Software Requirements Specification for Software Engineering: Alkalytics

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Contents

Revision History

Date	**Version**	**Notes**
Date 1	1.0	Notes
Date 2	1.1	Notes

1 Purpose of the Project

1.1 User Business

This project aims to aid in the data management and analysis of an ocean alkalinity enhancement experiment process. The research is working towards a scalable process to capture CO_2 using a combination of electric fields and membranes. The experiment's efficient generation process creates a very dilute base. The product serves a niche solution, to rebalance the ocean's pH levels to be able to absorb more CO_2. As earth's temperature rises, so does the ocean's, affects its pH balance. As this process is still on a small scale, it is currently being perfected which means many more experiments must be done to be able to bring it to a global scale. However, this requires a massive production operation to do so. Optimization of the experimental data is critical to improve process efficiency. This is a big data software problem requiring the ability to find and fine-tune specific parameters.

1.2 Goals of the Project

This platform will be able to consolidate and organize the data from the experiments with proper labeling across all given data sets allowing for a centralize method of data storage that is both scalable and maintainable. On the platform users can request to see certain data points from anywhere from the inputted data sets given any specified order. Once the data is returned to the user the platform can show inter-parameter comparability to better aid data analysis. This comparability acts as a starting point to analysis and is by no means show a final analysis of the data. This will all be presented in a web interface where all the user functions will be displayed and can be shared among those involved in the experiment.

2 Stakeholders

2.1 Client

Dr. Charles de Lannoy serves as the main client for this project as he is the lead supervisor of the research study. This solution directly affects his work and is intended to be a custom solution for the problem. Bassel Abdelkader is another client of this project as he is the person that works directly with the research data. One of his responsibilities is to record the experimental data and upload them to their current data storage system, Microsoft Excel.

2.2 Customer

Although this project is a tailored solution to one research study, its application can be extended to any other situation where large sets of data is involved. This could be shared among other researchers to aid in their data management and analysis. Depending on the research team's structure, there could also be different levels of permissions people can get.

2.3 Other Stakeholders

Current students and members of the lab working on the study is can also be considered stakeholders for the same reasons as the clients. However, since they will only be working with the study for a short amount of time without daily or consistent interaction, they do not serve as a main stakeholder. The founder of the study, who is currently funding the research project is another stakeholder. However, since they do not work directly with the processes of the study rather oversee the process, they may not have strong interest in the details of the solution.

2.4 Hands-On Users of the Project

The following is a special type of stakeholder as after this capstone project term, the project will be passed back to the research team to maintain.

- User name/category: Research project team for maintaining this project post capstone
- User Role: Maintain the codebase, adding new features, fixing potential bugs project post capstone
- Subject matter experience: Master knowledge on the goals of the research project. Master knowledge on how the experiment processes work.
- Technological knowledge: Novice knowledge on the technology stack being used in this project, Python, MongoDB, JavaScript, other front-end frameworks

2.5 Personas

- John Doe is an 23 year old McMaster undergraduate student who has a research position on the ocean alkalinity research project. They have been tasked to aid the experiment data collection process. After being told that the data is being stored in a master Excel file; they find that is it hard to use. Being an engineering student without much experience with Excel, they struggle to find the data they want. Inputting data is still a manageable process but they find themselves to be spending a lot of time looking at Excel documentation which they find frustrating as that time could be allocated to being more productive during the school term. Although, they want to a better way to manage the data, they know that it is not up to their decision on what tools are being used but suggested that there could be another better solution to use.

- Dr. Carly Kelvon is a 60 years old professor at a university and is working on her own research project for over five years. She has gathered lots of data and thankfully she has always been great at Excel. However, other the last two years she has found that Excel is becoming less sustainable. The queries are a lot slower and sifting through pages and pages of data is wasting a lot of her time. She sees this more evidently through those that work along side her as they are also facing the same struggles with even less Excel experience as her. She wants to find a more scalable solution but she fears that her lack of digital knowledge will do her more harm than good, as a result she fears that if she introduces a new platform to serve her needs better that she will find it hard and confusing to use.

- Dr. Alex Stark is a 30 year old associate professor who has recently gotten funding for his innovative research idea and has been dedicating all his time on perfecting its methodology. It has only been one year since his research started but had recently found a great application of his ideas to reach far more people and be more impactful that he had originally thought. But with his current data management set up, he quickly realises that it is not sustainable. He finds that there are many other solutions on the market but they do not exactly meet his needs and cost a lot more than what he can spend on a tool. He decided that the best way is to create his own tool but lacks the software knowledge to create something stable and reliable.

2.6 Priorities Assigned to Users

2.6.1 Primary Users

- Dr. Charles de Lannoy
- Bassel Abdelkader
- Students working on the experiment

2.6.2 Secondary Users

- Researcher with their own research studies
- The founder of the study

2.7 User Participation

Since this project is a personalized solution for a research team, there is no other user participants other than the research time and others teams with a similar need.

2.8 Maintenance Users and Service Technicians

As previously mentioned in section 2.4, the project will be passed on to the research time after this capstone project duration has finished. It will be left to the research time to maintain the project along with adding any new features.

3 Mandated Constraints

3.1 Solution Constraints

Description: The product must accept Comma-Separated Value (CSV) files as input.
Rationale: The lab apparatus generates and stores results as CSV files.
Fit Criterion: The product's input process (the processing and acceptance of input data) into the database shall be approved by testers and developers.

3.2 Implementation Environment of the Current System

Description: The product must be able to run on a Windows machine.
Rationale: Currently, the lab has a Windows machine that is used to operate the machine and analyse the produced results.
Fit Criterion: The product shall be approved as Windows compliant by testers and developers.

3.3 Off-the-Shelf Software

Description: MongoDB - a document-oriented, NoSQL database product shall be used to store the datapoints.
Rationale: Using an existing, verstaile and scalable solution like MongoDB that does not use SQL and is thus, non-relational, will allow greater flexibility in storing datapoints.

3.4 Anticipated Workplace Environment

Description: The product shall be used in the Chemical Engineering Lab run by Dr. Charles de Lannoy and Bassel Abdelkader.

3.5 Partner or Collaborative Applications

Description: The product shall be used in collaboration with the *name of lab software*.
Rationale: The *name of lab software* is used to retrieve data from the lab apparatus. The retrieved data shall be used as input for the product.

3.6 Schedule Constraints

Description: The project must be finished within the course of the current academic year.
Rationale: The finished product, as outlined in the project requirements, must be submitted by the end of the academic year.

A few relevant deadlines include:

- Proof of Concept Demonstration: November 11 to 22, 2024
- Revision 0 Demonstration: February 3 to 14, 2025
- Final Demonstration (Revision 1): March 24 to 30, 2025

3.7 Budget Constraints

Description: The total cost of the project must not exceed $750.
Rationale: The product must be economically feasible and all teams must have an equal budget to ensure conformity and equality in terms of access of resources.

3.8 Enterprise Constraints

N/A

4 Naming Conventions and Terminology

4.1 Glossary of All Terms, Including Acronyms, Used by Stakeholders Involved in the Project

- **Alkalinity Enhancement**: A process in ocean engineering to increase the ocean's ability to absorb CO.
- **CO**: Carbon Dioxide, a greenhouse gas that contributes to global warming.
- **Ion Exchange**: The process of exchanging ions between the dilute base and seawater to increase alkalinity.
- **pH Level**: A measure of acidity or alkalinity, critical in assessing the effectiveness of the alkalinity enhancement process.
- **Buffering Capacity**: The ability of seawater to resist changes in pH, essential for maintaining stable conditions during experiments.
- **Electrodialysis**: A process that uses electric fields to drive ion movement through membranes, facilitating the generation of the dilute base.

- **Oceans' Carbon Cycle**: The natural process by which carbon is exchanged between the ocean, atmosphere, and land, impacting global climate.
- **POC (Proof of Concept)**: A demonstration used to verify that a concept is feasible.
- **V&V (Verification and Validation)**: Ensures that the software meets the required standards and performs as expected.
- **CSV (Comma-Separated Values)**: A file format used for storing tabular data, such as those from experiments.
- **Data Migration**: The process of transferring data between storage types or formats.
- **Backend**: The server side responsible for logic, data management, and API services.
- **Frontend**: The user interface built using React, interacting with the backend.
- **Database**: A structured storage system (MongoDB) used to manage project data.
- **API (Application Programming Interface)**: The means by which the frontend communicates with the backend, using GraphQL.
- **CI/CD (Continuous Integration/Continuous Deployment)**: Automating testing and deployment to ensure reliable updates.
- **GitHub**: A platform for version control and collaboration on code.
- **Kanban**: A task management method used in GitHub Projects to track progress.
- **Branch**: A separate version of the codebase where changes are developed.
- **Commit**: A recorded change to the codebase.
- **Pull Request**: A request to merge changes into the main codebase after review.

- **Deployment**: Releasing the application to a live environment.

5 Relevant Facts And Assumptions

5.1 Relevant Facts

Currently, two sources of data input are used -

- The CSV files that contain datapoints generated by the apparatus.
- The initial parameter values for each experiment such as power voltage, age of membrane, density module and more. These values are manually inputted by the user and remain constant throughout each experiment.

5.2 Business Rules

N/A

5.3 Assumptions

N/A

6 The Scope of the Work

6.1 The Current Situation

Insert your content here.

6.2 The Context of the Work

Insert your content here.

6.3 Work Partitioning

Insert your content here.

6.4 Specifying a Business Use Case (BUC)

Insert your content here.

7 Business Data Model and Data Dictionary

7.1 Business Data Model

Insert your content here.

7.2 Data Dictionary

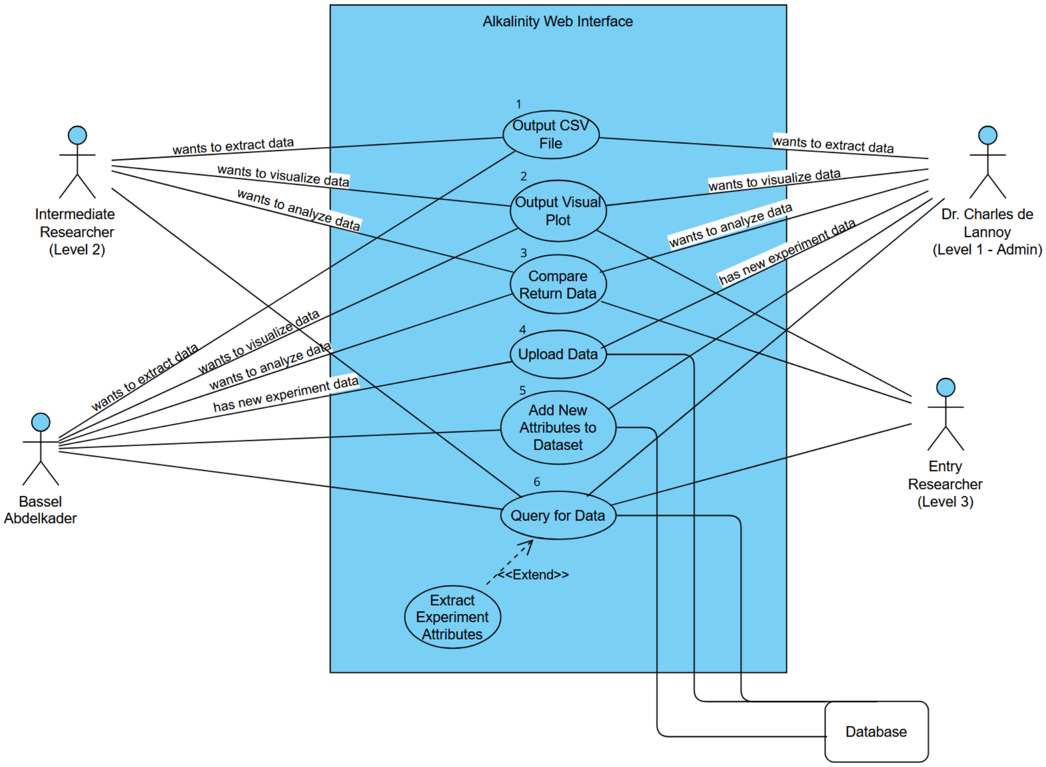
Insert your content here.

8 The Scope of the Product

The following section will highlight use cases of the product and how users and stakeholders will interact with the product.

8.1 Product Boundary

Below is a use case diagram involving the two clients and major customers. The diagram includes the back end database as an actor as it interacts with the interface system. Level 1 to 3 labeled actors are part of the research time customer mentioned in section 2.2 where depending how the team is structured, there are differnt use cases for different level actors. These are added for clarity of the system.



8.2 Product Use Case Table

The product use case table (PUC) is an extention of the use case diagram in the pervious section. The table aims to provide more

PUC No.	PUC Name	Actor/s	Input & Output
1	Output CSV	Dr. Charles de Lannoy Bassel Abdelkader Intermediate Researcher	Downloadable CSV file with appropriate data (out) Success or failure message (out)
2	Output Visual Plot	Dr. Charles de Lannoy Bassel Abdelkader Intermediate Researcher Entry Researcher	downloadable portable network graphic (PNG) or portable document format (PDF) file (out) Online viewable plot graphic (out)
3	Compare Return Data	Dr. Charles de Lannoy Bassel Abdelkader Intermediate Researcher Entry Researcher	Online viewable table of result (out) Data analysis results of involved data(out)
4	Upload Data	Dr. Charles de Lannoy Bassel Abdelkader Database	CSV file in expected format and attributes (in) Success or failure user message (out) Update database with inputted data (out)
5	Add New Attributes to Dataset	Dr. Charles de Lannoy Bassel Abdelkader Database	Update database with the new attribute (out) Success or failure user message (out) Attribute name of string type (in)
6	Query for Data	Dr. Charles de Lannoy Bassel Abdelkader Intermediate Researcher Entry Researcher Database	Visual online table with the queried data (out) Selected attribute(s), dates, restrictions (in)

8.3 Individual Product Use Cases (PUC's)

8.3.1 Output CSV

- Description: The user can export/output the data that they have received from any function on the website system
- Pre-condition: There must be some data in the database. The information the user wants to output must also be able to be stored in a CSV file
- Post-condition: The user will get to download the desired CSV file containing data from the database. If the download file has been sent to the system, the user will receive a success or failure message.
- Basic path: After querying the data from the database is successful, the user can click on the download CSV button to export the file onto their system.

8.3.2 Output Visual Plot

- Description: The user is able to generate a graphical plot based on data from the database. The contents of the graph can be customized to include any sort of data that the user decides from the data base. The graph type can be determined by the user.
- Pre-condition: There must be some selected data to be used to plot a graph.
- Post-condition: A online view of the plot will be generated and displayed on the website. There will also be an option for downloadable version.
- Basic path: After querying the database for desired data, the user can pick the option to plot the returned data. The website will then generate a graphical plot based on the returned data.

8.3.3 Compare Return Data

- Description: This use case will allow the user to compare two sets of data such as differences or similarities among other criteria.

- Pre-condition: There must be two sets of data and what attribute(s) are being compared.
- Post-condition: The analysis of the data will be presented in a visual manner. Possible outcome may include colour coded elements or a small statement.
- Basic path: After querying the database for desired data, the user can choose to enable the compare function. The user will then need to pick what attributes they would like to compare and then continue with the website prompts which will eventually give the data analysis result.

8.3.4 Upload Data

- Description: When the user has more experimental data and would like to update the database, this function of the website will be used to take in the data and update/add to the existing database.
- Pre-condition: The file with the new data will be a CSV file and will need to be uploaded through the website interface.
- Post-condition: A success or failure message will be displayed to the user once the file is done uploading and have been added to the database.
- Basic path: The user will need to click on the upload data button and find the file they wish to upload on their system and upload it through the website's drop box.

8.3.5 Add New Attributes to Dataset

- Description: As the experiment and data become larger or changes have been made, there will be times when the data set will need to be changed by adding new attributes.
- Pre-condition: The user must specify which data set that they want to edit. The user must then specify what is the attribute name is in the form of a string type input.
- Post-condition: A success or failure message will be displayed to the user once the new attribute has been added to the database.

- Basic path: The user will need to click on the edit data set button. The user must then fill in the input fields with the correct information

8.3.6 Query for Data

- Description: The user will want to get data from their past experiments. To do so, they will need to decide what they want. This is one of the main use case for any user/actor.
- Pre-condition: The database must have the some data. The user's query request must be filled in through the input fields. The fields can range from dates, to strings, to constraints.
- Post-condition: The returned data will be shown to the user through a visual table representation and will be presented with a range of other functions that the user can do with the returned data.
- Basic path: The user will need to click on the query function button. They will then need to fill in the input fields, go through the user prompts to then get the output.

9 Functional Requirements

9.1 Data Input Requirements

FR-1. The system shall allow the user to input new experiment data or parameters.

- *Rationale:* The system needs to be kept up-to-date with ongoing experiments, which may include new parameters that did not exist previously.
- *Fit Criterion:* The user should be able to input new data and parameters with 0 errors.

FR-2. The system shall store experiment data in the database with all associated parameters and values correctly labelled.

- *Rationale:* Ensures that data retrieval and analysis will be correct and accurate.

- *Fit Criterion:* The system database parameters and values shall match the original experiment data parameters and values.

9.2 Data Migration and Organization Requirements

FR-3. The system shall read existing experiment data stored in .CSV files.

- *Rationale:* Existing experiment data is stored in Excel spreadsheets and must be integrated into the new system for continuity and analysis.
- *Fit Criterion:* The system shall read and import the data files with 0 errors.

FR-4. The system shall organize experiment data by timestamps and experiment ID for unique identification.

- *Rationale:* Each experiment needs to be separately identified for quick retrieval of data and efficiency in search or query actions.
- *Fit Criterion:* Each ID and timestamp shall be traceable to one experiment.

9.3 Data Search and Query Requirements

FR-5. The system shall allow the user to search for specific datasets based on different parameters.

- *Rationale:* Allows for quick look-ups of certain experiments and their results.
- *Fit Criterion:* The system shall retrieve the correct experiments based on the matching parameters.

FR-6. The system shall allow the user to query two or more parameters or datasets for comparison and analysis.

- *Rationale:* Allows for direct comparisons between different experiment parameters and/or results, which is necessary for analysis.
- *Fit Criterion:* The system shall retrieve the correct parameters and/or experiments based on the query inputs.

FR-7. The system shall display the results of a user's selected search or query in a format that is readable to the user.

- *Rationale:* The user needs to see the results in a format that they can interpret.
- *Fit Criterion:* The results shall be displayed in a table with all labels correct and legible.

9.4 Data Visualization Requirements

FR-8. The system shall generate visual graphs based on selected parameters and datasets.

- *Rationale:* Visual representation of the data allows for easy interpretation and graphical analysis.
- *Fit Criterion:* The result should display a graphical plot with a title, axes, labels, and a legend.

FR-9. The system shall allow the user to customize the data visualization by adjusting axes, data ranges, labels, etc.

- *Rationale:* Allows the user to adjust the graphical representation to their needs for their analysis.
- *Fit Criterion:* Modifications to axes, data ranges, labels should be reflected in the generated graph in real-time.

9.5 Data Analysis Requirements

FR-10. The system shall analyze patterns and trends in the experiment data based on the user's selected parameters.

- *Rationale:* Trend analysis is critical for the user to discover important findings pertaining to the experiment.
- *Fit Criterion:* The system shall generate a result of the analysis to display to the user.

FR-11. The system shall use machine learning algorithms to predict and interpolate the data.

- *Rationale:* Allows for future predictions of data and efficiency in running future experiments.
- *Fit Criterion:* The system shall generate a report of value predictions or interpolate a graph and provide the interpolated data points.

9.6 Error Tracking Requirements

This section outlines functional requirements for one of the project's stretch goals.

FR-12. The system shall track and log errors in the experiment data.

- *Rationale:* Helps users identify irrelevant or missing parameters.
- *Fit Criterion:* Missing values from input data should be flagged.

FR-13. The system shall remove data logged as errors.

- *Rationale:* Ensures data is organized and produce accurate results in analysis.
- *Fit Criterion:* Flagged data should be removed from the database after user confirmation.

9.7 User Access Management Requirements

This section outlines functional requirements for one of the project's stretch goals.

FR-14. The system shall allow the user to sign in with valid credentials.

- *Rationale:* Ensures the data can only be accessed and modified by authorized users.
- *Fit Criterion:* The user shall be able to log in with a username and password.

9.8 Data Export Requirements

This section outlines functional requirements for one of the project's stretch goals.

FR-15. The system shall generate a report of queries in a session for the user to save or download.

- *Rationale:* Allows user to keep a record of their findings for future use or reference.
- *Fit Criterion:* The report should be exported in CSV or PDF format.

10 Look and Feel Requirements

This section will highlight the look and feel of the web interface for the project involving the appearance and the style of the user interface and experience.

10.1 Appearance Requirements

LFR-1. The website should have a simple and organized layout, with clearly defined sections where all major functions should be easily accessible and viewable

- *Fit Criterion:* A users should be able to identify all the major functions of the website within five minuets of use.

LFR-2. The website shall be responsive on all computer and laptop screens aside from mobile screens

- *Fit Criterion:* The usability of website should be the same as the default view on big and smaller computer, laptop and monitor screens

LFR-3. The website's functions and buttons shall be properly labeled where no button is ambiguous to users

- *Fit Criterion:* A user should be able to tell what all buttons inherently does without the needing to ask questions

LFR-4. The produced plot from the data shall be properly labeled

- *Fit Criterion:* The plots should not be ambiguous. Users should be able to understand what is the plot about within five minuets of viewing it.

10.2 Style Requirements

LFR-5. All icons on the website must be in the artistic style

- *Fit Criterion:* After a user's first encounter with the product, 90% of users should see that there is unity among all the icons on the website.

LFR-6. All colours must match the theme of the website

- *Fit Criterion:* After a user's first encounter with the product, 80% of users should agree that there is a common theme throughout the website.

LFR-7. All fonts are to be consistent throughout the website

- *Fit Criterion:* After a user's first encounter with the product, there should be no user who feels that any fonts do not belong on the website.

11 Usability and Humanity Requirements

11.1 Ease of Use Requirements

Description: The product must be easy to navigate and use for individuals with basic computer literacy.
Rationale: The product must be user-friendly. In the context of this project, basic computer literacy is defined to encompass five computer skills - using a keyboard to type, using a mouse to navigate, understanding basic software applications such as word processing and spreadsheets, browsing the internet, and managaing files and folders.
Fit Criterion: An individual with basic computer literacy must be able to

launch the application and upload an input file without any assistance from the administrator.

11.2 Personalization and Internationalization Requirements

Description: The current version of the product will only be available in English (EN-US) and more languages can be added in the later versions.
Rationale: Currently, the product is only expected to be used by McMaster faculty and staff who are fluent in English.

Description: The product must recognize commonly used scientific and mathematical symbols.
Rationale: The product shall be used to store scientific parameters as datapoints so the product must be able to recognize commonly used symbols used to specify scientific properties.
Fit Criterion: The product must be able to recognize the uppercase and lowercase Greek Alphabet.

11.3 Learning Requirements

Description: Users must be able to use the product without any formal training and with minimal guidance.
Rationale: The product shall be intuitive to use. Users must be able to freely naviagte and experiment with the product after a simple product walkthrough.
Fit Criterion: A new user with basic computer literacy skills should be able to upload an input file, enter initial experiment parameters, select fields to be compared and view their graph after a simple product walkthrough by the administrator.

11.4 Understandability and Politeness Requirements

N/A

11.5 Accessibility Requirements

N/A

12 Performance Requirements

12.1 Speed and Latency Requirements

1. The system shall store new data or parameters within 60 seconds of input.

2. The system shall retrieve data from the database within 50ms for typical search and queries.

3. The interaction between the interface and the user shall have a maximum response time of 2 seconds.

4. The system shall have a maximum latency of 2 seconds for typical search and queries.

5. The system shall generate a visualization of the data within 5 seconds.

- *Rationale:* Quick response times ensure efficiency and smooth user experience without disrupting the flow of the user's thought processes.

- *Fit Criterion:* The system shall satisfy the requirements above.

12.2 Safety-Critical Requirements

The product does not have safety-critical requirements to consider.

12.3 Precision or Accuracy Requirements

1. All parameter values shall be accurate to four decimal places.

2. All timestamps of experiment data shall be accurate to milliseconds.

3. Values on visual data plots shall be accurate to four decimal places.

- *Rationale:* Accuracy of the data is critical for data analysis, prediction, and interpolation.

- *Fit Criterion:* The system shall satisfy the requirements above.

12.4 Robustness or Fault-Tolerance Requirements

1. The application shall not terminate but display an error message if it loses connection to the backend server.

2. The application shall provide basic functionality if it loses connection to the internet.

- *Rationale:* The system should not fail or crash when experiencing unexpected circumstances.

12.5 Capacity Requirements

1. The application shall allow for up to three simultaneous users.

2. The system shall store up to x amount of data.

- *Rationale:* The system must be capable of storing and processing large amounts of data.

- *Fit Criterion:* The system shall satisfy the requirements above.

12.6 Scalability or Extensibility Requirements

1. The system shall be able to process and store the existing data. The amount of data going into the system is expected to grow until the experiment study comes to an end.

2. The system shall be able to add additional parameters that did not previously exist in the database at the discretion of the user.

- *Rationale:* The system must be able to expand to keep up with future experiments.

12.7 Longevity Requirements

1. The system shall operate for the duration of the experiment study.

13 Operational and Environmental Requirements

13.1 Expected Physical Environment

1. The application shall operate in a typical office environment with reliable internet connectivity.
2. The application shall be compatible with a desktop or laptop environment.

- *Rationale:* Ensures functionality in environments where end-users are most likely to use the application, accomodating several screen sizes and operating systems.
- *Fit Criterion:* Testing will be conducted on the two most common operating systems, Windows and macOS.

13.2 Wider Environment Requirements

Insert your content here.

13.3 Requirements for Interfacing with Adjacent Systems

1. The application shall operate on the most recent versions of Google Chrome and Apple Safari.

- *Rationale:* The application must be able to operate on these two most common web browsers, as these will be the primary platforms where it is hosted and accessed by users.
- *Fit Criterion:* Performance testing shall be done to ensure the application functions correctly.

13.4 Productization Requirements

1. The system shall be distributed as a web application.

2. The system shall have an easy onboarding process with user documentation.

    - *Rationale:* Ensures that users can use the application without needing frequent support.
    - *Fit Criterion:* Usability testing shall be done to ensure users are able to onboard easily.

13.5 Release Requirements

1. The first version of the system shall be released after project completion.

14 Maintainability and Support Requirements

14.1 Maintenance Requirements

- The application's maintenance must be the responsibility of the development team with no involvement from the users.

    – *Rationale*: This ensures that skilled personnel handle maintenance.

- Documentation must be provided to be referenced for future maintenance and to enable seamless knowledge transfer to new developers.

    – *Rationale*: This ensures smooth onboarding and continuity in development.

    – *Fit Criterion*: The documentation must be updated with every major release.

- The application must be designed to accommodate future development, including the addition of new experimental parameters or features without backwards progression.

    – *Rationale*: This ensures the application can scale and evolve without compromising existing features.

14.2 Supportability Requirements

- The application must be self-supporting, featuring an intuitive user interface that minimizes the need for external assistance.
  - *Rationale*: This ensures a user-friendly experience that reduces the need for help desk support.
  - *Fit Criterion*: At least 90% of users should complete tasks without needing support, as measured by usability testing.
- The application must have automated guidance, such as error messages, to assist users in troubleshooting common issues.
  - *Rationale*: This ensures users can resolve issues on their own, reducing the volume of support requests.
  - *Fit Criterion*: The documentation must be updated with every major release and reviewed quarterly to ensure accuracy.

14.3 Adaptability Requirements

- The application must be compatible with modern web browsers to ensure widespread accessibility.
  - *Rationale*: This ensures the application is accessible to a broad range of users and devices.
  - *Fit Criterion*: The application should at least be able to run on the latest version of Chromium-based web browsers.

15 Security Requirements

15.1 Access Requirements

- Access to the application must be restricted to authorized personnel, with an authentication mechanism.
  - *Rationale*: This ensures that only authorized users can interact with the application.
  - *Fit Criterion*: Only users with valid credentials should access the application.

- Only authenticated users should have the ability to query or modify the data, and each user's access must be limited to their capabilities within the application.
  - *Rationale*: This ensures users can only perform actions that align with their roles.
  - *Fit Criterion*: Role-based access control (RBAC) must restrict 60% of actions to users' defined permissions.

15.2 Integrity Requirements

- The application must validate data inputs to ensure they conform to expected formats and values before they are processed.
  - *Rationale*: This ensures only valid data is processed, reducing errors.
  - *Fit Criterion*: 100% of inputs must pass validation checks before processing.
- The application must not modify the data unnecessarily through its transfer process.
  - *Rationale*: This ensures the original data remains accurate and unaltered.
  - *Fit Criterion*: Data should remain unchanged unless explicitly modified, with logs confirming its integrity.
- The application must ensure that any data processed or transferred is free from duplication or inconsistencies.
  - *Rationale*: This ensures data consistency and prevents corruption.
  - *Fit Criterion*: The application must detect and prevent 100% of duplicated records.
- The application must have safeguards in place to maintain the accuracy of the transferred data.
  - *Rationale*: This ensures reliable data transfer without loss or error.
  - *Fit Criterion*: Transfer operations should maintain 100% data accuracy, verified by validation tests.

15.3 Privacy Requirements

- All personal information related to experimental participants or stakeholders, if applicable, must be anonymized and handled in accordance with relevant privacy laws and regulations.
  - *Rationale*: This ensures user privacy and legal compliance.
- The application must restrict data sharing with external parties unless expressly authorized by stakeholders, and users must be fully informed about the privacy policies.
  - *Rationale*: This ensures transparency and control over data sharing.

15.4 Audit Requirements

- The application must maintain a comprehensive audit trail, logging all access and modification events, including timestamps and identities of users performing actions.
  - *Rationale*: This ensures accountability and traceability of actions.
  - *Fit Criterion*: 100% of data access and modification events must be logged and retrievable.
- Audit logs must be securely stored and accessible only by authorized personnel.
  - *Rationale*: This ensures the security and integrity of audit data.
  - *Fit Criterion*: Logs must be encrypted and accessible only to users with administrative privileges.

15.5 Immunity Requirements

- The application must have proactive measures to detect and mitigate suspicious activities, such as repeated unauthorized access attempts, ensuring the application remains secure at all times.
  - *Rationale*: This ensures early detection and prevention of security breaches.

  - *Fit Criterion*: The application must detect and block unauthorized attempts after three failed login attempts, with automated alerts sent to administrators.

16 Cultural Requirements

16.1 Cultural Requirements

Insert your content here.

17 Compliance Requirements

17.1 Legal Requirements

Insert your content here.

17.2 Standards Compliance Requirements

Insert your content here.

18 Open Issues

Insert your content here.

19 Off-the-Shelf Solutions

19.1 Ready-Made Products

Insert your content here.

19.2 Reusable Components

Insert your content here.

19.3 Products That Can Be Copied

Insert your content here.

20 New Problems

20.1 Effects on the Current Environment

Insert your content here.

20.2 Effects on the Installed Systems

Insert your content here.

20.3 Potential User Problems

Insert your content here.

20.4 Limitations in the Anticipated Implementation Environment That May Inhibit the New Product

Insert your content here.

20.5 Follow-Up Problems

Insert your content here.

21 Tasks

21.1 Project Planning

The team will adopt an agile lifecycle approach, focusing on iterative progress and adaptability. Work will be organized into stages, milestones, and phases, with regular reviews and adjustments to ensure alignment with goals. Issues are managed via GitHub and all communications are documented to ensure accountability. Stakeholder feedback will be integrated throughout the process to ensure the solution meets evolving requirements.

In addition, project planning will include weekly team meetings, biweekly supervisor meetings. Deliverables are categorized into stages where roles are rotated among team members to share responsibility.

21.2 Planning of the Milestones

The milestones provide a structured approach to the project's documentation, planning, and demonstration activities. By the deadlines, the team is expected to complete and review the documents to ensure accuracy, compliance with project requirements, and readiness for subsequent stages.

Stage	Milestone	Deadline
Stage 1	Problem Statement, POC Plan, Development Plan	Sept 24
	Requirements Document Revision 0	Oct 9
Stage 2	Hazard Analysis	Oct 23
	V&V Plan Revision 0	Nov 1
Stage 3	POC Demonstration	Nov 11 - 22
Stage 4	Design Document Revision 0	Jan 15
Stage 5	Revision 0 Demonstration	Feb 3 - 14
Stage 6	V&V Report Revision 0	Mar 7
Stage 7	Final Demonstration (Revision 1)	Mar 24 - 30
	EXPO Demonstration	Apr TBD
	Final Documentation (Revision 1)	Apr 2

Table 1: Project Decomposition and Deadlines

21.3 Planning of the Development Phases

The development phases outline the progression of the project's coding and implementation efforts. Each phase is focused on achieving significant technical progress that works alongside the milestones to allow for incremental progress and continuous refinement.

Stage	Milestone	Deadline
Phase 1	POC	November 11
Phase 2	Revision 0 Demonstration	February 3
Phase 3	Revision 1 Final Demonstration	March 24

Table 2: Development Phases and Deadlines

Phase 1 focuses on the Proof of Concept (POC), where the team is expected to develop and present a functional prototype that demonstrates the core features and feasibility of the project. This phase focuses on the backend, including building a database capable of querying and sorting data, and implementing an algorithm to transfer data from a CSV file into the database format.

Phase 2 involves the Revision 0 Demonstration, where the backend is expected to be fully completed according to the project requirements. In addition, a basic frontend will be developed and integrated into a website to allow interaction with the backend functionality. It is expected that some bugs or issues will be displayed.

Phase 3 is the Revision 1 Final Demonstration, where the final version of the project is presented. This phase represents the culmination of all development efforts, with a fully functioning product that meets all requirements. Ultimately, it highlights the project's readiness for production.

22 Migration to the New Product

22.1 Requirements for Migration to the New Product

Q: Will you use a phased implementation to install the new system? if so, describe which requirements will be implemented by eahc of the major phases?
A: No, the system will be installed in a single go after being tested and approved.
Note: Include cross-references between development tasks, project phases and the Product Use Cases and atomic requirements.

Q: What kind of data conversion is necessary? Must special programs be written to transport data from an existing system to a new one? If so, describe the requirements for these programs here.
A: Currently, the files are stored in the CSV format. In order to make them compatiable for migration to the new database (MongoDB), the files must be converted into JavaScript Object Notaion (JSON) format. Yes, a special program must be written to transport the data as the new system will only accept JSON files. This means that when the file is inputted to the new system (in CSV format), a special program must first convert it to JSON so that the data can be entered in the database.

Q: What kind of manual backup is needed while the new system is installed?
A: The installation of the new program should not be a long process and can be accomplished on a day when there are no experiments being run in the lab. This means, no manual backup would be necessary while the new system is being installed.

Q: When are each of the major components to be put in place? When are the phases of the implementation to be released?

A: No phases of implementation to be released. Major components will be put in place based on this timeline -

- Database with migrated data and funtionality to compare parameters: Proof of Concept Demonstration
- Interface that allows inputting data and adding new parameters: End of December (before Christmas break)
- Dashboard that allows analysis of data and visualizing graphs: End of January

Q: Is there a need to run the new product in parallel with the existing product?
A: No, there is no need to run the new product in parallel with the existing product. Data can be migrated at regular intervals once the database is up and running.

Q: Is there any special effort needed to decomission the old product?
A: The old product is essentially a collection of spreadsheets so no special effort is needed to decomission them. A visual inspection and testing might be required after data is migrated to the new product to ensure the accuracy and integrity of the data.

22.2 Data That Has to be Modified or Translated for the New System

Q: Description of current technology that holds data.
A: Currently the data is retreived in the form of CSV files and copied onto existing Excel templates that are used to sort and analyse the data. Although the templates are sophisticated and well-deisgned, a lot of manual work is involved to flag incorrect data (rows of zeroes for all parameters), remove redundant data (the data file is sometimes split into multiple CSV files that might contain some overlapping data) and more.

Some of the collected paramteric data is also inaccurate (such as the power voltage and density module) and so those columns of data are ignored. To compare different experiments, the user is required to switch between experiment files to view their respective graphs. This is cumbersome and as the number of experiments increase, unsustainable in the long-term.

Q: Description of data translation tasks.
A: A scirpt will be written to automate the translation of files from CSV to JSON format.

Q: Foreseeable Problems.
A: N/A

22.3 Costs

Insert your content here.

22.4 User Documentation Requirements

User documentation will cover the more complicated features and functionalities of the website.

This documentation will include how to add new attributes to the data set, how to request data plots and any major functionality features.
This document is intended to be a help/tutorial for the end users who will be using the site for its functionalities. Its target is for those who have limited software knowledge. Although most functions aims to be as intuitive as possible to the user, since this is an analysis platform there should be documentation explaining for those who have no idea about how research data works and how to interact with it using the website.

22.5 Training Requirements

No training is required to use the end product.

23 Waiting Room

The following requirements are beyond the sophistication of, or time allowed for, initial release of the product.

23.1 Automatically Download Data from Lab Apparatus

Description: The product shall automatically download the CSV data files from the lab apparatus and after conversion, upload them to the database.
Rationale: Currently, the data has to be manually exported from the machine at the end of every week to ensure that the data does not get lost or overwritten.
Expected Version: Version 2

23.2 Dynamic Dashboard to Generate Comparison Reports

Description: The product shall include a dashboard that hosts multiple visual plots that are dynamically updated based on changes in the data.
Rationale: For the initial release, only basic plots that are already being used by the user will be available for viewing. Whenever data is modified, the graph must be regenerated to view the updated plot.
Expected Version: Version 2

23.3 Machine Learning Analysis and Projections

Description: The product shall use machine learning algorithms to automatically compare parameters and generate visual graphs based on simple text prompts.
Rationale: The idea is to use artificial intelligence to suggest parametric comparisons or visual graphs that the user might not have though of. The aim is to explore analyses that might not have been considered by a user.
Expected Version: Version 3

23.4 Mobile Development and Accessibility

Description: The product shall comply with relevant accessibility standards both for the web version and the mobile version.
Rationale: The project can be extended to include a mobile application version of the product to increase accessibility and reachability.
Expected Version: Version 4

24 Ideas for Solution

Insert your content here.

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Lifelong Learning. Please answer the following questions:

1. What knowledge and skills will the team collectively need to acquire to successfully complete this capstone project? Examples of possible knowledge to acquire include domain specific knowledge from the domain of your application, or software engineering knowledge, mechatronics knowledge or computer science knowledge. Skills may be related to technology, or writing, or presentation, or team management, etc. You should look to identify at least one item for each team member.

2. For each of the knowledge areas and skills identified in the previous question, what are at least two approaches to acquiring the knowledge or mastering the skill? Of the identified approaches, which will each team member pursue, and why did they make this choice?