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## PROJECT SPECIFICATION REPORT 2023/2024

# Title: STORAGE AND DISPLAY OF SUSTAINABLE/LARGE DATA IN DATABASE SYSTEM FOR ONLINE DISPLAY

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## **Abstract**

This report aims to gain insight into the project and find the relevant source which can help for project execution. This report includes literature review exploring the utilization of different software like JavaScript, MYSQL, HTML and CSS. The research investigates the role of MYSQL as a robust RDBMS for data storage and retrieval. Additionally, the research explores the crucial role of JavaScript, HTML and CSS in web development, data visualization, emphasizing its importance in developing user-friendly web-interfaces. The literature review explores the relevance of these software in the project and evaluates their combined impact on enhancing data-driven websites.

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## **1.1 Background of Project**

Nowadays, industries gather data to shape their business models and strategies, collecting information from various sources depending on their specific needs. For instance, businesses gather data on their sales and growth, the stock market tracks price and exchange data from numerous locations, and engineering firms store information related to various equipment and sensors. To support data storage, a range of software tools is employed, often in conjunction with high-speed hardware like faster drives and cloud storage.

After storing the data, visualizing data is another part. Data visualization facilitates information retrieval and helps in understanding the structure and relationship between data (Keller et al., 2006). This is why companies produce graphical representations like Bar Chart, Pie Chart or line chart from the data or information stored, for their employees or audience to know about the progress of the company.

These visualizations can be showcased on various platforms depending on the company's requirements. Displaying them on websites through the internet is the most relevant option, given the widespread access to the internet in today's time. Therefore, many companies choose to present their data and information through their websites.

This project will deal with data storage from different source in dedicated database, followed by developing a user-centric websites for intuitive data visualization and analysis, ensuring an efficient data visualization system.

For reference, websites such as [worldometer.info](http://worldometer.info) and [data.worldbank.org](http://data.worldbank.org) store substantial datasets spanning various topics like Population, GDP etc. Presenting this data without any graphical representations will be immense and confusing. Therefore, these websites provide

graphical visualization in the form of Line Charts, Bar charts etc. These websites empower users to visualize resource changes and track patterns over time effectively. Figure 1 shows an example of graphical visualization of population throughout time.

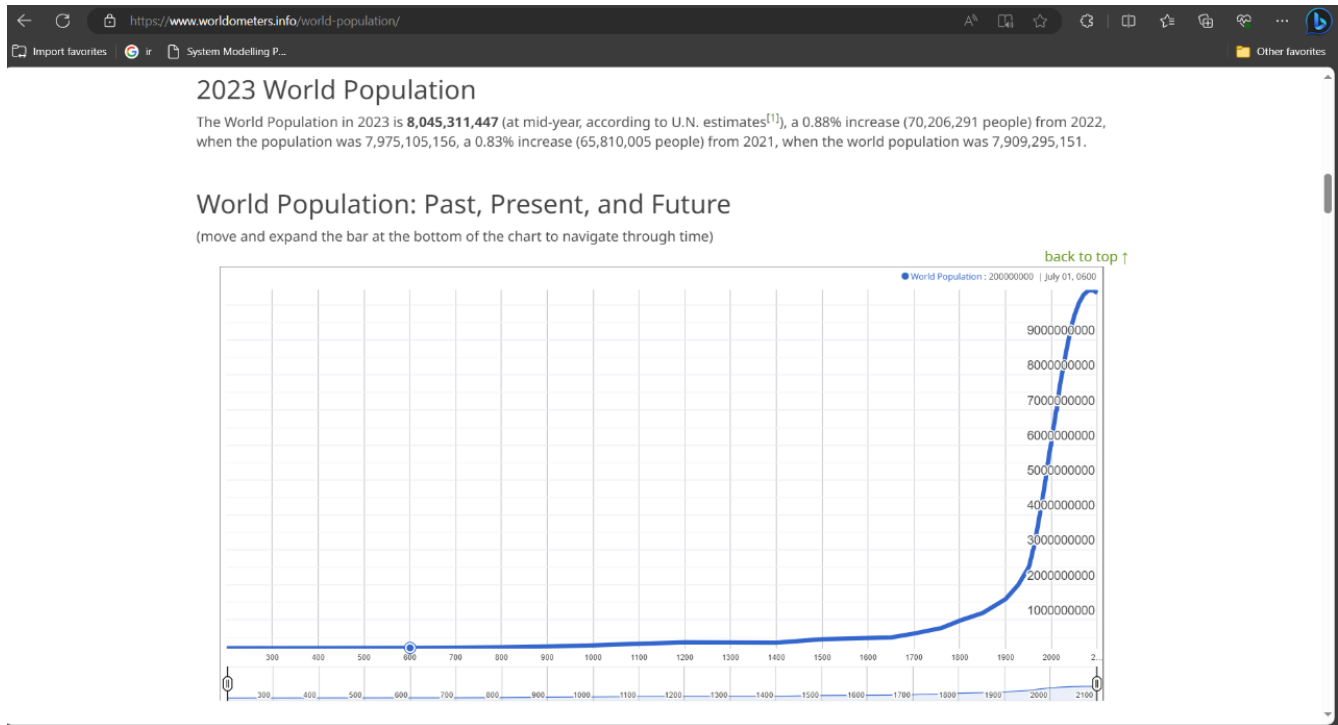


Figure 1: Chart Illustration of change in world population throughout history  
[Worldometer, *Current world population 2023*]

## 1.2 Aims and Objectives of the Project

Modern software development employs a structured approach, breaking complex issues into smaller, manageable components, a methodology mirrored in this project where the overall goal is defined in 'Project Aim' and further divided into 'Project Objectives'.

### 1.2.1 Project Aims

The main goal of this project is to systematically store data from various sources such as solar panels, wind turbines, a weather station, and a Combined Heat and Power (CHP) system into a MySQL database, followed by implementing graphical data visualization techniques to enable user customization and user-friendly presentation through a web-based interface.

### 1.2.2 Project Objectives

#### I. Data Collection and Database Schema Design

- Designing an optimized database schema to facilitate efficient data storage.
- Integrate the database with the excel file provided and establish a method for efficiently importing data from the Excel file into the database.
- Implement data validation and cleaning procedure to handle data inconsistency or erroneous data.

#### II. Back End Development (Web Interface)

- Choosing a right web development JavaScript framework for back-end web development.
- Develop the functionality to query the database and retrieve the selected data based on user inputs.

#### III. Front End Development (Web Interface)

- Designing an interactive User Interface (UI) that allows users to select their preferred datasets, duration, and other parameters.

#### IV. Data Integration and Visualization

- Integrate MYSQL database with Website and implement data visualization according to users' preference.

### 1.3 Definition of relevant terms

The relevant term of the report is given below in the table:

<b>CSS</b> (Cascading Style Sheet)	Computer language to style HTML
<b>DOM</b> (Data Object Model)	Programming interface for HTML and XML documents
<b>HTML</b> (Hyper Text Markup Language)	Markup language for Structuring the content of webpage
<b>JSON</b> (JavaScript Object Notation)	Light-weight format for storing and transporting JAVA object, array, and scalar data.
<b>RDBMS</b> (Relational Database Management System)	Program to create, manage and update relational database.
<b>XML</b> (Extensible Markup Language)	markup language and file format for storing, transferring, and editing arbitrary data.

Table 1: Relevant Terms and Definition



## **1.4 Scope of the Project**

In the scope of this project, a robust database will be designed to accommodate substantial data volume. A huge surge of data is predicted due to the numerous sensors that are constantly monitoring data flow from the system. Therefore, it is crucial to design a database which will be able to hold a large amount of data.

However, as sufficient data has already been extracted, data collecting will not be included in the project's scope. To test the program's functionality, some sample data are already given in an Excel document in a table format.

As website designing is the core part of the project, a user-friendly website is to be developed where the user can choose range of sensor data according to the time and type. The user will also be able to choose the kind of graph they want. For this part of the project JavaScript will be used for the backend, whereas HTML and CSS will be used for the front end.

Before designing the website, the data will be stored in the database. My SQL will be used to subsequently import the data to database and JavaScript library (like D3.js) will be utilized to seamlessly integrate database into the website and present it in a graphical format for visualization and analysis.

## **1.5 Literature Review**

### *1.5.1 Data Storage*

Silberchatz et al (2020) defines database as a collection of data containing relevant information to an enterprise. As database is the collection of data, a management system is required to access those data or information from the database, called DBMS (Database Management

System). The primary goal of DBMS is to provide a system that can store and retrieve information in a convenient and efficient manner (Silberschatz et al., 2020).

There are several open-source DBMS available, including MYSQL, PostgreSQL, and SQLite. When selecting a database system, users should consider factors like performance, features, support, licensing, and cost. MYSQL, in particular, stands out due to its speed, query language support, capabilities, availability, and affordability. MYSQL can also integrate with other development tools like JavaScript with few steps, therefore it is easy to generate dynamic pages from the result of database queries (DuBois, 2013). MySQL exhibit scalability, handling over 50 million rows, typically enough for substantial data volumes, and can extend its default 4GB file size limit to reach 8TB (W3schools, 2023). Therefore, making MYSQL best choice for this project. Additionally, Developer Survey conducted by Stack Overflow ranks MYSQL as second most used database by developer, chart shown below (stackoverflow,2023).

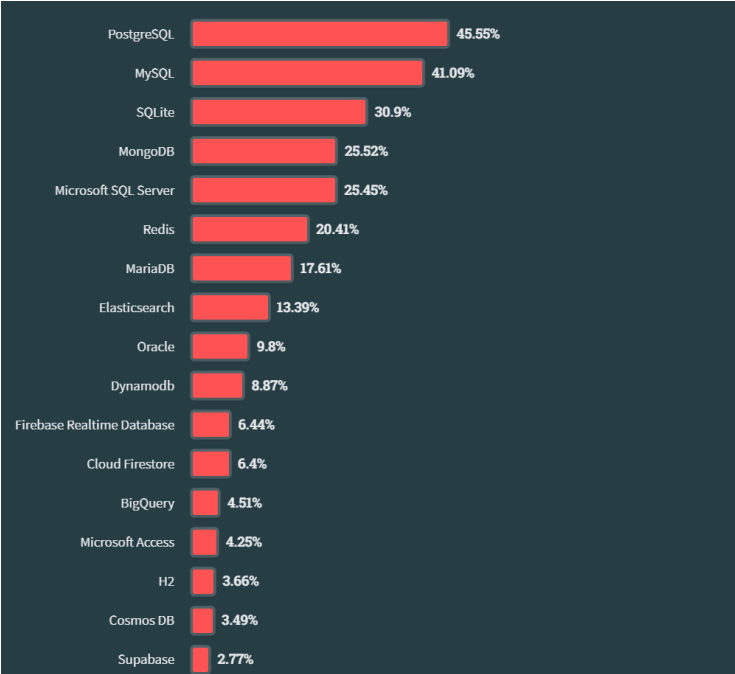


Figure 2: Stack Overflow Survey 2023: Most Used Database

### *1.5.2 Requirements for designing front-end of a website.*

Websites vary in complexity and purpose, leading to differences in coding requirements and levels based on their specific needs. Static websites where content is not generated dynamically typically needs HTML, CSS, and JavaScript whereas complex dynamic websites like Netflix where different user will be provided with different content according to their interest and location needs other programming language like PHP, Ruby, ASP.net to help the web server carry out the complex decision-making process (Macaulay, 2018). Designing a responsive website is essential for today's user interface (UI), as users moves from device to device, therefore code must work in different environment without requiring different solution. HTML5 and CSS3 enable effective rendering of code on a wide range of devices, irrespective of screen size, ensuring compatibility across most devices, making it perfect solution for responsive interface (Lane & Lane, 2014).

There are other few markup languages which can be used to design a web like Unified, XML based language or HyperCard. But HTML has been Standard Markup language used by World-Wide Web (WWW) global information initiative since 1990. Since then, HTML has evolved quite a lot with different add-on technologies and more functionality (Tabarés, 2021). Hence, owing to its extensive range of functions, accessibility, and compatibility, HTML and CSS is the suitable option for this project.

### *1.5.3 Requirement for designing back-end of a website*

JavaScript is an interpreted language with object-oriented capabilities; hence problems can be solved using classes and objects. It is also dynamically typed, which means variables can change their datatype during the execution (Flanagan, 2020).

JavaScript has a powerful object literal notation called JSON. JSON is a light-weight format for storing and transporting JAVA objects, arrays, and scalar data. JSON is a text format therefore readable by human and machine. Additionally, JSON is language-independent, allowing data to be exchanged between different programming languages (Crockford, 2015).

JavaScript dominates the complete market in the form of the wide variety of powerful frameworks and featured-rich libraries which makes the web development process well-structured and easy. JavaScript can handle both client-side code and server-side logic with ease. JavaScript possesses numerous frameworks both front-end and back-end. The front end includes framework like React and Angular which is used by companies like Facebook and Google whereas for back-end layer JavaScript includes Node.js and Express which is built-on Chrome V8 JavaScript engine. (Ranjan et al., 2020). JavaScript, with its comprehensive libraries, and its status as one of the most widely used web development languages, is an ideal choice for this project.

#### *1.5.4 Data Visualization for online display*

Data Visualization allows users to gain insight, understand and analyze the system. JavaScript has various libraries which help in manipulating data on websites like Processing.js, Raphael.js, D3.js etc. D3.js is a JavaScript library for manipulating HTML based data providing powerful visualization components. D3 stands for Data-Driven Document, and it provides developers with the ability to create visually interactive and animated content based on data and integrate the content to a webpage element (Meeks, 2017).

Earlier visualization tools like Protovis.js and Tableau were successful in practice, but their expressiveness and accessibility were limited which makes it difficult to learn representation of

a webpage since the DOM in this tool were encapsulated in tool-specific-format (Bostock & Heer, 2009).

To mitigate the drawbacks of Protovis.js, D3.js was developed and updated making it compatible providing reusable components to improve accessibility and efficiency. D3.js also simplified debugging process giving access to JS console in developer tools, therefore code can be interactively debug by running JS in the browser. D3.js also prioritizes transformation rather than representation as it shifts responsibility of visualization to developer, for instance, by using HTML and CSS, which avoids redundant computation, improving its performance (Bostock et al., 2011).

## **1.6 Research Methodology**

### *1.6.1 Problem Definition*

By the end of this project a system must be designed that store systematically accumulated data from diverse sources, like solar panels, wind turbines, a weather station, and a Combined Heat and Power (CHP) system, and meticulously into a MySQL database. Subsequently, a web-based interface must be developed that employ sophisticated data visualization techniques, allowing users to customize their selections, including data types and time stamps, to present data visualization in an illustrative and user-friendly manner.

### *1.6.2 Proposed Solution and justifications*

For the first part of the project, a database should be designed which can store a substantial amount of data. The concept of RDMS along with knowledge and skill of integrating excel file with the database is required. After achieving the first aim, a website should be designed. HTML

and CSS will be used to design the front-end of the website as it is efficient for designing the content of the website in user friendly manner. JavaScript will be used for designing the backend of this project as it is one of the most used and effective web developing tools. Finally, the database will be linked with the website using JavaScript library and graphical representation will be done using JavaScript library like Chart.js or D3.js.

#### *1.6.3 Research method for investigation*

Research papers and relevant projects pertaining to web development, data visualization and database integration are used, and it will also help furthermore in project's execution. This project involved a comprehensive review of relevant books concerning software, specifically focusing on MYSQL, JavaScript, HTML, and CSS. These resources played a pivotal role in the selection of appropriate software components for the project. Primary sources, such as documentation from Microsoft and Oracle, were consulted to gain in-depth insights into the capabilities of the selected software.

#### *1.6.4 Research deliverables*

By the end of the project, a dynamic and fully functional website is expected with the capacity to host a robust database and offer graphical data visualization. Database capable of handling substantial data volume is expected as well. Moreover, the project aims to foster a deeper knowledge and understanding of databases and software used like JavaScript, HTML, CSS and MYSQL.

### 1.6.5 Resources needed.

Given the project's objective of creating a functional website for data visualization, the key resources predominantly comprise computer software and related documentation. For the first part of the project, MYSQL workbench will be used to design a database as it provides developers with different features like data modeling, SQL development and compressive administration tools for server configurations, backups and many more (Oracle).

Additionally, JavaScript will be used along with HTML and CSS for the web development part of the project, therefore IDE for JavaScript, HTML and CSS will be required. There are many IDEs available on the internet but one of the most used and optimized for JavaScript projects is Visual Studio Code (VS Code) which includes built-in JavaScript IntelliSense, debugging, formatting, code navigation, refactoring and many more functions (Microsoft, 2021).

### 1.6.6 Risk Assessment

Table 2 below lists every potential risks along with the necessary course of action:

<b>Risk</b>	<b>LIKELIHOOD (1-5)</b>	<b>SEVERITY (1-5)</b>	<b>ACTION</b>
Ambiguous Project Objective	3(Possible)	4(Major)	Clear goal and objective should be established at project initiation
Poor Progress Documentation	2(Unlikely)	3(Moderate)	Documentation should be done effectively and reviewed in timely manner
Ineffective Time Management	2(Unlikely)	4(Major)	Project Timeline should be established (i.e., GANTT chart) and followed,
Poor Quality Code	2(Unlikely)	4(Major)	Supervisor Monitoring in timely manner

Table 2: Risk Table

## 1.7 Conclusions

In conclusion, the development of a responsive website for visualizing sustainable data in graphical form, requires the utilization of various software with different functionalities. Following a thorough review of research papers and relevant sources, it has been determined that MYSQL is the ideal choice for DBMS, as it is user-friendly, scalable, adaptable and has capability to hold large data. Additionally, HTML and CSS will form the core of website content design, and JavaScript, with its framework Node.js, will be employed to develop the website's backend. Furthermore, graphical data visualization will be facilitated through the use of libraries such as D3.js.

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## Appendix:

### 1. Gantt Chart:

		▸ <b>First Phase: Literature Research and Software Selection</b>	<b>19 days</b>	<b>Mon 09/10/23</b>	<b>Fri 27/10/23</b>	
		FP1.1 Project Specification and Literature Review Report	18 days	Tue 10/10/23	Fri 27/10/23	
		FP1.2 Researching about Softwares	12 days	Tue 10/10/23	Sat 21/10/23	
		<b>M1: Project Specification and Literature Review Submission</b>	<b>1 day</b>	<b>Fri 27/10/23</b>	<b>Fri 27/10/23</b>	
		▸ <b>Secon Phase: Databse Design</b>	<b>40 days?</b>	<b>Thu 26/10/23</b>	<b>Tue 05/12/23</b>	
		SP 1. Learning MYSQL & DATABASE	30 days	Fri 27/10/23	Sat 25/11/23	
		SP 2. Designing Database using MYSQL (Sample Data)	6 days	Sun 26/11/23	Fri 01/12/23	8
		SP 3. Supervisor Meeting for Database Analysis	1 day?	Tue 05/12/23	Tue 05/12/23	9
		▸ <b>Third Phase: Designing Front End</b>	<b>55 days</b>	<b>Wed 22/11/23</b>	<b>Tue 16/01/24</b>	
		TP 1. Learning HTML and CSS	30 days	Thu 23/11/23	Fri 22/12/23	
		<b>M2: Progress Review Viva with Supervisor</b>	1 day	Tue 12/12/23	Tue 12/12/23	
		TP 2. Designing Front End for the project	15 days	Sat 23/12/23	Sat 06/01/24	12
		TP 3. Supervisor Meeting for Analysis	1 day	Tue 16/01/24	Tue 16/01/24	14
		▸ <b>Fourth Phase : Designing Back End</b>	<b>46 days</b>	<b>Sun 07/01/24</b>	<b>Wed 21/02/24</b>	
		FP 1. Learning JavaScript along with D3.js	30 days	Sun 07/01/24	Mon 05/02/24	14
		FP 2. Designing Back-End for the project	15 days	Tue 06/02/24	Tue 20/02/24	17
		<b>Christmas Break and Personal Holidays</b>	21 days	Fri 22/12/23	Thu 11/01/24	
		FP 3. Supervisor Meeting for Analysis	1 day	Tue 20/02/24	Tue 20/02/24	
		▸ <b>Final Phase : Integrating and Testing</b>	<b>20 days</b>	<b>Tue 20/02/24</b>	<b>Sun 10/03/24</b>	
		FP 1. Combining database with website	5 days	Tue 20/02/24	Sat 24/02/24	
		FP 2. Testing with Different Data	15 days	Sun 25/02/24	Sun 10/03/24	22
		▸ <b>Final Report</b>	<b>81 days</b>	<b>Mon 08/01/24</b>	<b>Thu 28/03/24</b>	
		Final Report Submission	1 day	Thu 28/03/24	Thu 28/03/24	
		<b>Poster Presentation VIVA with Employability Document</b>	1 day	Tue 21/05/24	Tue 21/05/24	

