DIGITAL HEARING ASSISTANT

PREPARED FOR

Heidelberg Hearing

PREPARED BY

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HOCHSCHULE SRH HEIDELBERG

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Team Roles

Team Members						
Tasks & Responsibilities	Nathan	Snehal	Abhijeet	Rohan	Raj	Shivam
Requirement analysis	✚	✚	✚	✚	✚	✚
Project description	✚	✚	✚	✚	✚	✚
Market analysis				✚		
Target state	✚	✚	✚	✚	✚	✚
Application flow					✚	
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User stories		✚				
Project structure plan			✚			
Network Plan						✚
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1. Project Description

According to a study in 2018 by the World Health Organization (WHO), 6.1% of the total world population (~466 million) is affected by hearing loss. Out of this, 7% (~34 million) are children and 93% (~432 million) are adults. The WHO estimates that the number could increase to over 900 million in 2050 if no proper actions are taken to mitigate the issue.

As delivered by Heidelberg Hearing, one option to partially restore hearing involves the **cochlear implant**, an electronic device that bypasses damaged areas of the ear to successfully transmit sound signals to the auditory nerve (Mayo Clinic, 2019). With continuous rehabilitation and training, the brain will learn to interpret these signals as sound.

In order to assist with the rehabilitation of customers using cochlear implants, as well as to further promote sales of these devices, we propose herewith a **Digital Hearing Assistant** application for Heidelberg Hearing. The system will be primarily developed as a teaching platform to cater to children aged 4 to 6 years old who will just start to learn hearing with the use of cochlear implants. These children also do not have formal training in reading and writing.

The prime objective of developing this application is to rehabilitate hearing-impaired children to be able to learn, recognize, and be made aware of the sounds that are commonly found in everyday life and in nature. The system will train them to properly identify the sounds and activities in their surroundings and make it easier for them to integrate with daily life, using the concept of associating different kinds of sounds to their sources.

To make it very easy to use and understand by children, we have developed the application on the basis of child-friendly graphical and illustrative models. Learning will be made fun and interesting using tested gamification concepts. The application will follow a model which consists of:

1. The learning platform for children; and
2. A performance review portal and module editor for parents, teachers, and medical professionals.

2. Target State

The goal of the project is to develop an interactive mobile learning application that allows children of age 4 to 6 years using cochlear implants to develop and train their hearing by using various sounds present in nature and everyday life. The goal is for the children to be rehabilitated to be able to associate the sounds with their sources in real life.

In order to achieve this, the following description summary is proposed to aid in understanding the final target state of the project.

Table 1. Target state description.

Must Have	Should Have	Nice to Have
Intuitive and effective UI/UX (measurable results)	In-app messaging functionality	Adaptive question difficulty depending on user progress
Native applications for iOS and Android	Incorporation of best practices in web app accessibility	Localized content (incorporating language and cultural differences)
Accurate database of text, images, and videos	Cost-effectivity through partnerships with governments and medical institutions (in coordination with Heidelberg Hearing)	Forum and user community
User management (for children, parents, teachers, and medical professionals)	At least 99.9% server uptime per month	Expansion to cater to different age groups
Ability for mentors to add additional text, images, and videos		Web application with offline support (progressive web apps)
Scalable infrastructure with built-in security and backups		Integration with technological advancements (bone conduction, etc.)
Ability to restore backup data by IT provider		Ability to restore backup data by user

Learning Module Content

The application home screen will initially contain modules for:

- Human voices and emotions
- Household objects and activities
- Nature and animals
- Various city sounds

Each module will have sub-modules, for example, the nature and animals module may contain the following sub-modules:

- Pet animals that can be seen in everyday life (e.g., a dog, a cat)
- Animals that are less commonly seen (e.g., a lion, a tiger)

User Interface and Design

The user interface for each module will display pictures, and an animal lead figure will invite the user intuitively to tap or click on the picture. When the user taps or clicks on the picture, the app will show a 5-second video with sound showing a real-life scenario with that particular animal (e.g., a dog barking, a lion roaring). A button will prompt the user to proceed to the next card.

At the end of each module, there will be a small interactive exercise in a virtually created real-life environment (e.g., a jungle, or a kitchen) where a particular sound will play, and the student will have to identify the source of a particular sound by tapping on the correct object or animal. To intuitively indicate if the student has chosen the correct option, a “Thumbs up” pop-up and point markers will be displayed on the top portion of the application. If the answer is incorrect, the application will show a red X.

User Management and Performance Monitoring

Parents, teachers, and medical professionals will have separate login credentials to monitor the performance of the corresponding children. The report will indicate, among others:

- Modules accomplished within the week
- Percent accuracy on accomplished modules
- Rate of question answering and module completion
- Data on incorrect answers to guide mentors whether the child needs some specific attention on particular topics

With their login credentials, parents will be able to monitor the status reports of their own children. Teachers and medical professionals will be able to monitor the status reports of each student and patient enrolled with them. They will also be able to add additional text, images, videos, and even whole modules if needed.

3. Market Analysis

The most predominant hearing aid applications currently available in the market are the Nucleus Smart App and the Baha Control app. Australian medicinal gadget organizations have developed the Nucleus Smart app, which has been utilized by over 500,000 individuals. The Baha Control app, on the other hand, was designed by Cochlear Americas and Cochlear Canada Inc. Both apps are designed primarily for mobile devices.

The global market for Hearing Healthcare Devices is valued at 7.360 million USD in 2018 and is projected to reach 9.840 million USD by 2025, growing at a compound annual growth rate of 3.7% during 2019-2025 (MarketWatch, 2019). Technological advancements, strategic initiatives by business players, and favorable reimbursements for cochlear implantation surgery are the key drivers in the market.

For example, in November 2015, Advanced Technology launched a replacement sound processor Naída CI Q90, that delivers advanced technology in automation, noise reduction, and waterproof protection. In 2016, MED-EL launched a replacement reversible battery for Sonnet Audio Processor. The battery charges quickly and provides 10 hours of battery life. The development of such improvements and the growing awareness among patients and physicians boost the business prospects of cochlear devices through the years.

The figures below illustrate the market size and market share of cochlear implants in the U.S. market.

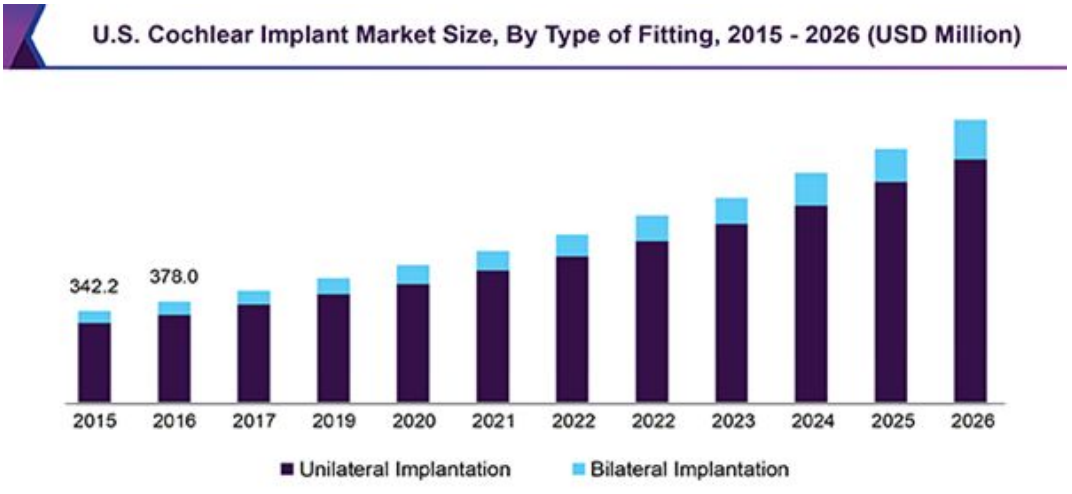


Figure 1. U.S. Cochlear Implant Market Size (Grand View Research, 2019).

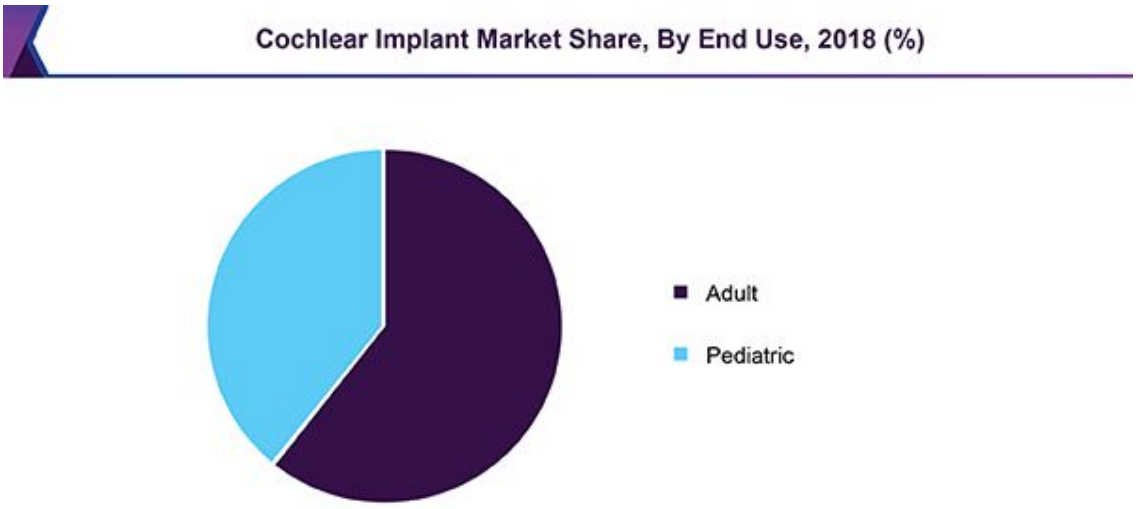


Figure 2. Cochlear Implant Market Share, By End Use, 2018 (Grand View Research, 2019).

The figures above illustrate that the U.S. cochlear implant market size is increasing steadily year-on-year, and that approximately 37% of the cochlear implant market share usage are from children.

Currently Available Applications

The current state of the market involves the following applications:

Table 2. Currently available applications.

Name of App	Available in	Brief Description and Features
Get Talking	Swinburne School of Design	The app primarily focuses on stories and games which require speech recognition, using complex research algorithms to develop story-like modules.
Mimi Hearing Test	Google Play / Apple App Store	The short but accurate Mimi Hearing Test measures a person's hearing ability at different frequencies to create a personal Mimi Hearing ID. The Mimi Hearing ID consists of more than 100 scientific parameters, mapped directly to a person's unique hearing.
Name of App	**Available in**	**Brief Description and Features**
AB Listening Adventures	Google Play / Apple App Store	Developed by Advanced Bionics, the leading company in making cochlear implants. The application focuses on game-based learning strategies. There are a total of 6 types of games with music and images. The application is meant to be used with adult supervision.
Fun With Directions	Google Play / Apple App Store	Developed by Patti Hamaguchi, M.A., CCC-SLP. The application puts emphasis on early direction concepts and language and auditory processing. The app is designed for learning basics like colors and shapes, and is also helpful for reading comprehension with the text feature toggled on.

4. Requirement Analysis, User Stories, Use Cases, User Interface Design

The native app is preferred over the web portal with reference to the usage habits of children, who can more intuitively open and use apps on smartphones and tablets than web applications in a browser.

User Stories

Sprint 1: Mobile application development

User Story 1: User Registration

Type	Description
Mobile Application	User will be asked to fill up the required information to validate the identity of the user and gain access to the application.

User Story 2: User Login

Type	Description
Mobile Application	Using the registered information, user will login into the system. User will also be verified before giving access to the service.

User Story 3: Kids Learning section

Type	Description
Mobile Application	After successful login, parents and children will be redirected to the kids learning section. Children will see different modules and parents can check the modules and the performance of children.

User Story 4: Dashboard

Type	Description
Mobile Application	The dashboard will be used by medical professionals, teachers, and parents to check the children's performance or to modify module data. Medical professionals and teachers can add a new child to monitor, view the performance of different children, and can communicate with one another (also with parents) within the app.

Use Cases

Use Case 1: Header	
Sprint Release	
Author	Business Analyst
Body	
Title	User Registration
Stakeholders	Users (Parents, Teachers, Doctors)
Use Case Description	New User will have to provide the basic user details.
Normal Flow	1. User opens the mobile application 2. User clicks on "New User?" 3. User fills in the required details. 4. On successful submit, user profile will be created and the user will be taken back to the login page.
Contingency Flow	

Use Case 2: Header	
Sprint Release	
Author	Business Analyst
Body	
Title	User Login
Stakeholders	Users (Parents, Teachers, Doctors)
Use Case Description	Registered user will attempt to login into the mobile app
Normal Flow	1. User opens the mobile application. 2. User enters his credentials. 3. If the credentials are correct, user (Parents) gets access to the Kids section page / user (Doctors and Teachers) gets access to Dashboard page. If not, the application gives an error popup "Incorrect User ID or Password".
Contingency Flow	

Use Case 3: Header	
Sprint Release	
Author	Business Analyst
Body	
Title	Forgot Password
Stakeholders	User (Parents, Teachers, Doctors)
Use Case Description	If the User forgets his credentials
Normal Flow	1. After clicking on “Forgot Password” a link will be sent to the user on his registered email address. 2. The user has to change the password from this link by entering the unique ID which is generated for each child while registering. 3. The user can then enter the new password and click on “Submit”.
Contingency Flow	

Use Case 4: Header	
Sprint Release	
Author	Business Analyst
Body	
Title	Kids section
Stakeholders	User (Child)
Use Case Description	The user (child) can access the different modules.
Normal Flow	1. After successful login, the child can access different modules of different types. 2. The child can do different exercises and quizzes.
Contingency Flow	

Use Case 5: Header	
Sprint Release	
Author	Business Analyst
Body	
Title	Kids section
Stakeholders	User (Parents)
Use Case Description	The user (Parent) can access the different modules and the Dashboard of his/her Child.
Normal Flow	1. After successful login, the Parent can see the different types of modules for his/her Child. 2. Parents can also access his/her Child's dashboard.
Contingency Flow	

Use Case 6: Header	
Sprint Release	
Author	Business Analyst
Body	
Title	Dashboard
Stakeholders	Users (Parents, Teachers, Doctors)
Use Case Description	The user (Parents, Teachers, or Doctors) can access and modify data on the dashboard of a Child.
Normal Flow	1. The user (Parents, Teachers, or Doctors) can see the overall performance of a Child and can modify data in the modules. 2. Doctors and Teachers can add new children in the list. 3. Parents, Doctors, and Teachers can communicate with each other inside the app and can also see the module-specific performance of a child.
Contingency Flow	

Application Flow Diagram

In the figure below, a diagrammatic representation of application workflow is developed considering all the user stories and use cases.

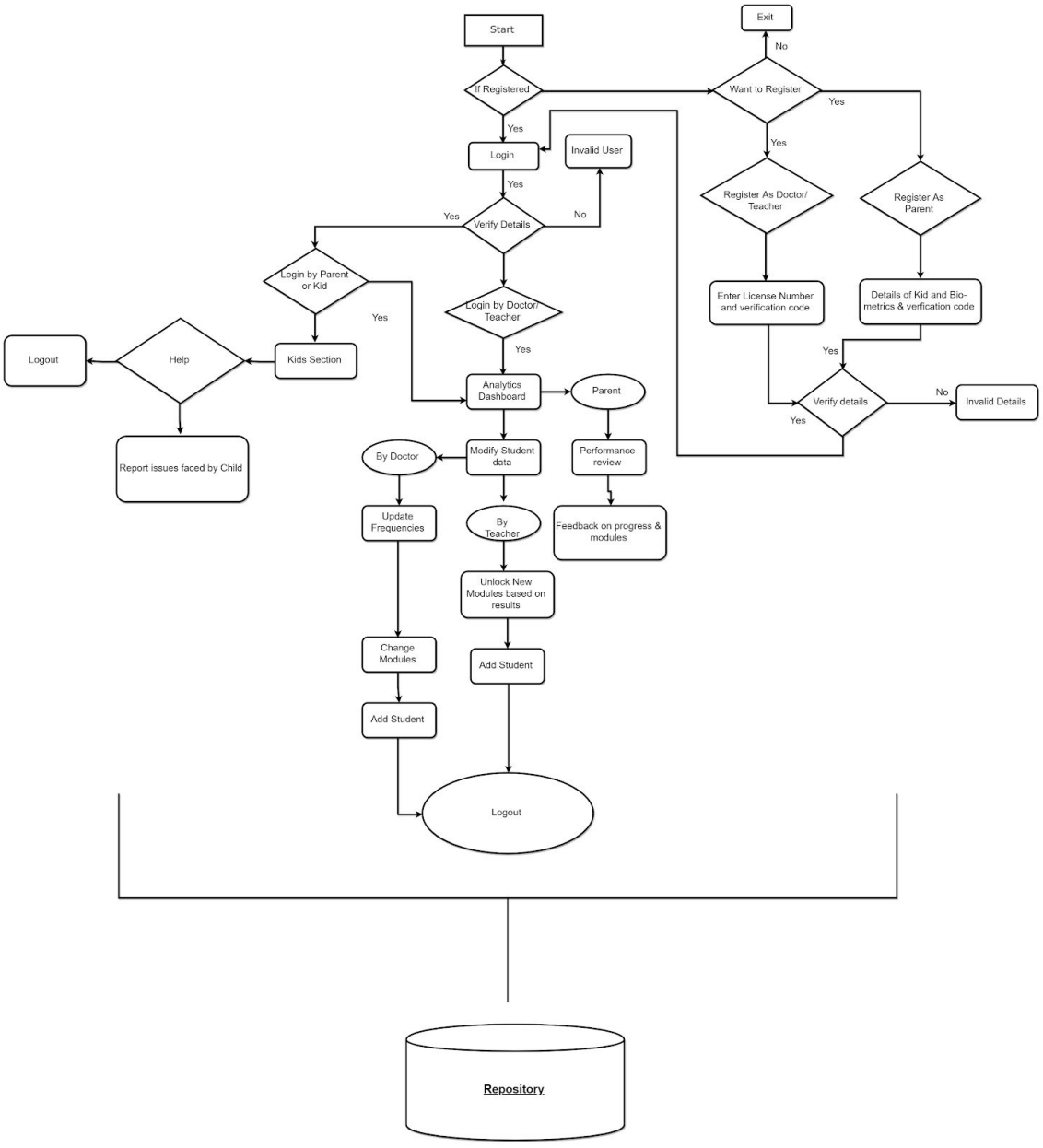


Figure 3. Application Flow Diagram.

UI/UX Design

Once a user has successfully logged in, based on his details and the option selected, the following possibilities are available:

- If Parents are logged in, they will be redirected to the Kids section. After which, they can navigate to the Analytics Dashboard through a menu.

- If Doctors / Teachers are logged in, they would be redirected to the Analytics dashboard, where they can review the child's performance and can update data as well if needed.

In case a user is not registered in the app, they can register by clicking on “New User?”.

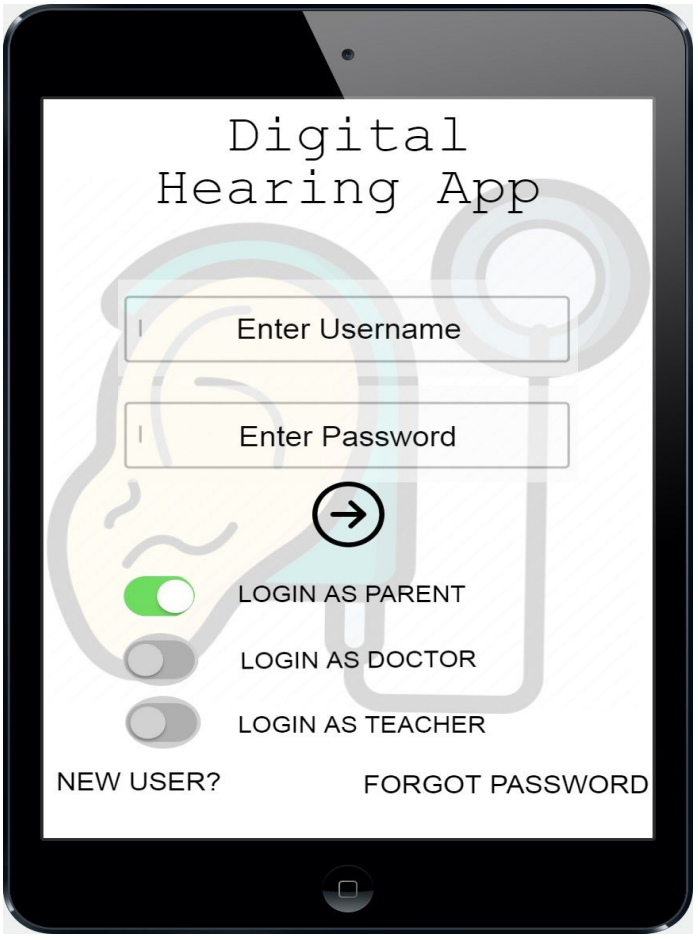


Figure 4. Login Page Mockup.

The **Kids Area** is shown below where the parent will manage and provide access to the child during initial login. After login, the child will be redirected to the Kids Area. This area consists of the aforementioned modules consisting of images and videos with sound to train children on the basics of listening. Some modules are also included which will be initially locked, and can be unlocked by doctors or teachers after a review and assessment of the child's performance.

Figure 5. Kids Area Mockup.

To keep a track of child's progress we have designed an **Analytics Dashboard**. Doctors and teachers can use this dashboard to review children's overall performance. They can also monitor a child's detailed module-specific performance and discuss and gather feedback from parents if necessary. They can add a child to their portfolio using this dashboard. Parents can also use this dashboard to monitor their child's performance and discuss any necessary concerns with doctors and teachers using the messaging module.

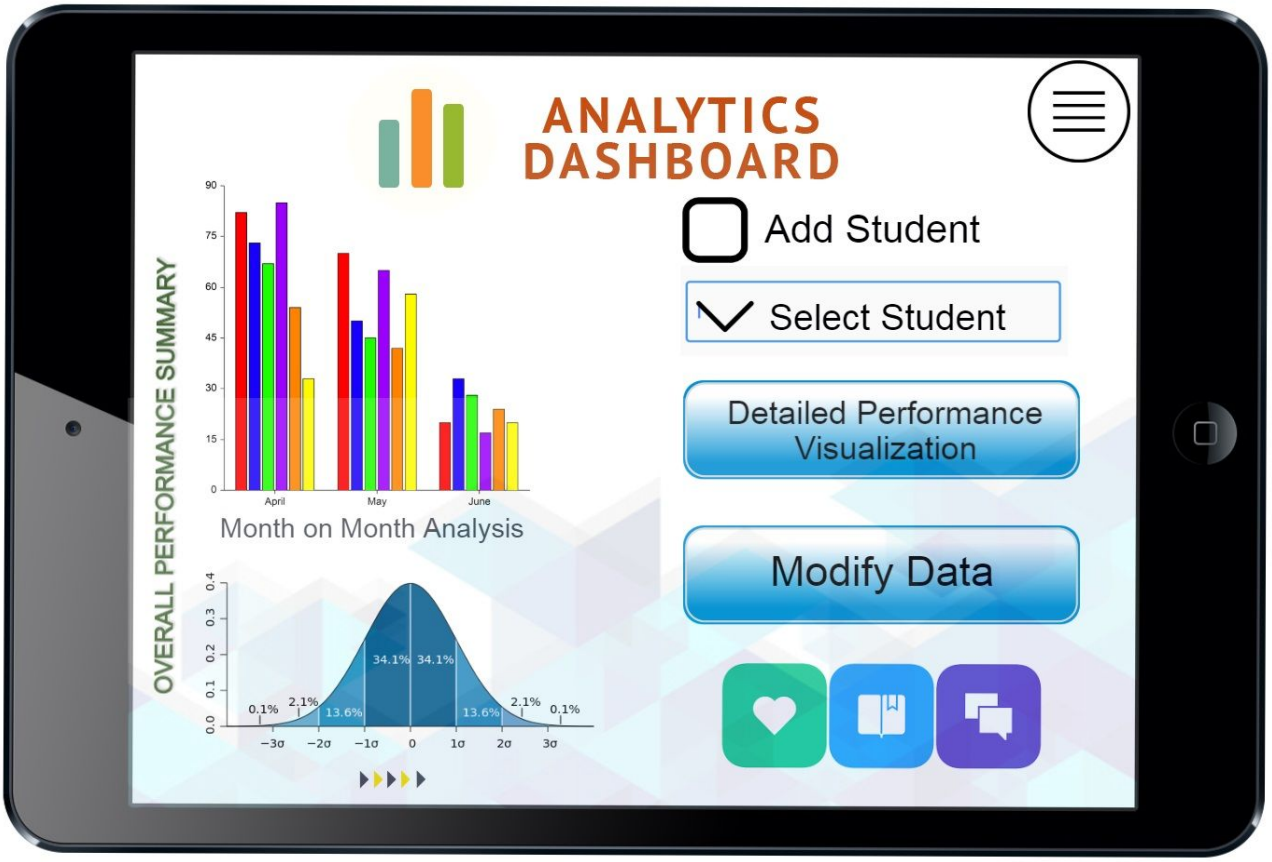


Figure 6. Analytics Dashboard Mockup.

5. Project Structure and Network Plan

Project Structure Plan

The project structure plan based on workflow orientation is as follows:

- The five main phases of the project are divided into smaller work packages that are independent and are measurable with respect to the time and result.
- These smaller work packages help in determining the cost and effort required to complete a particular task.
- The overall benefit of this kind of sub-division of tasks is to monitor the continuous progress of the project with respect to defined timelines.

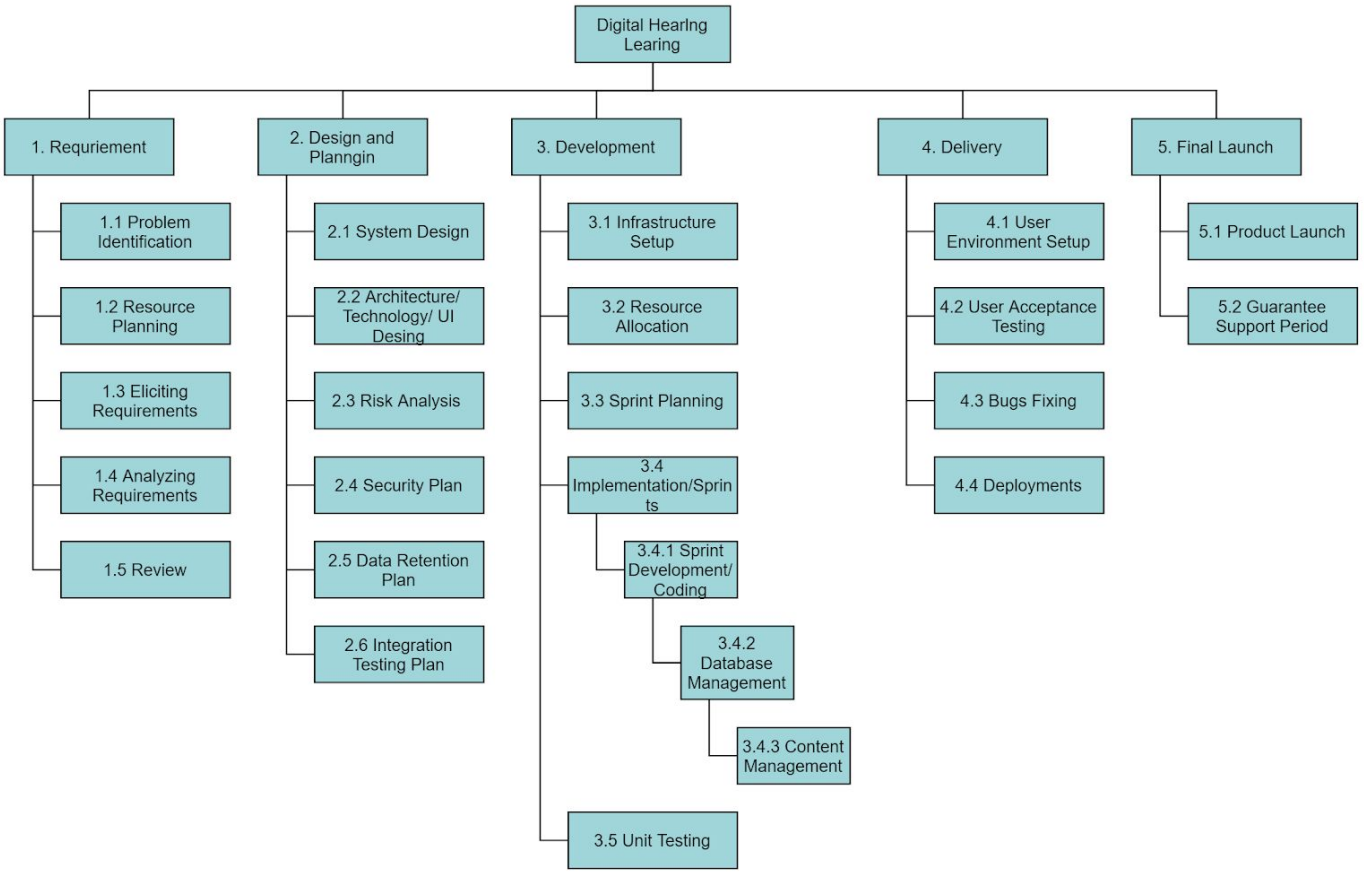


Figure 7. Project Structure Plan.

Product Structure

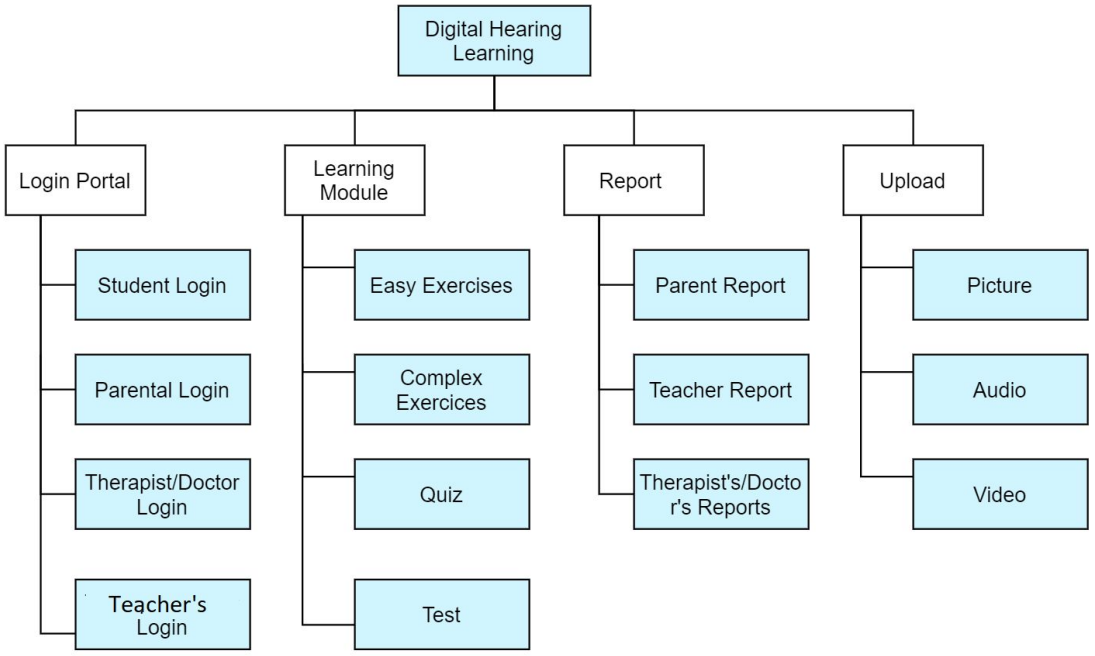


Figure 8. Product Structure.

The following defines the importance of the Product Structure:

- It defines a clear picture of the deliverables at the end of the product development.
- This complete hierarchical structure helps in realizing that the understanding of the requirements is correct.

Milestones

A milestone is a specific point of time when a particular task is achieved. These points in time and the achievements associated with them are decided during the project structure plan. The following lists the benefits of defining milestones:

- Monitoring the progress of the project
- Meeting deadlines
- Marking important dates
- Evaluating efficiency and performance

In this project we have defined the milestones with the following considerations:

1. Importance of deliverables
2. Impact on the deadlines
3. Impact on the stakeholders
4. Monitoring of progress and deviation

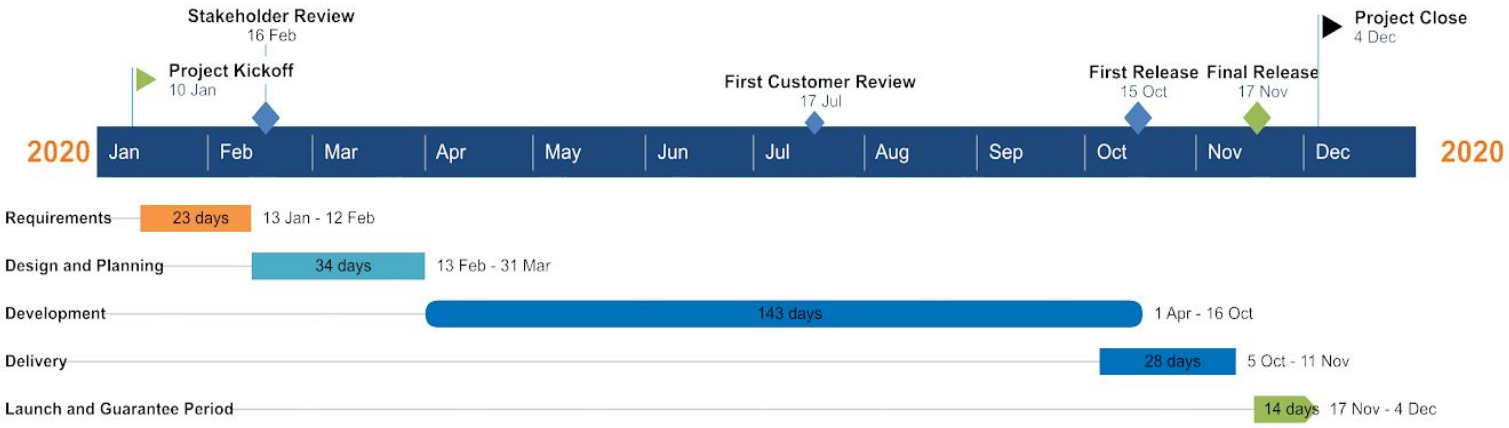


Figure 9. Milestones.

Project Timelines

The project is estimated to run for 11 months which will include requirement analysis, technology assessment, development, testing, and a guarantee period after the first roll out.

- In requirement gathering, the business analysts will document the important features and functionalities and understand the requirements from the perspective of a student, parent, teacher, and a doctor. This part is necessary to evaluate what is the current understanding level of the students (the primary user of the application) and how the application can be developed to give maximum output in terms of learning. This phase will also involve creation of use cases/user stories.

- The second phase of the project will discuss about the technology that is to be used both for developing the user interface and the database. This phase would require involvement of user interface designers and subject matter experts / technical architects with reference to several technologies to discuss the best possible design and architecture based on the use cases/user stories.

- The third phase is the development phase where the team will start with database and server infrastructure setup and the sprint planning. Since the agile methodology is followed for the implementation phase, the process of sprint planning, development, and testing is an iterative process.

- At the end of the implementation phase, the application will cover the 'Must Have' and 'Should Have' functionalities after which the product will be released to few users for acceptance testing. During the testing, there will be continuous roll-outs to the users to verify the fixes.

- After the completion of the User Acceptance Testing, the product will be launched for the intended customers to use. During this process, the development team will provide support for 3 weeks to monitor the application performance and address technical issues, if any.

Cost Estimates

Listed below are the cost estimates for the resources that are required for the project. Cost estimation is an iterative process and hence these estimates are subject to change based on the following factors:

1. Change in technology / product licenses.
2. Change in industrial value of the resources (Business Analysts, UI Designers, Project Manager, Technical Architects, Scrum Master, Developers, Content Administrator).
3. Change in infrastructure cost.
4. Change in requirements that may involve additional development, which would affect the resource planning and implementation phase

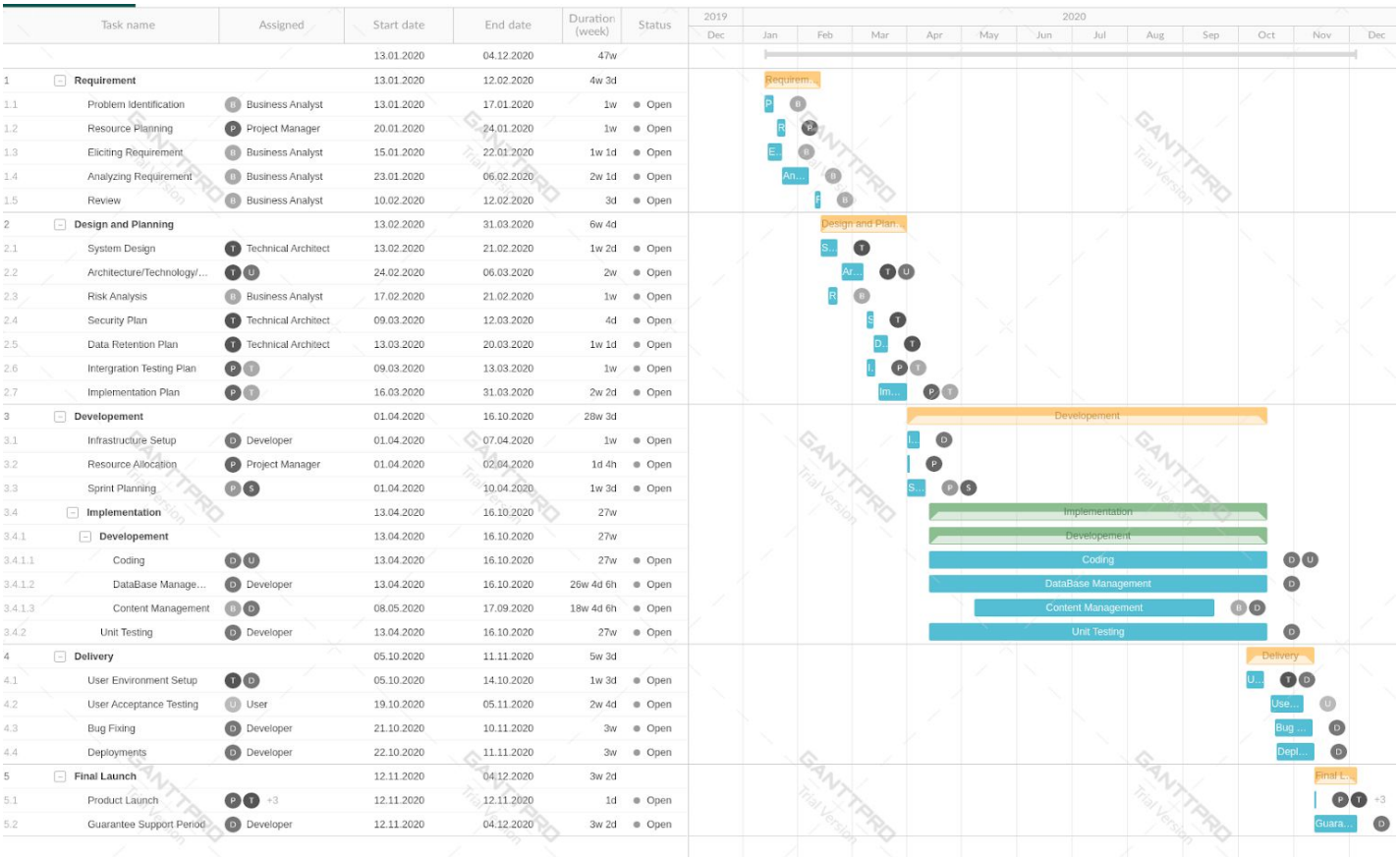
Table 3. Cost estimates.

Resources	Duration in months	Units	Cost per hour per Unit (Euros)	Total Cost (Euros)
Business Analyst	1	2	30	9.600
Business Analyst	10	1	25	40.000
UI Designer	1	2	25	8.000
UI Designer	10	1	20	32.000
Project Manager	11	1	30	52.800
Scrum Master	10	1	30	48.000
Developers	11	5	25	220.000
Technical Architects	2	2	35	22.400
Technical Architect	9	1	35	50.400
Content Administrator	10	1	15	24.000
Work Space	11	1	15	118.800
Logistics	11			10.000
Internet / WLAN	11			5.500
Technical Infrastructure setup	10			20.000
Total				**661.500**

Gantt Chart

The timeline for the project is shown below as a Gantt Chart. Appropriate buffer time is added in the Design and Planning and Development Tasks. Buffer time is calculated by considering the risks involved in these tasks. Such risks include system failures and unforeseen situations like illness of team members.

The buffer time considered for the Design and Planning phase is 2 days, while for the Development phase it is 4 days.



	Task name	Assigned	Start date	End date	Duration (week)	Status
			13.01.2020	04.12.2020	47w	
1	**Requirement**		13.01.2020	12.02.2020	4w 3d	
1.1	Problem Identification	Business Analyst	13.01.2020	17.01.2020	1w	Open
1.2	Resource Planning	Project Manager	20.01.2020	24.01.2020	1w	Open
1.3	Eliciting Requirement	Business Analyst	15.01.2020	22.01.2020	1w 1d	Open
1.4	Analyzing Requirement	Business Analyst	23.01.2020	06.02.2020	2w 1d	Open
1.5	Review	Business Analyst	10.02.2020	12.02.2020	3d	Open
2	**Design and Planning**		13.02.2020	31.03.2020	6w 4d	
2.1	System Design	Technical Architect	13.02.2020	21.02.2020	1w 2d	Open
2.2	Architecture/Technology/...		24.02.2020	06.03.2020	2w	Open
2.3	Risk Analysis	Business Analyst	17.02.2020	21.02.2020	1w	Open
2.4	Security Plan	Technical Architect	09.03.2020	12.03.2020	4d	Open
2.5	Data Retention Plan	Technical Architect	13.03.2020	20.03.2020	1w 1d	Open
2.6	Intergration Testing Plan		09.03.2020	13.03.2020	1w	Open
2.7	Implementation Plan		16.03.2020	31.03.2020	2w 2d	Open
3	**Developement**		01.04.2020	16.10.2020	28w 3d	
3.1	Infrastructure Setup	Developer	01.04.2020	07.04.2020	1w	Open
3.2	Resource Allocation	Project Manager	01.04.2020	02.04.2020	1d 4h	Open
3.3	Sprint Planning		01.04.2020	10.04.2020	1w 3d	Open
3.4	**Implementation**		13.04.2020	16.10.2020	27w	
3.4.1	**Developement**		13.04.2020	16.10.2020	27w	
3.4.1.1	Coding		13.04.2020	16.10.2020	27w	Open
3.4.1.2	DataBase Manage...	Developer	13.04.2020	16.10.2020	26w 4d 6h	Open
3.4.1.3	Content Management		08.05.2020	17.09.2020	18w 4d 6h	Open
3.4.2	Unit Testing	Developer	13.04.2020	16.10.2020	27w	Open
4	**Delivery**		05.10.2020	11.11.2020	5w 3d	
4.1	User Environment Setup		05.10.2020	14.10.2020	1w 3d	Open
4.2	User Acceptance Testing	User	19.10.2020	05.11.2020	2w 4d	Open
4.3	Bug Fixing	Developer	21.10.2020	10.11.2020	3w	Open
4.4	Deployments	Developer	22.10.2020	11.11.2020	3w	Open
5	**Final Launch**		12.11.2020	04.12.2020	3w 2d	
5.1	Product Launch	+3	12.11.2020	12.11.2020	1d	Open
5.2	Guarantee Support Period	Developer	12.11.2020	04.12.2020	3w 2d	Open

Figure 10. Gantt Chart timeline.

Action Nodes for the Requirement Phase

In the first rolling phase, action nodes are made for the Requirement phase only. The Requirement phase will run on a critical path as also indicated in the Gantt Chart. As the tasks are completed, further action nodes for more work packages will be created.

Earliest starting date	Duration	Earliest End date	
13.01.2020	1 Week	17.01.2020	
Number	Name of Action		
1	**Problem Identification**		
Time buffer	Resources		
0 Days	Business Analyst		
Latest starting date	Entire Buffer	Free Time	Latest End Date
13.01.2020	0 Days	0 Days	17.01.2020

Earliest starting Date	Duration	Earliest End Date	
20.01.2020	1 Week	24.01.2020	
Number	Name of Action		
2	**Resource Planning**		
Total Time Buffer	Resources		
0 Days	Project Manager		
Latest starting date	Entire Buffer	Free Time	Latest End Date
20.01.2020	0 Days	0 Days	24.01.2020

Earliest starting Date	Duration	Earliest End Date	
15.01.2020	1 Week & 1 day	22.01.2020	
Number	Name of Action		
3	**Eliciting Requirement**		
Total Time Buffer	Resources		
0 Days	Business Analyst		
Latest starting date	Entire Buffer	Free Time	Latest End Date
15.01.2020	0 Days	0 Days	22.01.2020

Earliest starting Date	Duration	Earliest End Date	
23.01.2020	2 Week 1 Day	06.02.2020	
Number	Name of Action		
4	**Analyzing Requirement**		
Total Time Buffer	Resources		
0 Days	Business Analyst		
Latest starting date	Entire Buffer	Free Time	Latest End Date
23.01.2020	0 Days	0 Days	06.02.2020

Earliest starting Date	Duration	Earliest End Date	
10.02.2020	3 days	12.02.2020	
Number	Name of Action		
5	**Review**		
Total Time Buffer	Resources		
0 Day	Business Analyst		
Latest starting date	Entire Buffer	Free Time	Latest End Date
10.02.2020	0 Days	0 Days	12.02.2020

6. Risk Analysis

Table 4. Risk analysis.

Risk	Severity (a)	Probability (b)	Visibility (c)	Product (a x b x c)
Incorrect text-image-video association	4	2	3	24
Incorrect reporting of progress statistics	4	2	2	16
Security breach	3	1	3	9
Budgetary risks (missed deadlines and going over-budget)	3	2	1	6
Mismatched student data (mentor assigned to a different student)	4	1	1	4
Sharing of user accounts	1	1	4	4
Data loss	4	1	1	4
Development technology becoming outdated after launch	1	2	2	4
Unplanned server downtimes	3	1	1	3
Decrease in number of users	2	1	1	2
Competitor app	1	2	1	2

The product cut-off for risk management is calculated as (highest-product risk / 8) = 24 / 8 = 3. It is proposed that risks on or below the cut-off (with a product of 3 and below) be excluded in the risk management scope for the project.

Risk Mitigation Strategies

Risk:	**Incorrect text-image-video association**
Strategy:	**Mitigation**
This particular risk is ranked the highest as it pertains to the accuracy of content. Guidelines for systematic and accurate input of text, images, and videos with sounds shall be established for content administrators. Machine learning-based image and video analysis will also be utilized to verify the accuracy of text content. Guidelines for actual beta-testers to verify the accuracy of text, images, and videos with sounds will also be established.	

Risk:	**Incorrect reporting of progress statistics**
Strategy:	**Avoidance**
Risk shall be managed through functional testing using sample data and test output during development.	

Risk:	**Security breach**
Strategy:	**Delegation**
Security is integrated in the designated cloud-based infrastructure (Google Firebase). Data access is protected and managed through Cloud Firestore with Firebase Authentication and Cloud Firestore Security Rules for Android, iOS, and JavaScript, or Identity and Access Management (IAM) for server-side languages (Cloud Firestore, 2019).	

Risk:	**Budgetary risks (missed deadlines and going over-budget)**
Strategy:	**Mitigation**
Agile methods shall be utilized during development to prioritize set timelines and development cost, and thus minimize the risk of going over-budget. Perceived risks to budgetary requirements shall be immediately communicated to Heidelberg Hearing.	

Risk:	**Mismatched student data (mentor assigned to a different student)**
Strategy:	**Avoidance**
Teachers and medical professionals will be presented with a name confirmation to verify the identity of the student. Risk will also be managed through regular monitoring of student progress during actual meetings with teachers and medical professionals.	

Risk:	**Sharing of user accounts**
Strategy:	**Acceptance**
Sharing of user accounts is not perceived as a high risk because each child will have his own progress that will deter account sharing. Accounts will have to be created only through the parents.	

Risk:	**Data loss**
Strategy:	**Delegation**
Risk on data loss will be delegated to the designated cloud-based infrastructure integrating regular database backups.	

Risk:	**Development technology becoming outdated after launch**
Strategy:	**Mitigation**
Risk will be mitigated through best practice development, future-proofing, and modular development.	

7. Stakeholder Analysis

Project stakeholders involve individuals, groups, and organizations that have an interest or concern in a project. Stakeholders may affect or be affected by decisions, activities, or outcomes of the project. The following table lists the recognized stakeholders for the Digital Hearing Assistant project.

Table 5. Stakeholder analysis.

Stakeholder	Impact on Project Success	Impact of Project on Stakeholder	Attitude
Heidelberg Hearing	4	4	+
Development Team	4	3	+
UI/UX Designers	4	3	+
End-users: Children	2	4	+
End-users: Parents	3	3	+
End-users: Teachers	3	2	+
End-users: Medical professionals	3	2	+
Competitors: App Developers	1	3	-
Competitors: Cochlear Implant Manufacturers	1	3	-

Heidelberg Hearing as the primary stakeholder and client entails the highest stakeholder ranking with a positive attitude as the proposed application has high support from top management in line with the higher-level objectives of the company.

Due to their nature, competitors are generally negative towards the successful execution of the project. They are also, for the most part, impacted by a successful project execution, such that it prompts competitor actions such as developing a similar application or ramping up their marketing initiatives.

During the development process, there will be an iterative **consultative meetings** held with parents, teachers, and medical professionals regarding their experiences and recommendations to incorporate best practices in teaching methodology and design interface in the application. Such meetings will ensure that children will be able to learn in the best and most efficient way towards rehabilitation.

During the beta-testing and user acceptance phase in coordination with Heidelberg Hearing, **end-user representatives** (children, parents, teachers, medical professionals) will participate in the process to simulate use case scenarios and provide continuous feedback. The feedback loop is important not only to fix bugs encountered during the beta-testing, but also to spur better iterations of the application by feature improvement, addition of functionality, or streamlining of the application flow.

Management, development, and end-user attitude towards the project is **generally positive** as the project entails support to a good cause for millions of hearing-impaired children worldwide.

8. Project Process Models

The V-Model (Verification and Validation) methodology in combination with Agile methodology will be adopted for the project. The V-model will be adopted in the planning and testing phase to account for accurate and rigorous product testing, necessary as a companion to a medical device. The use of Agile methodology during the implementation and coding phase allows for constant delivery timelines, maximum utilisation of resources, easier incorporation of feedback from stakeholders, and early detection of bugs.

It is a modified version of the Waterfall model, as shown in the figure below.

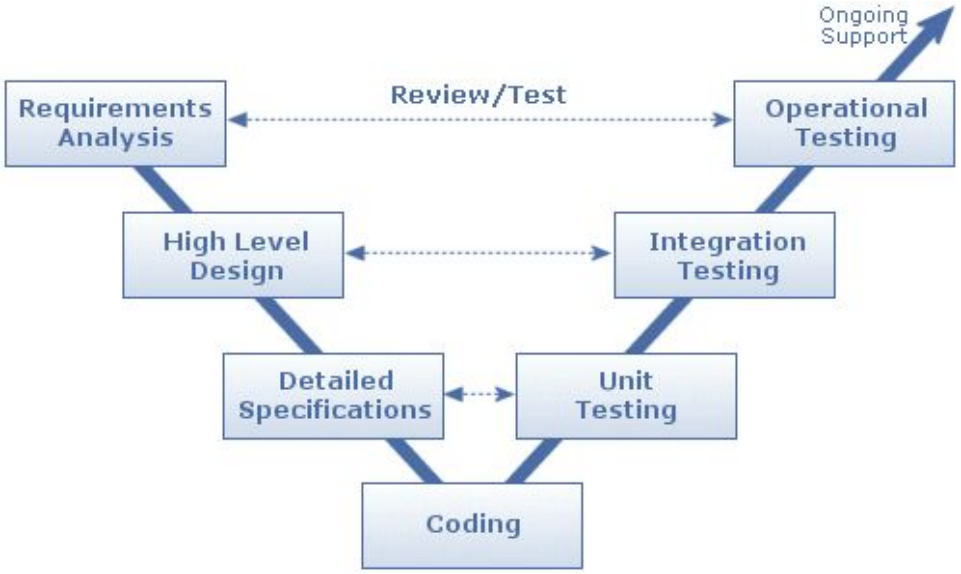


Figure 11. The V-Model (Verification and Validation) methodology.

Why V-Model?

For the project, the V-Model methodology was chosen in combination with the Agile methodology for the following reasons:

1. The requirements are clear from the beginning; nevertheless, there is scope to adjust requirements during the development phase if the customer requires such.

2. The time, cost and resource planning is done in the planning phase itself as part of the V-model, and the Agile methodology allows the maximum utilisation of the available resources via the extreme programming process,

constant delivery timelines, and target visualization during the sprints.

3. Accurate and rigorous product testing as well as continuous stakeholder feedback is a requirement necessary as a companion to a medical device.

In the V-model, testing takes place at an early stage, whereas in the traditional Waterfall model, the testing phase only starts after the development is completed. Moreover, as the specifications and application design are well-defined prior to the start of the implementation phase, it becomes easier to understand and follow.

In addition, the flexibility provided by the Agile methodology makes it easier to incorporate requirement changes even during the development phase. It also provides opportunities to detect application bugs from the early phase of development which ensures a better delivery quality. Customer satisfaction is increased as the product is reviewed at regular intervals which in turn increases the business value.

9. Technological Aspects and Concept Details

Table 6. Proposed front-end and back-end technologies.

Front-End Technologies	Back-End Technologies
React Native NativeBase (design framework) JavaScript	Firebase (Google Cloud Platform) - Cloud Firestore (NoSQL cloud database) - Cloud Functions - Authentication - Firebase Security Rules

Front-End Technologies

To speed up development for both iOS and Android, the popular React Native mobile application framework will be utilized along with the NativeBase design framework.

With **React Native** (built upon **JavaScript**), a single codebase can be used across platforms: for iOS and Android, such that the development team can manage two platforms simultaneously. The single codebase will be compiled into native application code (iOS or Android) running directly on the device operating system.

The **NativeBase** design framework will enable the development team to create platform-specific designs for both iOS and Android using a single codebase.

Back-End Technologies

Firebase, built upon the Google Cloud Platform, will be used as a comprehensive app development platform and unified backend to speed up development time. Firebase services that will be used are Cloud Firestore (NoSQL cloud database), Cloud Functions (hosted backend code), Authentication, and Firebase Security Rules.

Cloud Firestore is a flexible and scalable NoSQL cloud database and will be used to store and sync the application data. It keeps data in sync across client applications through real-time listeners. Data is also indexed by default, so query performance is proportional to the size of the result set, and not the data set (important for this application as it involves numerous files, images, and videos). Scalability is integrated along with automatic multi-region data replication. Offline support is provided through data caching so the app can make queries and update data even when the device is

offline. When the device goes back online, any local changes made are synchronized in the cloud.

Cloud Functions for Firebase will enable hosted backend code to be triggered in response to events such as HTTP requests, database changes, and authentication triggers. It also keeps the application logic on the server side (in the Google Cloud Platform) to maintain privacy and security.

Firebase Authentication will be utilized as a secure end-to-end identity solution for end-users to support email and password accounts, phone authentication, and Google, Twitter, Facebook logins.

Firebase Security Rules will be used to secure application data in Cloud Firestore, and define which data can be accessed by which users. They are flexible, extensible, and can accommodate various complex rule definitions. Rules are defined independently in the Firebase console or the command line interface.

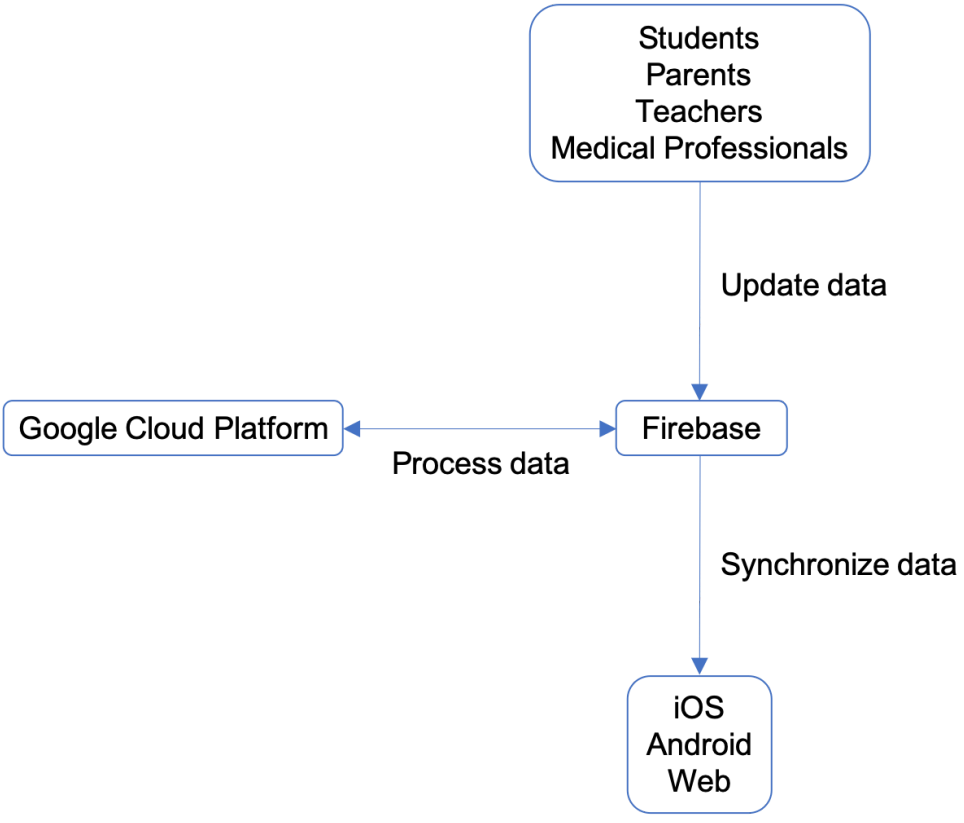


Figure 12. Data Framework.

10. Executive Summary

A Digital Hearing Assistant application is proposed for Heidelberg Hearing to aid in the rehabilitation of customers using cochlear implants, and to further promote device sales. The application will be developed as a learning platform for hearing-impaired children aged 4 to 6 years old who will just start to learn hearing with the use of cochlear implants, to learn and recognize the sounds that are commonly found in everyday life and in nature.

To make it very easy to use and understand by children, the application will be developed with child-friendly graphical models and tested gamification concepts. The application will consist of:

1. The learning platform for children; and
2. A performance review portal and module editor for parents, teachers, and medical professionals.

The project kickoff will be on 10. January 2020 and targeted to close on 04. December 2020. The V-Model (Verification and Validation) methodology in combination with Agile methodology will be adopted for the project. The V-model will be adopted in the planning and testing phase to account for accurate and rigorous product testing, necessary as a companion to a medical device. The use of Agile methodology during the implementation phase allows for constant delivery timelines, maximum utilisation of resources, easier incorporation of feedback from stakeholders, and early detection of bugs.

Total cost for the whole project duration is estimated at EUR 661.500. Major potential risks involve the accuracy of texts, images, and videos in the application, as well as reporting accuracy of child progress statistics. These shall be managed through appropriate risk mitigation and avoidance strategies, respectively.

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