INFORMATION SYSTEM FOR THE ASSESSMENTS OF SEAGRASS, MANGROVES AND CORAL REEFS WITHIN THE SARANGANI BAY PROTECTED SEASCAPES

A Capstone Project Presented to the Faculty of the IT/Physics Department Mindanao State University – General Santos

In Partial Fulfillment of the

Requirements for the Degree

BS Information Technology

By

Jaen, Emmanuel Jr.

Freires, Emmanuel

Quita, Loyd Ryan

COLLEGE OF NATURAL SCIENCES AND MATHEMATICS MINDANAO STATE UNIVERSITY–GENERAL SANTOS

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1.0 Background of the Study

Marine Coastal Ecosystems are vital areas where the land meets the sea, encompassing diverse habitats such as seagrass beds, mangroves and coral reefs. These habitats are crucial for marine ecology, providing shelter, food and breeding grounds for various marine animals, and they also play a significant role in supporting human livelihoods.

At Mindanao State University, Marine Biology Students undertake an annual thesis project to assess the status and distribution of seagrass, mangroves and coral reefs within the Sarangani Bay Protected Seascapes (SBPS) in Mindanao. These projects contribute valuable insights into the health and trends of these marine coastal ecosystems.

Currently, the data collected from these assessments are managed using paper documents, word files, photographs and visual documentation. This reliance on manual methods proves to be inefficient and limits the potential of the collected data.

A centralized Information System could offer numerous benefits, especially in the context of marine coastal ecosystem studies. Manual documentation often falls short in processing complex ecological data and identifying significant patterns, and it can hinder the effective mapping of research locations over time. Moreover, the absence of a dedicated information system restricts researchers from sharing their findings broadly, thereby limiting the potential for community awareness and education.

In response to these challenges, we propose the development of an Information System designed specifically for the collection and analysis of data on marine coastal resources, particularly the assessments of seagrass mangroves and coral reefs conducted by the students of the College of Fisheries. This system will integrate advanced analytics and mapping capabilities to facilitate in-depth analysis, allowing researchers to uncover meaningful patterns and trends from the collected data.

By centralizing and streamlining the management of assessment information, the system will enhance the efficiency and impact of marine coastal ecosystem studies.

1.1 Technology Application Context

The Information System For the College of Fisheries will be developed as a web-based application. By developing a web-based application, faculties and students are empowered to efficiently store and provide information for the community about the Ecological studies conducted in Sarangani Bay Protected Seascapes (SBPS).

For the development of the system, HTML, Javascript and CSS will be chosen as the Frontend of the system allowing a flexible design for the system.

As for the back-end, Django framework and PostgreSQL server will be utilized to handle the server side and data processing.

1.2 Project Objectives

1.2.1 General Objective

To develop an Information System for Marine Coastal Resources for Seagrass, Mangroves, and Coral Reefs in Sarangani Bay Protected Seascape. (SBPS), including the integration of data analytics.

1.2.2 Specific Objectives

The specifics objectives of the project are:

1. To develop and design an information system that will store and manage information about seagrass, mangroves and coral reefs including:
    - **Classification:** The contributor will manually categorize the marine resources by selecting them based on their Species, Local Name, Kingdom, Phylum, Class, Order, Family, and Genus. Each category will include detailed descriptions and images for better identification.
    - **Taxonomy Management**: The Administrator can manage the Taxonomy Classification including Species, Local Name, Kingdom, Phylum, Class, Order, Family and Genus.
    - **Collection Information:** This encompasses the documentation of data related to the field observations, such as the name of the field observer, the date of the observation, and the specific location where the data was collected.
    - **Collection of Assessments**: Storing raw data related to seagrass, mangroves, and coral reefs assessments.

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2. To integrate data analytics to provide insights into the following:
    - The fluctuations of species populations over time using time series visualization.
    - The distribution of marine coastal ecosystems using proportional mapping tools.

3. To evaluate the acceptability of the website through the use of The Unified Theory of Acceptance and Use of Technology (UTAUT) among the Marine Biology students of the College of Fisheries, Mindanao State University.

1.3 Scope and Limitations of the project

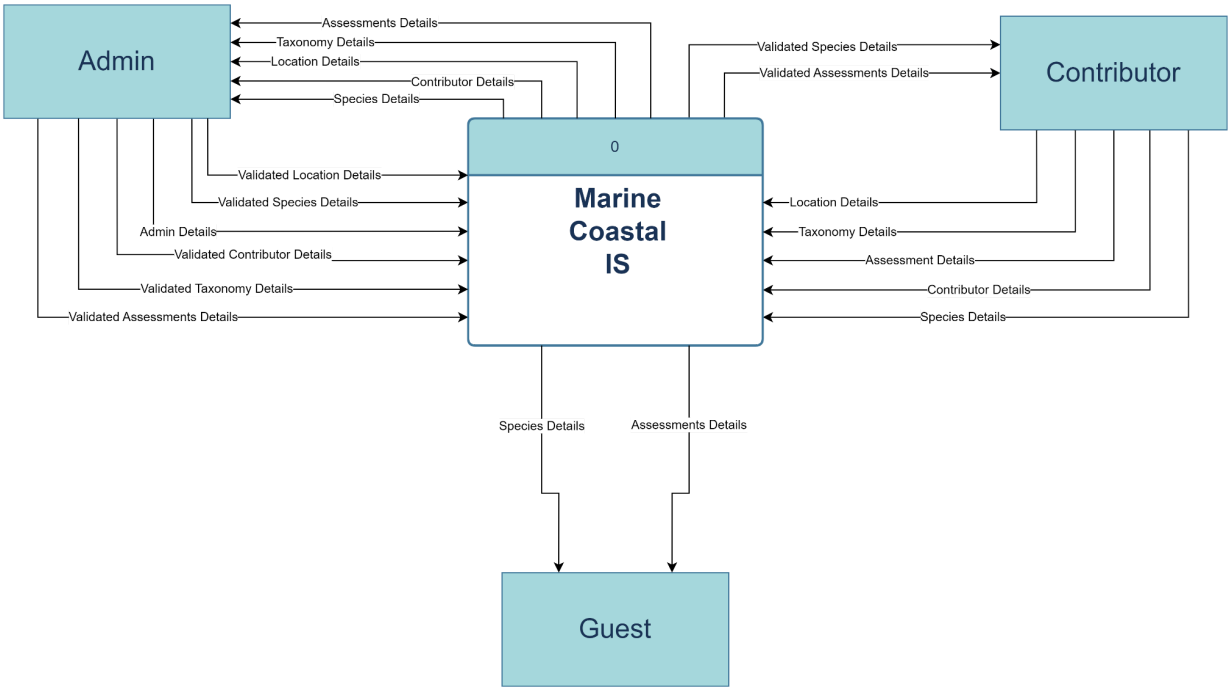


Figure 1.3.1 Context Level Data Flow Diagram

Marine Coastal IS, aims to manage and store comprehensive information on the marine coastal ecosystems, particularly focusing on seagrass, mangroves, and coral reefs. The main goal is not only the effective management of this data but also the integration of analytics to aid in the monitoring and evaluation of these ecosystems.

Roles & Access:

- **Admin**: The Admin user has the highest level of access, managing everything from location details to species, taxonomy, and assessment data. Admins can also access, add, and validate data submitted by contributors.

- **Contributor**: Contributors are responsible for adding detailed information about species, locations, taxonomy, and assessments. They can submit raw data, which will later be validated by admins.
- **Guest**: Guests have limited access to the system. They are mainly viewers of data and do not have permissions to add or validate data. Guests can view species, assessments, and location details but cannot contribute or manage the information.

Data Flow:

1. **Admin Interaction**: Admins interact with various modules such as location, species, taxonomy, and assessments. They are responsible for validating and managing all the data within the system.
2. **Contributor Interaction**: Contributors submit detailed information about locations, species, taxonomy, and assessments, which is then validated by the Admin.
3. **Guest Interaction**: Guests can view public details about species, assessments, and locations, but do not have any rights to modify or contribute new data.

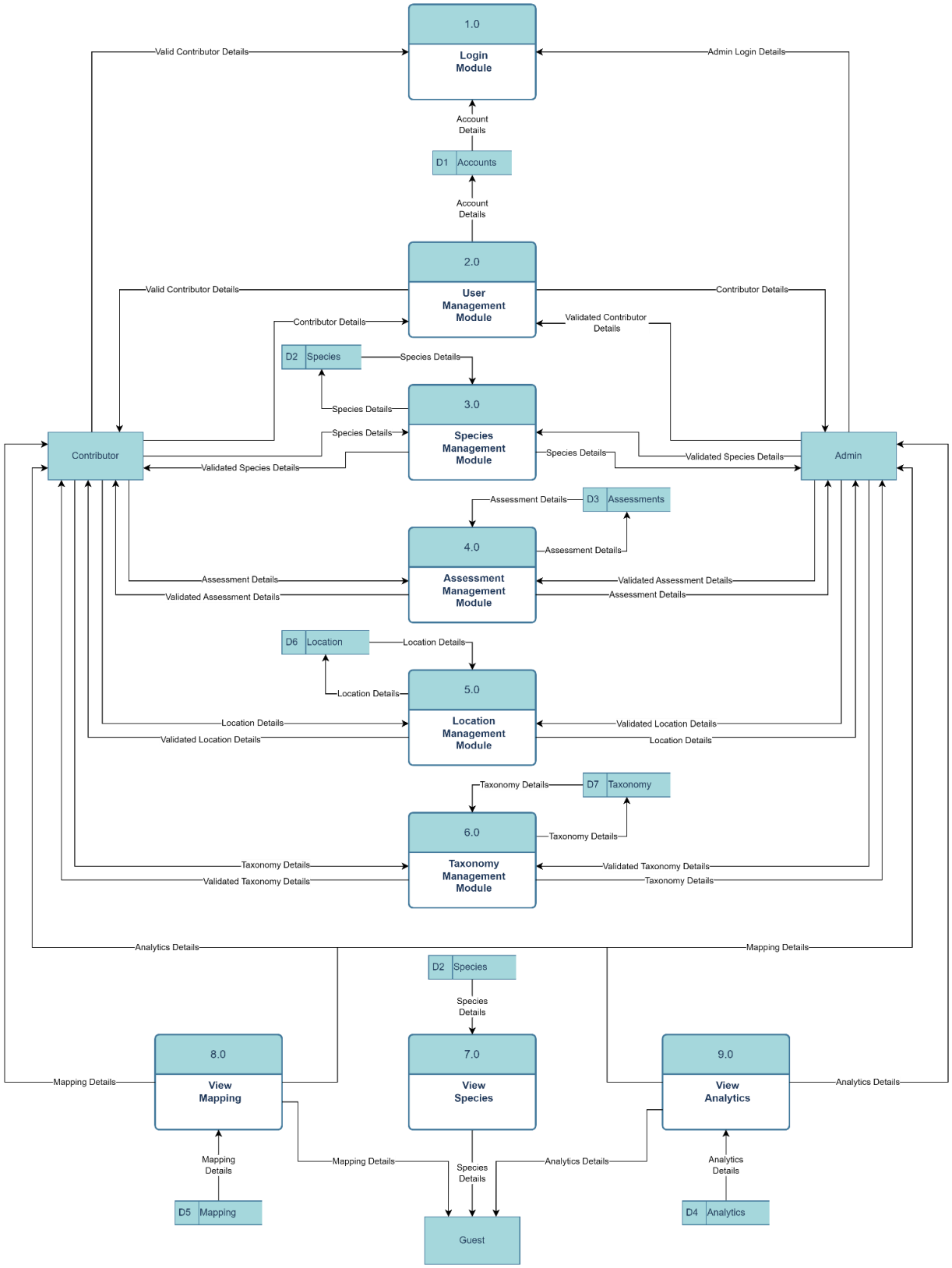


Figure 1.3.2. Level 1 Data Flow Diagram

- **Login Module (1.0)**:
    - This is the entry point for all users. Depending on the credentials entered, the system determines whether the user is an Admin, Contributor, or Guest.
    - Users are granted specific access based on their role, ensuring that data management is appropriately controlled.
- **User Management Module (2.0)**:
    - This module manages user accounts and profiles, including contributors and admins.
    - Admins can validate contributor details and manage user permissions, ensuring only authorized individuals can contribute or edit data.
- **Species Management Module (3.0)**:
    - **Contributor Access**: Contributors add species details related to marine ecosystems such as seagrass, mangroves, and coral reefs.
    - **Admin Access**: Admins validate the species data submitted by contributors and ensure it meets the necessary standards before it becomes part of the system.
- **Assessment Management Module (4.0)**:
    - This module focuses on assessments submitted by contributors concerning the status of marine ecosystems.
    - Admins are responsible for validating these assessments to ensure accurate and actionable insights for ecosystem management.

- **Location Management Module (5.0)**:
    - Locations are critical to mapping marine ecosystems, and this module handles the details related to geographic locations of seagrass, mangroves, and coral reefs.
    - Admins validate the location data, ensuring that it aligns with actual ecosystems.
- **Taxonomy Management Module (6.0)**:
    - Taxonomy details about species are managed here, ensuring a clear classification of the organisms found within the marine ecosystems.
    - Admins validate the taxonomy details provided by contributors.
- **View Species (7.0)**:
    - This section allows all users (admin, contributors, guests) to view species information. Admin and contributors can see more detailed information than guests.
- **View Mapping (8.0)**:
    - **Mapping Details** are available here, providing a geographic view of the marine ecosystems and their locations.
    - The System can visualize where different species and ecosystems are located.
- **View Analytics (9.0)**:
    - The analytics module provides insights based on the validated data. This module helps in tracking trends over time, understanding species distribution, and identifying ecosystem health patterns.

Data Validation Process:

- After data is submitted by contributors (species, location, taxonomy, and assessments), the Admin reviews and validates the information before it becomes part of the system. This ensures accuracy and reliability in the system's data, supporting better decision-making for ecosystem management and conservation

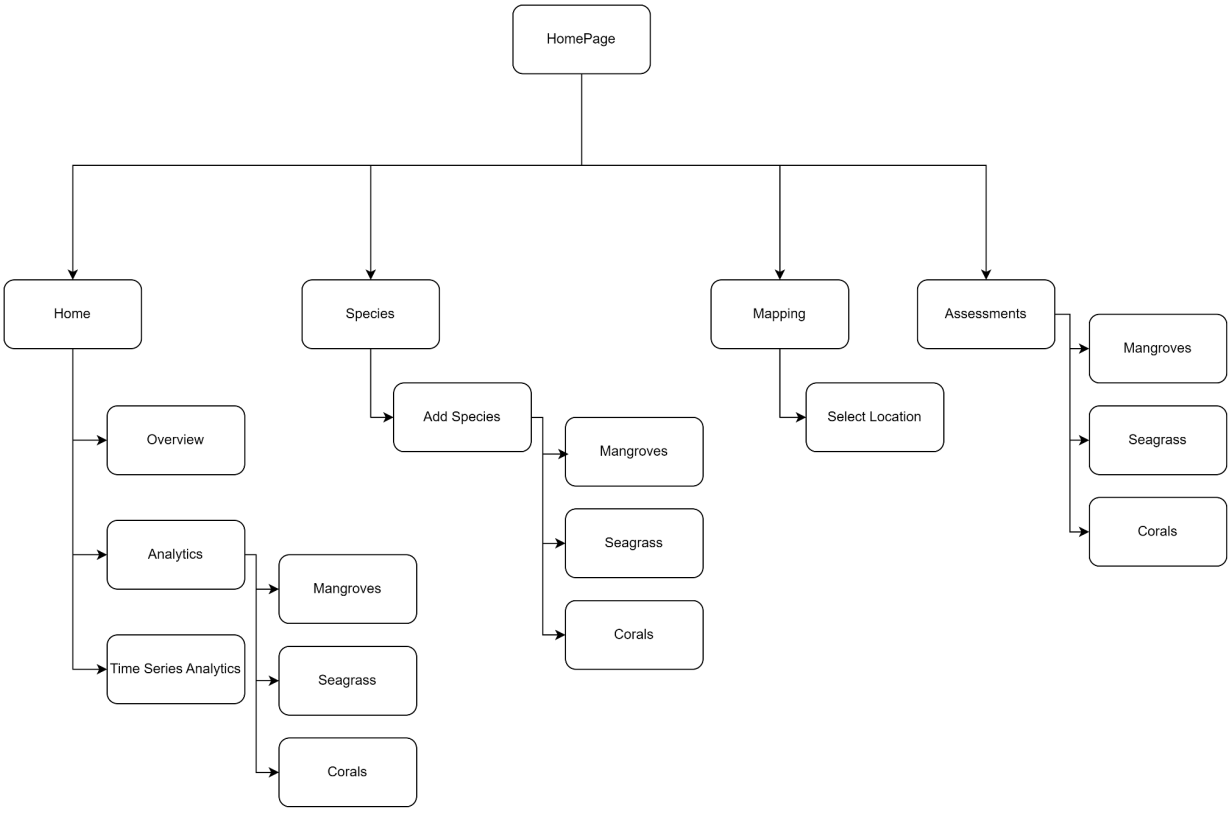


Figure 1.3.3. Sitemap of the Information System for the Assessments of Seagrass, Mangroves and Coral Reefs within the SBPS

The system will be designed to store and manage information about the Marine Coastal Ecosystem particularly Seagrass, Mangroves and Coral Reefs. The general objective of this project is not only for management but also for the integration of analytics. The system aims to collect information about the assessment of Marine Coastal Ecosystems and provide insights to help the monitoring the status and identifying new trends in the context of Marine Coastal ecosystems.

Upon accessing the website, users will land on the **Homepage**, which serves as the central hub for navigation. From here, users can access several key sections of the site, including **Home**, **Species**, **Mapping**, and **Assessments**. Each section offers specific functionalities and information relevant to the conservation and study of marine ecosystems.

The **Home** section includes an **Overview**, providing general information about the project, and an **Analytics** subsection that features various data visualizations. One notable feature of the Analytics section is the **Time Series Analysis**, which allows users to track trends in marine ecosystem data over time, helping in the analysis of long-term changes.

In the **Species** section, users can find a gallery featuring different marine ecosystems such as **Mangroves**, **Seagrass**, and **Coral Reefs**. The gallery is organized by ecosystem, providing classification and images for each species. Additionally, users have the option to contribute to the gallery via the **Add Species** feature, which enables them to submit new species information.

The **Mapping** section is an interactive tool where users can view the distribution of different marine ecosystems, including **Mangroves**, **Seagrass**, and **Coral Reefs**. Users can select specific locations to view the mapped data for these ecosystems. This section helps visualize the geographical spread of these ecosystems, highlighting areas of importance for conservation efforts.

In the **Assessments** section, users can upload assessment data for each of the marine ecosystems—**Mangroves**, **Seagrass**, and **Coral Reefs**. This data is critical for understanding the current state of these ecosystems and making informed decisions about their conservation.

Lastly, the project's scope and limitations are outlined within the site, providing a clear framework for users and developers to understand the website's objectives. This ensures that as the website evolves, it continues to meet its goals of facilitating the study and preservation of marine coastal ecosystems.

1.4 Significance of the project

The Online Information System will document data involving the assessments of the Marine Coastal Ecosystem conducted by the College of Fisheries (COF) students in Mindanao State University (MSU) that will be beneficial for the following:

Student Researchers: This will help them gain valuable insights and a comprehensive understanding of the trends in Marine Coastal Ecosystems, including:

- The fluctuations of species populations over time using time series visualization.
- The distribution of marine coastal ecosystems using proportional mapping tools.

Faculty Members of the College of Fisheries: This will help them to have valuable management and assessing research data.

Future Researchers: This project will serve as a valuable resource for their ongoing and future endeavors as researchers.

College of Fisheries: This project will help them to have an efficient thesis repository about Marine Coastal Ecosystems.

Local Communities: This project will help them gain valuable knowledge about the assessment of Marine Coastal Ecosystems in their area.

Chapter 2

2.0 Review of Related Literature

This section provides an overview of the functionalities, capabilities, and constraints of previously developed work, algorithms, or software that bear relevance or similarities to the project.

A. Related Literature

2.1.1 Marine Online Data Repository Systems

Costello and Berghe (2006), conducted a study entitled: **‘‘Ocean Biodiversity Informatics’: A New Era in marine biology research and Management”**, this study is about the concept of Ocean Biodiversity Informatics (OBI), which involves the use of computer technologies to manage marine biodiversity information comprehensively. The study suggests that the success of Ocean Biodiversity Informatics (OBI) depends on collaborative efforts from various sectors, including governments, science-based organizations, scientists, and publishers. The key to success lies in a collective insistence on online data publication in standard formats that facilitate interoperability; this collaborative approach will signify a cultural shift in marine biology and is in progress.

Pathak et al., (2011), also conducted a study entitled: **‘’A data repository website on marine ornamental fin fishes and shell fishes from Indian waters”.** This study is about the development of an online data repository focused on marine ornamental fin fishes and shellfish found in Indian waters. The repository takes the form of an interactive web database and was created using SQL Server 2008 as the relational database management system, along with an integrated web interface utilizing Microsoft's .NET technology.

Furthermore, Cros et al., (2011), also conducted a study entitled: **''The Coral Triangle Atlas: An Integrated Online Spatial Database System for Improving Coral Reef Management''.** This study describes the development of an online Geographic Information System (GIS) database system hosted by WorldFish. The database is designed to store diverse types of data, including biophysical, ecological, and socio-economic information.

Similarly, Swastai et al., (2011), also conducted a study entitled: **''Coral Reef Management Information System (CRMIS) for the Sustainable Management of Coral Reef in Indonesia''.** This study is about the solutions related to the management of data on coral cover and associated ecosystems in Indonesian marine waters, with a focus on the implementation of the Coral Reef Management Information System (CRMIS) to enhance efficiency and integration in data management processes.

Additionally, Bongaerts et al., (2011), also conducted a study entitled: **''Mesophotic.org: a repository for scientific information on mesophotic ecosystems''.** This study aims to consolidate scientific literature, facilitate data retrieval, and contribute to the advancement of knowledge about the occurrence, composition, and functioning of these deep-sea ecosystems.

These existing online data repository systems serve as a relevant reference point as we strive to enhance and differentiate our Online Data Repository System about the assessments of Marine Coastal Ecosystems.

Moreover, by these existing solutions, we gained insights into technical functionalities, and potential areas for improvement, all of which inform the development of our project.

2.1.2 Significance of Seagrass and Coral Reefs Ecosystems and Challenges

Ort et al., (2006), in An article entitled ‘’ A global crisis for seagrass Ecosystem’’, this article emphasized how important seagrass is and it was recommended that people respond to seagrass crisis by providing an education for the public and resource managers and sanctuaries and protected areas for these marine life.

In addition, Short and Echeverria (2009), conducted a study entitled ‘’Natural and human-induced disturbance of seagrasses’’, this study suggests that anthropogenic activities caused the most serious causes of seagrass habitat loss and also the human population expansion in coastal areas.

Nadiarti1 et al., (2012), this study is about the challenges in ecosystem management in Indonesia. It was revealed that managing seagrass is an essential part in managing fisheries, especially in the nursery stage and it must be included in Integrated Crop Management (ICM) practices.

Moreover, Garcia et al., (2008) also conducted a study about the comprehensive overview of Puertorican Reefs. It was recommended that management and research activities are a crucial part of maintaining a healthy coral reef ecosystem.

B. Related Technologies

2.1.3 Online Data Repository Systems for Marine Coastal Ecosystems/Marine Biology

The Ocean Biogeographic Information System (OBIS) website name ‘’obis.org’’ is an international project that was initiated by the Census of Marine Life (CoML), a global network of researchers that conducted a 10-year scientific initiative to assess and explain the diversity, distribution, and abundance of marine life. Its main goal is to facilitate free and open access to marine biodiversity data to support scientific research, conservation, and sustainable management of marine ecosystems. The primary functions of OBIS are (1) to collect Marine Biodiversity data, (2) Marine Biodiversity data validation, (3) Publication of Marine Biodiversity data making it accessible around the world, (4) Downloading of Marine Biodiversity data.

Furthermore, ‘’fishbase.mnhn.fr’’ is a global database on fish species that provides a wealth of information on taxonomy, distribution, biology, and ecology.

Its main goal is to provide a central, standardized repository of information on finfish species worldwide. It includes (1) Manual inputs for finfish species information, (2) Downloading of Fishbase data, (3) FishBase also offers access to detailed information on a vast number of finfish species, (4) Also offers photographs and illustrations of finfish species

Additionally, ‘’mabida.upmin.edu.ph’’ is a unified information system that will allow users to search, store, and contribute valuable data on marine species that will be valuable in the advancement of biodiversity research in Mindanao. Its goal is to evaluate the diversity of reef fish in the Southern Sea Systems of the Philippines, establish a system for stakeholders to access information, and enhance the capabilities of local stakeholders in conducting marine biodiversity research and utilizing the information system. The primary function of MaBiDa are (1) Input morphological and genetic data of specimen to find a potential match in their database, (2) Online library for Mindanao Fauna and Flora, (3) Tracks the location of documented species

2.1.4 Related Technologies and and Proposed Project Comparison

To further explain and showcase the differences and similarities between the proposed project and chosen technologies, a detailed presentation is provided below.

Table 2. The Ocean Biogeographic Information System (OBIS) Features

Technology Name	Features
The Ocean Biogeographic Information System (OBIS)	1. Allows a comprehensive and global dataset access and contribution on Marine Species Distribution. 2. Offers tools for generating maps that depict the spatial distribution of marine species. 3. Allows users to freely access and use the data for research and educational purposes.

Table 2.1 FishBase Features

Technology Name	Features
FishBase	1. FinBase offers access to detailed information on a vast number of finfish species. 2. Offers photographs and illustrations about finfish species providing a visual presentation of their characteristics.

Table 2.2 Marine Biodiversity Database (MaBiDa)

Technology Name	Features
Marine Biodiversity Database (MaBiDa)	1. Allows users to input morphological and genetic data to find a match in the MaBiDa's database for matching to reduce and eliminate data redundancy. 2. Allows users to explore its library of marine species in

	Mindanao, specifically fish. 3. Allows users to track the documented species using interactive maps.

Table 2. Proposed Project and Chosen Technologies Comparison Assessment

Technology Name	Focus	Strength	Weaknesses
The Ocean Biogeographic Information System (OBIS)	To facilitate open access to marine biodiversity for scientific research, conservation, and management.	It contains multiple functions such as comprehensive data access for marine species distribution and allowing users to generate maps	Such lacks in allowing local/community users to contribute data.
FishBase	Focuses on providing detailed	Contains functions for the	It only focuses on providing

	information about finfish species.	presentation of marine finish species using photographs and illustrations.	information about finfish species and also lacks functionality to allow users to contribute and input data.
MaBiDa	Focuses on taxonomic identification using morphological and genetic data of marine species, specifically fish in the Southern Seas of the Philippines.	Contains multiple functions such as the matching and alignment of marine species, as a database and interactive mapping of documented species.	It prioritizes marine species, specifically fish neglecting other ecological biodiversity.
Proposed Project	It will concentrate on providing a data repository and information	It is personalized and adapted to meet the specific requirements and	

	on Marine Coastal Ecosystems locally.	preferences of individuals within the designated project.	

Table 3. Proposed Project and Chosen Technologies Features Assessment

Features	**Proposed Project**	**OBIS**	**ReefBase**	**FishBase**	**MaBiDa**
Marine Biodiversity Database	✓	✓	✓	✓	✓
Mapping	✓	✓	✓	✗	✓
Monitoring	✗	✗	✓	✗	✗
Data Analytics	✓	✗	✗	✗	✗

Chapter 3

3.0 Project Methodology

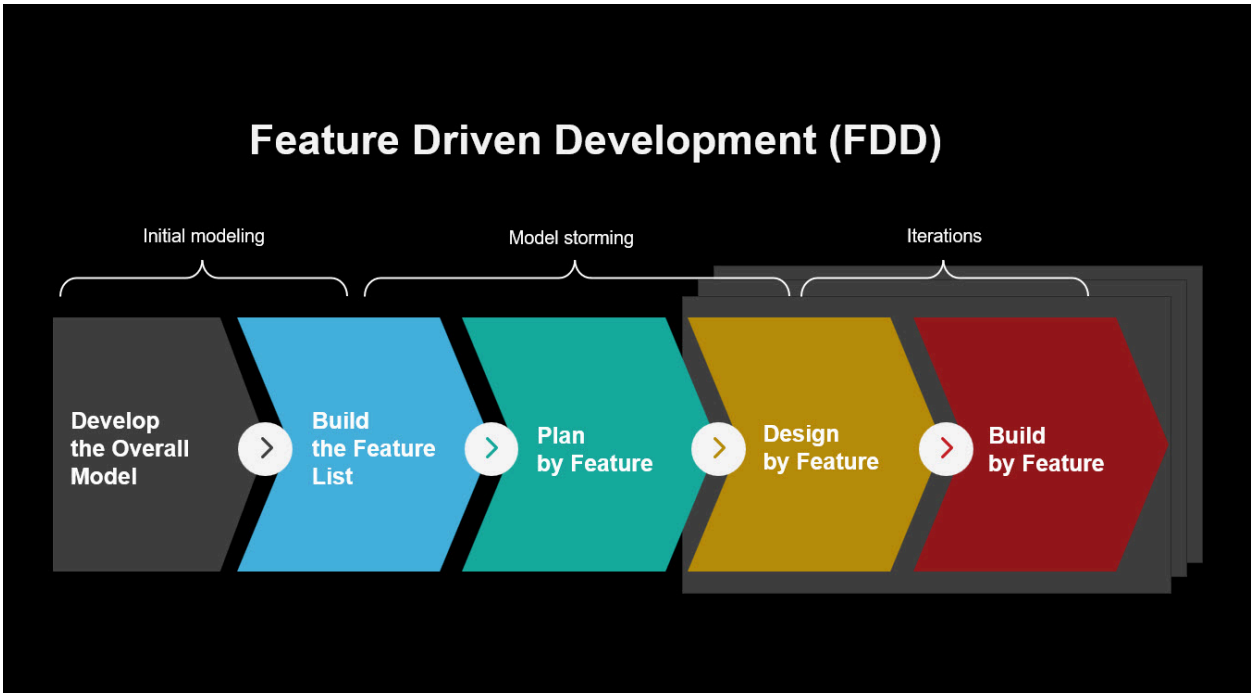
This chapter presents the software development methodology chosen by the proponents and schedules to follow to accomplish the project.

3.1 Project Design

The overall methodology of the project will pursue Feature Driven Development Approach. FDD is customer-centric, iterative, and incremental, with the goal of delivering tangible software results often and efficiently. FDD in Agile encourages status reporting at all levels, which helps to track progress and results. This approach offers

several advantages which includes a five step process that allows a more rapid development, it establishes rules and guidelines which helps the team to work faster and be more efficient. By adopting FDD, projects can benefit from increased visibility and adaptability to changing requirements and allowing a quality software.

Figure 2 Agile Development Model



The Feature Driven Development Approach is composed of 5 phase

					2024			2025					
ID	Phases	Start	Finish	Duration	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	Develop the Overall	10/18/2024	10/28/2024	10d									
2	Build the Feature List	11/04/2024	11/18/2024	14d									
3	Plan by Feature	11/20/2024	11/23/2024	4d									
4	Design by Feature	11/25/2024	11/29/2024	5d									
5	Build by Feature	12/02/2024	06/30/2025	210d									

Figure 3. Phases of Information System for the Seagrass, Mangroves and Corals Reefs within Sarangani Bay Protected Seascapes Gantt Chart

3.2. Develop the overall Model

The Develop the overall Model stage is where the proponents determine the project's goals and objectives. In this phase is where the proponents develop a model such as Diagrams and features that aligns the primary goal of the project.

3.2.2 Feature Sets

Feature Set Name	Features Included	Description	Target Schedule	Responsible Persons
User Management	User Registration	Allows users to register into the system with the required information	October 18 to October 21, 2024	Emmanuel Jaen

	User Authentication	Validates users login credentials		
Taxonomy Management	Classification Management of Species	Allows the Administrator to manage the Classification of species.	October 22 to October 29, 2024	Emmanuel Jaen
Data Collection	Upload Field Observations	Allows user to upload their assessments into the system	October 29 to November 13, 2024	Emmanuel Jaen
View Marine Coastal Ecosystems Details	Display Marine Coastal Ecosystem Details	Allows user to view detailed information about the different types of Marine Coastal Ecosystem	November 14 to January 30, 2025	Emmanuel Jaen
	Validate data	Validates the		

	for consistency	data entered for consistency		
Assessments Analysis	Trend Analysis	It provide insights for the fluctuations of species over time	February 5 to April 10, 2025	Emmauel Jaen
Mapping	Spatial Mapping	Visualize the distribution of species in SBPS	April 12 to June 30, 2025	Emmanuel Jaen

3.3 Build the feature list

In this phase the proponents will determine the project's features by using the information gathered in the first phase.

3.3.1 Detailed Feature Sets

Feature Set Name	Features Included	Description
User Management	User Registration	Allows users to register into the system with the required information such as Name, Email and Password
	User Authentication	Checks the stored credentials in the database for authentication
Taxonomy Management	Classification Management including Species, Local Name, Kingdom, Phylum, Class, Order, Family, and Genus.	Allows the Administrator to manage Species Classification
Data Collection	Upload Field Observations	Allows users to upload their field observations such as the assessments of Seagrass, Mangroves and Coral Reefs
	Validate data for consistency	Validates the data entered for consistency. This will

		ensure a reliable analysis
View Marine Coastal Ecosystems Details	Display Marine Coastal Ecosystem Details	Allows user to view the informations such as the Classifications, Image and Collection Information of the Marine Coastal Ecosystems
Assessments Analysis	Trend Analysis	It provide insights for the fluctuations of species over time using time series as visualization tool
Mapping	Spatial Mapping	Visualize the distribution of species in SBPS using Leafleat.js framework

3.4 Plan by Feature

In this phase, the proponents will start the planning of the task by analyzing the features that were established in the second phase. In this, the proponents will assess the features and plan on which feature will be implemented first.

3.4.1 Priorities and Implementation Steps

Priority	Feature	Description	Steps
High	Upload Field Observations	Allows users to upload their field observations such as the assessments of Seagrass, Mangroves and Coral Reefs	1. Design Upload Interface 2. Work with the backend development including databases and data validation 3. Testing
	Trend Analysis	It provide insights for the fluctuations of species over time	1.Design user interface 2.Develop the backend 3. Testing
Medium	Spatial Mapping	It provide insights for the fluctuations of species over time	1. Design user interface 2. Choose a framework for mapping 3. Develop backend

			4. Testing
	View Marine Coastal Ecosystem Details	Allows user to view the informations such as the Classifications, Image and Collection Information of the Marine Coastal Ecosystems	1. Design User Interface 2. Develop Backend 3. Testing
Low	User registration	Allows users to register into the system with the required information such as Name, Email and Password	1. Design user interface for the login page 2. Develop backend functionalities including authentication 3. Testing
	Classification Management of Species	Allows the Administrator to manage Species	1. Design a database for Taxonomy

		Classification	2. Develop backend functionalities 3. Design User Interface 4.Testing

3.5 Design by feature

In this phase the proponents will determine who will be assigned in different tasks such as in technical designs, designing project's UI and creating the schema and relationships.

3.6 Build by feature

In this phase the proponents will focus on implementing the outlined design by building a prototype. Also, in this phase the system will be tested and analyzed to ensure it meets the specified requirements.

3.8 Project Method

In the overall methodology of the project, the proponents choose Feature Driven Development as it provides a straightforward and yet organized framework for the project's needs.

3.3 Tasks

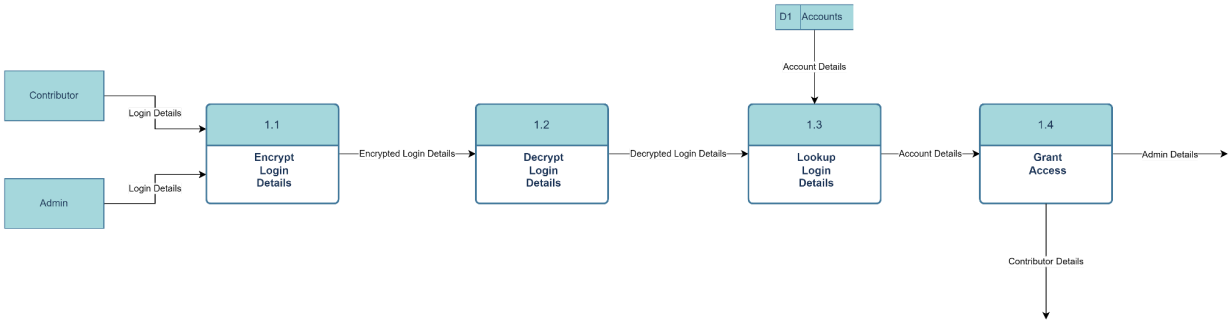
Activities	**Fulfilled by**	**Fulfilled to**	**Deliverables**
Problem Identification	Emmanuel Jaen Emmanuel Freires Loyd Ryan Quita		Capstone Project Topic
Project Feasibility	Emmanuel Jaen Emmanuel Freires Loyd Ryan Quita	Capstone Project Topic	Documentation
Interview with Sir Julz Mingoc from the College of Fisheries	Emmanuel Jaen Emmanuel Freires Loyd Ryan Quita	Sir Jose Trillo	Project Overview
Features Identification	Emmanuel Jaen Loyd Ryan Quita	Capstone Project	Project Features
Readings	Emmanuel Jaen Emmanuel Freires Loyd Ryan Quita	Capstone Project	Documentation
Prototype Design	Emmanuel Jaen Loyd Ryan Quita	Sir Julz Mingoc Sir Jose Trillo	Prototype Design

APPENDIX

DIAGRAMS

Level 2

Login Module Child Diagrams



User Management Module Child Diagrams