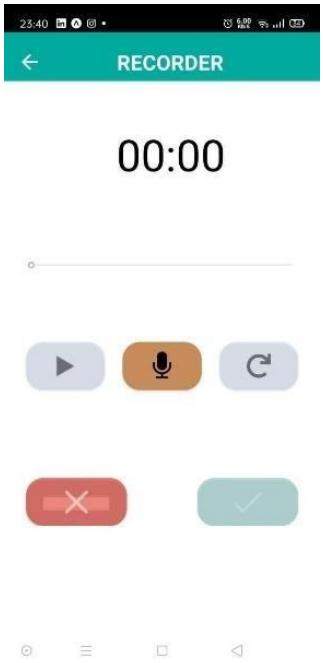


Figure 13. Voice recorder function in Speakable Me

All added words or sentences, along with their corresponding audio, will be displayed in the library for each category as depicted in Figure 14. In the library, the researcher provides a list of existing words or sentences stored in the database, along with the 'Delete' function for each word or sentence. The user can remove any words or sentences that they wish not to have in their own library. The system will then erase all data that is related to the deleted word. The library for all categories is displayed in Figure 14, 15 and 16.

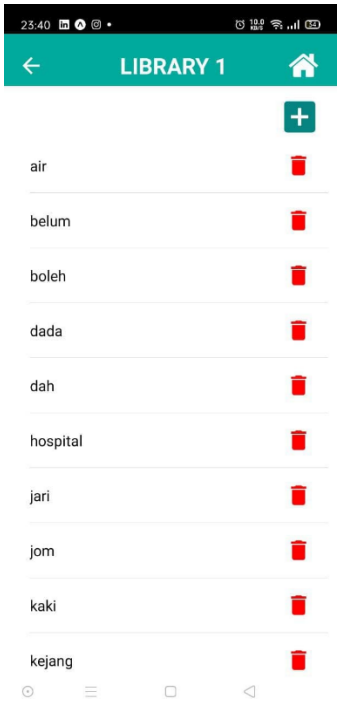


Figure 14. Library functions for Category 1 in Speakable Me


Figure 15. Library functions for Category 2 in Speakable Me


Figure 16. Library functions for Category 3 in Speakable Me

## VI. IMPLICATIONS OF THE PROJECT

This section discusses the implications of the study in terms of its benefits, constraints, and potential applications. This application addresses the healthcare issues of aphasia and dysarthria rehabilitation of stroke patient who are facing challenges coping with their communication abilities.

This project embodies inclusivity and offers a means to improve the quality of life for individuals affected by stroke. The development of this application also emphasizes the use of the common used language, as it facilitates effective communication between patients and their caregivers. In essence, Speakable Me aims to reduce stress and depression levels of stroke patient who are facing challenging moments coping with their ability. They can use this tool to express their emotions and desires. The simple yet interactive design of Speakable Me facilitates various types of digital literacy among caregivers, enabling them to effectively use this system. It is both handy and user-friendly, requiring less navigation. This feature will motivate caregivers to utilize the system. Furthermore, the development of this tool has opened a new way for the healthcare industry to manage patients with communication disorders. It is also a new avenue for improving communication among doctors, nurses, and patient caregivers in the healthcare setting.

Despite the implications, this project has few constraints. Since this project is developed using React Native Expo, it requires the researcher to use the same local host for both the emulator and the computer where the code is stored. If the local hosts are different, the project will not be able to run. This is problematic, as occasionally the local hosts do not align, although both the emulator and the computer are using the same internet connection. The researcher is also unable to run the project without running the Metro Bundler. To overcome this problem, the application must be published in the Google Play Store or Apple App Store.

## VII. CONCLUSION

Speakable Me is a speech assistance tool designed to help patients, especially Malaysians with speech disabilities, communicate better at a lower cost. This is attributed to the fact that currently, there are no speech assistant tools that are both economically available and flexible in language for users. Based on the survey during the user requirements collection, most doctors and caregivers noted that patients become stressed when they cannot deliver their message properly due to their speech disabilities. The caregivers also admitted that they struggle to understand the messages that the patients are trying to convey. Regarding the suggestion for future research, the human-computer interaction aspect should be considered to make the application more user-friendly. The category suggestion can be implemented to help users choose the category that best suits the patient. In conclusion, Speakable Me has been successfully developed and has met the objectives set at the beginning of the development phase.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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