Delirium in Paediatric ICUs

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Team Report: Interim Report (SDP2a)
CSC3068, Software Development Practice

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1. Requirements

1.1. Problem Statement

Delirium, specifically within children, is an often-misunderstood illness by both medical professionals and within the general public. This is a prevalent issue within Paediatric Intensive Care Units (PICUs) across the UK and ROI.

Further research and education need to be carried out, and therefore 2 systems have been proposed to tackle each of these issues. An 'audit' system that will facilitate research within this field will provide a platform to record and visualise compliance data within PICUs, regarding delirium.

The other system will focus on the education aspect of this problem. By developing an e-learning package, which can be modified to contain the contemporary knowledge of paediatric delirium. Including interactive content within the package that will increase engagement and therefore increase the likelihood that the information will be retained by the learner.

1.2. Elicitation & Analysis Process

The main method of eliciting the requirements was through the detailed brief provided by Lisa McIlmurray, the main end-user stakeholder. By developing the user stories within section 2 of the first submission, further requirements were produced by analysing the problem more thoroughly. Further along within the elicitation process interviews were conducted between the requirement engineers and the relevant stakeholders, Charles Gillian (Technical Support) and Lisa McIlmurray. The interview questions were derived from the earlier steps within the elicitation process to clarify on points mentioned within the brief.

The 'Structured Natural Language' notation [1] was used to promote the standardisation of the requirements.

Within analysing the requirements, a prioritisation system was developed to assist the development stage of the project. This consists of three levels: "High", "Medium" and "Low". The "High" and "Medium" requirements are essential in delivering to the client. The "Low" requirements are in the "waiting room" [2] which is to say that, depending on time constraints, they may be implemented although not necessary in order for a 'completed' product and are candidates for future implementation.

Figure 1.2.1 displays the number of requirements within each category.

Requirement Type	Count
Functional	32
Non-Functional	19

Priority	Count
High	7
Medium	29
Low	15

System	Count
Audit + E-Learning	21
Audit	19
E-Learning	11

Category	Count
GUI	5
Login	8
Accessibility	5
Security	6
Content	9
Scalability	5
Maintainability	2
RBAC	6
Backup	5

Total	51

Figure 1.2.1: A summary of the requirements

Figure 1.2.2: The requirements for both systems

Requirement ID	Requirement Type	System	Category	Description	Rationale	Dependencies	Fit Criterion	History	Priority	State of Requirement	Use Case IDs
REQ LOGIN 1	Functional	Audit + E learning	Login	Allow users to have accounts, in which they can log into the system	Allows for a separation of users and details about the users to be stored	N/A	For a user to be able to create an account, login when a correct username and password is provided and reject a user which provides an incorrect username and password	Created: 23/02/23	High	In Progress	UC 1, UC 16
REQ CONTENT 1	Functional	E learning	Content	Keep track of the user's place within the e learning course	It may not be feasible for users to complete the course in one sitting and therefore the ability for users to be able to complete this in multiple sessions is extremely important	REQ LOGIN 1	For the user to resume their previous place within the course	Created: 23/02/23	High	Not Started	UC 13
REQ GUI 1	Functional	Audit + E learning	GUI	Be available on major types of devices, such as smartphones, tablets and PCs through the chrome web browser	As nurses do not get dedicated time to fill in the audit data or for learning it is imperative that the system is available on major types of devices to allow them to quickly fill use the system, when they have spare time	N/A	For the system to be displayed in an appropriate way on all devices	Created: 23/02/23	High	In Progress	N/A
REQ SCALABILITY 1	Non Functional	Audit	Scalability	Be able to support 500 concurrent users	As the system will be used across the globe it can be assumed that there will be a large user base and therefore a possibility of many concurrent users	N/A	The system should be able to handle when 500 users attempt to login to the system, at the same time	Created: 23/02/23, Updated 10/03/23	Medium	Not Started	N/A
REQ CONTENT 2	Non Functional	Audit	Content	Display PICU compliance data as interactive graphs and charts, such as line graphs	To allow users to be able to analyse the audit data and draw their own conclusions	N/A	For the data, within the database, to be displayed accurately on a variety of charts and graphs	Created: 23/02/23	High	In Progress	UC 7
REQ ACCESSIBILITY 1	Non Functional	Audit + E learning	Accessibility	Include accessibility features to improve the user experience for the public, such as support for screen readers and a high contrast mode	Allows all user's to be able to make use of the system, without discrimination	REQ ACCESSIBILITY 2, REQ ACCESSIBILITY 3, REQ ACCESSIBILITY 4, REQ ACCESSIBILITY 5	For the system to contain accessibility features, allowing those with disabilities not to be disadvantaged when using the system	Created: 23/02/23	Medium	Not Started	N/A
REQ LOGIN 2	Functional	Audit + E learning	Login	Reset a forgotten password	To allow a user will be able to regain access to their account if they have forgotten their password	REQ LOGIN 6, REQ LOGIN 7	If a password of an account can be reset	Created: 23/02/23, Updated 10/03/23	Medium	Not Started	UC 6
REQ ACCESSIBILITY 2	Non Functional	Audit + E learning	Accessibility	Have a high contrast mode	Assists users with impaired visibility	N/A	For the high contrast mode to assist visually impaired individuals	Created: 23/02/23	Low	Not Started	N/A
REQ GUI 2	Non Functional	Audit + E learning	GUI	Contain the PDGUKI branding	Provides consistency across the existing systems	REQ GUI 3, REQ GUI 4	If the branding of this site matches that of the other sites hosted by PDGUKI	Created: 23/02/23	Medium	In Progress	N/A
REQ GUI 3	Non Functional	Audit + E learning	GUI	Use the colour #009999 as the primary colour of the website	Provides consistency across the existing systems	N/A	For the colour #009999 to be used within the site	Created: 23/02/23	Medium	In Progress	N/A
REQ GUI 4	Non Functional	Audit + E learning	GUI	To use the PDGUKI logo within the website	Provides consistency across the existing systems	N/A	The logo to be placed in an appropriate position and for it to be identifiable	Created: 23/02/23	Medium	In Progress	N/A
REQ SECURITY 1	Non Functional	Audit + E learning	Security	The passwords should be hashed when stored to ensure security	Adds additional security if a malicious actor gains access to the database	N/A	If the passwords are hashed when stored within the database	Created: 23/02/23	High	Completed	UC 6
REQ LOGIN 3	Functional	Audit + E learning	Login	Need to be linked to the current QUB hosted site	Allows user's which currently know the location of the existing site to easily access the new systems	N/A	A hyperlink to be included in the current site that points to this system	Created: 23/02/23	Medium	Not Started	N/A
REQ CONTENT 3	Non Functional	E learning	Content	Content should be broken up into logical 'chapters'	Allows for users to navigate to the relevant part of the course, for what they are attempting to change	N/A	For the content to be broken up into chapters which then can be navigated through	Created: 23/02/23	Medium	Not Started	UC 12
REQ LOGIN 4	Functional	Audit + E learning	Login	Store a user's name, email, profession, and geographic location (country level)	To allow analyses of those who use the system	N/A	For the relevant information to be permanently stored on the system	Created: 23/02/23	Medium	In Progress	UC 16
REQ ACCESSIBILITY 3	Non Functional	E learning	Accessibility	Contain information to assist screen readers	Ensures that those with visual impairments can effectively use the system	REQ ACCESSIBILITY 5	For a screen reader to 'read' all of the information on the system	Created: 23/02/23	Medium	Not Started	N/A
REQ SECURITY 2	Non Functional	Audit + E learning	Security	Passwords should be 8 characters long, contain at least one number, letter, special character, upper case character and lower case character	Ensures all users have secure passwords	N/A	A user should not be able to create a password which does not fit the requirements	Created: 23/02/23	Medium	Not Started	UC 16
REQ CONTENT 4	Functional	Audit	Content	Process the required calculations based on the audit data	For analysis to be carried out on the audit data	N/A	Certain calculations will be applied to the audit data and the results of these will be stored	Created: 23/02/23	Medium	Completed	UC 4
REQ LOGIN 5	Functional	Audit	Login	Each PICU must have their own login	To allow login to the audit system	N/A	For a PICU to have an account, which allows a user to log into	Created: 23/02/23	Medium	Completed	UC 9
REQ SECURITY 3	Functional	Audit	Security	Activity on the audit system must be logged	To provide additional security, as a malicious user's activity can be tracked	REQ SECURITY 4, REQ SECURITY 5, REQ SECURITY 6	What happens on the system should be stored for a period	Created: 23/02/23	High	Not Started	UC 18
REQ SECURITY 4	Functional	Audit	Security	The time, date, where and who viewed certain data and visualisations must be stored	To provide additional security to the system	N/A	This data should be stored for a defined period	Created: 23/02/23	Low	Not Started	UC 18
REQ SECURITY 5	Functional	Audit	Security	The time, date, where, what and who updated data must be stored	To provide additional security to the system	N/A	This data should be stored for a defined period	Created: 23/02/23	Medium	Not Started	UC 18
REQ SECURITY 6	Functional	Audit	Security	The time, date, where, what and who added data must be stored	To provide additional security to the system	N/A	This data should be stored for defined period	Created: 23/02/23	Medium	Not Started	UC 18
REQ ACCESSIBILITY 4	Functional	E learning	Accessibility	Transcription of videos must be available to users	Allows users who may have difficulty hearing to use the system	N/A	A document which contains the transcript of any videos hosted on the system	Created: 23/02/23	Low	Not Started	N/A
REQ ACCESSIBILITY 5	Non Functional	Audit + E learning	Accessibility	Alternative text, for both images and graphs, should be provided for users	Assists with screen readers and if the image cannot be displayed allows for a short description	N/A	For all images and graphs to contain alternative text	Created: 23/02/23	Medium	Not Started	N/A
REQ GUI 5	Non Functional	Audit + E learning	GUI	Consistency of design across systems	Improves the user experience as the layout will be familiar from one system to the next	REQ GUI 2	For both systems to use the same design template	Created: 23/02/23	Low	In Progress	N/A
REQ MAINTAINABILITY 1	Functional	E learning	Maintainability	Non technical staff must be able to add new content	Allows the system to be continually updated when the development team has left the project	N/A	For the content on the site to be available to add to, in a noncomplex way	Created: 23/02/23	Medium	Not Started	UC 17

Requirement ID	Requirement Type	System	Category	Description	Rationale	Dependencies	Fit Criterion	History	Priority	State of Requirement	Use Case IDs
REQ MAINTAINABILITY 2	Functional	E learning	Maintainability	Non technical staff must be able to edit existing content	Allows the system to be continually updated when the development team has left the project	N/A	For the content on the site to be available to edit, in a noncomplex way	Created: 23/02/23	Medium	Not Started	UC 17
REQ CONTENT 5	Functional	E learning	Content	On completion of the course a certificate will be provided to the user	Will allow nurses to show proof of continued professional development	N/A	A pdf document containing the full name of the user will be provided to them upon completion of the course	Created: 23/02/23	Low	Not Started	UC 15
REQ RBAC 1	Functional	Audit	RBAC	For an administrator account to be able to manage users associated with the PICU	Allows a user to remove other users when they have stopped working for the PICU or if a user has transferred to one PICU to another	REQ LOGIN 2, REQ RBAC 2	If a user can remove and add other users to the PICU	Created: 01/03/23	Medium	Not Started	N/A
REQ RBAC 2	Functional	Audit	RBAC	An account must only be able to add the data relevant to the logged into PICU	Ensures a user cannot change add data to another PICU	N/A	For a user to able to add data for their PICU and not for any other	Created: 01/03/23	Medium	In Progress	N/A
REQ BACKUP 1	Non Functional	Audit + E learning	Backup	The user login data must be backed up	If the data is corrupted/lost it is imperative that the login information is still accessible as otherwise the system will be inaccessible	REQ BACKUP 2	If there is, at least one, other copy must be available	Created: 07/03/23	High	Not Started	N/A
REQ BACKUP 2	Non Functional	Audit + E learning	Backup	The data must be recovered from the most recent backup within 2 hours	It is important that the data is recovered as soon as possible	N/A	If the database is fully recovered within 2 hours	Created: 07/03/23, Updated 10/03/23	Low	Not Started	N/A
REQ BACKUP 3	Non Functional	Audit + E learning	Backup	The 'grandfather' backup must be updated once every month	If both the 'father' and 'son' backups are corrupted, then there is still a copy, and all the data is therefore not lost	N/A	If a copy of the database is made once every month	Created: 07/03/23	Low	Not Started	N/A
REQ BACKUP 4	Non Functional	Audit + E learning	Backup	The 'father' backup must be updated every 24 hours	To keep a mirror backup of the login data	N/A	If a copy of the database is made once every 24 hour period	Created: 07/03/23, Updated: 10/03/23	Medium	Not Started	N/A
REQ BACKUP 5	Non Functional	Audit + E learning	Backup	To use the 'son father grandfather' backup methodology	To have a robust and industry standard backup methodology	REQ BACKUP 4, REQ BACKUP 3	For there to be 3 versions of the user login information, 2 being backups and 1 being the active information	Created: 07/03/23	Low	Not Started	N/A
REQ LOGIN 6	Functional	Audit + E learning	Login	To allow a field engineer to reset a password	For a password to be easily reset	N/A	If a user with the role 'field engineer' is able to reset an accounts password	Created: 10/03/23	Medium	Not Started	N/A
REQ LOGIN 7	Functional	Audit + E learning	Login	To allow an administrator to reset a password	For a password to be easily reset	N/A	If a user with the role 'admin' is able to reset an accounts password	Created: 10/03/23	Medium	Not Started	N/A
REQ RBAC 3	Functional	Audit	RBAC	For an administrator to be able to edit compliance data, for all sites	If a mistake is made, then someone is able to edit this data	N/A	If an administrator is able to edit pre-existing compliance data, across all of the sites	Created: 10/03/23	Medium	Not Started	N/A
REQ RBAC 4	Functional	Audit	RBAC	Prevent the PICU accounts from editing their own compliance data	This functionality is not required as the data itself is not integral to the system and this functionality is covered in requirement REQ RBAC 3	N/A	If a user logged into the PICU account in unable to edit compliance data	Created: 10/03/23	Low	Not Started	N/A
REQ RBAC 5	Functional	Audit	RBAC	Prevent the PICU accounts from editing other site's compliance data	To ensure the integrity of the data	N/A	If a user logged into PICU account is unable to edit the compliance data from another PICU	Created: 10/03/23	Medium	Not Started	N/A
REQ CONTENT 6	Functional	Audit	Content	Audit data must be separated within two categories: SOSPD and CAPD	To keep a record of the method used to calculate the compliance score due to the different data inputs used	N/A	When adding data to the system, this information must be recorded	Created: 27/03/23	Medium	In Progress	UC 4
REQ CONTENT 7	Functional	Audit	Content	An admin must be able to view all compliance scores, and export this data as an excel spreadsheet	This data should be able to be examined further, within other applications	N/A	The compliance scores of all the PICUs can be exported to an excel spreadsheet by an admin	Created: 27/03/23 Updated: 05/03/23	Low	Not Started	UC 11
REQ LOGIN 8	Functional	E learning	Login	The account details, excluding passwords, must be able to be exported as a CSV	This data should be able to be examined further, within other applications	REQ LOGIN 4	The account information can be exported to a CSV file by an admin or field engineer	Created: 27/03/23	Low	Not Started	UC 19
REQ SCALABILITY 2	Non Functional	E learning	Scalability	A record of the courses that users have completed	If other courses are added to the e-learning platform, the system will need to have a way to determine which courses a user has completed	N/A	A record of the courses a user has completed has been made	Created: 27/03/23	Low	Not Started	UC 12
REQ CONTENT 8	Functional	E learning	Content	A series of questions must be provided to the user to test their knowledge of the content learned within a chapter	By including interactive content this entices individuals to use the product	N/A	If a quiz is inlcuded at the end of a chapter, which then provides a user's score	Created: 31/03/23	Medium	Not Started	UC 14
REQ CONTENT 9	Functional	E learning	Content	Permanently stores a user's score in the quiz	Promotes learning as it allows users to increase their score by redoing the quiz	REQ CONTENT 8	For the score of a user, in the completed quizzes, to be stored within the database	Created: 31/03/23	Low	Not Started	UC 14
REQ SCALABILITY 3	Functional	Audit	Scalability	Be able to view accurate data when another user is updating the same data	To prevent the displayed data from being updated each column at a time	N/A	For the data being displayed to update only when it is completly updated within the database	Created: 03/04/23	Medium	Not Started	UC 5
REQ SCALABILITY 4	Functional	Audit	Scalability	To be able to handle when two users update data at approxiamtely the same time	Within the future, it is possibly that more administrators will be added to the system and therefore the possibility of this must be taken into account, as if this does not occur data may be lost	N/A	To disregard the second users input and display a message to this user informing them on what has occured	Created: 04/04/23	Low	Not Started	UC 4
REQ SCALABILITY 5	Functional	Audit	Scalability	Be able to view accurate data when another user is submitting data	To prevent the displayed data from being out of date	N/A	For the page, which allows users to view data, to be refreshed when another user submits data	Created: 04/04/23	Low	Not Started	UC 5
REQ RBAC 6	Functional	Audit	RBAC	Only the admin should be able to compare compliance data from each site	This data is sensitive and therefrore should only be made available to those with elevated privilages	N/A	For an admin to be able to view and compare the overall compliance scores of all PICUs within graph form	Created: 05/05/23	Medium	Not Started	UC 10
REQ RBAC 7	Functional	Audit	RBAC	Anonymise the site which data comes from, when another site is comparing data	When a user is comparing sites, they must not know which site produced what data and therefore this must be anonymised	N/A	For a user to not be able to identify which site the data is related to	Created: 23/02/23 Removed: 05/05/23	High	Completed	N/A

2. Design

2.1. Software Architecture

During the design phase of the project, the team encountered some issues that needed to be discussed surrounding the architecture of the system. There are multiple systems which will interact and connect in different ways to each other, and the discussions surrounding the connection of these systems using APIs and docker. One of the main points would be whether the Audit and E-learning systems would be separated or kept connected as a single system to more easily reuse common code. It was decided by the team that the Audit and E-learning systems would be separated and use shared components to create the two separate systems along with the APIs (Figure 2.1.1).

The team decided that a service oriented architecture would be best suited for the project because it would allow for the customisation and adaptation [3] of each capability on their own and allow them to be connected, only where they need to be. It also allows for easy and quick creation and debugging of new services which can mean swift capability addition and speedy fixes for existing services. This type of architecture also allowed the team to split up and assign work in a simpler fashion because when each member of the team has their own service to work on, problems which could occur when working on one larger system do not appear as often such as working on functions that conflict or changing pieces which could stop other functions working.

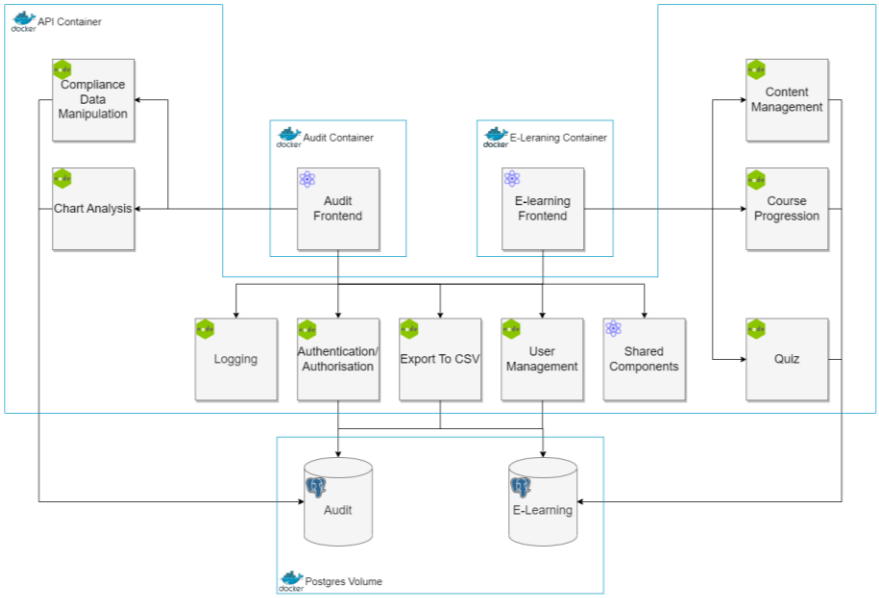


Figure 2.1.1: System Architecture Block Diagram

2.2. System Design

For how the system functions, use-case diagrams were created for the Audit and E-learning systems respectively (Figure 2.2.3 and 2.2.4) to allow the system to be created with a greater understanding of what way it has been planned. These diagrams were created using the understanding of what is needed by the project champion and an understanding of how we would need to put the systems together. The Audit use-case diagram was used to put together the website and system which allows for the 3 different types of users to interact with the system in their own unique way, as per the RBAC requirements.

There were discussions based around the database and how it was going to be set up, whether there would be two separate databases, one for the audit system and one for the E-learning, and what tables were going to be created for the database. The actual setup of these databases and the different connections between the tables allow us to have the best functionality and allow us to meet the requirements that are relevant to the database which were chosen based on what the project champion was looking for when it came to database functionality. Below is shown the ER diagrams to show how the tables will relate in each database and the Use Case diagrams for each user pathway.

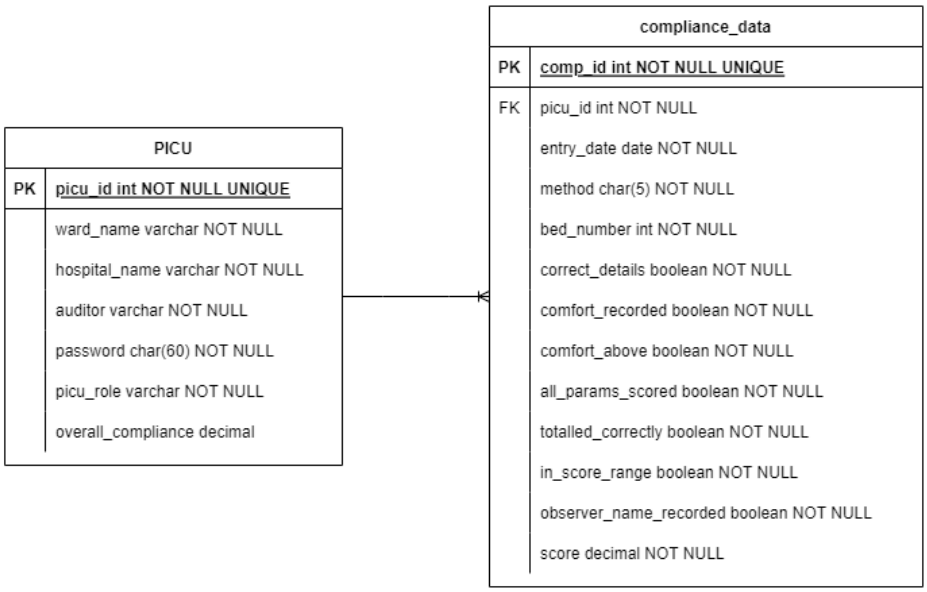


Figure 2.2.1: The Audit ER Diagram

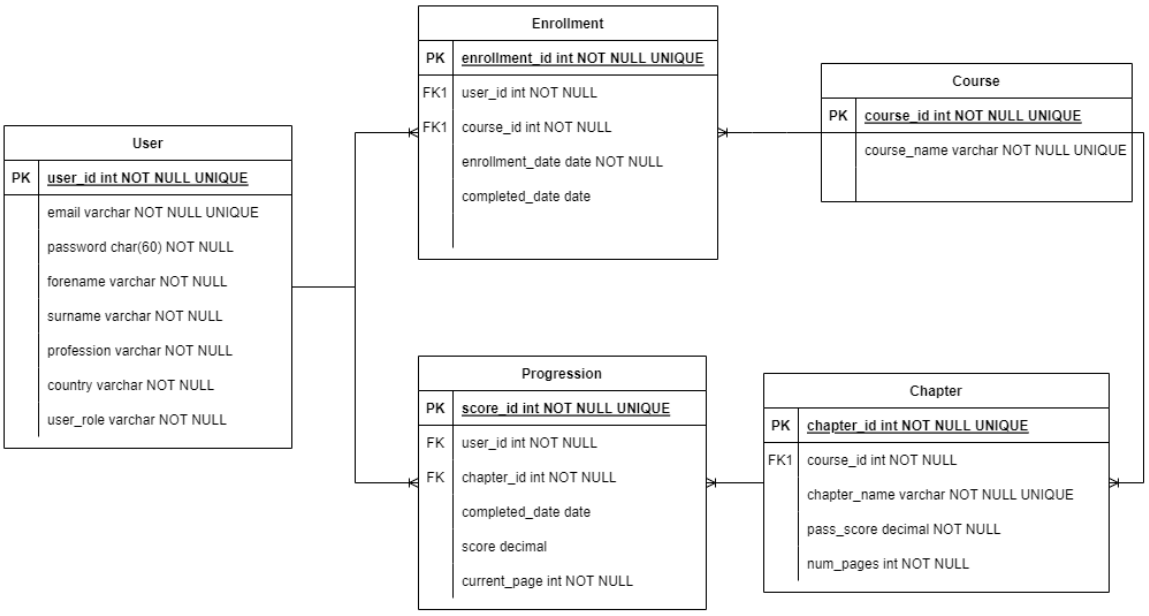


Figure 2.2.2: The E-Learning ER Diagram

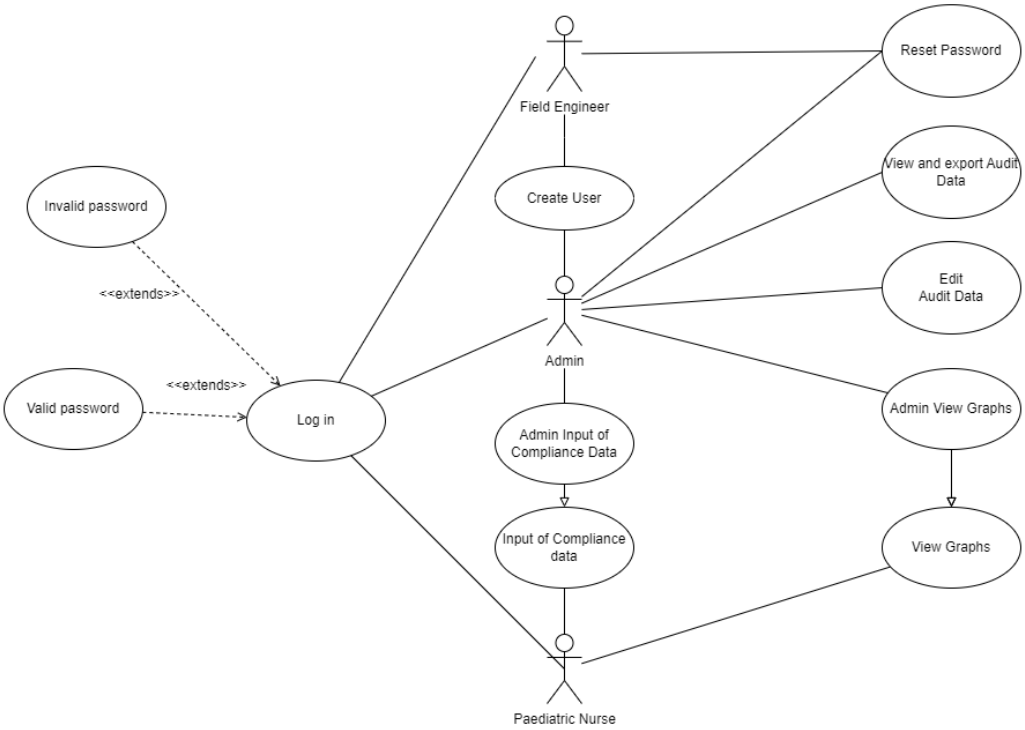


Figure 2.2.3: The Audit Use Case Diagram (Use case descriptions can be seen in Appendix 1)

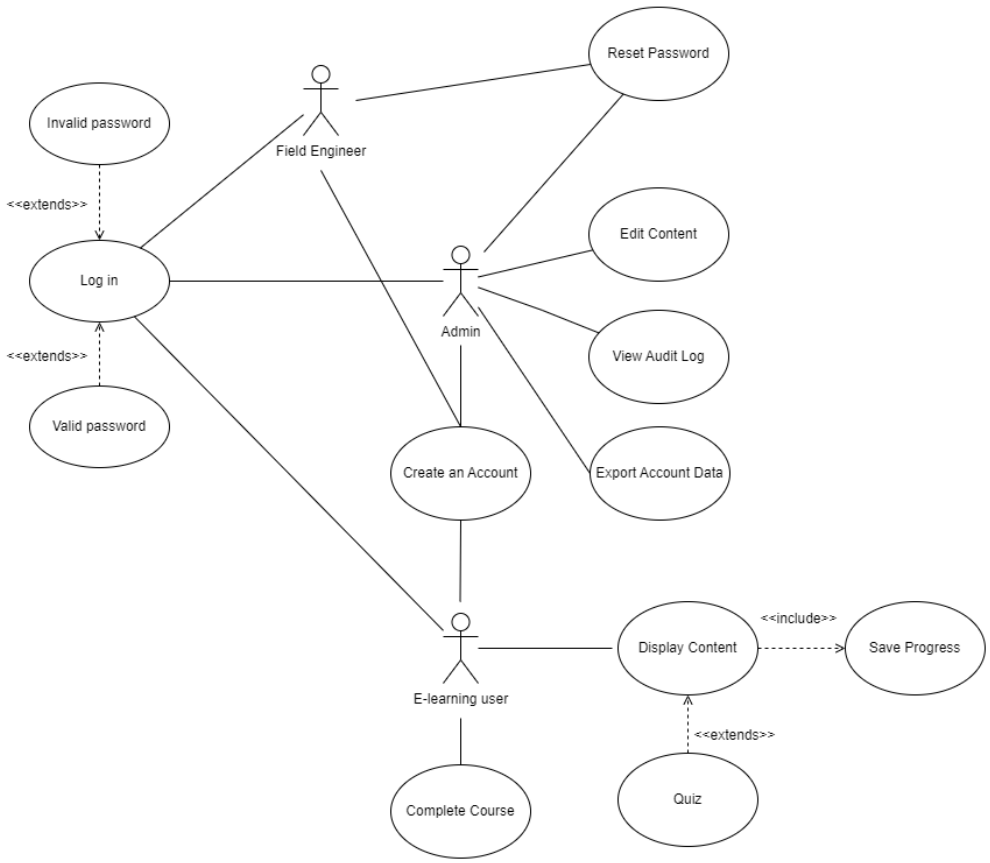


Figure 2.2.4: The E-Learning Use Case Diagram (Use case descriptions can be seen in Appendix 1)

2.3. UI Design

The team had discussions during the start of the development of the prototype around what to do when it comes to the development of the pages of the site. This involved how everything would be connected, including the order in which the pages would be accessed and how the Audit and E-learning pages would be separated. There were also discussions regarding the design and how development would be carried out. To solve the issue of the design and the development of the pages, members of the team spent time to create wireframes of the pages so when it came to putting everything together, the whole team would have an understanding of the design, and everything would be consistent (A2.2 - A2.5). It was also decided that it was best to mainly use React components when making the pages so each one is standardised but still has the level of customisability that is required for them to be placed on multiple different pages. This solution saves the team time and prevents them from rewriting the same objects repeatedly.

The team was also discussing the design of the site when it came to the layout and colour scheme etc. of both the Audit and E-learning systems as this would be a great way to help the users move over to this new system because it would be a familiar setup and design. With the help of the Project champion and some discussions, it was decided that the colour scheme would stay the same as the current system (REQ-GUI-2). The team also decided to keep the same layout between the systems to keep a level of consistency that would avoid any confusion among the users. This also follows the requirements to use the same colour and logo and to keep the design between systems the same (REQ-GUI-2).

To ensure that the system can be used by anyone, regardless of any sort of disability, the team wanted to ensure that there are adequate accessibility features that could be used. This would ensure that access to the system is as fair as possible, as anyone may struggle using the system and accessibility features will allow people with any issues that may prevent them from using the system wherever and whenever they like. This is to fall in line with the accessibility requirements for the system (REQ-ACCESSIBILITY-1).

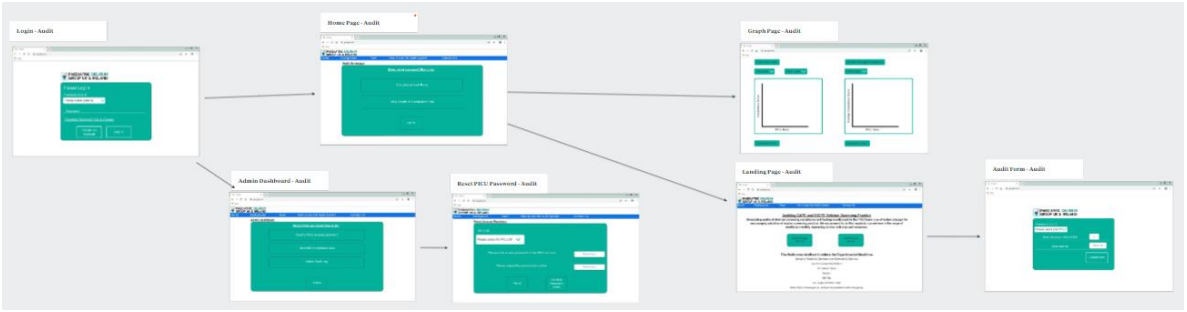


Figure 2.3.1: The Audit Storyboard

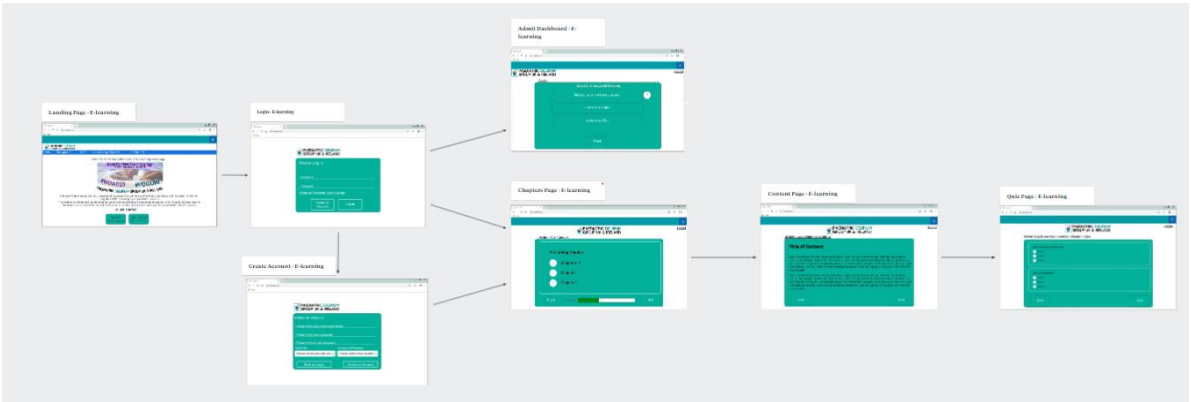


Figure 2.3.2: The E-Learning Storyboard

3. Implementation

The team's prototype implementation currently has a few key features with functionality which will be discussed in detail below. The group focus was to try to completely implement a small amount of the application's features as opposed to a large number of features with very limited functionality.

3.1. Features Implemented

3.1.1. Audit Log In

Feature Description

The current prototype implementation features a fully functional Login system which includes both an initial front end design and the backend capabilities. The Login system works through API calls to check and retrieve data from the database for user authentication, as well as attaching roles to a user's session for the Role-Based-Access-Control (RBAC) [4] to different areas of the web application.

Reason for Prioritisation

The reason for prioritising this feature was due to its integral role as part of the team's web application. There are also multiple other features in the proposed web application that have dependencies on user roles and user authentication. After discussing these matters as a team concluded that rather than faking these items for future development it was an advantageous option to prioritise this feature for development.

3.1.2. Postgres Database

Feature Description

For the prototype the team decided to implement both the audit and e-learning Postgres databases, with some 'dummy data' for testing purposes. The team implemented the database structure that they intend to use for further development; Create, Read, Update and Delete (CRUD) APIs required to retrieve and insert data into the database and the roles necessary to access the database. The team decided to not implement the backup system for the database for the prototype as the team believed that to be out of reasonable scope within the designated time frame.

Reason for Prioritisation

The reason for the Postgres Database taking a priority position in the development backlog was its integral role for other features in the application's functionality. By having this database implemented it will save time in future development by not having to create dummy data to fulfil feature dependencies that would later have to be refactored. This database can also be considered a stand-alone component of the system meaning future changes of other components will not affect the database.

3.1.3. Audit Graph Visualisation

Feature Description

The team made the decision to partially implement the Audit graph visualisations for the easy ingestion of the PICUs audit data. The implementation is of a fully functioning line graph (REQ-CONTENT-2) built from data that is retrieved through API connections to the Audit database. The reason this isn't a complete implementation of this feature is due to not having the other graph and chart designs the team plan to develop in the coming sprints.

Reason for Prioritisation

The team's reasoning for prioritising this feature is due to its high priority in the project's requirements (REQ-CONTENT-2) as well as having a working prototype implementation of this feature helped the team to demonstrate a full user path of the Audit system for a PICU nurse submitting audit data. This partial implementation allowed the team to establish a solid base to more easily implement the other types of visualisations they plan to deliver as the implementation process should be similar.

3.1.4. Audit Data Input Form

Feature Description

For the prototype implementation the team has developed a complete data input form. This form takes 'Yes' or 'No' values for the information required to complete the Cornell Assessment of Pediatric Delirium (**CAPD**) [5] and Sophia Observation withdrawal-Symptoms Paediatric Delirium (**SOSPD**) [6]. The form is mostly implemented including its transfer of information collected to the Audit database through an API; The only measures left to be implemented are that of minor aesthetic means and miniscule functionality.

Reason for Prioritisation

Implementing this feature early in development allowed for the team to establish the APIs needed to input audit data into the audit database, which then helped with the development of other features such as the audit data visualisations as they could be built using verified data. This feature is also a key step in a typical user path of a PICU conducting their regular tasks.

3.2. Technology Components

Due to the complexity of the implementation, there is a substantial number of technologies used; it would be impractical to discuss every single one of them in depth. Therefore, the team has handpicked some of the most vital technologies used in the implementation for discussion in the table below.

Figure 3.2.1: Current Technologies in Prototype

Technology	Utilisations	Discussion
React / Bootstrap	Web application page components	React [7] uses a virtual Document Object Model (DOM), this is a lightweight representation of the actual DOM, this means a high level of performance is achieved. This approach gives React the capability to efficiently update and render its components without affecting the entire page. As with most website solutions the web application will need a structuring markup language to use alongside React. React also has a strong active community of other developers that the team will be able to utilise for support during development of the implementation through the multitude of forums and other resources available. Unfortunately, previous implementations have been developed using Angular, this means the team used a different technology for the implementation. However, React's higher performance due to the virtual DOM and its considerations for mobile development that help with the implementation's requirements for mobile devices (REQ-GUI-1) mean this is a worthwhile drawback.
Typescript	Web application functionality, Used alongside React to dynamically customise components	The development team for the web application have decided to implement TypeScript as the main functionality language as opposed to JavaScript. The main reasoning for this is that the development team's main experience is with Object-Oriented Programming languages, which through TypeScript's strict type checking, more closely resembles the statically typed languages the development team have experience with. This reduces the learning curve the team has to overcome and therefore increases the development speed and effectiveness of the implementation. Furthermore, TypeScript's type checking functionality allows for the team's developers to detect and catch many errors at compile time, thereby enhancing the reliability of the code. Another benefit of using TypeScript in the application is its ability to integrate seamlessly with React's component based architecture and enable the development team to create dynamic custom React components whilst following best practice through the static type checking capability of TypeScript. TypeScript code can be easily integrated into an existing JavaScript codebase. This easy integration will allow the development team to build alongside existing JavaScript code used in previous implementations and utilise external sources with minimal refactoring.

Technology	Utilisations	Discussion
JEST.js	Testing	Jest is a JavaScript testing framework that is primarily used to test JavaScript code (can be used for TypeScript), in web applications such as the team's implementation. Jest is optimised for speed and can run multiple tests in parallel, this allows for rapid testing of the web application, perfect for the rapid development style of the prototype implementation. Jest also provides a system that allows the team's testers to mock dependencies required for the application's TypeScript code and therefore isolate its tests from external factors. As optimisation for speed is not a characteristic of the Jest framework this means for extremely large applications Jest may not be able to handle the large test suites and code with many complex dependencies and other options may be more suitable. For the size of this implementation this factor should not be of concern for the team. Jest focuses on unit testing and is great for testing individual units of code, this limits the coverage of testing for the overall functionality of a web application. For the most robust solution the team is required to complete further methods testing such as Black Box testing referencing the requirements of the web application.
Node.js	APIs	For the APIs in the implementation the team have used the Node.js library which is a popular JavaScript runtime environment that allows the implementation to execute JavaScript code on the server-side, particularly APIs. For the implementation the team decided to also utilise the express.js framework which is specifically designed for creating and calling RESTful APIs during backend web application development. For security measures when using APIs the team implemented password-hashing before the login system's API calls for user verification. JSON web tokens (JWT) were applied alongside this to enable the team to enforce endpoint authentication for the different user roles in the system.
Docker	Used to 'containerise' the application	Docker gives the team the ability to create, deploy, and run the web application in environments called containers. Containers are lightweight, portable, and isolated environments that can be easily moved between the development, testing (local machines), and production (a QUB server) environments. As a docker container provides a consistent environment for the application to run, there is a level of confidence that the application will work as intended either on a Linux or Windows machine. Docker has a simple and intuitive command-line interface that allows the development team to easily create, start, stop, and manage containers, there is also a GUI through the desktop application that provides similar functionalities. However, Docker is a relatively complex technology for those without experience to understand. Prior to this project the team had zero experience with Docker and its capabilities and therefore requires time and effort to fully master. As Docker containers are isolated from each other, security is improved by not allowing one container to affect another. Docker also provides us the option to easily scale the application [8] by creating multiple instances of a single container, it is likely this won't be utilised during this development cycle however for future sprints this is an important factor. Docker is another external technology used for the implementation, in the future it may require additional configuration (A2.1) and maintenance, which can increase the repeating workload for the team responsible.
PostgreSQL	Database solution	The team decided on using PostgreSQL as it allowed them the option to use either a relational or non-relational database while using the same software and it also supports MVCC (Multi-Version Concurrency Control) [9]. This feature allows for the database to be configured so it can be used by multiple users at the same time and prevent errors during use. This fits with the project requirements to prevent any errors or bad data when two users try to submit forms at the same time, or someone views the data before submission has been completed (REQ-SCALABILITY-5).

3.3. Technology Choice Reflection

When reflecting on the first technology choices made from the initial design of the system, most of the technologies previously stated are used in the current prototype implementation.

Figure 3.3.1: Previous Technology Choice Reflection

Previous Choice	Alternative Used	Reasoning
D3.js	react-chartjs-2	In the previous implementation report the team decided that they would use the D3.js library for the audit data visualisations. Upon further investigation into what is required for the visualisations (REQ-CONTENT-2), it was discovered that D3.js was an over complicated technology choice and the decision was made to switch to the simpler chart.js library. The team are required to only give simple graphs and charts to represent this data, to which the team found that react-chartjs-2 was sufficient technology which would be simpler to utilise.

3.4. Forecasted Technology Choices

It is impossible to predict the exact future, however, the paragraphs below discuss the technologies the team is deliberating on integrating into the final web application. This discussion will cover what the team believes they can use these technologies for in the final implementation as well as the benefits they may facilitate.

3.4.1. PuTTy for server

In order for the NHS and other affiliated parties to be able to access and utilise the web application the team need to place the application code files onto a private Queen's University Belfast related server which can then be accessed through the public internet. The discussion on this subject has concluded with the decision to use the PuTTy software to establish a connection with the server. The advantage of this is that it allows the team to connect with the server through a Graphical User Interface (GUI) before interacting with it through a Linux terminal. Furthermore, the team will use the WinSCP protocol to transfer the application files to the server through the connection established in the PuTTy environment. This protocol greatly simplifies the file transfer method, ideal for this project's implementation.

3.4.2. HTTPS

An advantageous future technology choice discussed among the team was to switch from using the HTTP protocol for the endpoints of the application to using the HTTPS protocol. This would modernise the solution as well as future-proof it for later development. The main advantage of this change for the application is that HTTPS is the secure version of HTTP and uses encryption methods to hide packet contents in network traffic from the application to external hosts. This would increase the security of the application and the application's users as it would encrypt the traffic from any malicious third parties that may be looking into the packet traffic with ill intent [10].

3.5. Third-Party Components & Code

3.5.1. Use of Bootstrap

For development of the web system the team decided to make use of the unlicensed open-source Bootstrap framework. Bootstrap gives the team access to an extensive range of pre-designed HTML, CSS, and JavaScript (can be adapted for TypeScript) components that can be easily customised and used to suit the system's needs. By using Bootstrap, the team is able to rapidly create a professional web application with consistent components easily. The use of Bootstrap in the prototype implementation includes components such as navigation bars, buttons and large modals.

3.5.2. Use of External Resources

Alongside development of the prototype application the development team used external resources to share knowledge amongst the team members and help decipher issues they faced. These external resources include public help forums from websites such as Stack Overflow as well as tutorials from the basic to advanced examples of the technologies used in the application. The team used these resources as reference points to aid their personal development with unfamiliar technologies and to help solve common development speed bumps that other software engineering communities have faced.

4. Testing

4.1. Code Test Plan

4.1.1. Introduction

The following test plan will be used to identify any bugs in the team's prototype to ensure that it is robust and fit for use. This test plan outlines our approach to testing and improving the prototype before the next stage of development. The main goal is to test as many of our functional and non-functional requirements as possible.

4.1.2. Testing Approach

The team has decided to use white box testing, specifically unit testing, to verify that the system's main functionality operates correctly. The team believes that conducting unit testing will lay the foundation for ensuring the system performs as intended. This testing methodology is designed to take the path of least resistance to validate the fundamental software requirements.

In addition to unit testing, they will also employ coverage-based testing to ensure that all code paths and branches are thoroughly tested. The team's objective is to achieve a 90% branch coverage and a 95% line coverage. This approach aims to verify that every line of code functions as intended, leaving no stones unturned, and any missed items in the unit testing are found. To perform these tests, the team has opted to use Jest, a JavaScript testing framework.

4.1.3. Scope

Below is a basic overview of the categories we will be testing.

Figure 4.1.3.1: Testing Scope

Category	Description
GUI	Consistency throughout the theme and of the webpage and ensuring popular devices (smartphone, laptop) can access the site.
Content	The functionality of the site must enhance the content provided by the stakeholders
Login	Logging into the site is a key feature in ensuring a connection can be made with a secure user.
RBAC	RBAC ensures that admins can access key parts of the site that other users cannot.
Scalability	Future proofing to make sure that if the system grows the website will be able to handle it.
Security	Activity throughout the site will be logged and a history of changes to the data should be saved.
Visualisation	Graphics of audit data must be correct and display data in an easily digested way.
Accessibility	Make sure that the site can be used by users with accessibility issues, for example, high contrast mode.
Maintainability	Staff without technical experience should be able to edit and make changes to data if they have the correct privileges.
Backup	The database must be maintained and backed up regularly.

4.2. Code Testing

4.2.1 Unit Testing

Below is a unit test plan based on the requirements to ensure that the specification is met for our prototype. Each test case will cater towards a requirement. “Unit testing is the process of testing program components, such as methods or object classes. Individual functions or methods are the simplest type of component.” [1]

Figure 4.2.1.1: A Selection of Test Cases

Test Case No.	System	Description	Action (Input)	Expected Outcome	Actual Outcome	Requirement No. fulfilled	Test Result	Test Comments	Method Name
TEST-AUDIT-AND-E-LEARNING-1	Audit-And-E-learning	Users can Log in to the system.	Input correct username and password.	User logs on.		REQ-LOGIN-1, REQ-LOGIN-5	Not Tested		
TEST-AUDIT-AND-E-LEARNING-2	Audit-And-E-learning	User logs in with incorrect details	Input incorrect / random password and username.	Error message should appear.			Not Tested		
TEST-AUDIT-AND-E-LEARNING-3	Audit-And-E-learning	Users can reset their password.	User presses the reset password button.	User is greeted with an email to message the admin.		REQ-LOGIN-2	Not Tested		
TEST-AUDIT-AND-E-LEARNING-4	Audit-And-E-learning	Admin can log in using a special account.	Input admin username and password.	Admin logs on with extra privileges.		REQ-LOGIN-1	Not Tested		
TEST-AUDIT-AND-E-LEARNING-5	Audit-And-E-learning	Admin can reset passwords of desired accounts.	Admin selects an account and resets password.	Password will be reset for the account.		REQ-LOGIN-7, REQ-LOGIN-6, REQ-RBAC-2	Not Tested		
TEST-AUDIT-AND-E-LEARNING-6	Audit-And-E-learning	Admin can view details of selected accounts including - date, email, profession and location.	Admin selects an account and view’s details.	Displays users details.		REQ-LOGIN-4, REQ-RBAC-2	Not Tested		
TEST-AUDIT-AND-E-LEARNING-7	Audit-And-E-learning	Admin can export details to a .csv file.	Admin view’s an accounts details and click “export to .csv”	downloads a .csv file with the details of the user on it.		REQ-LOGIN-8	Not Tested		
TEST-AUDIT-AND-E-LEARNING-8	Audit-And-E-learning	Users can log out of the system.	User clicks the logout button.	User logs out from the website.			Not Tested		
TEST-AUDIT-1	Audit	Users can upload compliance data for SOSPD.	User clicks Upload SOSPD data.	User prompted with a SOSPD data sheet to fill out.		REQ-CONTENT-6	Not Tested		
TEST-AUDIT-2	Audit	Users can upload compliance data for CAPD.	User clicks Upload CAPD. data.	User prompted with a CAPD data sheet to fill out.		REQ-CONTENT-6	Not Tested		
TEST-AUDIT-3	Audit	Users can upload data using the google sheet.	User submits the data.	Data is saved within the database.		REQ-RBAC-3	Not Tested		
TEST-AUDIT-4	Audit	User uploads invalid / incorrect data into the sheet.	User submits blank / empty data.	System will not let the user upload the sheet and display an error at the correct textbox.			Not Tested		
TEST-AUDIT-5	Audit	The database can be retrieved from the server by an admin.	GET * FROM database	database will be retrieved		REQ-CONTENT-7	Not Tested		
TEST-AUDIT-6	Audit	Admin can add data manually using SQL	INSERT INTO database “PICU1, …”	data will be inserted into the database.	Select query was invalid	REQ-RBAC-4	Failed	Query was fine but there were 2 SELECTS at start	testCreateInsert(basic insert query)
TEST-AUDIT-7	Audit	Admin can delete a row in the database	DELETE FROM database WHERE…	row will be deleted from database	row deleted from database	REQ-RBAC-4	Passed		testCreateDelete(no predicate)
TEST-AUDIT-8	Audit	Admin can edit a row in a database.	UPDATE database WHERE	data will be updated	data updated	REQ-RBAC-4	Passed		testCreateUpdate(valid)
TEST-AUDIT-9	Audit	Compliance score is calculated using the algorithm once compliance data is uploaded.	User uploads valid data.	Compliance score will be displayed in a table on the screen.		REQ-CONTENT-4	Not Tested		
TEST-AUDIT-10	Audit	PICU accounts can only view data they uploaded.	User clicks view data.	Displays all the data they’ve uploaded.		REQ-RBAC-3	Not Tested		
TEST-AUDIT-11	Audit	PICU accounts without admin privilege cannot view other PICU data.	User click view data.	Only that specific PICU that’s logged in will show its data.		REQ-RBAC-6	Not Tested		
TEST-AUDIT-12	Audit	PICU accounts without admin privilege cannot edit their PICU data.	User click view data.	No option to edit the data. (must reach out to an admin)		REQ-RBAC-5	Not Tested		
TEST-AUDIT-13	Audit	Admin can export compliance score and data.	Admin clicks on view data, then export.	Data is exported on a csv file.		REQ-CONTENT-7	Not Tested		
TEST-E-LEARNING-1	E-learning	Users can make an account.	Inputs, email, username and password twice.	Account is created.			Not Tested		
TEST-E-LEARNING-2	E-learning	User makes an account with a weak password.	User enters the password as “password123”.	Displays an error message saying Passwords should be 8 characters long, contain at least one number, letter, special character, upper case character and lower-case character		REQ-SECURITY-2	Not Tested		
TEST-AUDIT-14	Audit	Activity is logged for each user.	Log in with a PICU account and select “upload SOSPD data”	this activity should be logged in a text file on the server.		REQ-SECURITY-3	Not Tested		
TEST-AUDIT-15	Audit	Admin can select data from database	Admin uses a SELECT query to use on the database with valid statement	Data is selected from the database	Data is selected from the database	REQ-RBAC-4	Passed		testCreateSelect(valid)
TEST-AUDIT-16	Audit	Admin can select data from database using default parameters	Admin uses a SELECT query to use on the database with valid statement using default parameters	Data is selected from the database	Data is selected from the database	REQ-RBAC-4	Passed		testCreateSelect(default columns)
TEST-AUDIT-17	Audit	Admin can select data from database using no select condition	Admin uses a SELECT query to use on the database no select condition	Data is selected from the database	Data is selected from the database	REQ-RBAC-4	Passed		testCreateSelect(no condition)
TEST-AUDIT-18	Audit	Admin tries to insert invalid data into the database	Admin INSERTs invalid data	Fail	Fail	REQ-RBAC-4	Passed		testCreateInsert(data doesn't match table)
TEST-AUDIT-19	Audit	Admin tries to insert data with invalid columns	Admin INSERTs data with invalid columns	Fail	Fail	REQ-RBAC-4	Passed		testCreateInsert(invalid columns)
TEST-AUDIT-20	Audit	Admin tries to update data using invalid parameters	Admin UPDATEs using data with invalid columns	Fail	Fail	REQ-RBAC-4	Passed		testCreateUpdate(invalid upsert)
TEST-AUDIT-21	Audit	Admin tries to delete data with a predicate	Admin DELETEs data using a predicate	Data is deleted	Data is deleted	REQ-RBAC-4	Passed		testCreateDelete(with predicate)

4.2.2 Coverage Based Testing

The team's test plan for white box testing aimed to achieve the highest possible line and branch coverage possible. This was achieved by examining the code with the goal of improving them and by adding more test methods. "Code coverage in principle, every code segment that you write should have at least one associated test. Therefore, you can be confident that all the code in the system has actually been executed. Code is tested as it is written, so defects are discovered early in the development process." [1]

White Box testing was used to make sure that all independent paths within a module have been exercised at least once. This means all statements need to be covered to see if they are true or false and all loops are executed in full. Below is an example of testing code coverage of our prototype, this is just for sake of demonstration as time constraints meant the team couldn't test the software in full as it is just a prototype.

File	% Stmts	% Branch	% Funcs	% Lines	Uncovered Line #s
All files	7.69	6	11.39	7.73	
src	0	0	0	0	
index.tsx	0	0	100	0	16-47
reportWebVitals.ts	0	0	0	0	3-10
src/components	0	100	0	0	
line.tsx	0	100	0	0	12-36
src/components/BodyText	100	100	100	100	
BodyText.tsx	100	100	100	100	
src/components/ConsumeAPI	0	100	0	0	
ConsumeAPI.tsx	0	100	0	0	11-16
src/components/ContactInfo	100	100	100	100	
ContactInfo.tsx	100	100	100	100	
src/components/GraphCanvas	0	100	0	0	
GraphCanvas.tsx	0	100	0	0	3
src/components/HeadingText	100	100	100	100	
HeadingText.tsx	100	100	100	100	
src/components/LineGraph	0	100	0	0	
LineGraph.tsx	0	100	0	0	12
src/components/NavBar	100	100	100	100	
NavBar.tsx	100	100	100	100	
src/components/PButton	100	50	100	100	
PButton.tsx	100	50	100	100	19-23
src/components/RadioButton	0	100	0	0	
RadioButton.tsx	0	100	0	0	9-25
src/components/TypeDropDown	0	0	0	0	
TypeDropDown.tsx	0	0	0	0	7-64
src/hooks/useAPI	13.33	100	16.66	13.33	
useAPI.tsx	0	100	0	0	12-31
useHover.tsx	50	100	33.33	50	13-14
src/pages/Admin	0	100	0	0	
Admin.tsx	0	100	0	0	15-41
AdminPassword.tsx	0	100	0	0	11-33
src/pages/AuditGraphs	0	100	0	0	
AuditGraphs.tsx	0	100	0	0	11-87
src/pages/FieldEngineer	0	100	0	0	
FieldEngineer.tsx	0	100	0	0	17-40
src/pages/Form	0	0	0	0	
form.tsx	0	0	0	0	11-137
src/pages/Home	100	100	100	100	
Home.tsx	100	100	100	100	
src/pages/NoPage	0	100	0	0	
NoPage.tsx	0	100	0	0	3-4
src/pages/OtherPage	0	100	0	0	
OtherPage.tsx	0	100	0	0	10-31
src/pages/login	0	0	0	0	
login.tsx	0	0	0	0	18-70

Test Suites: 1 failed, 1 total
Tests: 4 failed, 2 passed, 6 total
Snapshots: 0 total

Figure 4.2.2.1: Prototype Test Coverage

4.2.3 Code Reviews

"Code review is a process in which code is reviewed by someone other than the author, often before the introduction of that code into a codebase." [11]

Throughout our implementation of our prototype, before the team merged their personal branches they always reviewed the code as a group. During peer programming sessions (A2.6 - A2.7) the team would review the code produced at the end of the session. This way the team could maintain consistency throughout development and know which branches were used for a particular feature.

"Some of the benefits of code review, such as detecting bugs in code before they enter a codebase, are well established." [11] Reviewing code helped with consistency throughout the code and made sure the entire team was engaged in development.

4.3. User Evaluation

As an extended precaution the team had peers within the module (outside of the team) come in to help test the prototype to ensure it meets the expectations. User evaluation helps identify defects and functional gaps, ensuring that the final product satisfies user needs and requirements. “Production based testing makes it possible to collect a lot of data about user behaviour.” [11] This would simulate end-users testing the prototype as if it were released.

A member of the team acted as a guide, showing the subjects how the system worked by sharing their screen. Observers could ask questions and steer the guide into showing them parts of the system. The team created a google form for the observers to describe their thoughts / opinions on the prototype.

The form responses can be viewed in detail here.

Comments from Dean Logan (PwC Colleague and Peer):

As Dean is a fellow peer of the team, he gave a lot of useful information offering his insights on how the site could be improved from a technical and user friendly perspective.

Dean’s comments on the GUI:

- “Logo looks squished and the text is too small.”
- “The navigation bar doesn't appear to be centred, it looks like there is a slight lean to the left side of the screen.”
- “The chart that's displayed on the graph page is too small, lots of empty screen space that could be used here on every screen size.”
- “Font type and colour used are clear and legible.”
- “The dropdown on the chart page works well, the additional ability to search/filter the different types of charts is a great feature.”
- “The home page is not consistent at all with the rest of the website. The home page should be contained within a ‘tale’ coloured box with white text, similar to the rest of the pages on the website.”
- “The navigation bar should be fixed to the top of the screen at all times, this will avoid the user having to scroll to the top of the page.”

Dean’s comments on the logic:

- “Whenever a user is logged in they should not be able to log into another account again by pressing the login button (or navigate to this page through entering it into the URL), this should be replaced with a logout button whenever a user is logged in.”
- “There should be an alert to notify the user when they have logged into the system and somewhere on the website where the user can see what account is currently logged in (e.g. username of current user displayed in the corner of the screen or in the nav bar).”
- “Overall the system does look good with only some minor complaints mainly surrounding sizing for 24 inch screens (1920x1080) and above where there seems to be large amounts of whitespace, which for a prototype really is a minor complaint however in the finished system it would be great to see better utilisation of this space and it works well on mobile.”

Comments from Lisa McIlmurray (Medical PhD Candidate and Project Client):

Lisa was very pleased with the overall system especially the theme and colourway describing it as “well established project branding” also saying the site was “easy to use” and “very self explanatory” in nature. She mentioned that a “how to use” guide could be useful for less tech-savvy people.

Comments from Charles Gillian (Senior Professor and Course Lecturer):

Charles was also very happy with the system at hand saying the theme showed a “Nice choice of colours” and it was well presented too. Charles described the system as a “Good Solution at hand” which is very encouraging coming from him as an expert within the field.

In conclusion the team is very happy with the general feedback we’ve received. People are content with the prototype and feel like it’s fit for purpose. This is very encouraging as the software is in early stages of development. Dean’s comments were helpful as they critiqued the system from a software developer’s perspective and will definitely be reviewed when developing the entire system next year.

5. Project Management: Roadmap and Sprint Plan Updates

5.1. Project Management Tools

5.1.1. Managing Documentation and Meetings

It was decided, at the beginning of the project, that the team would primarily use G Suite (A2.8) as the primary tool for collaboration. One key reason for this is due to the groups greater experience using these tools, due to our time on placement with PwC, over similar tools such as Microsoft Teams.

A shared Google Calendar was created to schedule team meetings and to remind each member of the team of both the internal and external deadlines. The shared Google Drive is used to share 'non-code' related documents, such as those related to the report. Due to its integration with Google Drive and compatibility with '.docx' files, Google Docs was chosen to edit and create documentation. Additional benefits of this platform include the ability for multiple users to work concurrently on a document, 'suggestion' mode allowing the changes to be made without committing them, being able to leave comments and assigning tasks to individuals with email notifications. A single Google Sheet was used to manage the requirements, use case descriptions and the test plan allowing for more meaningful IDs to be created and for when these IDs may change for them to be referenced more easily. Other advantages of using a spreadsheet to record this data include greater analysis of this data and ensuring data consistency. Another advantage of G Suite applications is the built in version control, in which changes, and who made them, can be tracked and if necessary, these older versions can be reverted too.

A disadvantage of using this platform is that we must ensure the compatibility of our reports within the '.docx' file format, as this is used by the examiner. Another disadvantage is that the project champions use Microsoft Teams for video calls and therefore the same integration with the documentation and the meeting cannot be used.

To collaborate when working on the diagrams used for design, LucidChart and diagrams.net were used to allow for the same concurrent use provided by Google Docs.

5.1.2. Managing Development

To manage the development of the system a mixture of Jira and Google Sheets were used. Google Sheets is used in the small, yet still important, aspect of keeping track of the state of each individual requirement, whether it has not been started, still in progress or has been completed.

The use of Jira was primarily to delegate, manage and review individual's workloads through what is known as 'issues' which translate to both singular tasks and a collection of tasks regarding development and documentation. These tasks are grouped together by 'epics' which represent a larger task or deliverable, in which the deadlines for each 'epic' is mapped onto the road map which can be seen in figure 5.2.1. Each issue is assigned to a team member to allow the whole team to be aware of the work being completed by others, and the state of said work.

One disadvantage of using Jira is that it adds overhead to the work, which is being completed, as time is required to be invested in ensuring that the state of the tasks is accurately represented. Time must also be spent to decide which tasks relate to which group, which again distracts from developing the system.

The chosen source control technology was Git, along with GitLab for the repository. As Git is the industry standard this was perhaps an easy choice for the team to have made. Due to the ability to track each team member's progress, revert to previous versions and the ability to merge, this was extremely beneficial within development.

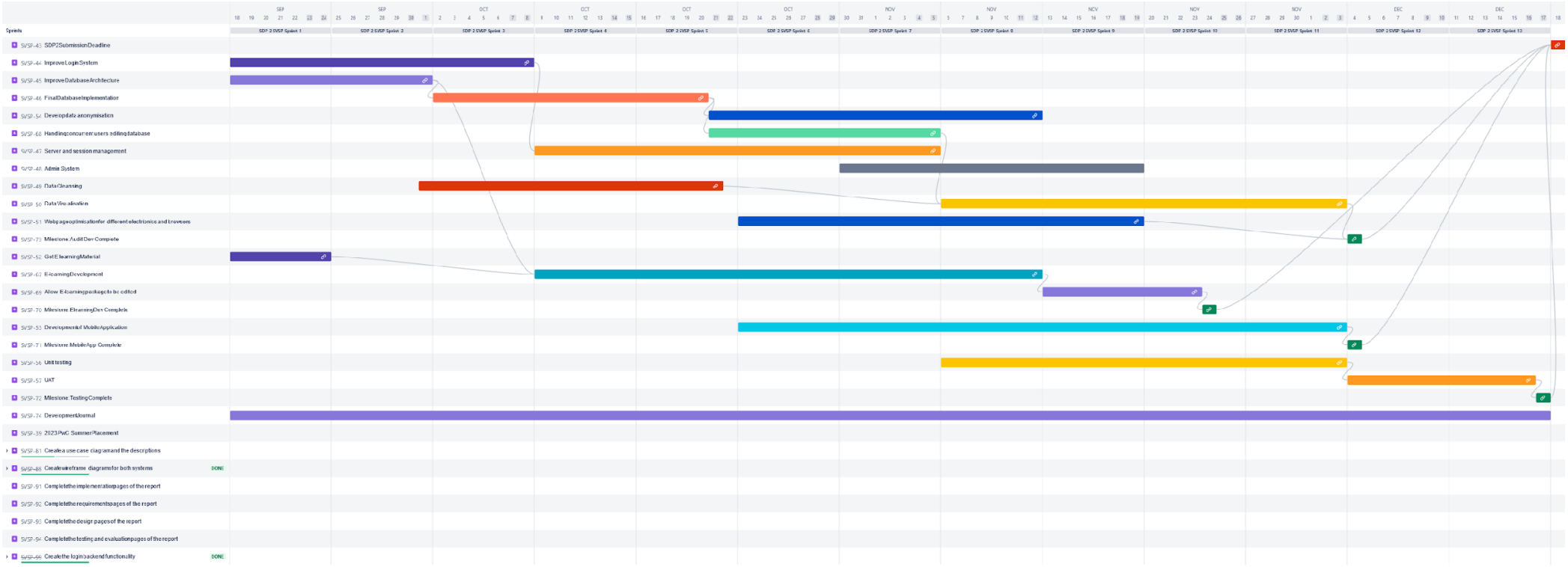
5.1.3. Links for Online Work Environment

- Jira
- GitLab
- Project Sheet
- Shared Drive

5.2. Gantt Chart

The team designed a Gantt Chart to help organise our future development plan for our prototype. This Gantt Chart will be for SDP 2 and covers from September – December. It goes into detail of what we need to complete in the future.

Figure 5.2.1: Gantt Chart



5.3. Sprint Plan

5.3.1. Sprint Description

For the Sprint 4 period, the team plans to enhance existing features from the prototype implementation they have developed over the course of CSC3068.

One of the first enhancements the team will implement to the system is improvements to the Audit Login system. The team will include features such as the ability for a user to request a password change as well as added security measures on the acceptance of these passwords. New passwords will have to include at least 8 characters, 1 numeric character, 1 upper-case character, 1 lower-case character and 1 special character.

A further enhancement the team will implement to the prototype system will be to the graph visualisations. The enhancements brought to this feature will be extended ways to view the audit compliance data through further chart designs, as well as the user having the ability to compare their own PICU compliance data against the rest of the compliance data held on the system.

A new feature the team will implement to the system is the Admin / Field Engineer role's functionality. These users require the ability to be able to edit and export the audit compliance data, change a user account's password and create new user accounts.

For security and system admin reasons, the team will implement an audit logging system that will only be accessible by users with an admin role. This audit log will document all the changes to the Audit database including data being added or removed as well as the user committing the change.

5.3.2. Reviewed Risk of Features

Figure 5.3.2: Risk of Features Breakdown

Feature	Description	Risks	Mitigation	Acceptance Measure
Improved Login System	Improved security on user accounts is a priority. This would mean added password restrictions such as required characters and length and the addition of the 'change password' feature if anyone forgets or loses their password.	The added complexity of the password requirements may mean that users are more likely to forget their password and require it be changed or reset.	The addition of the change password feature resolves the risk of people forgetting passwords because it allows the user to get a new password, removing the risk of them not being able to access their account.	Having a Login system which requires passwords to be at least 8 characters long with at least 1 numeric, upper-case, lower-case and special character each along with a feature to change an account's password
Increased Audit Visualisations	Further development will be made to the existing visualisation, such as including different types of graphs and better support for mobile devices. A new visualisation, in regards to overall compliance of PICUs, will also be created with the same functionality as the above visualisation.	When comparing PICU data sensitive data needs to be anonymised. Comparisons between PICUs should follow GDPR guidelines.	An action that is already taken, which mitigates the risk, is by shuffling the overall, using the Fisher–Yates algorithm, compliance data into a random order and therefore a single user is not able to identify which compliance score belongs to a specific PICU patient. By representing a patient as a bed number within the system this allows for the identity of the patient to remain hidden.	Having a visualisation page that allows a user to select multiple chart types. Upon selection of the chart types the visualisation will change to correlate with the specified type.
Admin / Field Engineer Functionality	Admins and field engineers need their functionality implemented. They will be able to edit and export compliance data, along with being able to reset passwords for accounts and create new accounts.	The admin and field engineer page needs to be secured as sensitive data can be downloaded and serious changes can be made	Make sure the admin and field engineer pages are secured and only an admin and field engineer can log into it.	An admin and field engineer page with the ability to change passwords, edit and export compliance data and create new accounts.
Audit Logging	The team has decided to log every action made on the website. Actions will be logged to a downloadable file. This improves security as the attacker's actions will be recorded and therefore allow identification of the attacker.	The data being logged is very sensitive and the integrity of this data may be compromised by attackers attempting to mask their activity. The logs may also take up a lot of storage space on the servers if they are backed up regularly.	Ensuring that the log file is secure, possibly through encryption. A rolling deletion method which deletes logs which are of a certain age, such as 30 days.	Major activities which are conducted by users are recorded along with the time, username and user role

6. Appendices

Appendix 1: Use Case Descriptions

Use Case ID	Description Name	Objective	Pre-Condition	Main Flow	Alternative Flow	Post Condition
UC-1	Log in	To log the user into the Audit service	N/A	1. To Prompt the user for a username and password 2. Check if the username and password are within the database	Invalid Password	Correct Password
UC-2	Invalid password	Inform the user that the username and password was incorrect	Login Failed	1. Display message informing user of either incorrect username or password 2. Prompt the user to try and login again	N/A	N/A
UC-3	Valid Password	Allow the user to access the system when they enter a correct password	Correct Password	1. Assign a session token for the user 2. Display a message that the user has successfully logged in	N/A	Logged in as Admin Logged in as Field Engineer Logged in as user
UC-4	Input of Compliance Data	User inputs data into the form and submits it for the database to calculate the	Logged in as user	1. The user enters all the data into the form and submits it to the database 2. The database will take this data and perform calculations to work out a compliance score for the bed 3. Display a message that the data has been successfully input and display the graphs page.	N/A	N/A
UC-5	View Graphs	Allows the user to view graphs containing compliance data of their own PICU	Logged in as user	1. The system brings up the graph screen. 2. All compliance data that is connected to the logged in PICU site is taken from the database and displayed in whatever way the user chooses from the dropdown	N/A	N/A
UC-6	Reset Password	Reset the password for any of the standard PICU accounts if they ever need changed	Logged in as Admin Logged in as Field Engineer	1. The field Engineer or Admin enters the pages to reset passwords. 2. The system will allow them to replace the current password with a new one by replacing the hashed value in the database	N/A	N/A
UC-7	View and Export Audit Data	View and export the raw audit data	Logged in as Admin	1. The admin will click a button to view the raw audit data 2. The system will retrieve the raw data and display it for the admin while giving them an option to export it as an excel file.	N/A	N/A
UC-8	Edit Audit Data	View raw data and change it if there are any errors or mistakes in the inputs	Logged in as Admin	1. The admin will click the option to edit audit data 2. The system will display the data in the browser for the admin in an editable format. 3. The admin will make their changes and save them to the database.	N/A	N/A
UC-9	Create User	Allows an Admin or Field Engineer to create new PICU accounts	Logged in as Admin Logged in as Field Engineer	1. The admin or field engineer will click the button to create a new account. 2. The system will ask for any relevant data to the PICU and when it has this data, it will create a new account and the admin or field engineer will generate a password.	N/A	N/A
UC-10	Admin View Graphs	To view graphs of all PICU's compliance data	Logged in as Admin	1. The system will bring up the admin graph screen 2. The admin graph screen will show data for every PICU site, from the database, and will allow for the admin to change the type of graph.	N/A	N/A
UC-11	Admin Input of Compliance Data	Input compliance data for any PICU	Logged in as Admin	1. The admin enters all the data into the form, including the PICU site this input is for, and submits it to the database 2. The database will take this data and perform calculations to work out a compliance score for the bed 3. Display a message that the data has been successfully input and display the graphs page.	N/A	N/A
UC-12	Display Content	Allows the user to view the content created for the E-Learning chapters, based on paediatric delirium	Logged in as user	1. once logged in, the user can choose different chapters with different content 2. The user will work through any of the chapters they desire and when they are finished, they will have the ability to save their progress.	1. Instead of saving their progress, they can go on to complete a quiz once they have finished the content.	Content Displayed
UC-13	Save Progress	Allows the user to save their progress wherever they are and quit the Learning section to continue whenever they want	Content Displayed	1. The user finishes with the content they are currently on and clicks the save button 2. This will take all the data about their session and save it to the database before leaving the content page.	N/A	N/A
UC-14	Quiz	Brings the user to a quiz based on the current content they are learning which allows them to test their knowledge	Content Displayed	1. The user will finish all the relevant content and will be taken to a quiz page. 2. This page will have a few questions based on the content and when the user completes it, the score will be checked and shown to the user. This score will also be saved to the database	N/A	N/A
UC-15	Complete Course	Finishes the current section that the user is on and allows them to move onto another section	Logged in as user	1. When a user has completed all the relevant content and quizzes, they will have the opportunity to complete the course 2. The system will give them a digital certificate with their name on it that can be printed or kept digitally	N/A	N/A
UC-16	Create an Account	This creates an account that can be used for E-Learning, this can be done by any type of user to allow for all types of roles to be created	Logged in as Admin Logged in as Field Engineer Logged in as user	1. A new user or a admin/field engineer will need to create an account for themselves or someone else 2. The system will ask for an email, password and some personal details. 3. When all this data is entered, it will create the user and the data will be stored in the database.	N/A	N/A
UC-17	Edit Content	Allows users to edit the content on the E-Learning system because they are the subject matter experts	Logged in as Admin	1. An admin with intimate knowledge may want to edit or add new content so they will click the edit button 2. This will allow them to upload images, videos and text to create a new content page along with added questions to the quiz	N/A	N/A
UC-18	View Audit Log	View an audit log, showing who has accessed the system and what they done	Logged in as Admin	1. The admin will click the audit log button 2. This will bring them to the Audit logs, showing what has been done on the system and who has logged in, in the last 30 days	N/A	N/A
UC-19	Export Account Data	Export data related to accounts such as chapters completed and quiz scores	Logged in as Admin	1. The admin will click a button to export account data 2. The database will retrieve all the relevant data and return it to the admin in a downloadable format while conforming to GDPR.	N/A	N/A

Appendix 2: Photos

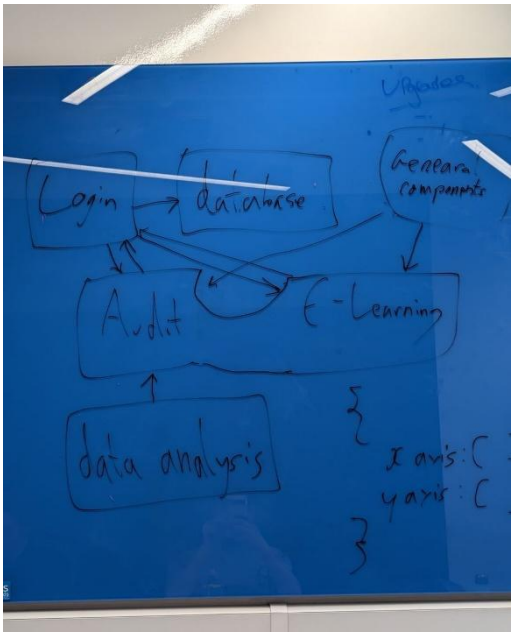


Figure A2.1: Hand-drawn Docker Architecture Sketch

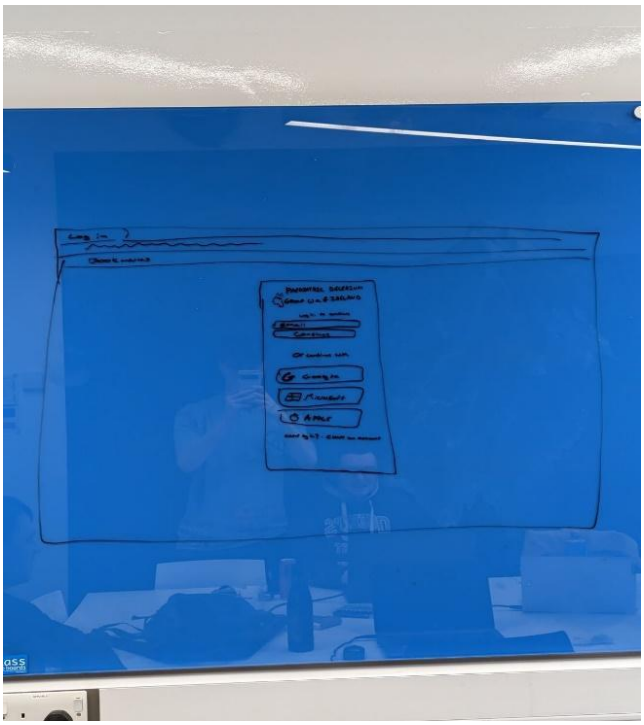


Figure A2.2: Hand-drawn login page wireframe

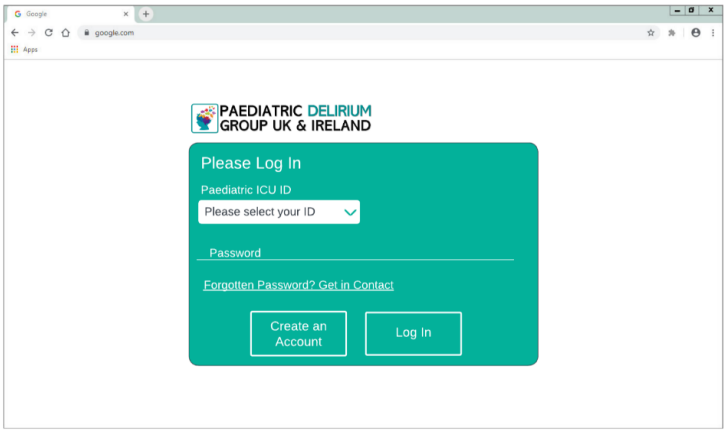


Figure A2.3: Digital login page wireframe

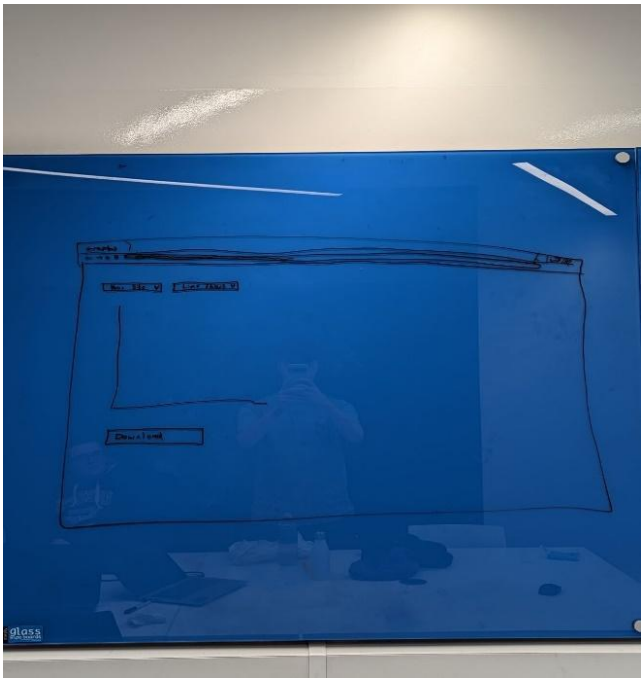


Figure A2.4: Hand-drawn Audit visualisation wireframe

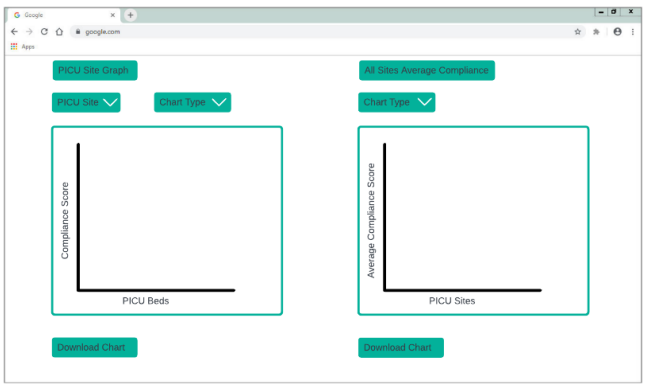


Figure A2.5: Digital Audit visualisation page wireframe

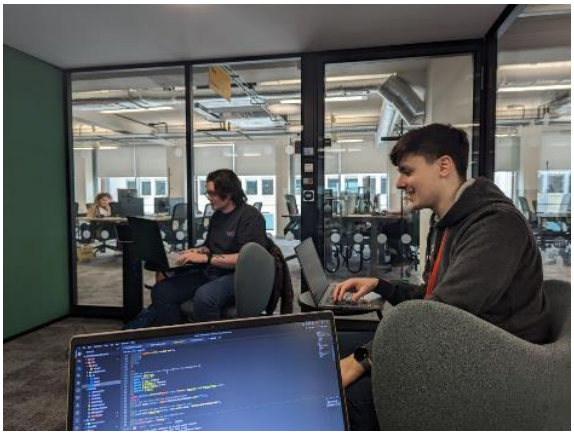
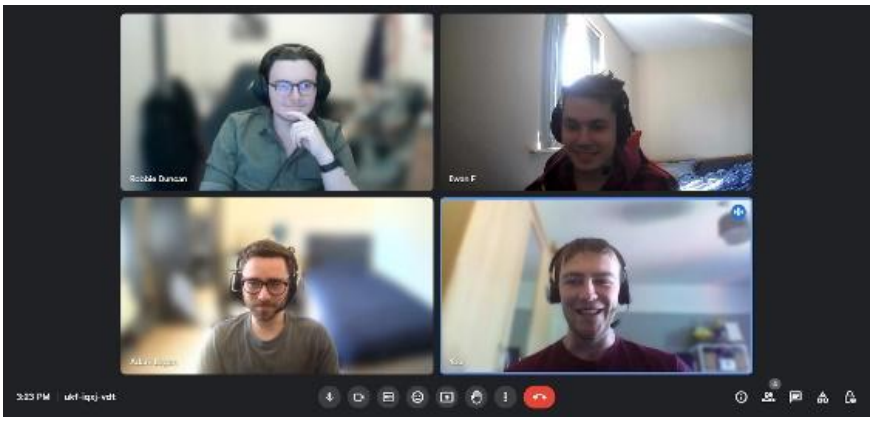


Figure A2.6: Robbie Duncan (Left) and Ewan Forsythe (Right) collaborating on the prototype

Figure A2.7: Adam Logan (Left) and Andrew Robb (Right) collaborating on the prototype



A2.8: Online collaborative session

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