**A feasibility report on developing medical cloud solution using web and mobile technologies to analyse absence seizures in children.**

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# 1 Problem description

## 1.1 Nature and context of the problem

According to (Kessler, S. K. and McGinnis, E. 2019) Childhood Absence Epilepsy (CAE), is a common paediatric epilepsy condition with absence seizures. It affects 10–17% of all children diagnosed with epilepsy. Absence seizures usually start between 4 and 10 years of age. Absence seizures look like brief staring spells. During an absence seizure the child is not aware of the surroundings. A child may have absence seizures occurring from few to many a day. After the seizure, the child will immediately return to the baseline level of awareness.

(Escoffery, C. *et al.* 2018a) says, “”there is a potential role for technology and mobile apps to assist with patient care and epilepsy treatment””. Many epilepsy monitoring apps (mobile and web) are available today. According to (Chiu, M. *et al.* 2021), currently there are 40 mobile applications available for epilepsy management.

The Author of the feasibility report is a parent and carer of a child suffering from Child Absence Epilepsy for over two years. According to the Author, the problem is that most epilepsy monitoring application technologies are generic and do not capture lifestyle factors (tracking sleep hours, exercise, meals, stress levels etc) comprehensively specific to Child Absence Epilepsy with the aim to understand their impact and get more valuable insights.

## 1.2 Benefits

It is anticipated that this new web and mobile technology should benefit the parents caring for children suffering from Child Absence Epilepsy in the following ways:

* Parents should be able to log child’s daily absence seizure events, medication and lifestyle choices data with ease.
* Parents should benefit from receiving event notifications and timely seizure reports that can be shared with a click of a button to the child’s healthcare provider.
* Reports obtained should benefit the parents to keep track of seizures and provide more valuable insights.
* Report sharing should also benefit the parents to analyse child's condition remotely in situations when they are unable to travel for long distance appointments.

It is also anticipated that this new web and mobile technology should benefit the healthcare providers. However, it is important to note that the benefits to the healthcare providers is the opinion of the Author of the feasibility report and the Author has no expertise of the medical field.

* Healthcare providers should benefit from the reports and should be able to gain insights and come up with effective treatment plans for the child suffering.

Another substantial benefit is that this new web and mobile technology should make it easier to have effective communication between the parents and healthcare providers.

## 1.3 Existing knowledge

The Author of this feasibility report is a parent of a child diagnosed with Child Absence Epilepsy. As witnessed and experienced by the Author, parents face several difficulties while monitoring and managing their child's condition. When it comes to seizures triggers most of the time it is difficult to know what causes or triggers seizures. Existing epilepsy monitoring and management apps have a long-complicated process to add seizure events data. All the recorded data into the apps is not effectively used. There is no way to look back at the data and seek patterns. In the opinion of the Author, daily lifestyle factors such as diet, sleep, exercise can sometimes have an influence on number of seizures affecting the child’ s quality of life. Existing web and mobile apps do not provide functionalities to record daily lifestyle data comprehensively to seek more insights.

## 1.4 Proposed solution

The proposed solution is a feasibility report on developing medical cloud solution using web and mobile technologies to analyse absence seizures in children. It should include the following key ICT aspects:

* Front-end development should include documenting functional and non-functional requirements and building wireframes.
* Back-end development should include creating a relational database design model with an ER diagram by capturing entity, attributes, describing their relationships, adding foreign key constraints, and using normalisation techniques. It should also involve suggestions on the use of possible data analysis such as building a data pipeline, a discussion about a suitable medical cloud hosting solution for the application and a solution diagram.
* Medical data cannot be discussed without the data privacy and security issues. So, the feasibility report should include a discussion about all the threats to data security and privacy of user’s data and how to avoid them. For e.g., include encryption, authentication, authorization etc. It should also include a discussion on General Data Protection Regulation (GDPR).
* A brief discussion of the likely impact of the application when developed. For e.g., how parents should be empowered as well as the negative impacts on children if the application was not used appropriately.

1.5 Analysis of likely impact

If adopted this web and mobile technology should empower parents, in the monitoring of the child’s absence seizures by providing tools to capture seizure, medication and lifestyle data and gain insights from the data.However, while considering social and ethical problems, (Parker, L. *et al.* 2017), explains that health apps which function as aids (for e.g., monitoring health) can sometimes have concerns regarding risk of harm to user’s health and safety.

* In context of this web and mobile technology, the analysis reports may have a risk of harm to the child suffering. Parents could apply the analysis output without the consent of the healthcare provider and make changes to child’s treatment or lifestyle.
* Inaccurate information and incomplete forms filled by parents may result in wrong data analysis report output.
* The feasibility report is solely based on Author’s personal experience of caring for the child with Child Absence Epilepsy. However, in the context of real world, if this report is accepted and a development is carried there might arise some features which have not yet been considered.

While considering legal impact,

* There is threat to security and privacy of the user’s child’s medical data as child’s seizures, medication and lifestyle data will be collected. More such legal issues are discussed in the legal issues section 4.1 later.

# 2 Account of related literature

A list of several literature resources that contributed to this feasibility report are divided into six groups.

* Monitoring epilepsy using technology
* Database Design
* Data Analysis
* Healthcare IT Solution diagram
* Data Security and Privacy Issues

## 2.1 Monitoring epilepsy using technology

(Escoffery, C. *et al.* 2018) did a study by reviewing mobile applications to promote epilepsy self-management. According to them many patients struggle with self-management practices such as remembering to take medications on time, maintain prescribed sleep, exercise, and stress levels etc. They further say that mobile apps play an important role for seizure management and there is a potential role for mobile apps to assist with patient care and epilepsy treatment.

As per the Author of this feasibility report, the observed findings from ‘Table 1. Epilepsy App Descriptions’ , displayed several mobile application functionalities such as record seizures and triggers, medication reminders, appointment manager, epilepsy information page with first aid tips for seizures, exporting the seizure diary to healthcare professionals, motion sensors, audio and video recording, real-time alerts etc.

However, this article also states that further research is needed to study the effectiveness of epilepsy management mobile apps of their impact on seizure control and quality of life. Which means that even if new self-management features were added within the apps, its efficacy is not guaranteed unless more studies on these types of application technologies are conducted. Also, in this article most apps reviewed were for adults with epilepsy and very few were specific for parents who use it to monitor for their children with epilepsy.

Whilst efficacy is not guaranteed, based on Author’s experience as a parent of a child with epilepsy, capturing the lifestyle events (tracking sleep hours, exercise, meals, stress levels etc) should greatly help the parent to keep a track of seizures.

## 2.2 Database Design

1. (Harrington, J. L. 2016a) outlined methods of designing a relational database in their book. They suggest several ways to create a good database design that will avoid unnecessary duplicated data, maintain data consistency, dealing with data insertion and deletion problems. Topics that have been useful from this book for the scope of this project include:

* identifying entities and their attributes,
* representing data relationships using primary and foreign key constraints,
* applying normalisation techniques and
* creating an entity relationship (ER) diagram.

They further discuss domains. According to them domains are the permissible values of each attribute. There are different domains that can be assigned to attributes depending on their size and data type. Most used domains are char, varchar, int, date, time, and Boolean. As per them choosing a right domain does make a huge difference to the database design. Once the entities are figured out the next task is about identifying relationships between them. There are 3 basic types of relationships i.e., one to one (1:1), one to many(1:M) and many to many (M:M). For the scope of this report, rules up to third Normal Form have been considered from this book. Normalisation rules make sure that the database will be in normal form. There are rules and relation that must meet each normal form. There are many more use cases that were beneficial to the Author of this feasibility report to use them as a guide while designing a database from scratch for this web and mobile technology.

However, certain concepts such as foreign key relationships were not explained clearly. The Author of this feasibility report had to seek out other sources such as online blogs which explained the concepts in a much easier way.

## 2.3 Data Analysis

1. (Chauhan, R., Kaur, H. and Chang, V. 2021a) has applied a data analytic technique on TB and HIV patients’ data while ensuring the privacy of patient’s personal data. The study was to detect patterns for future decision making. The useful part of this article to the Author of the feasibility report was Sec 3.2 Data processing. This section includes three parts (i) data cleaning, (ii) data transformation, (iii) data selection useful during data pre-processing. Data cleaning explanation were helpful for the feasibility report.

In data cleaning, they have suggested techniques to remove missing values, replace them with other values, like *NULL* values. Another technique involves replacing every missing value with mean or median value. In the context of the new web and mobile technology, data captured should be mostly structured as relational data base model is being used. Also, forms are to be designed in such a way that user should enter correct data with the help of form validations and helpful form fields to guide the user to enter correct data. The only technique useful from this article was to remove missing values or replace them with *NULL* value as sometimes if user does not fill a full form there should be missing data.

This article goes in depth of analysis techniques such as data mining and predictive data analytics which is beyond the scope of this project and could be included in future work. But for the context of this report only the data cleaning techniques suggested were used.

1. (McKinney, W. 2017a) in his book provide a complete practical guide for manipulating, processing, cleaning, and crunching datasets in Python. The author of this book is the creator of the Python panda’s project. This book outlines many data analysis tools in the panda’s library such as load, clean, transform, merge, and reshape data, create informative visualizations with matplotlib etc. Topics that have been useful from this book for the scope of this project included techniques used to interact with MySQL databases, extract data and load data as pandas’ data frames. Another important information found in this book included the procedure for handling missing data if any user has not entered any fields, filling in missing values with either zero or NULL. More information included data transformation techniques such as using statistics that included averages, combining data frames through sorting.

However, this could have been more useful if it was used for doing practical work. It does not explain the analysis techniques in detail.

## 2.4 Healthcare IT solution model

Article by (D. Sobhy, Y. El-Sonbaty and M. Abou Elnasr, 2012a) is about a proposed cloud computing system called ‘MedCloud’. It is used to provide services to the developers for building healthcare cloud application. In section III, ‘Medcloud: A cloud computing solution’, a three-layer architecture is described. The three layers consists of :

* Data storage layer: This layer comes with distributed file system that runs in clusters of commodity hardware. It continues working if any node fails which guarantees availability. However, it uses a column-oriented database which is not useful to the solution of this feasibility report.
* Server management layer with the master slave architecture.
* Application layer: This layer provides services to the users of the system by making a request via network access using HTTP. HTTP stands for Hypertext Transfer Protocol. The application layer accepts the request compares it with available services, does all the checks and then replies. In MedCloud Application layer, services are published based on REST architectural style. Application layer functions consist of elements such as authenticator to validate client’s login details, authoriser that gives permissions to safeguard users’ medical data based on HIPAA privacy rules and much more.

The above architecture is suitable for constructing the mobile and web-based application architecture design using cloud solution. One thing that can be added to this is the downstream layers for analysis and reporting of the data.

## 2.5 Data Security and Privacy Issues related to healthcare data

1. (Ducato, R. 2016a) discusses GDPR in cloud environment particularly related to healthcare data. GDPR addresses security responsibilities to the data processor (a person or a body that processes personal data).

Some of the GDPR regulations particularly with regards to user’s healthcare data discussed in this article include:

* Taking Consent of the data subject.
* No automated individual decision-making based on health data(Art 22, GDPR)
* If cross-border data transfer takes place it requires consent of the data subject.
* Maintain written Records of all data processing activities (Art. 30.2, GDPR)

According to the Author of the feasibility report most of the issues are related to data protection. While considering these regulations some of the solutions ideas that should not break the GDPR rules include obtaining consent of users for storing the data, not collect and store the PII data such as name, dob, address, mobile/phone number, provide privacy notice and [data breach](https://digitalguardian.com/blog/what-data-breach-or-cyber-security-insurance) notifications, etc. This article also addresses the fact that the new GDPR is still not robust given the complexity of cloud ecosystem, that is dynamic and involves multiple services and intermediaries.

The article was suitable in considering the web and mobile application security throughout its lifecycle.

1. To incorporate security features, article written by (Chauhan, R., Kaur, H. and Chang, V. 2021b) was useful. This article discusses the importance of big data analytics leading to knowledge discovery by displaying patterns and trends in healthcare data and assisting future decision making. The authors conducted a study where they took patient data and performed analytical techniques. All this was done while maintaining the privacy and security of data.

In Sec 2 the authors discuss several procedures that could be used to avoid threats related to healthcare data. These procedures include

* Ensuring authentication of the users to grant user access.
* Encrypting data can reduce packets sniffed during the data flow and minimise the threat.
* Secure data by auditing.
* Maintaining the integrity of the data as it should not be modified by the attacker.

However, some of these techniques mentioned still suffers drawbacks and need development to protect privacy and security. It will be beneficial to put these in practice and look for more information on securing privacy and security of healthcare data.

# 3 Account of project work and its outcome

## 3.1 Functional and Non-Functional Requirements

Requirements consist of two types i.e., Functional Requirements and Non-Functional requirements. As defined in the module of (Open University, 2021a), Functional requirements should specify the behaviour of a system and Non-Functional Requirements should be the qualities the system should have with respect to look-and-feel, usability, performance. Etc.

### 3.1.1 Functional Requirements

Functional Requirements have been further divided into groups and the following Functional requirements are derived:

|  |  |
| --- | --- |
| **Groups** | **Functional requirements** |
| log in | * The system shall display a login form with username and password. * The system shall provide an option of federated login for easy login. * The system shall display a user-friendly message if wrong login details are entered. * The system shall provide a link to register for first time users. * The system shall provide an alternative for forgotten password. |
| account | * The system shall follow the GDPR guidelines of data encryption. * The system shall not collect personal information data of the child such as name, age, address. * The system shall allow the user with an option to change password. * The system shall allow the user to edit accounts settings anytime. |
| forms | * The system shall provide a user-friendly error message if invalid data is added. * The system shall provide a form with automated date as well as an option to choose a date. * The system shall provide a form with fields to capture lifestyle data. * The system shall provide a share option. * The system shall provide forms with shorter length. * The system shall provide placeholders guiding the user to input relevant information in the form fields. * The system shall provide an easy way to collect seizure counts and seizure length data. * The system shall provide an edit and delete option on the form. |
| reports | * The system shall provide a functionality that will use the data, run automated analysis weekly and monthly and provide an analysis report that can be automatically available in parents’ email. * The system shall allow the users to search for past reports. |
| notifications | * The system shall provide an alert facility that is visible on the phone or desktop screen easily. |

### 3.1.2 Non-Functional requirements

* The application shall be easily accessible over the internet.
* The application shall handle multiple users simultaneously up to 100 users initially and scale later as the demand grows.
* The application shall be able to be modified to cope with changes to GDPR and data collection laws. That occur every six months.
* The language used in the interface will be formal and polite.
* The application will comply with GDPR and UK Data Protection Laws.
* The system shall load the user’s homepage in 3 seconds.
* Database security must follow the GDPR guidelines.
* Users should be able to fill the seizure and lifestyle forms without any struggle in < 120 seconds.

### 3.1.3 Requirements Conclusion

The list of functional and non-functional requirements is not exhaustive. The above stated FR and NFR are yet to be tested to checked.

***For evidence of how FR and NFR were derived through user stories created by the Author based on the experience of being a carer, please see Appendix A.***

## 3.2 Wireframes

Basic wireframe designs showing the prototype of graphical user interface of the application. (Note: Please zoom in to view the details of the images)

**1. Sitemap**

Diagram

Description automatically generated

*Figure 1 Sitemap* *:* Sitemap should depict the flow of pages within the application.

**2. Homepage with Sign in Window (desktop screen and mobile application screen)**

Table

Description automatically generated

*Figure 2: Homepage*

**Figure 2: Homepage description**

* After entering the URL, a Homepage appears displaying the logo and the About Us section on the left.
* On the right side of the screen, new users should register by providing email, username, and password. Verification should include an email to the given email address with a link where users can click on and have their email address verified.
* Registered Users should provide their login information (username and password) to sign in. Registered users also have the option of log-in via federated authentication of Facebook or Google identity.

**3 Record Seizures**

Table

Description automatically generated

*Figure 3: Top menu bar - Record*

**Figure 3: Record Seizures description**

After the user is logged in, the user is on the page with the record seizure. This page includes a menu bar on the top, a form in the middle and a footer at the bottom.

The top Menu bar with Record is highlighted. Under Record there are three pages

* record seizures
* record lifestyle
* record medication.

Record seizures page displayed on the screen above includes a form with placeholders in the boxes that will enable the users to enter accurate information. Since seizures are unpredictable and occur randomly it is not easy for parents to keep a track of all seizures. This form includes fields such as morning, afternoon, evening seizures that it easier for users to recall and add information about seizures that occurred during a particular timeframe. This form will only take relevant seizure information that can be used to appy analysis and is not very long.

1. **Dashboard**

Diagram

Description automatically generated with medium confidence

*Figure 4: Top menu bar - Dashboard*

**Figure 4: Dashboard description:**

The top Menu bar with Dashboard is highlighted. Under Dashboard there are two pages

* Graphs
* seizure summery.

For the scope of this report three types of graphs are displayed

* weekly seizure distribution graph
* a bell curve showing seizure distribution during the day of highest seizures
* a bell curve showing seizure distribution during the day of lowest seizures.

User can access past weekly graphs using the selection button on the top.

**Note:** Dashboard page is not complete. It needs some more refining in the future such as adding more different types of visualisations

1. **Add Events**

A picture containing table

Description automatically generated

*Figure 5: Top menu bar - Events*

**Figure 5 : Add Events description**

The top Menu bar with Events is highlighted. Under Events there are two pages:

* view events
* add new events.

This wireframe displays add new events page. Users can add events such as appointments, medication reminders and benefit from adding notifications that will be received on the mobile phones screen.

***For more wireframes, please see the Appendix B.***

## 3.3 Database Design

There are different types of database models. According to (Harrington, J. L. 2016b), a good database design ensures data accuracy and user satisfaction while optimizing performance. In the context of this application development, the data captured by the application front-end should be well structured for doing data analysis. Therefore, the Author suggests using a relational database model.

### 3.3.1 Relational DB Model

* *Entity and Attributes:*As per (Harrington, J. L. 2016c), ‘Most database designs begin by identifying entities.’ Within the context of developing a database for the application, the entities should be derived by looking at the application features described in the wireframes above.
* *Primary Key:* To distinguish between each entity instance there should be a unique identifier also known as primary key. Therefore, the user id should distinguish each user from every other user making it a unique identifier. Along with being unique, a user id should not contain the value null

Diagram

Description automatically generated

*Figure 6: Entity Login along with attributes. The unique attribute user id is primary key.*

* *Foreign Key:* Foreign key should be used to establish a link between two tables. When a primary key of table A is a column in another table B, that primary key column is a foreign key in another table. Foreign Key should act as a constraint on tables and enforce referential integrity. Which means it should prevent invalid data insertion into the foreign key column as one of the values is in the parent table.
  + The *accountID* column in the *account* table is the PRIMARY KEY in the *account* table.
  + The *accountID* column in the *seizure\_log* table is a FOREIGN KEY in the *seizure\_log* table.

Graphical user interface, text

Description automatically generated

*Figure 7: Foreign Key example*

* *Entity Relationships:* Entity relationships should be created by relating entities together. These relationships are explained into three basic types i.e one-to-one (1:1), one-to-many (1:M), and many-to-many (M:N or M:M). Below is an example of relationships between two tables.

Diagram

Description automatically generated

*Figure 8: Entity relationships is (1 or 0 : M) An account can have zero or more events and each event will have only one account.*

* *Normalisation:* Database normalisation should ensure to create entity relations without any problems. In most cases, if the relations are in third normal form (3NF), then most of the problems common to bad relational designs can be avoided. Therefore, to ensure normalisation, it is important to check if there is any repeating group of data, all non-primary key attributes are functionally dependent on the primary key and there are no transitive dependencies. The examples below depict how the database should be normalised.
* *First Normal Form:* In first normal form, there should be no repeating group of data. Every value entered in a column should be atomic and should not contain list of values. For e.g. There should not be a field name *medicineNAME* in which more than one medicine names appear. There should be separate *medicineNAME* columns for every individual name.

Table

Description automatically generated

*Figure 9: Table on right is in First Normal Form*

* *Second Normal Form:*In second normal form, database should be in first normal form. All non-primary key attributes should be functionally dependent on the primary key. For e.g. Account contains accountID(PK) and *medicineID*(PK) as the primary key with non-key attribute *medicineTYPE*. This violates second normal form, because *medicineTYPE* is dependent on *medicineID (PK)*, but not on *accountID (PK)*, so it is not dependent only on one entire primary key of the table. To change it to second normal form,
  + *account(PK)* and *medicineID(PK)* should be one table and *medicineID(PK)*, *medicineTYPE* should be another table.

Table

Description automatically generated

*Figure: 10 Tables below(account and medicine) are in Second Normal Form*

* *Third Normal Form:*In third normal form, database should be in second normlal form. There should be no transitive dependencies which means that every non-key column must be dependent on the primary key, there must be no dependencies between non-key columns.

For e.g., In *Medicine*, *dosage* is a non-key attribute, and it depends on *medicineTYPE.* Which means that *dosage* is dependent on *medicineTYPE.* A non-key attribute is dependent on non-key attribute and this violates the third normal form. To change it to third normal form, the *table* should be split into two tables as below.

Table

Description automatically generated

*Figure 11: Tables below (medicine and dosage) are in Third Normal Form*

### 3.3.2 Conceptual model: ER Diagram

Diagram, schematic

Description automatically generated

*Figure 12: ER diagrams to visualize database design. Includes 12 tables. (Please zoom in to view details)*

### 3.3.3 Database Design Conclusion

The role of defining entities, attributes, relationships using primary and foreign keys, and normalization is all very critical as it ensures referential integrity and data consistency within the database. Once ER model is designed, the Author recommends using structured query language (SQL) to perform queries and add data. According to the Author of the feasibility report, MySQL database should be an ideal choice as it is an open-source relational database management system and can be easily deployed on non-cloud as well as cloud-native applications.

In the opinion of the Author, the above-mentioned ER diagram is not yet completed for this report. It requires some more iterations and refining. This is due reasons because that the Author has not got any prior experience of designing a database and there are a lot of things to be considered in order to create a fully functioning database. For e.g., There could potentially be a need for an extra column which has not yet been considered.

The Author suggests evaluating the database by creating the database locally and populating the tables with sample data, trying queries, adding new records, and so on. The Author performed a similar evaluation of the above-mentioned ER diagram on a local machine with MySQL database and SQL commands.

***Please see Appendix C that includes:***

* *Failed ER diagrams and*
* *evidence of locally created working database.*

## 3.4 Possible Data Analysis Techniques

Once the data is stored into the database, the data should go through a data pipeline. According to (Open University, 2021c) data pipeline can be represented as

1. Acquisition (step 1)
2. Preparation (step 2)
3. Analysis (step 3)
4. Presentation (step 4)

The output of data pipeline should be a report that should be generated weekly and monthly. The Author recommends performing queries for data analysis using python programming language. According to (McKinney, W. 2017b) Python, the most popular interpreted programming language is ideal language for data analytics. Data processing in Python comprise of various steps such as importing data, data cleaning, data transformation, data selection and others. For the application, following data processing steps suggested by (McKinney, W. 2017c) in his book has been considered by the author of the feasibility report:

1. Acquisition and Preparation (step 1 and 2)

Data Extraction:To extract data from the database server, it requires a connection object to authenticate on the server and an SQL query. The Author recommends the following process based on the book:

* + Retrieve and Load: Python Pandas *read\_sql* command to retrieve the data and load it into panda’s data frame. Pandas is an essential library for data analysis in python. A pandas data frame makes selecting, combining, and transforming data possible. A segment of data can be loaded with a date constraint (from start date to end date) for weekly, monthly, and yearly analysis report requirements.

Data cleaning: The Author recommends the following two data cleaning processes from the book for removing or repairing obvious errors and inconsistencies in the dataset. They include:

* + Fixing missing values: The application forms should be designed with inbuild form validations to reduce user input mistakes and assist the user to add data in required formats such as dates. This should reduce the time spend on data cleaning. However, some of the obvious errors will still be found such as missing data which could occur if the user has missed out on adding data on certain dates or not completed the forms. Panda’s object uses *NaN* value to represent missing data. Descriptive statistics on panda’s objects exclude missing data by default thus making working with missing data less painless. Missing data in certain places should be dealt by using *Fill Na* that should replace the value that the user has forgotten to enter in places such as morning seizures, afternoon seizures, evening seizures, approx. seizure length. This should be replaced by a value 0.
  + Sorting by date: Data should be sorted by dates using the pandas sort function.

1. Data Analysis (step 3)

* Descriptive Analysis:(Open University, 2021 d) describes Descriptive Analysis as a technique used to describes the basic features of the data. This can be achieved by aggregating data using aggregation functions such as count, sum, min, max, average etc. Aggregation could be used to answer questions such as what date of the week or month the seizures were highest/lowest? More powerful statistical measures such as the distribution, the central tendency and the dispersion could be used to understand the seizure distribution throughout the day. This could reveal how the seizures are spread throughout the day (morning, afternoon, evening). If the distribution is skewed towards a particular end of the range, it could be useful indication that the data suggests something interesting might be happening.
* Inferential Analysis:(Open University, 2021 e) describes the technique Inferential Analysis aims to go beyond the descriptive. For e.g. ‘Are lifestyle choices triggering seizures? This can be achieved by making comparisons between two variables of the data which can reveal trends that might otherwise go unnoticed. Questions such as, ‘Is there a correlation between seizure and sleep?’ A regression analysis statistical model should help to visualize data on scatter plot with regression line. As per (Yan, et al. 2009) regression model is a statistical model for analysing relationships between variables. Therefore, scatter plot will showcase two variables x (sleep in hrs) and y (seizure numbers) and should clearly show if there is a positive or negative relationship. This graph should be examined by the healthcare provider to seek for any correlations. Similarly, many more questions could be explored using inferential analysis.

1. Presentation (Step 4)

Once the data analysis is completed and the reports are created, it should be viewed on the application in the reports section.The Figure 6 below, show a wireframe Prototype page of how the analysis reports are available on the application Reports are displayed with a pdf file icon making them easy to share. A date and month picker toolbox above is easier for choosing any past report.

Graphical user interface

Description automatically generated

*Figure 13: a wireframe Prototype page of how the analysis reports should be available on the application*

Diagram

Description automatically generated

*Figure 14: A prototype of Analysis Reports. Includes Visualisations and Data Summery.*

**Figure 14: Report Page Prototype Description:**

These pdf pages are opened when clicked from the reports section on the application. Wireframe include:

* reports displaying graphs created out of descriptive and inferential analysis
* seizure summery, lifestyle summery and medicine summery as per date using made-up data.

## 3.5 Data Security Risks and Measures

There are many challenges facing medical data security today. (Chauhan, Kaur, Chang, 2021c) discuss the risks to medical data security in their article. The list of security breach is inexhaustive. The Author of the feasibility report recommends looking into some of these security risks which are as follows:

1. Unauthorized Access: Eavesdropping which means sniffing into the data through an unsecured network. This tends to happen in the communication layer of network where the attacker tries to illegally sniff users’ medical data with unlawful interception.
2. Man-in the middle: This usually occurs where the two communicating networks were breach with third party and access is gain between information channel and attacker gain the access of entire data flow in the communication protocol.
3. Frisking of personal data**:** In general, the attacker modifies the original value with some modified values. This is the most popular attack on the data where the frisking is done with personal data of user which may include social security number, data of birth, address of the users and other values.
4. Unencrypted data: The encryption of data can efficiently reduce the packets sniffed and minimize threat.

To mitigate these risks (Chauhan, Kaur, Chang, 2021d) also discuss several procedures that should be used to maintain privacy of data. The Author of the feasibility report recommends looking into some of these security measures:

1. Authentication and Authorisation: To deal with threats of unauthorized access, endpoint authentication processes which include cryptographic protocols should be determined. User authorization should be used to restrict access depending on the role of the authenticated user. For e.g., admin users will not be able to read the data. Unique identifiers should be associated with each login credential.
2. Data Integrity: To prevent frisking of personal medical data of user data should be encrypted to minimize breach of security in the data flow. Moreover, to further protect user's data privacy the application should not collect and store the Personal Identifiable Information (PII) data such as name, dob, address, mobile phone number of the user and the child. Since the application should connect to its server via internet connection. According to security guide of (OpenStack.org, 2021a), all the traffic transmitted over the internet should be secured via SSL/TLS encryption.
3. Encrypting Data: Data should be encrypted at all levels especially when devices are connected via network.
4. User audit logs: User audit logs should be captured to ensure any intrusion detection which could also possible be the interaction with the system by the admin itself, or the operations team is audited in a separate user audit log. Several studies in past for intrusion detection are recorded to measure the traffic flow or data flow

## 3.6 GDPR compliance of medical data

The Author of the feasibility report recommends going through the following GDPR regulations which are also the additional obligations when the processing concerns health data as mentioned by (Ducato, R. 2016b) in the article

1. Taking Consent of the data subject (Art 9.2, GDPR)

User’s permission and consent should be taken regarding capturing user’s child’s seizure and lifestyle data, storing this data and processing for analysis reports. This consent should be easily identifiable and state what it is about. A document should be maintained of all the consents taken from the user. For the application the Author recommends taking user’s consent while users are registering.

1. No automated individual decision-making based on health data(Art 22, GDPR) The Author of the feasibility report recommends thatreports should not be taken as diagnosis and should have a clear visible disclaimer stating that reports must be shared with the healthcare provider to gain insights and no changes should be made to the child’s treatment without the consent of the healthcare provider.
2. If cross-border data transfer takes place it requires consent of the data subject.

All data should be stored within the border of the country where the app is hosted and made available.

1. Maintain written Records of all data processing activities (Art. 30.2, GDPR) Al The audit of the data processing should be maintained.

## 3.7 Considering technologies for Hosting the application.

To make the application available to the users over the internet, it requires web hosting.

### 3.7.1 A Non-Cloud technology (On-Premises)

As per (Pollock, P. 2013), on-premises is a traditional in-house IT system set up in a physical facility that is totally owned by the application developer. It has a datacentre that contains resources which include physical hardware, servers, software, and networks as well as a team of IT employees to support and manage it. The application developer should make decisions on configuration, system upgrades and changes. On-premises needs large capital investment and longer implementation time. Costs go up with regular maintenance and adding upgrades as the business grows. The chances of data loss are higher if the server crashes. This poses high risk to the user’s data. However, On-premises is also considered to be one of the most secure data hosting solutions. Location of the database that stores all the user’s sensitive medical data is in one centralised place within the known premises. Ownership of resources does not lie in the hand of commercial proprietors.

### 3.7.2 Cloud technology

According to (Lima, S. *et al.* 2019a), The National Institute of Standards and Technology (NIST) describe Cloud Computing to be ubiquitous and provides an on-demand availability of computing resources for e.g., servers, data storage capacity and networking resources which can be rapidly provisioned by the cloud service provider. According to (Sefraoui, O., Aissaoui, M., & Eleuldj, M. 2012), within the cloud model there are three commonly used service models as software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS). As per them cloud services benefits are more affordable as the services can be rented based on the usage and consumption of resources. This way it is more cost-effective i.e., pay-per-use basis. It enables quick application deployment within the cloud with much easy and fast provision for scaling up as well as scaling down. They also have plans for robust disaster recovery measures. However, there are data security concerns since the cloud services are provided over the internet.

### 3.7.3 Cloud technology in healthcare

According to (Sobhy, D., El-Sonbaty, Y., & Abou Elnasr, M. 2012), traditionally several healthcare providers stored a lot of electronically produced patient’s medical data in their own centralised databases. Sharing this data to patients’ other healthcare provider was very slow and difficult. Adopting cloud computing benefitted the healthcare provided to have common place where the patient’s medical data captured by various healthcare service providers such as physicians, therapists, etc was stored in one place, accessed, and helped to generate a complete vision of patient’s health status. As per (Zhang, Y.*et al*. 2015), health data is complex as it comes from heterogenous sources in different formats such as EMR’s , images, doctor notes etc. They need secure, stable, and flexible platform to collect, store, perform analytics and share insights as well as need to be supported by legal regulations (such as GDPR) to protect the privacy of sensitive information. Cloud technology suits these needs.

An e.g., of commercial healthcare cloud service providers is Amazon Health Data Lake. According to (Amazon Web Services, Inc. 2021), this cloud computing technology from AWS specifically designed for healthcare sector. It is a HIPAA-eligible service. Their services benefit the healthcare providers, health insurance companies, and pharmaceutical companies and all those associated with healthcare.

However, as suggested in the article written by (Lima, S. *et al.* 2019b) commercial cloud technologies controlled by big industry giants such as Google, Amazon, and Microsoft are making a lot of money from businesses who use their technology. Their main aim is to look into profits. In contrast to that, a free opensource cloud computing platform has no single company controlling and dominating the cloud technology. Opensource cloud technology such as OpenStack is an efficient and experienced free opensource cloud computing platform. It was developed by NASA and Rack Space and is being supported by an opensource community that is constantly contributing to make it better.

### 3.7.4 Open Stack Public Cloud

The diagram on conceptual architecture by , (Lima, S. *et al.* 2019c) best describes OpenStack as modular and flexible. OpenStack consists of various services. All of these services can be modified and customised through the dashboard. (OpenStack.org, 2021b) In OpenStack various services fall under compute, storage, and network. All these can be managed through APIs which has a common authentication mechanism. It supports several virtualization standards. It is scalable. OpenStack Public Clouds are used by general public who can easily access and connect to the infrastructure. The table below should help to understand how adopting OpenStack could be advantageous or disadvantageous over other proprietary owned cloud technologies.

Table: 1.

|  |  |
| --- | --- |
| **Author’s Requirements** | **Looking Into OpenStack Public Cloud Solution** |
| Hassle free Infrastructure at low cost | OpenStack should provide all the resources required for quick application deployment, easy and fast provision for scaling up or down and robust disaster recovery measures. The main benefit of using OpenStack public cloud is that it will be free of cost to use and non-proprietary due to its opensource technology. |
| Continuous availability of services and resources | OpenStack , being a cloud technology and provides continuous availability of services and resources. |
| Storage | As per (OpenStack.org, 2021c), OpenStack storage environment allows to create block storage, object storage and file-based storage. |
| Privacy and security of data | As per (OpenStack.org, 2021d), OpenStack provides the option to encrypt data at rest in the data storage. As per (Lima, S. *et al.* 2019d) OpenStack provides identity and access management for all the components of OpenStack. For OpenStack public cloud, (OpenStack.org, 2021e) recommends using SSL/TLS for domain services and intra-service communications including the use of TLS for API endpoints as well as Public Key Infrastructure (PKI) which provide encryption algorithms for securing data and authentication. |
| Helping with hosting | Using the opensource cloud technology is that there is always a lot of support and help online through a vast community. Many researchers, scientists and developers are always adding new developments and features to OpenStack. |

### 3.7.5 Cloud Hosting Recommendation

Although Opensource based cloud technology proves to be more efficient due to its advantages over commercial cloud technology, it is important to consider some of its disadvantages that could affect the web and mobile technology developed to be used for children suffering from child absence epilepsy.

While considering using OpenStack, for the web and mobile technology there are few concerns that cannot be neglected especially as the application should be dealing with medical data. According to the Author of this feasibility report, medical data is sensitive and is subject to stricter rules and regulations when processed and stored within the cloud environment. Putting medical data on cloud certainly comes with its own security challenges. (OpenStack.org, 2021f) does explicitly say that public clouds are more exposed to a higher degree of risk over the internet, and they should be considered untrusted. This is due to shared infrastructure with many different organisations. This may cause data leakage or access risk due to multitenancy by service provider. Data gets stored by third party vendors on servers placed in different locations. In the opinion of the writer, this could pose a major security as well as regulatory risks to the data.

According to the author, this application development has high concerns over privacy of medical data and these concerns does not make it ideal to host an application on OpenStack public cloud. And more cloud-based options and trade-off between OpenStack and public cloud providers need to be researched further.

## 3.8 Solution Diagram & Description

Proposed medical cloud-based solution architecture:

Graphical user interface, application

Description automatically generated

*Figure 15 : Cloud Solution Diagram*

Solution diagram Description. Table 2

|  |  |  |
| --- | --- | --- |
| **Layer** | **Component** | **Description** |
| Client | Mobile and Laptop Device | The mobile app should be downloaded on the mobile and laptop device through iPhone and android app store. |
| Public network | Internet | The application should connect to its app server via an internet connection. All connection from the device to server is secured via SSL/TLS encryption. |
| Cloud Infrastructure | Availability zone | The logical data centre should be in the London Region. |
| Application Layer | Application Server | The application server should make backend system accessible to the application on devices. It stores, processes and delivers data to the client |
| Data Storage Layer | Front-end MySQL database | All data captured via the application is stored here. |
| Data Analysis Layer | Data Analysis Pipeline | At the end of each day, data pipeline process should begin. |
| Data Analysis Layer | Extract | The first part of ETL process involvs extracting the data from the front-end MySQL database. Data is extracted by converting the MySQL data to csv file format. This csv file is loaded into the storage database. |
| Data Analysis Layer | Transform | Data transformation should involve data cleaning. The process of data cleaning should involve removing typographical errors, validating, and correcting values, checking missing values, sorting values by date etc. Once transformed the data should be again loaded in the data storage. |
| Data Analysis Layer | Load | This process should load the data into the back-end database. |
| Data Analysis Layer | Data Analysis Process | This process should involve inspecting, exploring, creating visualisations and creating data summery and generating reports. Once the reports are generated they are sent to the front-end MySQL database and can be viewed on the application screen. |

## 3.9 Conclusion

This is a feasibility report on developing medical cloud solution using web and mobile technologies to analyse absence seizures in children. It provides a technological solution in the form of a web and mobile technology that should assist parents of children suffering from Child Absence Epilepsy. This web and mobile technology should solve the problems related to monitoring and managing child’s seizures. It should capture child’s daily seizures, medication information and lifestyle events to generate weekly and monthly reports. These reports can also be shared with the healthcare providers to gain insights into child’s medical condition.

To develop this application, several technological factors have been considered in this report such as planning the requirements, sketching wireframes, designing a relational database model, suggesting possible data analysis techniques and the looking into different cloud hosting platforms.

Throughout the report, the Author has mentioned and used Opensource software and technologies such as creating wireframes using draw.io, a MySQL database storage solution, SQL and Python Pandas programming languages for querying the database.

The report also covers the discussion around data risks, GDPR compliance for medical data and privacy and security measures.

There are some parts of the solution design in this report that are still not complete, and according to the Author, more research and evaluation is needed. For example, the database model needs to be refined by iterating the capturing and storing data in a relational database by developing the proof of concepts. Understanding of relevant GDPR compliance measures and its technology implementation needs more research. More research and risk assessments are required to consider the hosting of application into cloud environment. Opinion and views of stakeholders such as other parents, healthcare providers should be needed. Hence this feasibility report should be considered as an initial assessment of designing the solution and should not be taken as a finished report to start developing the application.

\*\*\*\*\*

# 4 Review of current stage of project work

More work could have been done had there been more time. The author has briefly identified some activities that can be done in the future for the completion of this feasibility report .

|  |  |  |  |
| --- | --- | --- | --- |
| ID | Activity | Description | Timeline |
| 1 | More research | * Interviewing more stakeholders * Collecting more user stories of other parents who are in similar situation. * Taking opinion of healthcare providers | 2 weeks |
| 2 | Refine wireframes | Based on the above refine the wireframes | 1 week |
| 3 | Suitable Cloud Hosting Solution | More Research is required on suitable cloud solution hosting solution for medical data | 2 weeks |
| 4 | Rewrite the feasibility Report | Rewrite | 1 week |
| 5 | Actual development | Coding the web app pages, refining the database design and hosting the application on cloud. | 6 months |

## 4.1 Legal, Social, Ethical and Professional Issues

### 4.1.1 Discussing Legal, Social and Ethical Issues:

* It is unethical for the web and mobile application to process seizure, medication and lifestyle data of the child without parents ‘consent.
* It is unethical for the application to use child’s seizure, medication, and lifestyle data for research without agreement such as taking parent’s consent.
* It is illegal and unethical to not inform the users if a data breach has occurred.
* As mentioned in Section 1.5, it is unethical for parents to make changes to child’s treatment or lifestyle based on the analysis report output without the consent of the healthcare provider.

### 4.1.2 Professional Issues

The following has been answered according to the questions derived from (The Open University, 2021 f) that are from the BCS Code of Conduct.

* There is no conflict of interest as the project idea is developed by the Author based on personal experience of being a parent of a child with the medical condition of Child Absence Epilepsy. Furthermore, the Author is not associated or working with any healthcare or professional IT industry. The Author is just a parent who is trying to come up with a solution to the problem.
* All the software recommended in the feasibility report to develop the web and mobile application is open source.
* The skills developed from OU modules such as project management, cloud technology, data management and analysis are used to come up with a solution for the problem. Extra knowledge and learning from literature and scholarly articles were used to host the application on cloud.
* The scope of this project is a feasibility report and does not include any development. No stakeholder data has been involved. However, in the context of real world if this report is accepted and a development is carried there should be a need to involve various stakeholders such as other parents and healthcare professionals.

# 5 Review of project management

## 5.1 Project Lifecycle Model:

Diagram, engineering drawing

Description automatically generated

*Figure 16: Spiral lifecycle model.*

**Author’s Review of Spiral Lifecycle Model:**

I read about several lifecycle models provided in the Open University Module materials such as waterfall model, iterative and incremental model, spiral model, prototype model etc. Spiral model seemed more suitable as in the OU Lifecycle module resources it stated that in spiral model there is no need to complete the problem solution. Which means that the spiral model can be very adaptive and flexible to the changes such as project refinements and modification from TMA01 up until EMA.

Therefore, I explored this model more by reading another article on spiral lifecycle model in which the author (Ruparelia, Nayan B, 2010) has explained that the spiral model represents a risk-driven approach. According to the author, the structure of spiral model contains series of loops that keep on iterating. For each iteration risks are analysed, greater level of detail is considered, and evaluation is undertaken before the next iteration begins. Hence for every iteration, greater level of confidence is achieved for the success of the project work. This gave me the idea of thinking about the series of loops as TMA’s. Within the spiral’s loop, TMA01, TMA02, TMA03 reports were produced iteratively. Risks were identified and analysed. Each TMA report ensured to minimise previous risks and highlighted new risks. The vertical arrow in the diagram above is the time spent.

The only drawback with this model is that it may go on indefinitely. Instead after certain iterations switching to a prototype model would be beneficial. Creating a working prototype could help with the integration requirements and help me in deciding the hosting channels. However, to do both write a part of report and do a prototype there will be more time required.

Snapshot of Planning of activities were done using Excel. Below is an example of TMA03 and EMA Project planning.

Graphical user interface, application, table, Excel

Description automatically generated

*Figure 17: TMA03 activity plans*

Graphical user interface, table, Excel

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*Figure 18: EMA activity plans*

## 5.2 Author’s Project Experience

Choosing the Project topic was easy as it was based on my personal experience. As a parent/user of existing epilepsy monitoring mobile app my initial idea was to develop an epilepsy management mobile or web app with added features. After discussing this idea with my Tutor and evaluating my strengths and weaknesses, I decided to reduce the focus of the project to a feasibility study of web and mobile technology. This approach was useful as it helped me to define the scope of the project by focussing on some software engineering, some elements of data science and some use of complex IT infrastructure.

The project changed a lot after every TMA. TMA01 feedback was a biggest learning curve for the project. After a terrible start and poor marks on TMA01, I learned quite a lot. There were a lot of mistakes made. However, those mistakes gave an opportunity to correct and learn. For e.g. I learned that there are different writing styles and academic styles was best suited for my report. In the later stages during TMA02, the following Tutor’s comments were very important, and it helped to shape the project scope making it more defined.

*‘’ Your sources of information are lacking authority in relation to the epilepsy management and monitoring using mobile phone application and cloud architectures.’’* and ‘’ *You also need to research about data preservation and protection of sensitive data. We cannot discuss any medical data without discussing those….‘’*

Based on this feedback, I realised that there was a need to do some more exploratory research using the OU library and Google scholar and develop an adequate list of key resources.

**There were ongoing issues with the database design model:**

* **Issue No 1:** Accuracy of first database model was questionable as initial evaluation highlighted foreign key constraint issues while creating a database on the local machine. To mitigate this issue, I reworked on entities and attributes, changed and created new tables, their relationships and foreign key constraints.
* **Issue No 2:** Tutor suggested some changes. Changes were related to the breakfast, dinner, and snacks table. Tutor’s comments were*,” These tables are all modelling a meal. Instead use a table referred as meal. Add an additional one referred as meal\_type (i.e., breakfast, dinner, lunch, morning snack….). These table contains the same fields, so four are not required.”*
* **Issue No 3:** Going back and changing the database model several times and redoing the practical evaluation work of creating a database on the local machine resulted in time management issues. This had an impact on loss of time that was mitigated by reducing the allocated time to write the review part. I wished I had more time.

**Lessons learned from these issues:**

I learned from this issue that activity sequencing could have been done better. One way to achieve this could be to create a rough flowchart or sketch and this may be helpful for visualizing and identifying all dependencies between each of the activities.

**Ongoing Project Risks and how they were mitigated:**

* **Risk No 1: Data Risk**

I wanted to use my child’s personal data to do some data analysis. But tutor advice was to not use any form of personal data. According to the tutor, *“Legislation is preventing us to analyse data without the consent of the patient. It is not a good idea to analyse any data without consent. It is not suitable for this project, and I will strongly discourage you to add any data analysis using your daughter or other patients.’* Therefore, I decided to narrow the project scope by not including any data but just suggest possible analytical techniques.

* **Risk No2: Scope risk**

Until TMA03, the report was written for the parents and healthcare providers. The following risk was highlighted by the tutor*, “If I were you, I would suggest you refine the project, to focus on the careers use to monitor and capture data about their children suffering from the condition. Considering the medical practitioners is too ambitious.”* Using this comment as a guide, I made the project more concise and stuck with parents only which made the scope more concise and clearer.

* **Risk No 3: Confusion over suggesting a cloud technology for hosting**

Up until the end it was not sure which cloud-based web hosting solution to provide. On emailing my Tutor and asking for guidance helped to structure this part of the report and answering the suitability of a particular cloud technology. Tutor’s advice was *‘’I would conclude by discussing the benefits and drawbacks of both options within the context of your project. Keep an open mind until you have written your discussions.’’* In the end I managed to reach to a suitable conclusion.

* **Risk No 4: Information overload of OpenStack Cloud**

I struggled with information overload regarding OpenStack cloud. There was a lot of difficulty in understanding OpenStack cloud technology, and I feared that this may result in incomplete technical design. I managed to read some more resources on OpenStack cloud. Hopefully, I have done my best to answer those parts.

* **Risk No 5: Time Risk**

Time was limited. I kept check on time management by following the project schedule of tasks and subtasks. Allocated realistic extra buffer time to all project tasks and subtasks so that there will be enough time to take control and be on track. With refinements based on feedback from the tutor the project became more concise and involved few activities. Although I wished if I had more time I would do some more research around cloud technology and answer that part of the report better.

# 6 Review of personal development

Skills I have gained that have deepened from my level 3 study are as follows:

* **Data Modelling & Design** – I have never created a database from scratch before. Iterating through the databased model multiple times have helped me gained technical skills related to database design such as how to derive entities, attributes, normalise database and create a working database from scratch.
* **Report Writing** – I have learned different report writing styles that include more details that go beyond introduction, body, and conclusion. I have learned how to structure a report through Analysis, Synthesis and Evaluation. I will use this type of working in the future.
* **Project Management** – I have learned from the OU Module resources and my mistakes to effectively choose a project lifecycle model, plan by writing down the activities, sequencing the activities, considering the risks while allocating tasks and timelines, and monitoring progress.
* **Project Lifecycle** – I learned about the spiral lifecycle model and its application to the feasibility report. This format of working has strengthened my Project Management skills and will be useful in the future to analyse risks whilst creating tasks and plans at work.
* **Cloud/OpenStack** – I learned in more detail about various OpenStack’s components and their services. Although OpenStack was part of module materials, this project gave me an opportunity to think about the actual application to a web and mobile technology.
* **Communication skills** – Writing weekly logs and reflecting was something I had never done before. They helped me to effectively communicate with my tutor. Face-to-face online meetings were important in building good communicating relationship with my Tutor and it gave that extra clarity in terms of my report rather than the online TMA video tutorials.

# References

|  |  |
| --- | --- |
| **In-Text Citation** | **Full Reference** |
| Kessler, S. K. and McGinnis, E. (2019) | Kessler, S. K. and McGinnis, E. (2019) ‘A Practical Guide to Treatment of Childhood Absence Epilepsy’, *Paediatric drugs*, 21(1), pp. 15–24. doi: 10.1007/s40272-019-00325-x. Accessed on 20th March 2021 |
| Chiu, M. *et al.* (2021) | Chiu, M. *et al.* (2021) ‘Seizure action plans in the pediatric population with epilepsy: Uptake, determinants, and parental interest in a mobile application’, *Epilepsy & behavior*, 117, pp. 107860–107860. doi: 10.1016/j.yebeh.2021.107860. Accessed on 20th March 2021 |
| Escoffery, C. *et al.* (2018a) | Cam Escoffery, Robin McGee, Jonathan Bidwell, Christopher Sims, Eliana Kovitch Thropp, Cherise Frazier, Elizabeth D. Mynatt, A review of mobile apps for epilepsy self-management, Epilepsy & Behavior, Volume 81,2018,Pages 62-69,ISSN 1525-5050, <https://doi.org/10.1016/j.yebeh.2017.12.010>. (<https://www.sciencedirect.com/science/article/pii/S152550501730728X>) Accessed on 20th March 2021 |
| Parker, L. *et al.* (2017) | Parker, L. *et al.* (2017) ‘A health app developer's guide to law and policy: a multi-sector policy analysis’, *BMC medical informatics and decision making*, 17(1), pp. 141–141. doi: 10.1186/s12911-017-0535-0. Accessed on 20th March 2021 |
| Escoffery, C. *et al.* (2018b) | Cam Escoffery, Robin McGee, Jonathan Bidwell, Christopher Sims, Eliana Kovitch Thropp, Cherise Frazier, Elizabeth D. Mynatt, A review of mobile apps for epilepsy self-management, Epilepsy & Behavior, Volume 81,2018,Pages 62-69,ISSN 1525-5050, <https://doi.org/10.1016/j.yebeh.2017.12.010>. (<https://www.sciencedirect.com/science/article/pii/S152550501730728X>) Accessed on 20th March 2021 |
| Harrington, J. L. (2016 a) | Harrington, J. L. (2016) *Relational database design and implementation*. 4th ed. Accessed on 20th March 2021 |
| Chauhan, R., Kaur, H. and Chang, V. (2021a) | Chauhan, Ritu, Kaur, Harleen and Chang, Victor (2021) ‘An Optimized Integrated Framework of Big Data Analytics Managing Security and Privacy in Healthcare Data’, Wireless personal communications, 117(1), pp. 87–108. doi: 10.1007/s11277-020-07040-8. Accessed on 20th March 2021 |
| McKinney, W. (2017a) | McKinney, W. (2017) *Python for data analysis : data wrangling with pandas, NumPy, and IPython*. Second edition. Accessed on 30th March 2021 |
| D. Sobhy, Y. El-Sonbaty and M. Abou Elnasr, (2012a) | Sobhy, D., El-Sonbaty, Y., & Abou Elnasr, M. (2012, December). MedCloud: healthcare cloud computing system. In *2012 International Conference for Internet Technology and Secured Transactions* (pp. 161-166). IEEE. Accessed on 20th June 2021 |
| Ducato, R. (2016a) | Ducato, R. (2016) ‘Cloud computing for s-health and the data protection challenge: Getting ready for the General Data Protection Regulation’, in *2016 IEEE International Smart Cities Conference (ISC2)*. IEEE, pp. 1–4. doi: 10.1109/ISC2.2016.7580803. Accessed on 20th June 2021 |
| Chauhan, R., Kaur, H. and Chang, V. (2021b) | Chauhan, Ritu, Kaur, Harleen and Chang, Victor (2021) ‘An Optimized Integrated Framework of Big Data Analytics Managing Security and Privacy in Healthcare Data’, Wireless personal communications, 117(1), pp. 87–108. doi: 10.1007/s11277-020-07040-8. Accessed on 20th March 2021 |
| The Open University (2021a) | The Open University (2021), TM352, Software Engineering, Unit 2 Requirements Concept, Available at [Unit 2 Requirements concepts: 3 Functional requirements (open.ac.uk)](https://learn2.open.ac.uk/mod/oucontent/view.php?id=1524657&section=3)  Accessed on 20th March 2021 |
| Harrington, J. L. (2016 b) | Harrington, J. L. (2016) *Relational database design and implementation*. Accessed on 20th June 2021 |
| Harrington, J. L. (2016 c) | Harrington, J. L. (2016) *Relational database design and implementation*. 4th ed. Accessed on 20th June 2021 |
| The Open University (2021c) | The Open University (2021), TM351, Data Analysis, Available at [Part 1 Introducing data management and analysis: 4.2 The data pipeline (open.ac.uk)](https://learn2.open.ac.uk/mod/oucontent/view.php?id=1349952&section=4.2). Accessed on 20th March 2021 |
| McKinney, W. (2017b) | McKinney, W. (2017) *Python for data analysis : data wrangling with pandas, NumPy, and IPython*. Second edition. Accessed on 20th June 2021 |
| McKinney, W. (2017c) | McKinney, W. (2017) *Python for data analysis : data wrangling with pandas, NumPy, and IPython*. Second edition. Accessed on 20th June 2021 |
| The Open University (2021d) | The Open University (2021), TM351, Data Analysis, Available at [Part 4 Data analysis: 3 Descriptive analysis (open.ac.uk)](https://learn2.open.ac.uk/mod/oucontent/view.php?id=1349955&section=3) Accessed on 20th March 2021 |
| The Open University (2021e) | The Open University (2021), TM351, Data Analysis, Available at [Part 4 Data analysis: 4 Inferential analysis (open.ac.uk)](https://learn2.open.ac.uk/mod/oucontent/view.php?id=1349955&section=4) Accessed on 20th March 2021 |
| Yan et al. (2009) | Yan, X., Yan, X. and Su, X. G. (2009) *Linear regression analysis*. World Scientific Publishing Co. Pte. Ltd. Page 9 Accessed on 30th June 2021 |
| Chauhan, R., Kaur, H. and Chang, V. (2021c) | Chauhan, Ritu, Kaur, Harleen and Chang, Victor (2021) ‘An Optimized Integrated Framework of Big Data Analytics Managing Security and Privacy in Healthcare Data’, Wireless personal communications, 117(1), pp. 87–108. doi: 10.1007/s11277-020-07040-8. Accessed on 20th March 2021 |
| Chauhan, R., Kaur, H. and Chang, V. (2021d) | Chauhan, Ritu, Kaur, Harleen and Chang, Victor (2021) ‘An Optimized Integrated Framework of Big Data Analytics Managing Security and Privacy in Healthcare Data’, Wireless personal communications, 117(1), pp. 87–108. doi: 10.1007/s11277-020-07040-8. Accessed on 20th March 2021 |
| OpenStack.org, (2021a) | OpenStack.org, (2021a), OpenStack Documentation, Security Guide, Available online [Introduction to TLS and SSL — Security Guide documentation (openstack.org)](https://docs.openstack.org/security-guide/secure-communication/introduction-to-ssl-and-tls.html) Accessed on 20 Dec 2021 |
| Ducato, R. (2016b) | Ducato, R. (2016) ‘Cloud computing for s-health and the data protection challenge: Getting ready for the General Data Protection Regulation’, in *2016 IEEE International Smart Cities Conference (ISC2)*. IEEE, pp. 1–4. doi: 10.1109/ISC2.2016.7580803. Accessed on 20th June 2021 |
| Pollock, P. (2013) | Pollock, P. (2013) *Web Hosting For Dummies*. 1. Aufl. For Dummies. Page 14 Accessed on 20th June 2021 |
| Lima, S., *et al*.(2019a) | Lima, S., Rocha, Álvaro and Roque, L. (2019) ‘An overview of OpenStack architecture: a message queuing services node’, *Cluster computing*, 22(S3), pp. 7087–7098. doi: 10.1007/s10586-017-1034-x. Accessed on 20th June 2021 |
| Sefraoui, O., Aissaoui, M., & Eleuldj, M. (2012). | Sefraoui, O., Aissaoui, M., & Eleuldj, M. (2012). OpenStack: toward an open-source solution for cloud computing. *International Journal of Computer Applications*, *55*(3), 38-42. Accessed on 20th July 2021 |
| Sobhy, D., El-Sonbaty, Y., & Abou Elnasr, M. (2012b). | Sobhy, D., El-Sonbaty, Y., & Abou Elnasr, M. (2012, December). MedCloud: healthcare cloud computing system. In *2012 International Conference for Internet Technology and Secured Transactions* (pp. 161-166). IEEE. Accessed on 20th July 2021 |
| Zhang, Y.*et al*. (2015). | Zhang, Y., Qiu, M., Tsai, C. W., Hassan, M. M., & Alamri, A. (2015). Health-CPS: Healthcare cyber-physical system assisted by cloud and big data. *IEEE Systems Journal*, *11*(1), 88-95. Accessed on 20th July 2021 |
| Amazon Web Services, Inc. (2021) | Amazon Web Services, Inc. 2021, Amazon Healthlake, Available on [Health Data Lake and Healthcare Analytics - Amazon HealthLake - Amazon Web Services](https://aws.amazon.com/healthlake/) Accessed on 12 th June 2021 |
| Lima, S., *et al*.(2019b) | Lima, S., Rocha, Álvaro and Roque, L. (2019) ‘An overview of OpenStack architecture: a message queuing services node’, *Cluster computing*, 22(S3), pp. 7087–7098. doi: 10.1007/s10586-017-1034-x. Accessed on 20th July 2021 |
| Lima, S., *et al*.(2019c) | Lima, S., Rocha, Álvaro and Roque, L. (2019) ‘An overview of OpenStack architecture: a message queuing services node’, *Cluster computing*, 22(S3), pp. 7087–7098. doi: 10.1007/s10586-017-1034-x. Accessed on 20th July 2021 |
| OpenStack.org, (2021b) | OpenStack.org, 2021b, What is OpenStack, Available online [Open Source Cloud Computing Platform Software - OpenStack](https://www.openstack.org/software/) Accessed on 12 th June 2021 |
| OpenStack.org, (2021c) | OpenStack.org, 2021c, [Storage architecture — arch-design 0.0.1.dev12 documentation (openstack.org)](https://docs.openstack.org/arch-design/design-storage/design-storage-arch.html#choosing-storage-back-ends)  Accessed on 12 th June 2021 |
| OpenStack.org, (2021d) | OpenStack.org, 2021d, [Storage architecture — arch-design 0.0.1.dev12 documentation (openstack.org)](https://docs.openstack.org/arch-design/design-storage/design-storage-arch.html#choosing-storage-back-ends)  Accessed on 12 th June 2021 |
| Lima, S., *et al*.(2019d) | Lima, S., Rocha, Álvaro and Roque, L. (2019) ‘An overview of OpenStack architecture: a message queuing services node’, *Cluster computing*, 22(S3), pp. 7087–7098. doi: 10.1007/s10586-017-1034-x. Accessed on 20th July 2021 |
| OpenStack.org, (2021e) | OpenStack.org, 2021d, [Secure communication — Security Guide documentation (openstack.org)](https://docs.openstack.org/security-guide/secure-communication.html)  Accessed on 12 th June 2021 |
| OpenStack.org, (2021f) | OpenStack.org, 2021f , [Security boundaries and threats — Security Guide documentation (openstack.org)](https://docs.openstack.org/security-guide/introduction/security-boundaries-and-threats.html) Accessed on 12 th June 2021 |
| Open University, 2021f | Open University, 2021f , Available online:[Legal, Social, Ethical and Professional issues: 4. Asking the right questions (open.ac.uk)](https://learn2.open.ac.uk/mod/oucontent/view.php?id=1707993&section=1.4). Accessed on 15th April 2021 |
| Ruparelia, Nayan B (2010) | Ruparelia, Nayan B (2010) ‘Software development lifecycle models’, Software engineering notes, 35(3), pp. 8–13. doi: 10.1145/1764810.1764814. Accessed on 20th March 2021 |

# APPENDICES

## APPENDIX A

**User Stories**

FR and NFR were derived from user stories. Author wrote user stories based on personal experience using epilepsy monitoring mobile apps while caring for the child with absence seizures. After collecting user stories, they were grouped into categories to derive functional and non-functional requirements.

**Login**

As a parent, I want to be able to login easily and securely into the system so that my login details are safe and can be accessed only by me.

As a user, I tend to forget my password, so I want to be able to request a new password.

**Data Security:**

As a parent, I want my child’s data to be secured so that it’s not hacked or compromised by other people.

As a parent, I don’t want to give my child’s identity information such name, age, address so that

**Adding data:**

As a parent, I want to be able to edit my childs details.

As a parent, I want the application to be tailored to my needs i.e., for CAE (4 to 14 years) so that I don’t have to waste time to go through customization and tailoring it to my needs.

As a parent, I want to be able to add my contact details as well as doctors contact details so that I can use it to share information.

**Filling forms:**

As a parent, I need help while typing data into forms, so that I don’t enter incorrect information.

As a parent, I want to be able to add details in the form without bothering to enter date.

As a parent I want to store my child’s lifestyle data along with seizure data so that I can be able to see if basic lifestyle choices such as diet, sleep, exercise are having an influence on seizure counts.

As a parent, I want to be able to share my child’s information with the doctors, so that I can discuss my child’s condition using the recorded data vs. anecdotal stories.

As a parent, I want the process to filling forms very easy so that recoding my child’s seizure data is not very time consuming.

As a parent, practically it is very difficult to remember the exact length of seizure or seizure numbers as they are so many and occur randomly. I want the forms to assist me in adding seizure counts and seizure length data easily.

As a parent I want to be able to delete and edit information added to the form.

**Data Analysis Reports:**

As a parent I want to be able to view graphs and visuals using my child s data so that it will be useful to seek any patterns and correlations in that data.

As a parent, I want to be able to view past data analysis reports.

**Notifications**:

As a parent, I want to receive timely medication dosage reminders and appointment reminders so that I am aware what dosage is given.

## APPENDIX B

**Remaining Wireframes**

Table

Description automatically generated

*Figure 1: Record Lifestyle(Some of the fields in this design have been changed again after redesigning the database ER diagram)*

Table

Description automatically generated

*Figure 2: Record Medicine*

Table

Description automatically generated

*Figure 3: View Events*

## Appendix C

* This was the initial design of Database model design. Accuracy of first ER diagram was questionable as initial evaluation highlighted foreign key constraint issues while creating a database on the local machine. To mitigate this issue, I reworked on entities and attributes, created new tables, their relationships and foreign key constraints.

A diagram of a flowchart

Description automatically generated with low confidence

*Figure 1: Rejected ER diagram*

* Tutor suggested some changes. Changes were related to the breakfast, dinner, and snacks table. Tutor’s comments were,” These tables are all modelling a meal. Instead use a table referred as meal. Add an additional one referred as meal\_type (i.e., breakfast, dinner, lunch, morning snack….). These table contains the same fields, so four are not required.”

Diagram

Description automatically generated

*Figure 2: Rejected ER Diagram*

## Appendix D

**I Installed Apache 2 webserver and MySQL database on my local machine. Created a database called epilepsy and populated it with 12 tables as shown below. All tables include rows with primary and foreign key constraints.**

Text

Description automatically generated

Fig 1: Login Table

Text

Description automatically generated

Figure 2: Account Table

Graphical user interface

Description automatically generated with low confidence

Figure 3: Medicine table

A screenshot of a computer

Description automatically generated

Figure 4: Dosage table

A screenshot of a computer

Description automatically generated

Figure 5: seizure\_log table

A screenshot of a computer

Description automatically generated

Figure 6: event table

Text

Description automatically generated

Figure 7: exercise table

Text

Description automatically generated

Figure 8: mood table

Text

Description automatically generated

Figure 9: sickness table

Text

Description automatically generated

Figure 10: meal table

Text

Description automatically generatedFigure 11: screen\_time table

Text

Description automatically generated

Figure 12: sleep table

Thank You

From: Rupal Lopes, F5113265.